Appraisal reports on priority ecological problems in Central Asia

Ashgabat, 2006

Foreword

The core of the United Nations Environment Programme (UNEP) mandate is to monitor, assess and report on global, regional and sub-regional environmental issues. The UNEP programme in Central Asia started in 1999 with support to the development of Central Asian Regional Environment Action Plan (REAP). The REAP is the first strategic sub-regional document that aims at protecting environment for sustainable development in Central Asia. The sub-region is very diverse in its natural endowment varying from glaciers in mountains of Kyrgyzstan and Tajikistan and arid and harsh deserts in Kazakhstan, Turkmenistan and Uzbekistan. Based on this the Plan has identified the following sub-regional issues of common concern: Water Resources Pollution, Waste Management, Degradation of Mountain Ecosystems, Land Degradation and Air Pollution.

The UNEP has been supporting the Central Asian states in addressing these issues by providing technical support through best practices, case studies and pilot initiatives. This report presents the progress made and the state-of-affairs of the mentioned environmental issues in the sub-region and is aimed for decision makers to better address environmental issues of sub-regional concern.

I would like to thank the Governments of the States, our partners such as, the Interstate Sustainable Development Commission, REAP Focal Points, the Scientific Information Center and Centers of Excellence for their efforts in preparing this report.

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Content

Appraisal report on pollution of transboundary waters in Central Asia

Degradation of mountain ecosystems

Regional Appraisal report on industrial and residential waste management

Lands degradation

Atmospheric air pollution in Central Asia countries

Foreword

The observations over the last years point out the fact that a number of ecological problems has come outside the scope of region and taken on a transboundary character. The Governments of the countries have arrived at a conclusion that such issues as air pollution, pollution of transboundary water resources, loss of biodiversity, soil pollution and other sources of pollution should be resolved jointly.

In February 2000 in Teheran, Ministries of Nature Protection Agencies came to an agreement to develop the joint strategy for the use of nature resources to achieve the sustainable development in a subregion. The development of Regional Environmental Action Plan (REAP) became the logical continuation of this meeting and was supported by UNEP.

The Interstate Sustainable Development Commission (ISDC) that includes ministers of environment protection, deputies ministers of economy and finance and representatives of science of CA countries advocate as a coordinating body of REAP process. The Management Committee of Authorized Persons (MCAP) comprising responsible authorized persons (RAP) was established for practical implementation of REAP. The expert and technical support of RAP as well as preparation of the Plan were carried out by the Scientific-Information Center (SIC) of ISDC. REAP considers the following priorities:

Uzbekistan – air pollution;
Kazakhstan – water pollution;
Turkmenistan – lands degradation;
Kyrgyzstan – waste management;
Tajikistan – degradation of mountain ecosystems

The active coordination with national environment protection strategies and plans have become the important aspect of establishment of REAP. The material and technical support for preparation of REAP was rendered by UNEP, UNDP and ADB.

REAP was officially initiated at the Conference of Ministries of Central Asia in September 2001 and approved by ICSD. In 2003 REAP was approved by the Board of International Fund of the Aral Sea as the common sub-regional environmental program.

The presented Appraisal Reports on priority ecological problems in Central Asia are the results of implementation of REAP over the last five years. The analysis, assessment and preparation of reports were carried out by SIC ICSD and Cooperation Centers in all countries and approved at the meeting of the Commission on 23 November 2006 in Ashgabat, Turkmenistan.

Appraisal report on pollution of transboundary waters in Central Asia

Content

Appraisal Report on priority "Water Pollution" has been prepared in accordance with the decision of Interstate Sustainable Development Commission (ISDC) of 02.03.2006, with direct coordination of the activity by FPs and SIC ISDC of Central Asia countries.

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1. Introduction

The hydrographic network of Central Asia has the uneven distribution of water objects. The average long-term resources of river flow along the Syr Darya River basin make approximately 38.8 cubic kilometers per year *(Picture 1)*. On average, over many years, 28.0 cubic kilometers per year (72.2%) form in Kyrgyz Republic, 5.59 cubic kilometers per year (14.4%) in Uzbekistan, 4.08 cubic kilometers per year (10.5%) in Kazakhstan and 1.1 cubic kilometers (0.3%) in Tajikistan.

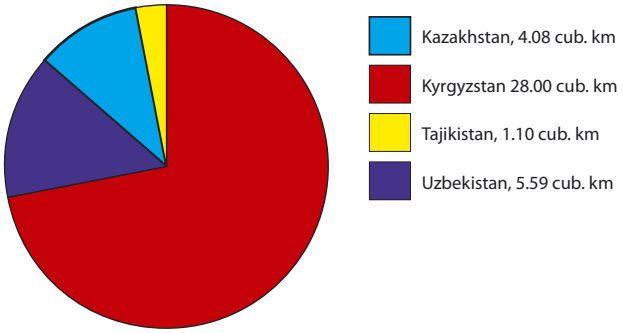
Average long-term resources of river flow in the Amu Darya River basin *(Picture 2)* exceed 78 cubic kilometers per year of which 62.9 cubic kilometers per year (over 80%) form on the territory of Tajikistan, while the share of Uzbekistan is 4.7 cubic kilometers (6%). Practically, all resources of the flow of rivers Shu (Chu), Talas and Asa making 4.1 cubic kilometers *(Picture 3)* form in Kyrgyz Republic (3.1 km^3)

The Central Asia region has considerable stocks of groundwater.

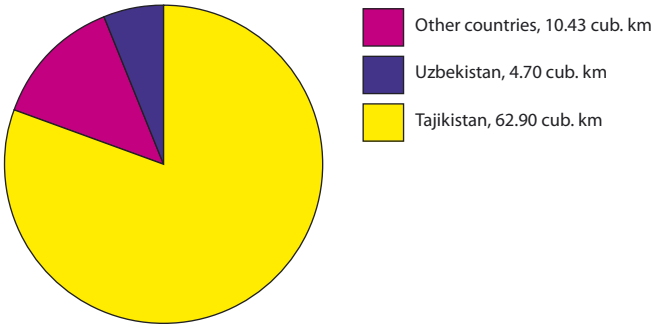
The potential stocks of fresh groundwater of Kyrgyz Republic are estimated as 11 cubic kilometers per year. Usable groundwater resources make 5.3 cubic kilometers per year, of which 2.2 cubic kilometers per year – by industrial categories *(Picture 6)*.

Tajikistan possesses rich stocks of groundwater available almost on all the territory. Over 46 fields have been determined for estimation of stocks. The stocks of groundwater good for technical, industrial and irrigation water supply as well as for drinking equal 1.65 cubic kilometers per year. Projected resources of groundwater in the territory of Republic constitute 6.41 cubic kilometers per year, of which 2.91 cubic kilometers per year are not associated with surface flows.

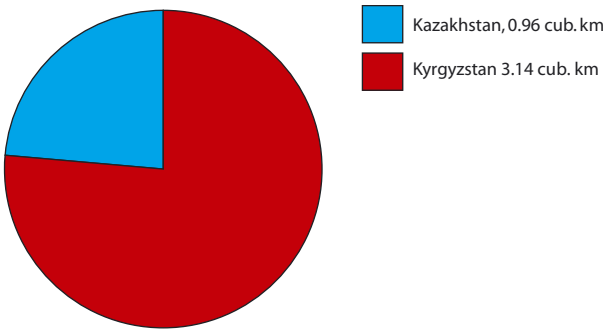
Uzbekistan has 95 fields of groundwater with 8.6 cubic kilometers per year of proved useful water stocks. The main stocks of fresh water are in Ferghana valley, Tashkent, Samarkand, Surhandarya and Kashkadarya areas.



Pic. 1. Average long-term resources of river flow along the Syr Darya River basin (cub.km)



Pic. 2. Average long-term resources of river flow in the Amu Darya River basin (cub. km



Pic. 3. Average long-term resources of river flow in the Shu (Chu) Talas and Asa basins (cub. km)

Pic. 4. Dried up bottom of the Aral Sea

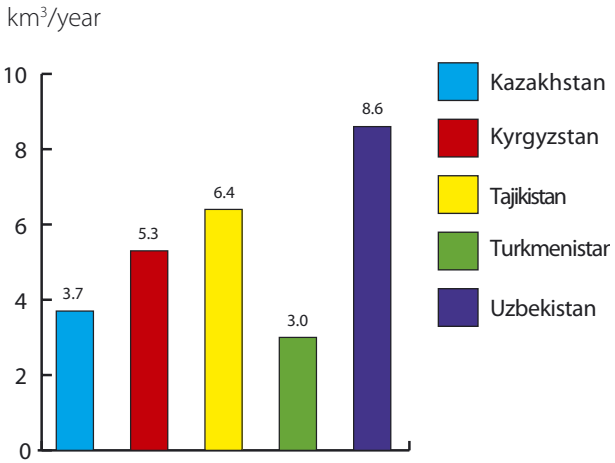
Pic. 5. Dusty storm in the Aral Sea zone, April of 2004

The south areas of Kazakhstan in the Syr Darya, Shu, Talas and Asa rivers basins have 105 groundwater fields with 3.7 cubic kilometers per year of proved reserves.

The total projected groundwater reserves of Turkmenistan are estimated as 3 cubic kilometers per year; however they are dispersed and located at sparsely populated and undeveloped territories.

Since the 1960s, in connection with the wide-ranging land development, extensive development of industry, livestock breeding, urbanization, drainage systems building and using of river water for irrigation, the water quality in river basins of Central Asia countries worsens progressively. This circumstance deteriorates the environmental and ecology-hygienic and sanitary-epidemiological situation, especially in downstream of rivers.

The deficit and pollution of water resources (surface and underground) are the acute problem of Central Asia. The water objects and also groundwater experience the many-sided anthropogenic impact. The main waterways of the region become practically useless for organization of drinking water supply due to the lack of regular supply of fresh water and discharge from irrigated lands of flushing water with excessive mineralization, polluted with pesticides and chemical fertilizers.



Pic.6. The Central Asia region has considerable stocks of groundwater (cub. km/year).

It happens against the background of worsening ecological situation because of the Aral Sea crisis. Over the last 40-45 years, the Aral Sea, to which the main water ways of the region Amu Darya and Syr Darya rivers flow, practically became the "dead" sea, its level reduced more than by 22 meters, the water area decreased more than 3.8 times, the volume of water reduced from 1064 to 115 km^3, the salinity of water reached 72 gram per liter. The area of dried up bottom of the sea amounted to 4.2 million hectares and turned to be the source of carry-over of sand-salt aerosols to the adjacent territories. Annually, 15-75 million tons of dust rise to the atmosphere and move to large distances *(Pictures 4, 5)*.

The decrease of water of river natural flow and increase of the pollution of the sea sharply deteriorated the quality of natural environment and of the living conditions of residents of the Aral Sea zone. The problem of pollution of surface and groundwater of Central Asia, side by side with the deficit of this water, affects the vitally important interests of all countries of this region.

2. Description of the Problem

2.1. Pollution of surface water

The qualitative composition of water resources of the region forms in the zone of flow outset (Tajikistan, Kyrgyzstan) under the impact of natural factors, while in the zone of transit and dispersion of flow (Uzbekistan, Kazakhstan and Turkmenistan) it forms under the impact of anthropogenic factors. The water quality in the rivers where they leave the zone of their forming mainly meets the standard requirements for different ways of water consumption. The water quality deterioration is also connected with discharge of wastes and collector-drainage waters (CDW) directly to the rivers practically without rectification.

2.1.1 Amu Darya River basin

The chemical structure of water of ***Amu Darya*** born from confluence of Pyange and Vahsh rivers is formed to a considerable extent due to availability of contaminants coming to the river with agricultural discharges from the territory of Turkmenistan and Uzbekistan.

Pyange River formed in a result of confluence of Vakhandarya and Pamir rivers is the source of water supply for over 130 thousand hectares of irrigated lands in Tajikistan Republic.

Vahsh is the second by size of flow high water river (after the River Pyange) being under intensive anthropogenic impact such as irrigation of 190 thousand hectares. The water of the Vahsh River is polluted by mineral fertilizers and pesticides, which come from agricultural lands and also by the discharges

from enterprises – water users of Kurgan-Tube water canal and Vahsh nitrogen fertilizer plant (VNFP). Large quantity of salts comes to the Vahsh River as the result of flushing of irrigated lands. The industrial sources of pollution are only in downstream of the Vahsh River, and namely: Yavan town (chlorine) and Sarband town (nitrogen). By the water pollution index (WPI) the water quality of the Vahsh River at all control points meets mainly the requirements of first class (very pure water), while in the river station, after discharges of VNFP- II class (pure water).

Partly, the flow of Surkhandarya River, the right hand tributary of Amu Darya is formed in the territory of Tajikistan. The chemical composition of the river water is associated with the waste discharges from industrial and communal objects of towns Deynau, Termez, settlement Shutchi and with agricultural drainage. By size of water pollution index (WPI) the water quality of Surkhandarya River throughout all its length changes from the II class of pure water to the III class of moderately polluted water.

Zaravshan River is also one of the tributaries of the Amu Darya River, which at present time does not reach with its water the Amu Darya River since this water is completely taken out for irrigation of three regions of Uzbekistan. In the territory of Tajikistan, 21 thousand hectares are irrigated by water of this river. The facilities of the Anzob ore mining plant of Tajikistan located in the zone of flow formation pollute the river by toxic metals, antimony and mercury. The concentration of antimony is found in groundwater (in alignment of Pervomai dam)- 0.001-0.11 milligram per liter, in Chupanat water intake – 0.001-0.008 milligrams per liter (maximum permissible concentration is 0.05 milligram per liter) and other water intakes. The concentration of antimony in the water reduces in downstream direction of the river. In the territory of Uzbekistan the wastewater from industrial enterprises of Samarkand, Katakurgan, Navoi cities and drain waters from agricultural fields come to the river. The water quality in the river lower of Navoi city improved according to WPI from IV class in 2000 to III class of moderately polluted waters in 2001, 2002, 2003 and 2005, while in 2004 it even reached II class – pure water.

The Kafirnigan River is the right hand tributary of Amu Darya, its average annual flow makes 1.3 cubic kilometers. This river in Tajikistan irrigates over 80 thousand hectares. The Varzob River, side by side with Kafirnigan River, is the main source of water supply to the capital city of Tajikistan – Dushanbe. The qualitative state of the Varzob River is good in 65% cases and sometimes satisfactory.

In the middle and lower flows of the Amu Darya River the chemical composition of water changes because of pollution coming from the territory of Turkmenistan and Uzbekistan, mainly in connection with collector-drainage waters (CDW). In Lebap velayat, about 1300 million cubic meters of CDW with 2.5 million tons of mineral salts drain to the river. From the territory of Uzbekistan, through South and Mahankul systems of drainage collectors about 750 million cubic meters of CDW drain to the river.

The water of the Amu Darya River is mainly polluted with nitrates (up to 3 MPC), organic fertilizers (BOC-Biological Oxygen Consumption 5 – up to 1.4 MPC) and phenols (up to 10 MPC). Within the last years, the concentration of chlorine- organic pesticides considerably reduced and at the present time only their traces are found.

In accordance with the value of Water Pollution Index *(Picture 7)*, the water quality of the Amu Darya River at the alignment Termez remains stably at the level of 1996 (II class- pure water), while at other alignments- III class, moderately polluted waters. In separate years the quality worsens till IV class (polluted water).

2.1.2. The Syr Darya River basin

The ***Syr Darya*** River basin consists of many rivers such Naryn, Karadarya, Chirchik, Ahangaran and others, the flows of which are formed in the territory of Kyrgyz Republic, Republic of Uzbekistan and Republic of Tajikistan.

In general, the water resources of the Syr Darya River basin formed in the territory of Kyrgyz Republic have the low level of pollution. All river basins have adequate concentration of oxygen in the water (5-6 milligram per liter) and low concentration of organic and nutritive materials (BOC5- less than 2-3 milligram per liter; nitrates – less than 1 milligram per liter). The riv-

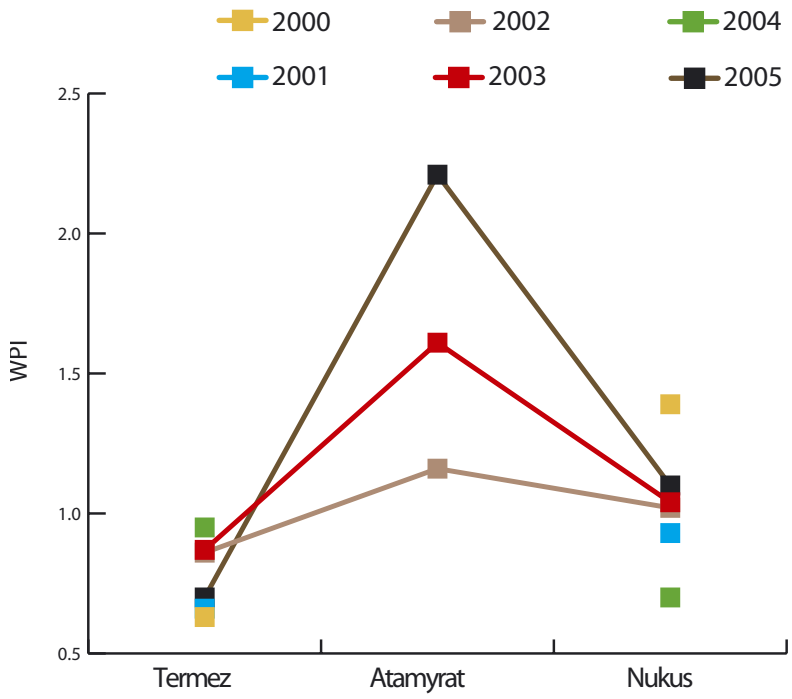
er water is pure especially in upstream (for example, Naryn and other mountain rivers). However, near city, rural and industrial centers the quality of river water worsens. The pollution is marked in the lower section of Kara-Darya and tributaries of Naryn in the Osh and Djalal-Abad region of Kazakhstan. In these places, there was found high concentration of nitrates (over 3 milligram per liter), nitrites (0.7 milligram per liter), oil and fat (0.5 mil-ligram per liter), phenol (over 0.001 milligram per liter). The pollution of surface water from dumps and tailing pits takes place in several areas such as the pollution of the Maili-Suu and Sumsar rivers in Djalal- Abad region.

The river Karadarya comes to the territory of Uzbekistan with the II class quality of water (WPI-1.24). In the territory of this Republic the effluents from Andijan, Assaka, Hanabad cities and also the drainage water releases worsened the quality of water in the middle stream of the river corresponding to III class.

The small water streams of Ferghana valley practically all come to the territory of Uzbekistan of II class quality of water are taken for irrigation.

The waters of the Syr Darya River at the entrance to the Kairakkum water reservoir are characterized as moderately polluted (by mineralization the excess of MPC makes 35-38%, while at the post Akjar this indicator is equal to 1.38 milligram per liter and by concentration of sulfate exceeds MPC by 34%). At the outlet (post Kyzyl-Kishlak) mineralization makes 0.8-1.0 milligram per liter, the concentration of carbonates, nitrates and chlorides is lower of MPC. In other words, the water reservoir is operating as settling basin, it cleans the water, and in Uzbekistan and Kazakhstan this water is cleaner. It should be noted that by results of the latest hydro-chemical analyses and biological testing the water quality in Kairakkum reservoir is steadily satisfactory and sometimes it is good.

By WPI, the water quality of the Syr Darya River in all alignments belongs to III class *(Picture 8)*. The tendency to deterioration of water quality remains along the whole flow of the river. In alignment located over Bekabad city the water quality since 2000 worsened from II class of quality to III class of quality. The greatest degree of water pollution of the Syr Darya River is marked in its downstream (Kazakhstan), where the concentration of copper and sulfate in the water exceed MPC more than Sfold. The tributaries in downstream of the Syr Darya River are polluted to a greater extent. For instance, by WPI (3.31) the water quality of the river Keles belongs to IV class.



Pic. 7. Changing of the value of Water Pollution Index along Amu Darya River, 2000-2004.

In addition to chemical pollution of the Syr Darya River, there is the potential danger of contamination of the river by toxic radioactive wastes through the river Maili-Suu in the territory of Kyrgyzstan having in the river basin the tailing pits and dumps from uranium ores mining.

2.1.3. The Shu (Chu), Talas rivers basins

The qualitative water composition of Shu (Chu) River coming from territory of Kyrgyzstan worsened over the last 10 years. The waters of this river by WPI turned from the category "pure" to "moderately polluted water". In 2005, there was marked the excess of MPC by copper – 4.8, BOC5 – 1.7, nitrite nitrogen – 1.6, phenol – 2.0 and oil products – 1.2 times. The river is used intensively for economic and residential needs and for irrigation that brought about the considerable change of water quality.

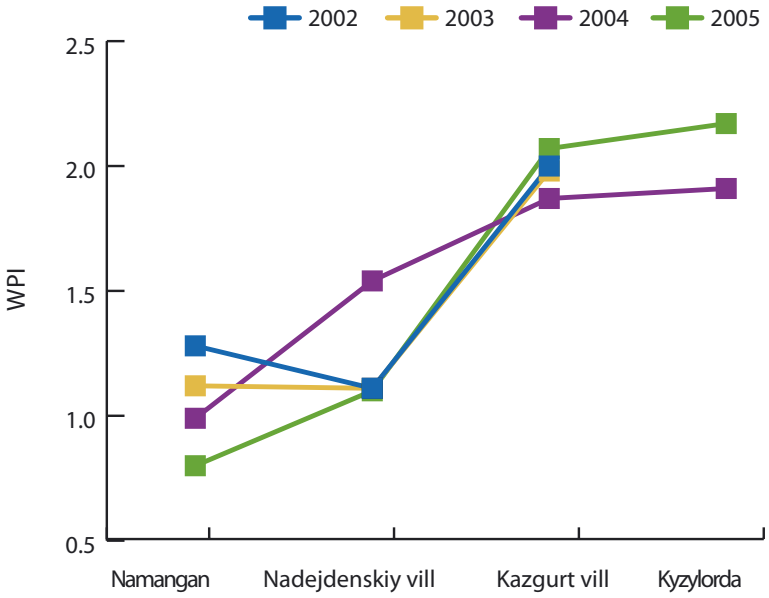
The level of pollution of water in the river Talas reduced by MPC in comparison with 1995 from 1.25 to 0.63. This river still belongs to category "pure" by the qualitative composition of water.

2.2. Pollution of groundwater

In South ***Kazakhstan*** region the pollution of groundwater of Badam-Sairam field still continues. Pollution comes from a number of chemical plants located in the valley of the river Badam. These effluents contain arsenic in a quantity of 10 MPC, phosphor – up to 5 MPC, fluorine – 1.3 MPC, lead – over MPC. In the zone of pollution the Badam-Sairam water intake – the main source of water supply of Shymkent city is located.

Large contamination of groundwater is also connected with chemical enterprises of Jambyl industrial region. Thus, at the section of settlings of the phosphor plant and industrial company "Himprom" the concentration of fluorine in these waters in some places exceeded the standards 3-6 fold. At the fields of filtration in the northeast part of Taraz city the surge of mineralization and the hardness of groundwater were marked; chrome and synthetic surface-active substances appeared in these waters.

The potential industrial sources of pollution of ground-water of ***Tajikistan*** include the tailing pits and different storages of technological wastes, refuses, unorganized landfills of residential wastes. The general reasons of pollution are the lack of impervious screens, drainage ditches, water collectors and absence of monitoring of the state of environment and impact of anthropogenic factors on it. Thus,



Pic.8. Changing of the value of Water Pollution Index along Syr-Darya River, 2002-2005

because of filtration of industrial effluents from tailing pits and waste storages of industrial company "Tajikhimprom", Takob fluor-spar plant, Chorukh-Daryon, Kansai and wastewater release from Anzob ore mining and processing enterprises the mineralization (ion ammonium, nitrates, lead, molybdenum and others) and hardness of surface and groundwater is several times higher of the norm.

There were no any data on pollution of ground water in ***Turkmenistan***.

As a result of impact of technogenic factors, about 35-38 percent of earlier developed fresh groundwater reserves of ***Uzbekistan*** are not good for drinking, and this process exacerbates further. The lenses of fresh groundwater formed along the large streams (Amu Darya River, irrigating canals) used as main sources of water supply of Khorezm region and Karakalpakstan Republic. However, within the last 10-15 years in connection with growing mineralization and hardness of water (the consequences of land irrigation) this water does not respond to standard requirements. The similar situation is in the lowlands of the river Zaravshan. Khorezm and Bukhara regions lost completely their local sources of ground water for drinking water supply. Zaravshan field in Samarkand region, Chirchic and Ahangaran fields in Tashkent region are the endangered ones. Since 1998, in Ferghana region, there was marked the process of contamination of Soh field of fresh groundwater.

After beginning of the development of Burgandy massif of ***Kyrgyz Republic***, the leaching and washout of soluble salts from the zone of aeration takes place. Mineralization of groundwater at the depth of 400 meters increased up to 1-1.5 grams per liter, the total hardness increased to 10-28 mg equiv/liter..

The lack of a common system of groundwater quality monitoring does not allow carry out a fair assessment of actual pollution of transboundary fields of ground-water.

2.3. The sources of pollution

The main pollutants of water resources in the south of ***Kazakhstan*** include the untreated collector-drainage waters from the irrigated fields, the total area of which is about 900 thousand hectares. Thus, the total length of collector-drainage networks of irrigated areas in Kysylorda region reaches 1000 kilometers. However, only three collectors enter the Syr Darya River, the qualitative composition and the volume of wastewater of which are not reported. The volume of release of CDW to water objects within the last years in the South Kazakhstan region made 236-332 million cubic meters per year, in Jambyl region – 3.7 million cubic meters per year.

Only three industrial enterprises in the south of Republic such as the Joint-Stock Company "Himprom", the mineral fertilizer plant (town Taraz), the Joint-Stock Company "Shymkentnefteorgsintez" have their own treatment facilities, while the other large enterprises release effluents to the municipal sewerage. Nearly 640 million cubic meters per year of appropriately treated industrial water is discharged by enterprises of Jambyl region to the surface water objects, filtration fields and pond-evaporators.

Municipal wastewater is not discharged to surface water objects. In Taraz town, the untreated and insufficiently treated effluents immediately, without stor-

Pic. 9. Discharge of effluents to the filtration fields in Taraz town (Kazakhstan)

ing and settling in ponds, are discharged to filtration fields *(Picture 9)*.

As the equipments at treatment plants of Shymkent city is worn out, the schedule of working of the biological purification complex is not fulfilled, the insufficiently treated wastewater is sent into storage and from there to agricultural fields, thus creating the threat of infection for people.

At present time, the untreated production and residential effluents of city Kysylorda are transferred in a volume of 33670 cubic meters per day by pipeline to the existing storages and then discharged to filtration fields.

The irrigation return water is also the main source of surface waters pollution in ***Kyrgyz Republic***. The existing technical condition of irrigation systems and imperfect methods of watering lead to leakage and wastes discharges from irrigated fields, which are saturated by the products of decay of mineral fertilizers and pesticides and are the sources of contamination of surface water objects.

The collector-drainage network of 5.4 thousand kilometers length functions at the irrigated lands of 149.4 thousand hectares in total. Due to the inefficiency of the collector-drainage network, about 8.5 percent of total area of irrigated lands does not respond to amelioration standards by indicators of salinity and excess of permissible levels of groundwater.

In collector-drainage water the sulfate, chlorine and sodium salts prevail. Moreover, its structure includes pesticides, nitrogen and phosphate. The total collector-drainage water release amounts to 2.7 cubic kilometers. Average weighted mineralization of irrigation return waters of collector-drainage system amounts to 1.152 gram per liter.

Considerable pollution of surface and ground waters comes from the objects of livestock – breeding, which have no system of collection, storage and utilization of sewage and are one of the most dangerous sources of pollution of water reservoirs and ground-water fields. As a whole, there is no reliable information on a quantity of release of contaminants from the agriculture activity, either local pollution (cattle-breeding manure) or dispersion (fertilizers and pesticides affecting the quality of river waters).

Over 15 years, the industry of Republic has experienced a hard crisis, which was accompanied by sharp recession of production and later the development of small and medium enterprises. Official statistical data showed the 10fold reducing of water consumption in industry. In this connection the wastewater release reduced too. However, the wastes of ore mining industry cause the serious concern. These are numerous landfills and tailing pits of mining enterprises where radioactive substances, salts of heavy metals, substances containing cyanic are available. They are located, as a rule, in inter-mountain hollows and narrows, valley trains and flood lands of rivers.

The industrial and residential wastes have a considerable adverse impact on the state of water resources. The issues of collection, utilization and burial of wastes are solved extremely unsatisfactorily. The indigested storage of industrial and residential wastes leads to pollution of ground waters.

The system of municipal services (water stations) has 20 rectification plants with the pipe capacity of 719.8 thousand cubic meters per day. Only 28.4% of the population of Republic (in cities, urban settlements and district centers outside the capital city) can use the centralized sewerage with treatment plants.

The worsening of economic situation created serious problems in operation of wastewater treatment facilities. Despite the volume of wastewater coming to treatment facilities decreased 2.5fold, a half of these facilities work ineffectively. The lack of funds for repairing and upgrading of these systems is the reason of inappropriate treatment.

The majority of operating treatment plants provide only mechanical treatment, the efficiency of which is estimated as 55-70%. The treatment enterprises in Djelal-Abad, Osh, Mailuu-Su, Naryn and other cities are in critical state and need urgent reconstruction.

Still the tendency to reduction of treatment facilities quantity remains, which is explained by financial and institutional difficulties. At the same time, the pollution from municipal treatment plants is of local character.

In ***Republic of Tajikistan***, over 90% of surface water pollution is attributed to release of collector-drainage waters from irrigated lands *(Picture 10)*. Due to the traditional technology of furrow irrigation dominating in Tajikistan agriculture and the lack of natural water reservoirs for accumulation of released collector-drainage waters, the surface and groundwater are polluted with nitrogen and phosphorus compounds, pesticides, products of erosion and others.

In the meantime, since the early 1990s, when the new lands development ceased and the areas under irrigation reduced, and also because of low level of functioning of drainage systems, the volumes of saline drain water release diminished.

The notable reduction of financing for maintenance of irrigation systems in comparison with 1990 led to their further degradation and as a result to swamping of lands and as a whole to decline in agricultural production growth. At the same time, the collection of fees for water supply from water users reaches nearly 50-60% only. Even if the payments collection reached 100%, this amount could not cover the costs of irrigation systems exploitation. One of the main reasons here is the low tariff for water supply services – 0.6-1.0 Diram per each 1.0 cubic meter of water or 6-10 Somon per 1000 cubic meters (2-3 USD).

The natural irrigation systems suggest the 50% and pumping stations – the 65% depreciation. In the country the irrigated lands occupy 720 thousand hectares of which 55.6 thousand hectares are in unsatisfactory ameliorative state.

Coefficient of efficiency of irrigated systems in Republic accounts for 55.2%.

Further growth of agricultural production contributes to the risk of increase of negative influence of collector-drainage waters on water objects, since the volume of water resources using in production rose.

The collector-drainage network was constructed on the area of 311.2 thousand hectares for regulation of groundwater level and salt balance.

In the territory of Tajikistan, 4.1 cubic kilometers of irigation return and drain waters form, of which for irrigation about 0.35 cubic kilometers are used, while the rest water is released to the surface water objects.

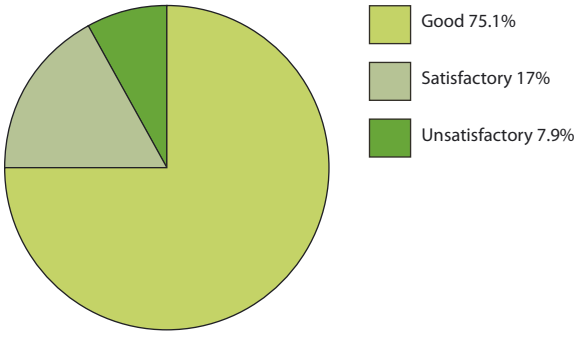
Presently, the fixed assets of irrigation and drainage systems and associated infrastructure suggest the 50% depreciation, and pumping stations – 65%.

The problems of pollution of water objects by agricultural wastewater take place practically in all Republic regions, and they are especially acute in Sogdi and Halton regions. Mineralization of water (the norm is 1000 milligram per liter) in river Syr Darya exceeds the norm 1.2-1.4 times, in the other basins it is 150-700 milligram per liter.

The share of manufacturing industry accounts for 2-2.5% in total volume of released effluents. The pollution of water resources happens mainly in the vicinity of objects of light, chemical and metal mining industries.

Water consumption by all branches of industry has lessened by 11.5% since 1990. The release of effluents has also reduced by 16%. The economic crisis was the reason of decrease of wastewater release from 138.6 million cubic meters in 1990 to 108.2 million cubic meters in 2004. Accordingly, the discharge of unrefined sewage in the country made 2.86 million cubic meters in 2004 and showed reduction by 59% compared to 1990.

The capacities of water recycling and successive water supply make 37.69 million cubic meters, which is 7.2% to the level of 1991. The capacity of treatment



Pic. 10. Melioration condition of irrigated lands,% (Tajikistan)

plants fell from 25.86 million cubic meters in 1991 to 16.43 million cubic meters in 2003.

The discharge of untreated wastewater reduced from 8.35 million cubic meters in 1991 to 6.31 million cubic meters in 2003. The volumes of standard treatment of effluents decreased from 14.86 million cubic meters in 1991 to 6.59 million cubic meters in 2003. The discharge of polluted effluents to surface water objects remained practically at the same level: 1991 – 7.05 million cubic meters, 2003 – 7.29 million cubic meters that proves the inefficiency of excising treatment plants.

The volumes of irrevocable water consumption in the process of using decreased accordingly from 319.6 million cubic meters to 158.23 million cubic meters (reduction by 49.5%).

The potential industrial sources of ground waters pollution also include tailing pits and various storages of technological wastes, refuses, landfills of residential wastes. The main reasons of pollution are the lack of impervious screens, drainage ditches, water reservoirs, the absence of monitoring of environment and impact of anthropogenic factors on it. Thus, because of filtration of industrial effluents from tailing pits and reservoirs of Industrial Company "Tajikhimprom", Takob fluor-spar plant, Choruch-Daryon, Kansay and discharge from Ansob ore mining and processing enterprises the mineralization (ion ammonium, nitrates, lead, molybdenum and others) and hardness of surface and ground water is several times higher.

Still there is a tendency of adverse impact on the water objects due to the economic growth and because of insufficiency of treatment facilities capacities and investments.

The water consumption by communal sector fell by 21%, while total reduction of discharge of wastewater fell by 34%.

The factual capacity of sewage treatment plants in Republic is 87.08 million cubic meters per year, as it reduced since 1990 by 158.82 million cubic meters. The access of the population of Republic to sewerage is 23%, of which 89% are the residents of cities and 10.1% – towns and district centers. The efficiency of sewage treatment plants does not exceed 40%.

The release of residential wastewater reduced from 260.7 million cubic meters in 1990 to 172.7million cubic meters in 2000. The discharge without purification amounted in 1990 to 2.36 million cubic meters, and it stopped since 1993. The sewages refined insufficiently are also discharged in less volume, from 88 million cubic meters in 1990 to 19.9 million cubic meters in 2000. The volume of release of standard pure water without treatment increased from 0.06 million cubic meters in 1990 to 0.2 million cubic meters in 2000.

The main portion of discharged residential wastewater is referred to standard treated waters, the volumes of which reduced from 169.3 million cubic meters in 1990 to 152.6 million cubic meters to 2000, and it is the indicator of reduction of effectiveness and stopping of operation of some part of treatment plants.

There are no any data on ***Turkmenistan.***

In ***Republic of Uzbekistan*** the danger is in carrying out of mineral fertilizers and pesticides by irrigation water from agricultural fields and also in coming of polluted wastewater from life-stock breeding complexes into surface and groundwater. The largest pollution by collector-drainage waters happens in downstream areas of small rivers and rivers Syr Darya and Amu Darya.

Sampling surveys showed that by total quantity of discharged toxic substances the largest contribution to pollution comes from Kashkadarya, Ferghana and Khorezm regions.

However, it is not easy to judge about the CDW quality as a whole, since the systematic observations are performed selectively and mainly with regards to mineralization. Out of total CDW sink the drainage to river made 10365.75 million cubic meters (49%) in 2002, 11062.41 million cubic meters (46%) in 2003, 10854.64 million cubic meters (46%) in 2004. For irrigation purposes there were used 3% of total drainage water, mainly in Samarkand, Tashkent, Syrdarya, Andijan, Namangan, Djizak, Ferghana and Navoi regions. Nearly 50% of CDW were diverted outside the regions.

Since 1990, there is a tendency of reduction of polluted industrial wastes releases. The main reasons

of this tendency are the work of enterprises with incomplete capacity and also the work of nature conservation agencies. The volume of standard treated effluents from industrial enterprises in 2004 reached 922.3 million cubic meters (1053.0 million cubic meters in 2003). The volume of discharge of polluted wastewater to surface water objects made 146.1 million cubic meters in 2004, i.e. in comparison with 2003 (140.9) they reduced by 5.2 million cubic meters. The water volume used in water recycling showed 4130.16 million cubic meters in 2003, 3971.3 million cubic meters in 2004. The decrease of water recycling volume is connected with production recession at some enterprises of industrial sector of the economy.

The residents (those who have no access to sewerage system) often discharge excrements and residential wastewater in aryk and collector-drainage network or to reservoirs, thus providing impact on the quality of ground waters. The wastewater from sewerage is diverted through communal treatment plants to water objects and sands. Inefficiency of majority of 48 treatment plants and their overloading cause insufficient wastewater treatment and pollution of environment.

The total volume of discharged wastewater across Republic includes 78% of polluted waters from irrigated agriculture, 18% from industry and 4% from communal services sector.Thus, the agriculture is the main pollutant in this regard.

Conclusions

The anthropogenic pollution of water resources in Central Asia may be identified as follows:

- pollution as a result of agricultural activity;
- pollution as a result of industrial activity;
- pollution from residential sector in urban and rural areas.

The main contribution to pollution of water resources falls to collector-drainage water, then to effluents from industrial enterprises and finally to municipal waste-water.

2.4. Drinking water supplies to the public and access to sanitation.

2.4.1. Kazakhstan

In 2004, the urban population of three southern regions of Kazakhstan totaling 1611 thousand people lived in 15 towns and 35 settlements. 14 towns and 27 settlements had central water supply systems. Most of the urban population in Jambyl region (up to 98.9%) used good quality water from underground reservoirs. In such towns as Kyzylorda, Aralsk, Saryagash, Shardara and Lenger drinking water was pumped from surface water sources and the quality of water in the central water supply systems did not meet the requirements. In those settlements where local authorities used only groundwater, citizens were provided with drinking water of good quality. Wear and tear of equipment of central water supply systems in towns and settlements was at the level of 40-80%, while in Saryagysh town and in three settlements of Jambyl region this figure reached 100% *(Table 1)*.

In rural areas the situation with good quality water supply is much worse. Only 32.6% of rural population had access to central water supply systems. 512 villages out of 1508 central water supply systems. In most cases the quality of tap water supplied from the surface water sources does not meet the requirements.

Availability of sanitation was limited even in regional centers only 54-65% of the population used central sewerage systems while in rural areas and in small towns of southern regions of Kazakhstan such systems do not exist.

2.4.2. Kyrgyzstan

The share of the population with the access to sanitation in Republic is 25.6%. Most of small towns and regional centers in Kyrgyzstan do not have central sewerage systems and systems for sewage treatment.

Central water supply systems are available for 81% of the population. Average water consumption per capita equals 97.5 l/person, while consumption of running water is 91 l/person.

In recent years the situation with good quality water supply in Republic has become tense.

Most of equipment of water wells, rectification and disinfecting plants of water supply systems is depreciated at full extent.

This problem relates to the general economic crisis in Republic, change of the forms of ownership of water supply plants, price increase on power supply, lack of financial support for rural water supply systems and collapse of rural service systems for water supply.

Poor storage, treatment and utilization of industrial and residential waste as well as bad quality of agriculture resulted in water pollution of surface and ground water reservoirs in Republic. Over the last few years sanitary situation with water reservoirs used both for running water and recreation remained unsatisfactory: share of "non-standard" samples due to sanitary-chemical indicators 4.6% - 7.3%, microbio-

Table 1. Percentage of water samples of drinking water that do not meet sanitary-chemical requirements,

Regions of Kazakhstan	2000	2001	2002	2003	2004
Jambyl region	0.97	2.3	1.7	0.8	0.5
Kyzylorda region	25.4	29.5	23.3	15.4	14.9
Southern Kazakhstan region	6.2	2.6	1.7	3.3	2.5

logical norms – 15.6%- 29.4%. The quality of water continues to deteriorate.

Actions undertaken by local authorities to improve the quality of drinking water supplied to the public are mostly not efficient, do not reach the set targets and do not contribute to the strengthening of the economic situation of the running water supply companies. The companies of running water supply are in a difficult financial situation that prevents them from covering major expenses to support working systems. Their material and technical supply is very poor. They are short of spare parts, equipment, fittings, disinfectant agents, etc. Insolvency of consumers worsens the situation.

Physical depreciation of municipal water supply systems makes 70%. 40% of rural water supply systems are damaged to a critical extent that causes breakdowns and contamination of drinking water with microbiological and chemical agents *(Picture 11)*.

2.4.3. Tajikistan

Access to drinking water in Republic is available for 4.01 million people, or 59% of the population. In towns and large settlements this figure reaches 93%, while in rural areas it is only 49%. Out of 62 towns, regional centers and large settlements 52 have central water supply systems and only 32 have central sewerage systems.

Out of 1.75 million of urban population 1.5 million (87%) use central water supply systems while in rural areas only 20% of the population use them. About 30% of total water supplies are not functioning, only 60% of total population use tap water, 40% use water from rivers, canals, small irrigation systems and other sources, sanitary situation of which is rather poor *(Picture 12)*.

Companies responsible for water supply and sewerage systems fail to maintain them properly due to the delay in payments for their services. Collapse of the unified municipal system, decentralization, and unstable functioning as well as institutional and economic reforms were the major factors that worsened municipal system.

The total infrastructure of water supply and sewerage systems is worn for more than 70% and is due to the urgent reconstruction and rehabilitation.

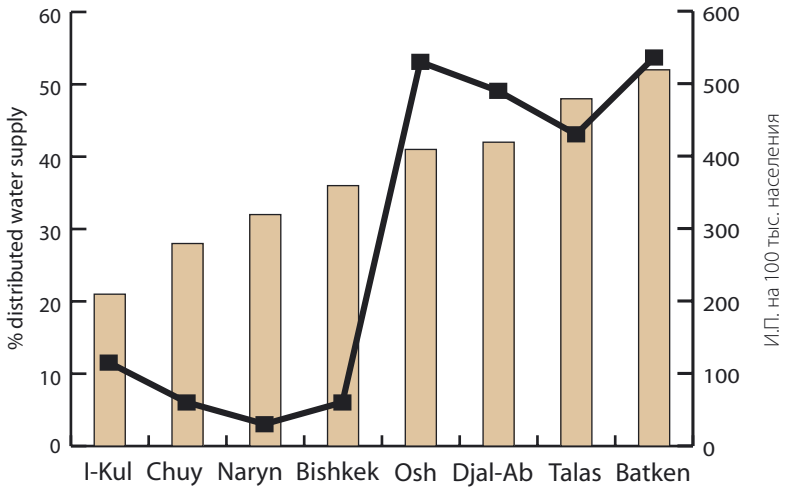
At present, government statistical reports provided by municipal companies in accordance with the established forms of state statistical reporting do not include information on the number of people having access to central water supply and sewerage systems.

WB Project "Achievement of Millennium Development Goals related to water supply and drainage systems fulfilled in 2005 examined indicators of water supply and drainage systems in Tajikistan. They examined the following indicators: access of the population to the central water supply and duration of systematic water supply. Consolidated data proved that 62% of the total population of Tajikistan had access to the central water supply systems. Among urban population this figure reached 90%, as for the rural areas – every other citizen used central water supply systems."

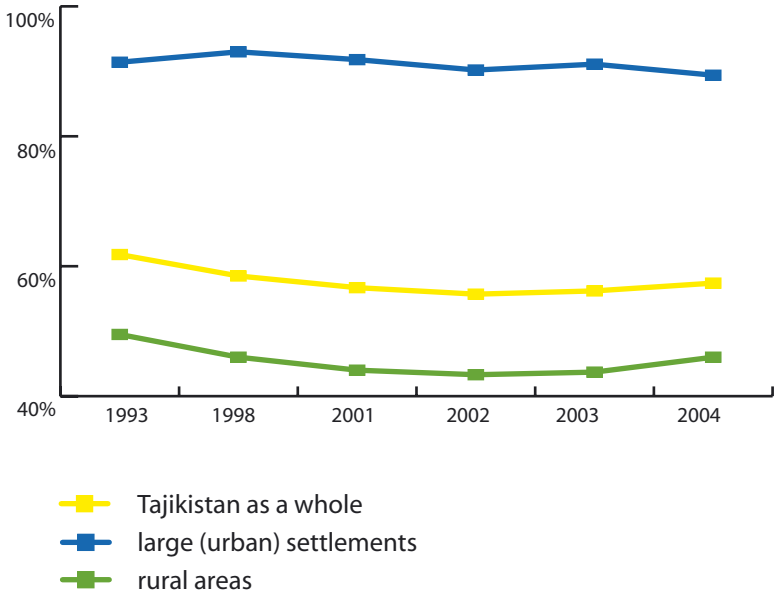
By 1998, this indicator fell to 60% due to the complete depreciation of the part of urban and rural water supplies. 93% of the urban population used running water and only 46% of rural people had access to running water. By 2002, the indicator fell down to 56%. 91% of urban and 43% of rural population had access to running water. By the end of 2004 57.4% of the total population received municipal services, of which 89.4% of the urban and 46% of the rural population.

Distance to the source of water plays an important role in the availability of water supply. There is no official statistics on this indicator. As at 2000, 43% of the public had sources of water in their houses; 5% lived at the distance of 5 meters from sources of water; 18% lived at the distance of 5-100 meters from sources of water and one third of the public lived at the distance of more than 100 meters from sources of water.

The level of drainage services was much lower than that of water supply. Only 23% of the total population used sewage systems. In urban areas every other citizen had access to this service, while in rural re-



Pic. 11. Correlation of infectious diseases with drinking water supply in the regions of Kyrgyzstan.



Pic. 12. Population covered with drinking water supply services in Tajikistan

Table 2

	2002	2003	2004
Number of samples that do not meet chemical requirements,%	16.3	15.9	16.3
Number of samples that do not meet bacteriological require-ments,%	5.1	5.2	5.5

gions sewage services were provided to only 10.1% of the population.

2.4.4. Turkmenistan

Out of total volume of water used for municipal water supply 20% comes from surface and 80% comes from groundwater. Consumption of water per capita increases. Percentage of water consumption per one person ranges as follows: in towns – 160 l/day; in large settlements – 57 l/day; in rural areas – 34 l/day. Nevertheless, only 85% of town-dwellers and 24% of countrymen use central water supply.

2.4.5. Uzbekistan

In 2000, about 77% of the public had access to central water supply. The quality of running water did not often meet chemical and bacteriological requirements in 2002 – 2004 *(Table 2)*.

For the improvement of sanitary conditions for the public and in order to prevent severe intestinal infection spreading the first and foremost task should be decontamination of sanitary waste and residential sewage. Sewage pollutes water sources and worsens the problem of drinking water supply for the public since less than 40% of sewage are rectified systematically.

3. Indicators of the problem under assessment

3.1. Indicators of impact

The following information is suggested as indicators of impact: the volume of annual surface and groundwat-er intake, wastewater release and annual water consumption, in cubic km. *(Annex 1-3)*.

Since 2001, the volume of annual water intake in the region has been increasing rapidly. At present this figure exceeds total average long-term river runoff in the Amu Darya and Syr Darya rivers. Only in Kyrgyzstan there seemed to be a tendency for the decrease in water intake. Uzbekistan uses almost half of the total volume of water intake.

Economic development of Central Asia countries resulted in the increase of annual water consumption. Only Kyrgyzstan reports on decrease in water consumption.

The volume of wastewater is also increasing. Up to 70% of wastewater is in Uzbekistan. Accurate data from Kazakhstan are not available because CDW flowing to water reservoirs is not taken into consideration.

In addition the ratio of water consumption by all branches of the economy to the volumes of water intake from natural water sources may serve as a consolidated index of the efficiency of water resources using. In 2004-2005, this index for Kyrgyzstan was 0.57, for Tajikistan – 0.74, for Kazakhstan (within Syr Darya, Shy and Talas rivers basins)- 0.59, for Uzbekistan- 0.91 and for Turkmenistan – 0.75. Since 1991, the efficiency of water resources using in Central Asia region has been going down. For instance in Kyrgyzstan in 2005 water leakage during transportation reached 1781 million cubic meters or 22.6% of total water intake. Total water losses in the country

were assessed at 2.5 cubic km/year. Water losses in other Central Asia countries were also large and estimated at the level of 3-6.5 cubic km/year. Up to 90% of unproductive water losses originated in the irrigation systems due to their unsatisfactory condition.

3.2. Indicators of quality

Three indices *(Appendixes 4-6)* may serve as indicators of quality: water consumption per capita (cubic meters/year), share of the population using running water (%), share of the population using sewerage systems (%). Index of water pollution in main transboundary rivers may also serve as an indicator of water quality in water sources *(Appendix 7)*.

Economic recession in Central Asian countries entailed decline in living standards that include water consumption per capita and share of population with the access to drinking water and sanitation. This tendency still exists only in Kyrgyzstan. In other Central Asia countries the governments undertook specific actions and managed to stabilize the situation. Moreover, there appeared the tendency for the improvement of the situation with living standards. These indexes characterize risks to the public health in the region.

Water pollution index allows get the dynamics of alterations in watercourse pollution including changes within certain periods in every reservoir under control.

3.3. Indicators of reciprocal actions

Within the last ten years wastewater release has been reducing *(Appendix 8)*, while the total volume of wastewater is increasing.

4. National policies and strategies pursued in Central Asia countries on solving the problems of pollution of transboundary waters

4.1. Kazakhstan

To solve the existing problems the Government of Kazakhstan approved ***"Conception for the development of water sector in the economy and water utilization policy in Kazakhstan until 2010"***. The Conception determined the guidelines for efficient use and preservation of water resources. The country also adopted ***"Water Code of Republic of Kazakhstan"***, the Law ***"On rural consumer cooperatives of water users"***, signed and ratified Convention on protection of transboundary rivers and international lakes.

The Government approved ***"Drinking Water"*** program for the stable supply of good quality water to the population in necessary volumes. In 2002-2003 the country spent 33.2 billion Tenge for this purpose. At present, there are four water supplies under construction for total amount of 970.3million Tenge (US$7.58million), they are: Aralo-Sarybulakskiy, Octyabrskiy, Jidelinskiy and Kentauskiy water supplies. In 2006-2010 the country intends to allocate 39.29 billion Tenge (about US$307million) for the implementation of this program. By 2010, they will connect 75-84% of the population of three regions situated along the rivers of Syr Darya, Shu, Talas and Asa to central water supply.

The station for biological rectification of sewage in Kyzylorda with capacity of 70 thousand cubic meters /day and a complex of pump sewage stations costing 2631.7 million Tenge (US$ 20.6million) is under construction *(Picture 13)*.

The national program ***"Environment protection in Kazakhstan for 2005 – 2007"*** stipulates the development of comprehensive ecological monitoring of groun-dwater on the basis of GIS-technologies. This will allow create a scientific system of groundwater management in the regions, set new hydrologic and hydro-chemical stations and reequip the systems for monitoring of environment pollution.

In order to stabilize the ecological situation in the middle and lower courses of the Syr Darya River the country implements the project on increasing the capacity of Syr-Darya river-bed and on regulating hydro-meteorological and ecological regime of the Small Aral Sea. There was erected the Karakalskaya dam with the complex of culverts separating the Small Aral from the Large Sea. This will allow stabilize the sea level at 39-42 m, water mineralization within 4-17 g/l and reduce wastewater release to Arnasayskaya cavity from 3 to 1 cubic meters *(Picture 14)*. This project will contribute to the enhancement of both the Kazakh part of the Aral region and the whole basin of the Aral Sea and to revive biodiversity and fishing. At present, water level of Syr-Darya River is increasing. In 2005, more than 9 cubic km. of water was released to the Syr Darya River.

Other technological and ecological actions in Aral region are undertaken in line with the ***"Program on complex solution of Aral Sea zone problems in 2004 – 2006".***

Nowadays, Kazakhstan participates in all the projects related to rehabilitation of the Aral Sea zone and in the projects connected with the activity of ICWC, IFAS and the others. Since 1998, Kazakhstan is an active member of the GEF-supported project "Water resources and environment management". In 2001, the country started to participate in "Rational and efficient use of water and energy resources in Central Asia Region SPEKA Project" and others.

4.2. Kyrgyzstan

Since 2001, the country has adopted a number of laws, among which the law ***"On the interstate use of water resources and related plants and stations in Kyrgyz Republic"***, Water Code. There was established the National Water Council of Kyrgyz Republic.

Kyrgyzstan has already implemented a number of international and local projects on water resources management:

- 2002 – 2003. TACIS project "Political instruments related to the water sector of the economy". The project outlined recommendations for Kyrgyzstan in its transition to the new standards of water quality;
- 2003 – 2004. Together with Kazakhstan and with the support of the UN European Commission the project on "Using of water resources in Chu-Talass river basin" was implemented. The Interstate Commission was established;
- 2001 – 2006. the second phase of Finnish project on "On environment monitoring and strengthening of management capacity " that covered the southern part of Kyrgyz region and Chuysk region was implemented. The project rendered technical support to the agencies conducting monitoring of nature in the regions (Oshskaya, Jalal-Abadskaya and Chuyskaya oblasti);
- since 2001 Kyrgyz State Agency on nature protection and forestry together with Jambyl regional agency on nature protection has conducted monitoring of the Chu River.

A number of projects relate to the access of Kyrgyz population to clean drinking water.

- 2002 – 2007. Asian Development Bank extended a US$36 million loan (co-financing with Kyrgyz Government amounts US$9 million) to implement the project on "Rendering infrastructure services in human settlements for rehabilitation and construction of water supplies in 730 villages and 7 towns of Chuyskaya, Oshskaya, Jalalabatskaya and Batkentskaya regions."

Pic. 13 Construction site of station for biological rectification in Kyzylorda (Kazakhstan)

Pic. 14. Hydro-technical complex on Kokaralskaya dam in the Small Aral (Kazakhstan)

- 2002 – 2007. World Bank extended a US$ 24.5 million loan for the project "Rural water supply and sanitation". The project aims to rehabilitate and construct rural water supplies in 270 villages of Issyk-kul, Naryn and Talas regions.

There were implemented some projects in irrigation with the purpose to improve the irrigation systems. This improvement would reduce river pollution by irrigated waters and losses during transportation:

- 2001. The water resources and salinity management implemented at national and regional levels.
- UNEP program "Acceleration of the implementation of IWM-2005 in Central Asia".
- 2006. World Bank launched its project "Improvement of water resources management"

4.3. Tajikistan

The country undertook certain actions for the protection and efficient use of water resources.

- The Government of Tajikistan issued a regulation № 236 dated 2 July 2005 that stipulates the improvement of lands until the year 2009 on the area of 55.51 thousand hectares. The amount of US$12.149 was allocated for this program. This project is a priority, and it will be financed by government and local budgets and for account of water users.
- 2001. The Conception on efficient use and protection of water resources in Tajikistan was approved;
- 2002. The Research institute of water problems, hydropower and ecology was established at the Academy of Sciences of Republic;
- The annual forecasts for economic and social development of Tajikistan provide for indicators on the improvement of technical conditions of irrigation and drainage systems;
- Centers on rehabilitation of irrigation systems in the pilot regions are established under the loans of Asian Development Bank and World Bank;
- More than 23 thousand rural associations of water users are set up on the basis of peasant, farmers' and other rural economic units for better maintenance and utilization of their irrigation systems;
- For rehabilitation of drainage systems the tariff system of the collection of payments for water usage is under improvement now;

- The government support of pilot projects on rehabilitation of infrastructure in water sector is increased from central and local budgets;
- Since March 2006 the Japanese International Cooperation Agency (JICA) has been doing researches on prevention of natural disasters on the river Pyandj;
- The National action plan on the hygiene of environment and the National program ***"Clean water and sanitation in Tajikistan"*** are adopted providing for gradual rehabilitate of existing purifying stations, completion of those under construction and erection of new ones *(Picture 15)*;
- "Water supply to Dushanbe" project provides for the Program of management and monitoring of environment;
- The government regulation № 616 dated 30 December 2001 approved the program for joint management of water and power resources in the basin of the Syr Darya River.
- National development strategy for the period until 2015 is now under consideration. The strategy includes such important sectors as ***"Water supply and sanitation"*** and ***"Ecological stability"*** that were developed on the basis of the document ***"Millennium Development Goals"***;
- with the support of World Bank the following is implemented: "Project on the development of municipal infrastructure (rehabilitation of water supplies, sewerage systems and disposal of solid residential wastes) in 8 towns of Tajikistan (Vakhdat, Garm, Dangara, Vose, Kulyab, Kurgan-Tyube, Istaravshan, Kanibadam); "Project on management of water resources in Fergana valley" that envisages rehabilitation of the irrigation system in the valley, improvement of the state of irrigated lands in Kanibadam, Bobojan and Gafurov regions and in the area of Kayrakkum water pond (grants for US$ 15 and 14.7million respectively);
- With the support of Japan Government (grant US$ 9.5 million) the project "Drinking water to the residents of Mir Said Alii Hamadoni region" is implemented.

4.4. Turkmenistan

The National strategy and policy of Turkmenistan in the field of nature protection is defined in the ***"National Program of economic, political and cultural development of the country until 2020"*** and in the National Environmental Action Plan of President of Turkmenistan Saparmurat Turkmenbashi (NEAP). The latter stipulates improvement of ecosystem in the country, prevention of ecological deterioration, stable functioning of ecosystem and reduction of negative impact of ecological factors on the health of the nation.

NEAP also stipulates a number of legal and institutional arrangements related to water resources protection:

1. Water Code of Turkmenistan was developed and on 01.11.2004 put in force (new version).
2. The agriculture started to grow less moisture holding plants with shorter vegetative period, such as mash, sesame, sugar beet and special type of cotton.
3. The interstate agreement on water quality management of the Amu Darya River is under preparation. The agreement will prohibit release of drainage water, manufacturing water and sewage to Amu Darya.
4. The possibility for Turkmenistan to join the Convention on protection and using of transboundary watercourses and international lakes is under consideration.
5. Regulations on protected territories, Amu Darya banks and other large water reservoirs are under preparation.
6. Biological methods for cleaning the manifolds are widely spread now. This method allows save money for the maintenance of drainage systems and increase fish production in water reservoirs

NEAP pays much attention to the improvement of water supply to the public, especially in rural areas, water quality and efficient water consumption and to the creation of favorable irrigation and sanitary conditions.

- In 2005, a complex of water engineering units on "Dostluk" reservoir (Tejen River) in Mary was put into operation. The construction was fulfilled together with the Islamic Republic of

Iran. This reservoir contains 12-50 million cubic meters of water;
- The country is introducing the system of drip irrigation of perennial plants on the foothills of the Kopet-Dag Mountains in Akhal velayat (region). The system covers 20 thousand hectares. Projects for 600 and 1280 hectares are under estimation and designing. The end of 2006 will irrigate additional 59 hectares using the drip irrigation system; (clari tans)
- Scientific research on defining special salt-resistant plants is conducted in the country. These plants allow reuse slightly mineralized drainage waters for irrigation in the areas of their origin;
- The new Turkmen lake of golden century for 134 cubic km is under construction. Thanks to this lake, Turkmenistan will no longer release drainage water to the Amu Daya River. Irrigation and fertility of lands will improve considerably.
- In order to provide citizens of Balkanabat with drinking water a pipe and water intake covering 40 km (out of 120 km) is under construction. Yashan – Balkanabat water pipe will have the capacity of 70 thousand cubic meters/day.
- Central water supply system for 200 thousand cubic m/day is under construction in Dashoguz.
- Drinking water plant with capacity of 150 thousand cubic m/day was put into operation in Turkmenabat.
- Sewage rectification stations with capacity of 100 thousand cubic m/day were put into operation in Turkmenabat in 2006. This improved sanitary and living conditions in Turkmenabat and reduced contaminant release.
- Feasibility study for setting a special unit conducting water and salt monitoring of irrigated lands is on the way.

Over the last 7 years, 4 projects defined in the program of water supply development were implemented. Within these projects 4 drinking water plants were erected and resolved water supply problems in three large cities of Turkmenistan (Ashgabat, Mary and Turkmenabat). Total capacity of these plants is 610 thousand cubic m/day; construction cost is US$70 billion. In 2004- 2005, 25 sites related to water supply were put into operation.

4.5. Uzbekistan

After gaining independence in 1991 Uzbekistan, practically, created a new legal framework for environment protection that differs from the previous one to a great extent. The quality and quantity of respective laws and regulations increased. Economic methods of natural resources management replaced an old administrative-command style of management. Special nature management became chargeable and specially authorized governmental agencies for nature protection and nature management were additionally established ("Goscomzemgeodezc adastr", different services at the Ministry of Water and Agriculture, the Ministry of Internal Affairs and others, State Inspection "Sanoatcontechnazorat"). Local and self-government authorities as well as citizens increased their competence in nature management and governmental control over environment protection.

Rights and responsibilities of those involved in environment management are expanded to a great extent. Punishment for the violation of environmental regulations became stricter. Additional clauses on sanctions for the violation of environmental regulations were added to the Criminal, Civil and Administrative Codes. All these measures contributed much in creating good ecological conditions for the stable socioeconomic development.

At present, more than 40 laws and 70 regulations on nature protection and using of natural resources are in force in Republic. The most important laws among them are the following ones: ***"0n nature protection"***, ***"On protected natural zones"***, ***"On the government sanitary supervision"***, ***"On water and water consumption"***, ***"On natural resources"***, ***"On preservation and using of fauna"***, ***"On protection of free air"***, ***"On preservation and using of flora"***, ***"On forestry"***, ***"On safety of hydraulic constructions"***, ***"On the government cadastres"***, ***"On***

waste products", ***"On environmental impact assessment"***, ***Land Code*** and others.

Among the most important regulations there should be mentioned the following decrees of the Cabinet of Ministers of Uzbekistan: "On Action Program on environment protection for the period of 1999- 2005"; "On measures for implementation of the international obligations of Uzbekistan under agreements on preservation of ozone layer", "On Red Data Book of Uzbekistan", "On approval of the Regulation on the government environmental impact assessment in Uzbekistan", "On development of hydrometeorology in Uzbekistan", "On creation and management of hunting grounds in forestlands", "On strengthening control for the efficient using of biological resources, their import and export from Uzbekistan", "On restrictions for water use", "On measures to increase the efficiency for land tenure", "On charges for the damage to vegetative life", "On approval of rules and regulations related to the laws of Uzbekistan "On natural resources", "On approval of the Regulation on government monitoring of environment in Uzbekistan" and "On approval of the regulation on land monitoring" and others.

In order to resolve the problem of water quality Uzbekistan needs special actions for conservancy, elaboration of specific projects and investments for their implementation as well as assistance in restructuring the system of water quality management.

The Aral Sea basin project sets an objective to use efficiently water resources, to develop and implement national and regional strategies on efficient utilization of water resources, to prevent land salinity, to create national reserves of water resources for sustainable development of Central Asian countries and resolution of the problems related to the Aral Sea crisis and for water monitoring in Amu Darya and Syr Darya rivers. For this purpose the equipment for registration of water consumption and water quality have been installed in a number of water stations. A pilot project on revival of natural biodiversity has been launched in the country.

The main manifold on the right bank of the Amu Darya River is under construction. It will collect all drainage water in the region and forward it to the Aral Sea. However, taking into account potential negative impact of the main manifold on the environment of Uzbekistan, Turkmenistan and the Aral Sea, the country initiated Drainage project for more detailed assessment of manifold's alternative. To improve the water quality in the Amy Darya River it may be very necessary to suspend the manifold construction or even terminate it.

The Government of Uzbekistan issued a specific Regulation for the improvement of environment and sanitary-epidemiological situation along the River Zaravshan. The Regulation stipulates creation of water protecting zone on the river and taking dangerous objects out of its water. The status of specially protected land area will be given to those zones where fresh ground water fields are located. The Government will build up a hydro-chemical lab at the border with Tajikistan for the automatic water quality control. Other hydro- chemical labs will be equipped with special devices for determining the specific ingredients (selenium, strontium, cobalt, stibium, mercury etc.). The same types of regulations of the Council of Ministers were issued for the rivers of Kashkadarya, Chirchik, Surkhandarya, Naryn and Karadarya. Out of 149 environmentally dangerous sites of these 6 rivers 112 ones have been removed from river zones. Feasibility study for creation of riversides and protected zones for the rivers of Amu Darya and Syr Darya on the territory of Uzbekistan have been fulfilled. The decisions of local authorities (hokims) of 7 regions and the Council of Ministers of Karakalpakstan approved these projects.

Pic. 15 "Clean banks – 2006" action (Tajikistan)

Uzbekistan participates in three international conventions on environment protection and efficient water using, such as Convention to Combat Desertification, Convention on Biodiversity, and Convention on Wetlands of international significance. International organizations support 9 programs and projects in the country.

5. Assessment of problems to be resolved

Resolving of water pollution problem in Central Asia requires the establishment of intergovernmental legal relations in this field, regulatation of using of water resources and their monitoring, improvement of the economic mechanism of water consumption, water quality standards and others.

Problem of irrational using of water resources. It is their volume that measures concentration of contaminants in water reservoirs. Issues on improvement of water management are very important in this respect. At present, 30 - 50% of water resources are lost due to obsolete technology and methods of watering, depreciated irrigation and distribution systems that leads to reduction of water resources and increase of contaminant concentration in water reservoirs, growth of groundwater level, soil swamping and salinization, water erosion of soil. Some countries are eager to build more new water intakes or artificial water reservoirs. This will contribute to further desiccation of Transboundary Rivers and worsening of water quality. Taking it into account it is very necessary to introduce compulsory consultations on new water intakes construction or reconstruction of existing ones among all the countries involved.

Problem of intergovernmental legal relations. Intergovernmental claims on irrigation, hydropower and apportioning of water are not settled and this fact leads to violation of natural hydrological regime of transboundary rivers. This results in increase of contaminant concentration in summer months when diversion of flow increases considerably. There is no coordinated approach to the creation of water protection zones on transboundary rivers. Moreover, neighboring countries in the region do not use international experience of member-states of Convention on preservation and using of transboundary rivers and international lakes.

Problem of hydrologic systems monitoring. Worsening of water quality and quantity monitoring is a serious problem in the region. After the collapse of the Soviet Union technical conditions of hydrologic and hydro-chemical network on Transboundary Rivers deteriorated to a great extent. There is no assessment of quantity and chemistry of drain water.

Problem of improvement of business factors for water consumption. This problem is still crucial for Central Asian countries. Business factors should accelerate introduction of water saving technologies.

Problem of standardization of water quality. There are some discrepancies in standardization of water quality in the region. Some countries are planning to introduce ISO standards. This may hamper the process of coordinated assessment of water resources**.**

Problem of rehabilitation of rectification systems of municipal and manufacturing wastewater as well as building of collector-drain water rectification systems.

Problem of influence of long standing polluted areas (waste rock disposal area and tailing pits) for hydrologic system.

In order to solve the above problems adequate time consuming, money consuming and material resources consuming measures should be taken.

6. Action Plan for near-term outlook

REAP suggests action plan in the following directions:

Water resources quality management at regional level:

- development of mechanism of implementation of existing agreements between Central Asia states related to protection and efficient using of transboundary rivers;
- rehabilitation of national systems of monitoring for the quality of surface water of transboundary rivers, creation of favorable conditions for the exchange of information on ecological conditions of transboundary rivers;
- development and application of common regulations and standards for documentation on water quality in line with the international requirements.

Reduction of water shortage:

- installation of water rating stations and watermeters at the sites of water users;
- reconstructuction and upgrading of the existing structure of water distribution;
- Development of the technology of drain water purification for reuse;
- upgrading of irrigation systems on the national level;
- development and introduction of water saving and water protecting technologies in all branches of economy.

Water quality improvement:

- harmonization of regulations on joint water protected zones (belts) of transboundary rivers and maintaining of their regime;
- conduction of ecological audit of sources of pollution influencing transboundary rivers;
- working out and coordination of standards of ecological drainage for Central Asia countries;
- discovery of areas with transboundary groundwater sources and statusing of specially protected zones;

- rehabilitation and monitoring of waste rock disposal area and tailing pits having impact on transboundary rivers.

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Appendixes

Appendix 1. The volume of annual intake, km^3

Country \years	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
Kazakhstan*				11.88	13.49	9.94	12.24	13.10	13.70	15.45	16.27
Kyrgyzstan	9.31	9.60	8.47	8.32	9.18	8.03	10.39	8.46	7.56	7.85	7.89
Tajikistan	12.91	13.17	13.38	13.15	10.70	12.60	12.58	12.47	12.55	12.32	
Turkmenistan	27.61	26.35	24.21	25.95	27.59	24.92	24.22	27.15	26.67	27.96	28.46
Uzbekistan**	60.6	60.3	59.2	59.2	60.7	48.1	49.4	50.3	56.5	58.5	59.48
Total				**118.5**	**121.66**	**103.59**	**103.43**	**111.48**	**116.98**	**122.08**	

* – for Kazakhstan the data are included only by basins of Syr Darya, Shu and Talas rivers.

** – for Uzbekistan the data are cited on water intake on the border of regions and Republic of Karakalpakstan.

Appendix 2. The volume of annual water consumption, km^3 per year

Country\years	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
Kazakhstan*							7.03	7.38	7.79	9.82	9.71
Kyrgyzstan	6.94	6.87	5.20	6.42	5.25	4.98	5.74	5.42	4.56	4.54	4.49
Tajikistan	11.87	11.04	10.20	9.94	8.82	9.57	8.48	9.31	9.27	9.10	12.6
Turkmenistan											20.16
Uzbekistan**	52.2	52.2	52.1	51.6	50.6	46.9	44.0	50.2	51.2	56.7	54.95
Total											

* – for Kazakhstan the data are included only by basins of Syr Darya, Shu andTalas rivers.

** – for Uzbekistan on-line information is cited as the state statistical information on water consumption is not available in the Republic.

Appendix 3. The volume of sewage discharge, km^3

Country\years	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
Kazakhstan*							(0.37)	(0.35)	(0.40)	(0.38)	(0.34)
Kyrgyzstan	1.18	0.65	0.73	0.93	0.93	0.80	1.16	2.27	1.49	1.51	0.78
Tajikistan	3.71	4.09	4.37	4.81	3.58	4.71	4.76	4.69	4.75	4.79	
Turkmenistan	5.71	6.20	6.04	5.98	6.73	4.75	3.87	5.89	5.09	6.08	6.50
Uzbekistan	26.9	26.9	26.9	26.9	26.9	26.9	26.9	27.2	29.9	29.5	29.32
Total							37.06	40.4	41.63	42.26	

* – for Kazakhstan the data are included only on basins of Syr Darya, Shu and Talas rivers.

Appendix 4. The water consumption per capita, m^3/year

Country\years	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
Kazakhstan	77.8	72.8	53.4	48.8	43.5	41.9	40.6	39.9	40.0	44.1	
Kyrgyzstan	60.9	61.2	66.9	64.4	42.8	37.0	25.1	18.6	16.9	32.2	28.9
Tajikistan	167.8	75.3	65.9	39.4	63.1	64.2	56.5	59.1	63.9	63.7	
Turkmenistan	64.5	63.7	61.9	80.1	76.9	72.7	83.1	-	-	73.7	74.8
Uzbekistan	146.0	116.8	109.5	94.9	87.6	76.7	73.0	69.4	65.7	65.7	65.7

Appendix 5. The population share with access to drinking water, %

Country\years	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
Kazakhstan*	75	75.1	75.2	75.2	75.1	73	74	73.7	75.1	76.4	(70)
Kyrgyzstan	81.8	81.3	82.6	86.5	85.9	81.5	80.6	84.2	78.6	81.0	84.4
Tajikistan	52.0	48.5	43.8	43.3	43.7	44.3	47.1	47.3	46.9	47.4	
Turkmenistan			42.8	56.8	62.0	54.2	54.7	54.19	55.0		
Uzbekistan	70.0	71.1	73.7	74.4	75.1	77.1	-				

Appendix 6. The population share with access to sanitation,%

Country\years	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
Kazakhstan*	42.5	49.1	48.5	44.2	46.8	47.1	42.1	44.1	43.1	41.1	
Kyrgyzstan	21.3	24.4	23.3	27.5	27.8	32.8	31.4	30.3	25.9	27.0	23.9
Tajikistan	45.3	33.0	30.0	38.7	64.8	64.4	69.8	69.8	69.6	69.3	
Turkmenistan	56.5	56.8	58.1	57.6	58.6						
Uzbekistan	72.5	72.4	72.1	71.5	68.7	-	-				

Appendix 7. Index of water pollution in main rivers of Central Asia region

Point\(country)\years	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
Amu Darya											
c.Termez (border of RU with RT)	1.27	0.78	0.80	0.93	0.75	0.63	0.66	0.95	0.87	0.86	0.70
c. Atamurat (Turkmenistan)									1.61	1.16	2.21
Kishlak Kyzyldjar (RU)	1.49	0.81	1.02	0.98	0.97						
c. Nukus (RU)						1.39	0.93	0.70	1.04	1.02	1.10
Zaravshan											
Downstream pool of Pervomay dam (border of RU with RT)						0.44	0.73	0.61	1.05	0.69	
Syr Darya											
R. Karadarya c. Andijan (RU)						1.19	1.54	1.18	1.15	1.24	
c. Namangan (RU)	1.11	0.81	1.27	1.12	1.12	-	0.69	1.28	1.12	0.99	0.80
s. Nadezdenskiy (RU)	1.71	1.28	1.04	1.14	1.25	1.27	1.56	1.11	1.11	1.54	1.10
S. Kazygurt (Kazakhstan)	1.60	1.72	2.89	2.30	2.50	2.43	2.31	2.00	1.98	1.87	2.07
c. Kyzylorda (Kazakhstan)	-	-	-	-	-	-	-	-	-	1.91	2.17
Shu (Chu)											
s. Blagoveshenka (RK)	1.30	0.82	0.77	0.92	0.83	0.77	1.13	1.29	1.84	1.93	1.85
Talas											
s.Pokrovka (RK)	1.25	0.72	0.69	0.69	0.62	0.74	0.83	0.50	0.63	0.70	1.21

Appendix 8. The volume of refined sewage, million m^3.

Country\years	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
Kazakhstan	203	164	142	254	228	212	212	217	253	188	
Kyrgyzstan	136	122	111	117	150	137.7	134	108	86	158	
Tajikistan	4.49	4.41	4.35	4.78	3.55	3.58	3.61	3.69	3.57	3.63	
Turkmenistan	18.3	19.3	19.1	19.1	18.3	18.4	18.0	24.0	23.0	26.0	25.0
Uzbekistan	1282	1222	1220	1160	1137	1101	1053	1071	1053	922.3	
Total	**1644**	**1531**	**1496**	**1555**	**1537**	**1473**	**1421**	**1424**	**1419**	**1298**	

Appendix 9. Measure units

%	Percent	м^3	Cubic meter
га	Hectare	ml/l	Milligram per liter
г/л	Gram per liter	mcr/l	Microgram per liter
Doll.	Dollar	mge/l	Milligram equivalent per liter
km^3/ year	Cubic kilometers per year	mln	Million
l/d.	Liters per day	bin.	Billion

Appendix 10. Index of water pollution

For integrated assessment of water quality in Central Asia countries the water pollution index (WPI) is applied, which is calculated as normal from values in portions of MPC of six hydro chemical indicators – dissolved oxygen content, biological need in oxygen and four contaminants having the highest concentration against the norm. According to classification prevailing in Republic, the surface water objects are divided to 7 classes:

I – very pure (WPI- 0.3 and less)

II – pure (WPI-0.31-1.0)

III – moderately polluted (WPI -1.1-2.5)

IV – polluted (WPI-2.51-4.0)

V – dirty (WPI-4.1 -6.0)

VI – very dirty (WPI-6.1-10.0)

VII. – extremely dirty (WPI- over l0.0)

Degradation of mountain ecosystems

Content

The report has been prepared in accordance with the ISDC Resolution of March 2, 2006, under direct coordination by Central Asia countries' FPs and SIC ISDC. The following persons participated in preparation of the report.

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1. Introduction

Mountains are the custodians of innumerable resources, and they also make up the main ecosystem of the dry land. The main water resources that feed the plains are formed in mountains.

The main waterways of Central Asia – Amu Darya, Syr Darya – are formed in the mountains of Tajikistan and Kyrgyzstan. Mountain glaciers are the main storages of sweet water. Forests and shrubbery play an important role as they shore up the land and contribute to preservation of diversity of flora and fauna in mountain areas.

Playing an important part in forming the land ecosystems, mountains themselves are the fragile natural system. They are prone to natural disasters – earthquakes, landslides, avalanches, including snowy ones, mudflows and anthropogenic impact – agricultural activity (tillage, pasturing, deforestation), construction of buildings, roads, industrial objects, hydraulic work (power stations, reservoirs, canals). Combined effect of all this factors leads to breaking of balance in mountain systems. If proper measures are not taken on time, mountains will turn from the source of life into the danger for life. The specially protected natural territories (national parks, nature reserves, game reserves) should become, as the sources of ecological stability of the region, the object of special care.

As a whole, mountain regions of Central Asia *(Picture 1)* can be described as follows: various huge natural resources are concentrated here; numerous mountain ethnicities possessing unique cultural and centuries-old traditions demonstrate the ways of man's pliant adaptation to the complicated conditions of mountain territories; mountain regions are very attractive for tourism.

In conditions of globalization of market relations and development of transport accessibility the mountain regions experience more intensive anthropogenic impact from the side of the developed centers; the processes of mar-ginalization, depopulation are typical here; mountain regions are characterized by

Pic. 1

transport and social infrastructure underdevelopment, unemployment. All of this may cause socials tensions and conflicts.

With the support of Asian Development Bank the Central-Asian strategy on sustainable development of mountains has been developed by the regional countries. Developed and implemented transboundary projects – "Preservation of biodiversity of West Tien Shan", "Preservation and stable use of biodiversity of Altay-Sayan mountain ecoregion", "Preservation in situ mountain agrodiversity" are significant steps in complex preservation of mountain ecosystems.

2. Description of the problem.

Role of mountains

The rational use of mountain resources or "sustainable development" is understood as the long-term use of resources without loss of their productivity.

There is also the lack of understanding that the over-ex-ploitation or misuse of resources of mountains boosts deterioration of the environment, causing consequently the additional economic expenses in valley areas.

The vital role of mountains is to condense moisture. The hydro energy potential of mountains is closely connected with water resources. Today, these resources are very important in lives of poor countries situated in highlands. The potential of other renewable sources, for example, energy of the sun and the wind actually is not used. Despite their relative inaccessibility, mar-ginality, fragility of resources, mountains possess the significant potential for agricultural activity, create a basis of people's life.

The main agricultural activity is the livestock breeding that uses huge pastures. Also, these pastures should be considered in connection with valley areas located around the mountains. During the winter and spring period a very big number of livestock is kept in valleys and mountain areas are used only within summer when droughty and hot climatic conditions of valleys impede the growth of forage crops on lands which are not irrigated.

Irrigated and non-irrigated agriculture is a part of mountain agricultural system, and they make a significant portion in incomes of the population of mountains. The non-irrigated agriculture is more or less risky, as it depends on a site as well as on a varying economic situation.

More than a half of the river flow of Central Asia is formed in territory of Tajikistan *(Table 1)*. Although water resources of Central Asia are formed basically in the territory of Tajikistan and Kyrgyzstan, the larger part of water resources is used by Republic of Uzbekistan and Turkmenistan. This fact is a subject of dispute in relations between these states in the sphere of water management.

In the former USSR, Tajikistan held the 2nd place after Russia by stocks of hydropower resources. It is not surprising that the electric power in Tajikistan is basically generated at hydroelectric power stations *(Picture 2)*. Moreover, the explored reserves of gas and oil in Republic are not large.

Although the construction of large water reservoirs and hydroelectric power stations on the territory where seismicity is estimated up to 9 degrees suggests the potential danger, the temptation of getting cheap energy stimulates such constructions.

Importance of mountains of Pamir as the link between Central Asia and the countries of Southeast Asia changes the role of mountains as peripheries. Mountain chains of Tien Shan and Pamir again acquire their function coming from the ancient times when the system of ways of Silk Road crossed them and connected China to Asia and Europe.

Pamir (or "a roof of the world") dominates in the mountain system of Central Asia, representing a mountain ridge with orbed mountains of 5000-7000 meters high. The larger part of the ridge is located in the territory of Tajikistan, the underlying areas in the east and the south reach up to borders with China and Afghanistan. Pamir includes very wide flat valleys with rich pastures located almost at one height with low peaks. Pamir joins in the south the mighty mountains of Hindu Kush, Karakorum and Kunlun, and in the north the Alai mountain ridge, which in its turn joins Tien Shan.

The special care should be taken in respect of specially protected natural territories (national parks, nature reserves, game reserves) being the source of ecological stability of the region (in Tajikistan the specially protected natural territories make up 21% of total area of the country).

Achievement of a long-term balance between ecology, economy and society can be possible in close cooperation with people living in this fragile ecosystem and using it in their vital activity. Stable food supply becomes problematic because of increasing competition for the limited resources of mountain territories. Agricultural works and casual earnings are insufficient to guarantee normal food supply. Therefore, mountain residents have to hunt for wildfowl, pick up unsystematically the useful plants and forest fruits.

The highest biodiversity and landscape variety of ecosystems of Central Asia has been identified in mountains of Tine Shan and Pamir. In comparison with vegetation of mountains, the vegetation in droughty and semi droughty plains is more monotonous and poor.

Table 1. River flow resources of Central Asia countries

Country	Area, sq. km	River flow (local), km³/annum /год	Specific river flow (local), thous. km³ per sq. km.	Per 1 resident thous. cu. m.
Turkmenistan	488.1	3.5	7.20	0.70
Uzbekistan	447.4	9.5	21.2	0.42
Kyrgyzstan	198.5	48.7	245	9.94
Tajikistan	143.1	52.2	331	7.90

Mountain ecosystems

Mountains are prone to natural cataclysms – earthquakes, landslips, avalanches, mudflows, flooding, etc., as well as to anthropogenic impact- deforestation, overgrazing, wrong agricultural and economic activities, contamination of air and lands from strongly polluted plains and the industrial activity in mountains themselves. Uncontrolled tourism and hunting bring essential harm to unique sites of mountain ecosystems.

Today, the mountain ridges of Central Asia face a number of social and economic, interstate and interterritorial problems arising from extensive resource-consuming nature management. It is expressed in the form of neglect or insufficient attention to reaction of the environment on increasing anthropogenic pressure; errors in placement of power generating and industrial enterprises; imperfections of industrial and agricultural technologies.

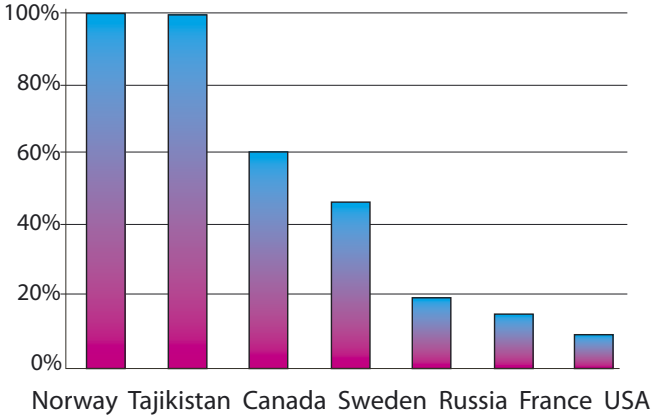
Changes taking place in the territories of mountain ecosystems of Central Asia are the direct consequence of ongoing unrestrained increase of anthropogenic impact. Even in sparsely populated areas of Pamir and Tien Shan there was identified the steady degradation of mountain-forest ecosystems: the areas under woods and bushes reduced essentially, natural recovery of coniferous species practically stopped and pastures begin to progressively degrade. Experts estimate that because of grazing, which largely exceeds the available fodder resources, the area of juniper forests within the last decades considerably reduced; opportunities for natural recovery of coniferous woods are lost or brought to the lowest notch.

Uncontrolled anthropogenic burden on mountain ecosystems results in ubiquitous change of natural dominants of plants, impoverishment of phyto gene pool, vegetative cover, degradation of soil, replacement of economically useful species of plants with weed. All this leads to progressing shrinkage of species diversity, exhaustion of fodder resources and, finally, desertification of territory and breaking of stability of ecosystems. These processes inevitably lead to radical changes of hydrothermal mode of a mountain surface, an exhaustion of renewable water resources and increase in probability of occurrence of dangerous natural disasters. Pollution of mountain ecosystems in Central Asia region becomes the more and more serious problem. It is especially distinctive with hydro-ecological situation: the concentration of polluting substances, including heavy metals dangerous for people's health, pesticides, chemical compounds of arsenic and chlorine in waters of the majority of rivers in the region continues to increase.

Socially, the life of residents of mountain areas is characterized by poverty, high unemployment, lack of energy resources, unsatisfactory infrastructure and weak economic integration to the general state system. There should be more proper attention to the needs and problems of people living in mountain areas.

Very high seismic activity, big variety of seismic and tectonic conditions are explained by the fact that the significant and most seismically active part of the territory is in the zone of direct interaction of one of the largest geological structures of Central Asia – Pamir and Tien Shan.

This high seismic activity showed such catastrophic earthquakes in Tajikistan as Karatagskoye in 1907, Sarezskoye in 1911, Faizabadskoye in 1943, and Khaitskoye in 1949. Mountain territories of Central Asia are located in the zone of current geological processes. Most dangerous are earthquakes, collapses, landslips, mudflows, periodic motions of glaciers, erosion of soil, etc. Catastrophes or natural



Pic. 2

calamities are the development of one of these geological processes associated with human victims or a material damage. Due to deficiency of land suitable for habitation and economic activities, people practically always settle in places prone to danger of occurrence of one or several natural calamities.

In the areas of developed mining and metal mining industry, and also in the zones of influence of large industrial enterprises, there is a significant technogenic disturbing of a natural condition of dry lands and their chemical pollution.

Building of such linear facilities as roads, dams, channels, gas pipelines, power transmission lines and facilities of communication without taking into account of a relief and type of the layers, necessary ecological restrictions leads to intensive development of gully erosion, silting of low lying agricultural lands and household constructions.

Highly rugged terrain of mountain territories in combination with sharply continental climate (hot dry summer and severe winter) are one of the objective reasons of appearance of specific type of building of mountain human settlements based on picturesque free compositions with terracing of constructions; using of unsuitable for agriculture land for construction of houses, etc. Thus, mountain conditions suggest serious town-planning, technical and economic problems when developing the mountain territories.

Mountain areas are polluted not only by mining enterprises (discharges to water, increase of tailing dumps), but also by the industrial enterprises located in valleys.

Central Asia is characterized by big duration of solar light within a year (2000-3000 hours on average). Favourable climatic conditions determine development of many sectors of the national economy, cultivation of agricultural crops, developments of tourism and recreation. On the other hand, specific environmental conditions demand a special approach and attention in order to avoid a burden on environment from industrial, energy generating and transport enterprises.

The basic transboundary problems that worsen the ecological condition of mountain ecosystems in Central Asia include:

1. Overgrazing
2. Construction of roads
3. Cataclysms
4. Irrational management of land resources
5. Illegal deforestation
6. Mining industry
7. Loss of biodiversity.

3. Assessment of situation in regional countries

3.1. Kazakhstan

Mountain territories in Kazakhstan occupy more than 18.6 million hectares (7% of total area of the country). Their allocation is determined by an altitude zone. (belt). Altay, North and West Tian-Shan groups come first and are characterized by maximum level of biodiversity, endemism and economical value.

Due to natural historical conditions and the established resource and raw material system of nature protection, being mainly primary, the technogenic impact on ecologically vulnerable nature systems and population living there remain extremely high.

System of state management of environment protection

The management of environmental conditions is carried out by the Government of Kazakhstan through central executive bodies of the country – Ministry of Environment Protection, Ministry of Finance and Budget Planning, Ministry of Energy and Mineral Resources, Ministry of Agriculture and Agency on Land Resources Management. The Government and local bodies establish procedures on protection and use of components of environment, approve rates of payment for use of resources, regulate the activity of nature users in accordance with the legislation and implement measures on reproduction of biological resources.

The main principles and priorities for foreign and internal policy, legal mechanisms and economic instruments as well as the most important trends of activity required for the provision and conservation of favourable environment and sustainable economic and human development, prevention of natural calamities and industrial accidents are identified in the Environmental Safety Concept (2003).

The basis for this activity is the Law "On environment protection" (1997). The laws "On ecological expertise", "On specially protected natural territories, "On protection of atmospheric air", "On protection, reproduction and use of fauna" are in force in Kazakhstan along with the law mentioned above.

The issues of nature management are regulated by provisions of the Land Code, Water Code (2003), Forestry Code (2003), Order of the President of Kazakhstan on mineral resources and mineral resources management and the Law of Kazakhstan on environment protection (1997).

State of problem and ways of resolving

Over the last decade mountain regions are more intensively involved in the sphere of economic activity of Kazakhstan. It directs to the fact that components of nature-resource environment of mountain and submountain territories having considered early as a means towards achieving goals of economic development began suffering the intensive degradation.

There are three mountain regions of high seismic activity in Kazakhstan: Tarbagatai-Altay, Zhetysuisk-North-Tian-Shan and Karataus. The regions of the highest seismic activity in south and south-east of Kazakhstan are Ileyskiy, Kungei Alatau and Kyrgyz ranges within which such catastrophic earthquakes as Belovod (1885, M=7.3), Vernen (1887, M=7.3), Chilik (1889, M=8.3), Keminsk (1991, M=8.2), Kemin-Chuisk (1938, M=6.9), Zhalanash-Tyup (1978, M=6.8) and others have occurred over the last 120 years. Clay flows are registered in 23 basins. They took place in all large basins of the range. The specific feature of the Shelek River basin is a repeated formation of clay flows caused by breaks of blocked lakes. Here, cases of clay flows originated while breaking dams in basins of the Kolas and Kayandy Rivers are registered and restored.

According to Emergency Control Ministry (ECM) of Kazakhstan the total damage from clay floods amounted approximately to US$50 million and a number of casualties at least 2-3 thousand people took place in 1993-2005.

One of the most threatening factors of degradation of mountain ecosystems is the decrease of area of glaciation *(Picture 3)*. Researches of dynamics of glaciation-nival system together with the development of evaluation methods of their current state as well as the forecast in view of tendencies of changing climate conditions and growing of technogenic and anthropogenic impact remain of great importance.

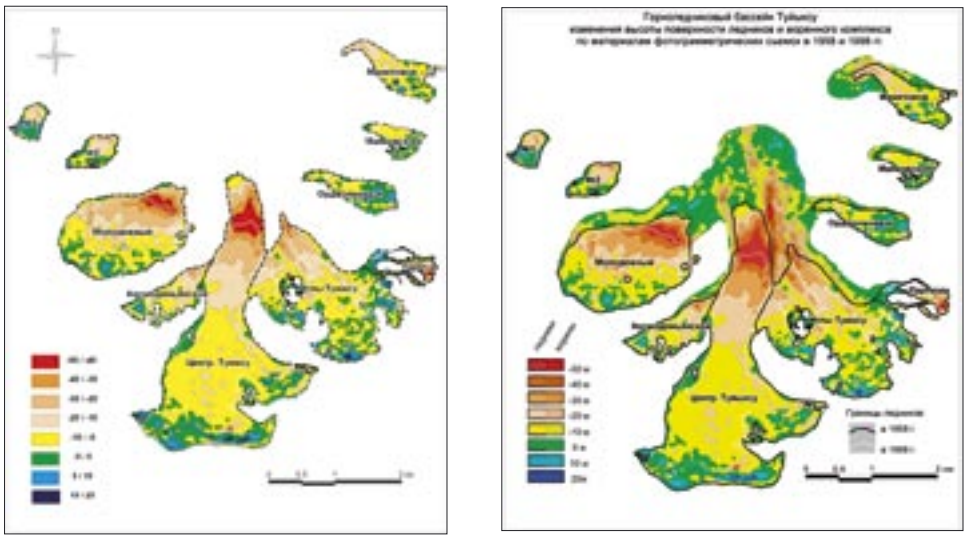
Problem of water resources

The water deficit in Kazakhstan is one on the main limiting factors of development of industry and agriculture and one of the causes of generation of ecologically based emergency situations and social and ecological tension. As of today resources of river flow on the water content average 100.5 cubic kilometers per year of which only 56.5 cubic kilometers are formed in the territory of Republic. The remaining volume of river flow comes from the contiguous states. The flow of main rivers is formed in mountain and low-hill regions. Out of all resources of surface waters formed in the territory of Kazakhstan more than 70% falls on the flow of mountain rivers of south-east of the Republic. The high mountains of Altay and Tina-Shan are characterized by the densest river network. (0.4-1.8 m/sq.m). Waters from melted snow-fields and glaciers serve as the main source of feeding of watercourses of mountain systems. The water content of mountain watercourses is increased by 10-15% because of rains in high-mountain regions and by 25-30% – in low-mountain regions. Over the last 20 years resources of river flow decreased to 25.3 cubic kilometers per year including local flow – to 10.3 and transboundary – 15.2 cubic kilometers per year.

The overwhelming majority of floristic diversity of Republic is concentrated in mountain regions of south and south-east of Kazakhstan. More than 1850 species of which 136 are endemics of this region. Flora of Karatay accounts 1710 taxons, out of which 9% are endemics. Out of 245 species registered here 94 are entered in The Red Data Book of Kazakhstan. Flora of north Tian-Shan is represented by almost 3000 species, of which 60 are entered in The Red Data Book.

The territory of Republic is forestless (moreover, their most part refers to mountain ecosystems). The state of forest resources had become significantly worse by 2000.

The habitation of 110 species of mammalians is registered in mountain ecosystems. Mountain forests are



Pic. 3 Reduction of glaciation

inhabited by brown bear, lynx, glutton, sable, musk deer, elk, maral, chipmunk and squirrel. Marmot, Tien Shan souslik, argali, treecreeper, field-vole, marten, ibex live in mountain steppes. 255 species or 65.6% of all nestling fauna built their nests in mountain zone. Mauntain systems are represented by 29 species of amphibia and creepers. Arthropoda fauna is characterized by a wide diversity. The main causes of reduction of a number and species composition of fauna in Kazakhstan are the weak control over the observance of volumes and quota of withdrawal of bioresources, lack of alternative types of earning for population, wastes disposal in productive territories, routing, road laying, piping, pollution of ponds, regulation of river flow, etc.

The changes made led to social tension in villages (unemployment, decline in living standards, migration of population to cities and towns). The presence of vast natural agricultural lands (25.4 million hectares) of mountain zone of Kazakhstan (pastures, natural hayfields), water sources and arable lands rich in humus allow successfully developing here meat horse breeding, production of kumis and goat-breeding which are the basis of development of economy and social protection of population. At present, creation of farming directed on production of livestock products could become a perspective type of economic activity capable to significantly improve social and economic situation in mountains.

3.2. Kyrgyzstan

Kyrgyz Republic is the mountain country with complicated broken relief. From 199.9 thousand sq. km. of total area almost 90% of territory of the country is at 1500 m. above sea level on Tien Shan and Alai hills. It is a complicated, very partitioned mountain system.

It is located at height of 500 m – over 7000 m above the sea level. Nearly half of its area lies at height of over 3000 m. The northeast site of Tien Shan is especially high – 7439 m (Pobeda Peak).The highest and powerful ridges are Kungey Ala-Too, Terskey Ala-Too, Kyrgyz, Talass, Chatkal, Ferghana, Alai, Turkestani, Zaalay, Kok-Shaal, Moldo-Too, Borkolday and others.

There are valleys between mountain ridges, among which the major ones are Chuiskaya, Talasskaya, Ketmen-Tyube, Ferghana, Kochkorskaya, Djumgalskaya, Atbashi-Karakaunskaya, Narynskaya, Chatkalskaya, Alaiskaya and Susamyrskaya valleys.

The lake Issyk-Kul located between the ridges Terskey Ala-Too and Kungey Ala-Too occupies the area around 6300 sq. km. into which 80 rivers flow and no one flows out. The rivers of Tien Shan have extremely rough flow and possess huge eroding force; therefore the territory is highly indented with ravines, gorges and canyons.

Climatic conditions are quite different in Tien Shan Mountains and valleys. Location of the country in the centre of Eurasia continent determines on the whole the continental character of climate. However, highness of territory and terrain irregularity with very high ridges smoothes a little the continental features of the climate: cloudiness and quantity of precipitations increases, amplitudes of an annual course of temperatures smooth out.

Precipitations are far from evenness on the territory of Kyrgyzstan. The most humidified area of Northern Kyrgyzstan is East Issyk-Kul region (500-600 mm per year, maximum 700 mm), while the western site of Issyk-Kul hollow represents a deserted area (100-300 mm per year). Northern slope of Kyrgyz Ala-Too is rather well provided by precipitations (400-500 mm per year).

Table 2. Areas of mountain territories of Kyrgyzstan

Height above the sea level (m)	% of territory of Kyrgyzstan
< 1.000	5.8
1000 — 2000	22.6
2000 — 3000	30.2
3000 — 4000	34.0
> 4000	7.0

Mountain territories of Kyrgyzstan are an important source of water, energy and biological diversity. Moreover, they are the source of such key resources as minerals, timber, agricultural products and recreation.

3.3. Tajikistan

Tajikistan has a small territory, with no outlet to the sea and it is the mostly mountainous country in Central Asia *(Picture 1)*. It occupies the area of 143100 sq. km. and borders with Afghanistan (1206 km), China (414 km), Kyrgyzstan (870 km) and Uzbekistan (1161 km). Mountains of Pamir and Alai dominate in the north above the western part of nearby Ferghana valley and above Kofarnigan and Vakhsh valleys in the southwest. Population – 6.440.732 people (as estimated as of July, 2000) with the tendency to growth (rate of population growth – 62.12%). Around 2.4 million people live in mountain areas of Tajikistan (except Dushanbe). The main natural resources are hydroelectric power, alongside with several fields of silver, gold, uranium and tungsten.

Mountain chains Tien Shan and Pamir

The rivers belong mainly to basins of Amu Darya and Syr Darya.

The largest glaciers: glacier Fedchenko (length 71.2 km) and glacier Grumm-Grzhimaylo (length 37 km).

Vegetation of Pamir is quite poor, although in Western Pamir it is richer. On lower sites of river valleys there is a vegetation of deserts with saxaul, teresken and wormwood. Above, (2600 – 3200 meters above sea level) there is a plain with thorny weeds (Acantholemons, thorny astragalus). More above (3200 – 3800 m above the sea level) these formations sometimes join the feather grass steppes, being gradually substituted (at height 3800 – 4300 m) by Alpine meadows, and at 4500 meters above the sea level the rare creeping vegetation is marked. East Pamir is a cold desert of upland with rare cushiony plants. Teresken bushes are met everywhere and are the sole source of fuel.

Situation at present time

Tajikistan is the typical high-mountainous country *(Picture 1)*. Territory of Tajikistan is occupied by the highest mountain ranges of Central Asia – Pamir and Tien Shan.

Mountain areas lying above 600 m account for over 93% of all the territory of Republic. By position and character of a relief the territory of Tajikistan is divided to some tiers: up to 800 m – hills; up to 2000 m – foothills; up to 3100 m – medium mountains; up to 4500m – high mountains; over 4500 m – very high mountains. Ismoil Somoni Peak has the height of 7495 meters. Half of the territory of Tajikistan is at height of over 3000 m. Formation of numerous microgeograp-hical areas is based on the mountain character of the relief. Almost all landscape zones of the Earth, from dry subtropics up to eternal ice and snow, are represented in each natural area. The population settles at heights unevenly *(Table 4)*.

Problems and ways of their solution

Water

Mountain glaciers are the basic accumulators of fresh water. Water from melted snow of glaciers and firn fields makes up 25% of volume of rivers flow of Tajikistan (in hot years a share of a glacial flow reaches 50%).

The glaciers of Tajikistan keep 400 cubic km. of high-quality sweet water. Glaciers occupy the total area of 8500 sq. km. There are 947 rivers (total length is over 10 km) in Republic. The average annual flow of surface water resources makes 52.2 cubic km. However, the uneven location of rich water resources always created certain difficulties in their using.

Despite the indicators of electric power generation per capita (3100 kilowatt-hour) are good, the residents of mountain settlements either have insufficient supply of electricity or have no this supply at all. In many areas the electricity is rationed (2-6 hours). These circumstances force the residents of mountains to use sparse mountain forests and bushes for heating of dwellings and cooking. Unfortunately, the alternative energy sources (the sun, wind, biogas and hydrothermal sources) and mini, micro-hydroelectric power stations are practically not used. Although the energy of small rivers makes up 5% of

overall potential of hydroresources of Tajikistan, they could play an essential role in stable supply of electricity to mountain human settlements.

The energy-intensive industries (TadAz, Vakhsh ATZ, Dushanbe cement factory and others) and large human settlements (cities, towns) are the main consumers of energy of big power stations.

Natural calamities and anthropogenic impact

Tajikistan is also unique from the point of view of man's engineering activity and its influence on geological environment. Here, on the river Vakhsh, the highest dam in the world of Nurek hydroelectric power station was constructed, with a water reservoir of around 11 million cubic m. in volume and over 70 km. in length The other high dam of Rogunskaya hydroelectric power station is under construction on the same river with a water basin around 16 million cubic m. in volume and about 100 km. in length. Practically, an uninterrupted man-made sea of about 200 km. in length and 27 million cubic M. in volume will be formed after launching into operation of Rogunskaya hydroelectric power station. Naturally, such large artificial formation will influence the geological environment in which it is located.

As far as these hydraulic engineering facilities are constructed straight in the zone of one of the largest seismically active structures of the region, it is logical to assume the change in seismicity of the area under influence of water basins. The change is expected not only in the immediate proximity from those water basins, but also along all seismically active structures.

One of natural peculiarities of Republic is low self-clearing ability of the atmosphere at the reason of such meteorological factors as slow movement of air and its stagnation. The mountain-valley circulation of atmospheric air contributes to moving and accumulation of polluted air in valleys. The natural high dust content of air in 2000 has increased by 400% in comparison with the last year because of small quantity of precipitations. Besides, the situation is aggravated by tec-hnogenic factors. The share of industry and transport in pollution of the atmosphere comes up to over 80%. Although TADAZ, Yavanskiy electrochemical factory, Vakhshskiy nitric factory work at 30-40% of their capacity, they appear to be the main stationary pollutants of the air basin.

Annually, Tajikistan experiences more than 5000 earthquakes of different force, around fifty thousand landslips, tens of thousands of avalanches, destructive mud flows, flood at rivers areas. All these natural disasters are related to extreme situations and cause big damage to the economy of our country and quite often result in deaths of people.

Table 3. Water resources of largest rivers, km^3

River basin	Average annual outflow volume	Including those in Republic Tajikistan	Water supply	Utilized volume	Loss
Pyandj	33.4	17.1	1.97	1.5	0.47
Vakhsh	20.2	18.3	4.6	3.5	1.10
Kafirnigan	5.1	5.1	2.5	1.95	0.55
Karatag	1.0	1.0	0.64	0.38	0.26
Zeravshan	5.3	5.1	0.43	0.4	0.03
Syrdarya	15.0	0.8	2.96	2.6	0.36
Total:	80.0	47.4	13.10	10.33	2.77

Socio-economic

Mountain regions of Tajikistan are characterized by a number of features that promote the preservation of traditional norms of behaviour among people and the demography. Although the birth rate in Tajikistan decreases within the last ten years, the natural increase from the point of view of demography has high indicator. For example, in GBAO the population increases by 2.1% on average per year, which is the highest indicator across Tajikistan.

Irrational and erroneous human activity (irrational land use) can intensify considerably the adverse consequences of earthquakes. For example, ordinary Gissarskoye (Sharora) earthquake in 1989 caused dilution of ground and occurrence of a landslip that led to many human casualties. Occurrence of the similar phenomenon is practically probable over the whole territory of Tajikistan.

The mountain relief of Tajikistan significantly influences the territorial organization of productive forces, sometimes creating large obstacles for agriculture, industrial and road construction. Dry terracing by perennial crops is widely applied in the mountain territory of Republic. However, improper arrangement of these terraces leads to intensive development of erosive processes. It has been determined that slopes of 10-25° are heavily washed out and washout of soil reaches 920 sq. m. per hectare; 5-10° slopes are subject to various degrees of washout, while the slopes of under 5° are slightly washed out.

Up to 30% of hillsides in the territory of Tajikistan are the slopes prone to landslides. The human activity impacts considerably to landslide formation. It is construction of roads, houses on the slopes, construction of dams, water reservoirs, channels, plowing-up of slopes, non-observance of water use regime.

Forests and shrubs in mountains play the important role of land fortifying factor. Forests in Republic occupy only the 3% area (the norm is 12%), they are represented by over 200 kinds and widespread on all high-altitude belts. The belt of juniper forests has the big economic significance as this tree manages the flow of water system. However, at present time, because of shortage of fuel the continuous cutting down of trees and bushes takes place. Although the total area of woods does not change significantly, their fullness has decreased considerably, which also leads to the erosion of soil. For instance, the surface flow in juniper forests with fullness of 0.5-0.6 makes 0.4-20 cubic meters per hectare, while with fullness of 0.1-0.2 – up to 100 meters per hectare.

Table 4. Settlement of the population of mountain regions by high-altitude zones

High altitude zones, meters above sea level	Belts area km²		Number of human settlements		Number of population		Index of dislocation and concentration of population		
	Absolute	% to total	Absolute	% to total	Absolute	% to total	Density (man/km²)	People of rural settlements	Average distance between human settlements
From 500 to 1000	2221.32	6.6	198	23.9	148267	35.5	67.7	749	11.2
From 1000 to 1500	4709.06	14.0	243	29.3	135738	32.5	28.8	559	19.4
From 1500 to 2000	11556.4	34.4	300	36.2	111096	26.6	9.6	370	38.5
From 2000 to 3000	15071.76	45.0	88	10.6	22553	5.4	1.5	256	171.3
Total	**33558.54**	**100**	**829**	**100**	**417654**	**100**	**12.4**	**504**	**40.5**

The continuous felling of forests happens now because of shortage of fuel. As a result, the slopes become bare, the moisture in soil decreases, the groundwater flows decrease and surface flows increase. These factors, in turn, intensify soil erosion; disturb hydrological regime of the rivers. Felling of forest and shrub vegetation and use of a mountain zone for winter pastures reduce density and species composition of herbage, thus aggravating the process of destruction of soil cover. Teresken, the basic vegetation of high-mountainous desert is almost destroyed on the western Pamir.

Uncontrolled felling of forests for heating purposes and wrong agrotechnical system of exploitation of mountain territories leads to washout of a fertile soil and occurrence of deserts in mountain areas. The damage caused to forestry within the latest decade is estimated as US$100 million.

Table 5. Protected territories of Tajikistan

Name of protected territories	Area, hectare
Reserves	
"Tiger Beam"	49786
"Romit"	16100
Dashtidshumsky	16000
National parks	
Pamirsky	1.5 — 1600000
Shirkent	30000
Game reserves	
Zorkulsky	16500
Muzkulsky	68000
Pamirsky	500000
Sangvorsky	51000
Kamarou	9000
Childukhtaronsky	12600
Karatausky	14200
Dashtimaidonsky	10100
Iskanderkulsky	18500
Sayvotinsky	4100
Zeravshansky	5000
Kusavlisaysky	20000
Aktashsky	15000
Sarikhosorsky	34000

Recreation and biodiversity

The flora and fauna of Tajikistan is extremely rich and diverse thanks to variety of the environment conditions. However, anthropogenic factor strongly impacted the structure and distribution of flora and fauna in cultural landscape. The natural habitat of many biological species has heavily narrowed. Some species became rare or have disappeared totally (for example, Turan tiger that dwelled in "Tiger Beam"of Lower Pyandj)

Around 10% of territory of Tajikistan is estimated as perspective for recreational use. The mean height mountains with comfortable summer and soft winter are most optimal for medical treatment rest, and high-mountainous areas are perspective for sport-improving rest.

The limited opportunity of expansion of agricultural activity in mountain areas of Tajikistan also can be stimulus for employment of recreational activity to solve unemployment problem.

3.4. Turkmenistan

Turkmenistan is in the western part of Central Asia (between 35°08′ and 42°48′ n.l. and 52°27′ and 66°41′ e.l.), occupies 491.2 thousand sq.km and spreads into latitude direction for 1100 km, and in longitude – 650 km. In the north, it borders with Kazakhstan, in the east and northeast – with Uzbekistan, in the south – with Islamic Republic of Iran and in south-east – with Afghanistan, in the west it is washed by waters of the Caspian Sea.

Foothill and mountain ecosystems occupy less than 1/5 part of territory of the country and are represented by: Koitendag mountains (spur of Gissar system), Kopetdag, Big and Small Balkhans; and also by island mountains-leavings of the pre-Quaternary period;

volcanic hills and rocky precipices – plateau mending. As a whole lower mountains are characterized by small rainfalls, poor vegetative cover and underdeveloped soil cover and are considered in the literature mainly as various types of deserts (bedlends, rubby, stony, loamy, clay, sandy) and their combinations. In this regard their low biological efficiency basically causes degradation due to natural factors since the population there is small and these territories are related to lands not used in agriculture, forestry and are partially maintained as low productive distant pastures. In these areas the assessment of degradation may reveal insignificant changes of ecosystems, as these territories are subject to those human-induced influences which are not connected with the activity of the national economy sectors (stay of tourists, isolated research or reconnoitering works).

When comparing, the mountain areas of Kopetdag, Big and Small Balkhans, Koitendag and Badkhyz to a certain extent are exposed to partial influence by virtue of their use as distant pastures and areas of local sporadic dry (poor, needy boghara prevails) agriculture. Mountain ecosystems of Southern Turkmenistan relate to Kopetdag, Badkhyz-Karabil provinces of Peredneaziatskaya highland, and of East Turkmenistan – to Southern Tien Shan province of the Central Asian highland. Thus, in mountain ecosystems of Turkmenistan, despite the relative stability of its separate components, the processes of degradation as a whole are similar to those in deserted landscapes (i.e. in different types of deserts).

Less than 10% of the population of the country live in remote regions of difficult access where application of solar or wind installations could be practically useful. As the practice shows, one rural household depending on its size consumes around 4000 kilowatt-hours of the electric power per year in case of thrifty using. Small solar or wind installations with a capacity of 1.5-2.0 kilowatts could completely satisfy the needs of small farms for electric power and potable water. It will also contribute to prevention of deforestation near the human settlements.

Legislation

The matter of mountain ecosystems protection and rational use of their resources in Turkmenistan is at the level of government policy. Legal acts specially referred to mountain territories and laws and decrees of general character are adopted in which there are clauses and items regulating and concretizing the matters of wildlife management in mountain ecosystems.

Laws currently in force do not cover completely specificity of economic activities of mountaineers. In this regard, the development of a regulatory act to govern anthropogenic actions (gathering of valuable herbs, nuts and berries of rare and endangered plants, grazing, etc.) leading to strengthening of processes of mountain ecosystems degradation will be expedient.

The integrated plan (2004-2005) coordinating transboundary management of Kopetdag mountain ecosystem between Turkmenistan and Iran has been developed at the regional level. Within the framework of this plan the water reservoir "Dostluk" on the boundary river Tedjen with the capacity of 1250 million cubic meters of water has been constructed. This reservoir will allow irrigating of 25 thousand hectares of land in Turkmenistan and in Iran.

Natural calamities

Mountain ecosystems and adjoining territories are located in the zone of high seismicity reaching from 6 to 9 points under the Richter scale. Danger of earthquakes exists and threat of human and material losses, deterioration of ecological and economic condition is not removed from the agenda of protection of mountain ecosystems.

Mudflows and water erosion

Mud and stone, mud and water mudflows are registered in Turkmenistan, 84% of which happen in April – August and the rest in April – August. The occurring solitary small streams do not fall outside

Table 6. Information about pastures

Velayats			Pastures, thousands hectare		Average annual fodder stock center/hectare		Grazing capacity, thousands cattle heads	
Name	Area, thousands hectare							
	total	including mountain ecosystems	total	in mountains	total on the country	eaten up in mountain pasture	total for sheep	in mountains, for output livestock
Akhal	9716.3	767.0	8330	690	1.17	3.6	1219.0	273.8
Balkan	13927.3	1603.6	9220	1570	0.88	2.7	1331.5	466.6
Lebap	9372.7	108.6	7260	101	0.98	3.4	974	44.0

the bounds of existing dry riverbeds. In mountain ecosystems of Turkmenistan about 350 dry riverbeds are available the gathering of water in which would allow not only to reverse destructive and erosive activity, but also to conserve a stock of water from mudflows.

In total, in Turkmenistan, mountain ecosystems occupy around 2.47 million hectares, but because of bed lands and other low-yielding deserted and semi-deserted sites of foothills the area of pastures in mountains composes over 2.3 million hectares. Although the average annual consumption of forages in mountain pastures is high compared to other territory, the distant pastures degradation takes place near the human settlements and on readily available slopes. Unfortunately, the measures against degradation of pastures are conducted in small scales so far, because of high costs of works and concentration of a greater part of livestock in private farms of leaseholders, inappropriate organization of works on increasing of the capacity of mountain pastures, and also absence of detailed data of the last years about condition of pastures, as well as insufficient volume of monitoring.

Mountain forests of Turkmenistan occupy the area of 524 thousand hectares, (5.05% of forest fund of the country or 1.07% of total area of Turkmenistan), of which 149.2 thousand hectares are covered with wood. The stock of timber in mountain forests is much higher per unit of area, than on average across the whole country (3.3 mVper hectare), and depending on local forest growing conditions reaches 10-40 mV per hectare. The area of plantings of Turkmen juniper in mountain woods makes about 858 hectares, of pistachio forests – 34.6 thousand hectares.

Also, the process of deforestation occurs partly and sporadically because of dying off of overmatured forest, hollow trees and of the trees and bushes affected with illnesses.

In foothills of Kopetdag the Service of forestry, seeds and natural parks of Ministry of Nature Protection of Turkmenistan produces in greenhouses and nurseries the trees and bushes numbering to over 70 names that promotes not only the preservation of valuable, rare and disappearing species of plants in mountains, but also to their rational use in culture. Plantings of trees and bushes mentioned in the Red Data Book replenish flora and create favourable conditions for dwelling of various kinds of animals.

There were established 7 national nature reserves in a mountain part of Turkmenistan. Three reserves-Central Kopetdag (created in 1939), Small Niazymskiy (1943) and of Turkmen mandrake (1944) were abolished in 1951. Now, in mountain and hilly area of the country there are 4 nature reserves and 10 game reserves occupying accordingly 191.1 and 231.0 thousand hectares. Only the Kopetdagsky reserve has a preservation zone on the area of 32.8 thousand

Table 7. The basic ecosystems of mountain SPNT

Reserves	SPNT (including game reserves, conservation zones, nature heritage), thousands hectare	Ecosystem		
		desert	mountain	valley-tugai
Badkhyzsky	144.7	94.0	39.0	12.0
Koitendagsky	122.3	4.0	116.3	2.0
Kopetdagsky	159.6	-	159.6	1.2
Syunt-Khasardagsky	30.3	5.15	23.9	15.2
Total:	**456.9**	**103.15**	**338.6**	**28.4**

hectares. As they are located in arid zone, more than 20% of their territories are represented by deserted ecosystems *(Table 7)*.

3.5. Uzbekistan

Uzbekistan is situated in central and northern parts of Central Asia. It borders in the northeast with Kyrgyzstan, in the north and northwest with Kazakhstan, in the southwest with Turkmenistan, in the south with Afghanistan, in the southeast with Tajikistan. The most northern point of Uzbekistan is plateau Ustyurt, at the western coast of the Aral Sea (45° 36′ north latitude); the most southern point- in Surkhan-Darya area at Termez (37° 36′ north latitude); the western – on a plateau Ustyurt (56° east longitude), the eastern – in the southeast of Ferghana valley, on border with Kyrgyzstan (37° 10′east longitude). Distance between extreme northern and southern points is 925 km, and between western and eastern points – 1400km.

The territory of Republic is stretched and has the general inclination from southeast to northwest. The area is 447.4 thousand sq. km (5th place by area among CIS countries). Larger part of the territory is occupied with plains, smaller – with mountains, adyrs and foothills.

The complex of foothill and mountain ecosystems occupies the southeast part of the country. The structure of the complex includes the western spurs of Tien Shan and ridges of Pamir-Alai. It is the area of high-altitude belting that includes sub-alpine and Alpine meadows, rocky formations and reservoirs, juniper and deciduous (including nuciferous) woods, light forests and bushes, dry motley grass low mountain steppes and semideserts. Over the last 10 years the total area of state forest resources decreased by 1 million hectares, and percentage of forest land – by 1%. Reforestation is conducted on area of 44 thousand hectares including planting and sowing on area of 42.3 thousand hectares.

Today, the area of state forest fund is 8051.3 thousand hectares, and the area covered with forests – 2369.1 thousand hectares of which less than 200 thousand hectares are occupied by mountain forests at present.

Despite the small area of wood communities, they are unique for the whole Central Asia region due by specific structure and by abundance of relic plants. They represent exclusive interest as natural nurseries with a material for selection and creation of new species. Widely known is their water regulatory, soil-protective, sanitary-and-hygienic and social role.

The areas of juniper woods (Southern Tien Shan, Dzungarian Ala Tau) – nearly 200 thousand hectares-continue to dwindle, their species and form variety is impoverishing. Natural renewal does not take place –

the undergrowth and the underbrush are destroyed in cases of grazing, some other economic activities and recreation. Modern nuciferous forests represent only fragments of former significant forest tracts. Grazing, felling, hay-mowing, injurious harvesting and other factors have worsened their condition and in comparison with the year 1950 their area has reduced tenfold.

About 2500 kinds of vascular plants grow in a wood zone of the southern part of Gissar Mountains (basins of the rivers Tupalang and Sangardac). It is the richest area by flora.

The nature of mountain areas of Republic, as well as of the whole Central Asia region is characterized by sharp landscape contrasts, big amplitudes of absolute heights, extremely complicated relief, various climatic conditions, vegetative cover and fauna.

Practically, all surface water resources of Uzbekistan (the rivers Syr-Darya, Amu-Darya, Zeravshan, Surhandarya, Naryn, Karadarya and a number of small rivers) are formed outside Republic- in Kyrgyzstan and Tajikistan. The most polluted is Zeravshan, which receives the portion of pollution from ore dressing industrial complex in Tajikistan. The river Karadarya comes to the territory of Uzbekistan with moderately polluted quality of water, similarly to Syr-Darya. However, there is a big danger of pollution of Syr-Darya with toxic radioactive waste products through river Mailuu-Suu.

The basic legislative acts on nature protection and rational use of flora and fauna and creation of protected natural territories are as follows: Nature Protection Law (1992), law "On protection and use of flora (1997), law "On protection and use of fauna (1997) and law "On protected natural territories" (2004).

4. Evaluation of the need of problem solution

Components of the action program necessary for removal of serious shortcomings in protection of environment:

1. GIS database monitoring.

Establishment of regional program of using the geographical information system (GIS) and remote control means for assessment of current changes in land exploitation, including woods and arable lands.

2. Control of deforestation

Development of the program to control deforestation which includes the following elements:

a) the analysis of authentic database, including information of GIS and the data of remote control for tracing in time the process of felling and planting of woods (including afforestation);
b) improvement of laws / instructions currently in force which demand control/forced measures;
c) planning of use of regional systems, including monitoring, and also measures on utilization of "regional reserves" under regional authorities' control.

3. Continuing growth of the population

This tendency, most likely, will continue in future, causing additional burden on mountain regions. It is intended to develop flexible methods of planning of birth rate and monitoring of anthropogenic impact on ecosystems.

4. Maintenance of the way of life of people in mountain areas.

Estimation of the means necessary for maintenance of minimally allowable standard of living for the population and measures for maintenance of these means, including:

- improvement of agriculture technique: use of methods of plowing of steep slopes, improvement of home animals breeds, more active use of energy available on site (biomass and cart traction);
- introduction of small enterprises to increase incomes of the rural population, including application of mini-hydroelectric power stations and production at households;
- development of ecotourism in mountain regions: ecotourism does not render harm to environment and creates jobs for the population of rural areas;
- preparation of large infrastructural projects in mountain region (necessary for satisfaction of needs of plains as a result of their urbanization/industrialization) to increase standard of living (piped water, sewerage, electricity, roads, schools, etc.) in villages and providing abundant labour force with jobs both at construction, and at projects implementation (including training).

5. Control over pollution level for disposal of contaminants:

a) household waste products of mountain human settlements,
b) drainage from washout of agricultural chemicals,
c) effluents from manure of animals, including use of sedimentation devices, where it is necessary,
d) contaminants transferred through the air from nearby territories.

6. Planning of mountain ecosystem conservation:

- estimation of existing bioresources in Central Asia, use of national nature reserves, formulation of the program of achievement of a necessary minimum of protection of environment by means of improvement of legal base, control and forced measures on performance of the approved decisions. The program should include mechanisms for an estimation of soil erosion and recu-ltivation of mountain territories removed from circulation;
- rational use of water resources: it is necessary to carry out planning for the whole basin;
- rational use of land: formulation of the general strategy or the plan of the best use of land resources in Central Asia;
- rational conduct of agricultural production.

7. Natural disasters combating

Assessment of each kind of natural disasters (earthquake, landslips, and etc) and development for each of them of the regional program for forecasting and preparation with the purpose of minimizing the negative consequences, and also preparation of reserve funds for use in case of natural disaster, including adoption of necessary legislative acts for maintenance of effective regional cooperation.

Suggested measures for reversing and prevention of mountain ecosystem degradation

1. Legislative initiative on development of social and ecological policy of maintenance of comfortable conditions of life and activity in mountain areas. The responsibility for damage brought to nature.

2. Creation of the state system of monitoring:
   - monitoring of indicators of mountain ecosystem dynamic;
   - monitoring of condition of natural resources in mountains (material, energy, human, and others)

3. Establishment of a database of indicators (criteria) related to degradation of the nature, sustainable development (informative factors).

4. Development of criteria of sustainable development for each zone of mountain district.

(For example: up to 500m, 1 km, 2 km, 3 km, 4 km, 5 km, 7 km).

5. Mathematical modelling (computerized) of dynamic developments of events andproviding of recommendations on sustainable development.

6. Activization of nature protection measures (national parks, nature reserves, game reserves).

7. Struggle against poverty of the population of mountains, supply of the population with energy.

8. Independent power supply of the mountain population with local renewable energy sources (RES) – the solar energy, wind power, biogas from agricultural waste products.

9. Spare land use, rational use of natural resources.

10. Restoring of traditional principles of nature management in consideration of science achievements, rational use of the landscape.

11. Construction of buildings and facilities in view of dangerous geological processes (earthquakes, mudflows, collapses, etc.).

12. Training of the population and its active attraction to environmental events and measures (release of newspapers, brochures, books, instructions, etc.).

13. Organization of tourism in mountains and creation of respective infrastructure.

14. Carrying out of regular trainings and working seminars on the problem called "Mountain ecosystem".

15. Attraction of non-governmental organizations to realization of measures.

5. Action plan for 2-3 years

A short-term plan (1 year):

1. Beginning of implementation of the approved projects on reversing of degradation of mountain ecosystems in Central Asia.

2. Organization of training seminars (including those on development of projects to prevent degradation of mountain ecosystems).

3. Development of national strategy on use of renewable energy sources.

4. Harmonization of legal base (development of regional regulatory acts corresponding to the European standards).

5. Strengthening of the system of state and non-governmental control over ecological condition of mountain ecosystems.

6. Education (introduction of courses on ecology in higher educational institutions and of subjects on ecological education at schools).

A medium-term plan (the next 2 years):

1. The subsequent implementation of projects related to improvement of mountain ecosystems of Central Asia.

2. Introduction of new techniques and technologies to supply power for mountain human settlements.

3. Perfection of legal base.

4. Performing of a common system of monitoring of pollution of the rivers and glaciers within a transboundary context; upgrading of seismic and hydrologic stations in mountain territories.

5. Holding of training seminars and courses on creation of a common system of monitor-

ing of degradation of mountain ecosystems within a transboundary context.

6. Creation of a common subregional information database about condition of mountain ecosystems

7. Integrated regional management of the water resources and biodiversity.

8. Improvement of the analytical control system (introduction of the automated system of monitoring of the seismic phenomena).

9. Development of regional strategy on use of renewable energy sources on the basis of fulfilled researches and introductions of pilot projects in the regional countries.

10. Realization of regional strategy and projects on use of renewable energy sources.

6. Consistent implementation of the proposed plan

Suggested possible actions:

1. Creation of new protected territories and/or improvement and strengthening of existing ones; creation of a regional network of protected territories.

2. Use of alternative energy sources.

3. Creation of a network of mountain monitoring.

4. Ecotourism development.

5. Development and/or improvement of legislative, economic and financial tools of protection (charge for nature use, charge for pollution, etc.)

6. Training and attraction of the local population to the decision-making process.

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APPENDIX

Indicators

1. Agricultural resources.
2. Land use. Fertility of soil.
3. Arable lands per capita.
4. The area of pastures.
5. The area of lands containing industrial, dangerous and radioactive waste products.
6. Water resources (quantity and quality).
7. Use of water resources (degree of satisfaction of need for water).
8. Biological diversity of fauna.
9. Evolution of vegetative cover.
10. Endangered species (in% to total natural diversity).
11. The area (%) of degraded lands (pastures, gardens, woods, and etc).
12. The area of woods (as a share of total area) and density of forestry cover.
13. Intensity of deforestation

Current projects in "Mountain Ecosystem Degradation" context in Central Asia

1. Use of renewable energy sources for development of rural population (with UNDP support, costs – US$5.000.000).

2. Preservation and sustainable use of agrobiodiversity of Tajikistan (with UNDP support, costs – US$175.000).

3. Use of mini HPS in highlands (with UNEP support, costs – US$55.000)

The pilot projects approved by ISDC

1. Improvement of socioeconomic conditions of mountain regions (expenses- US $1.600.000)

2. Mitigation of risk of natural disasters in vulnerable mountain regions (expenses – US $2.500.000)

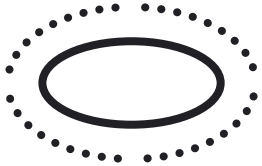
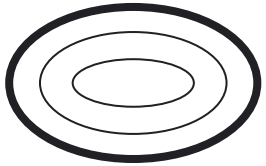
3. Increase of capacity of the countries of Central Asia for sustainable management of mountain ecosystems (expenses- US $300.000)

4. Use of renewable sources of energy (RES) US $750.000.00 (for each country)

5. Use of energy of the small rivers US $1.000.000.00 (for each country)

Appendix. Structure of PNT territories under the Law "On protected nature territories" (03.12.04)

<table>
<tr><th colspan="3">1. Without zoning, without protected zone</th><th colspan="3">2. Without zoning, with protected zone</th><th colspan="3">3. With zoning, without protected zone</th></tr>
<tr><th>PNT name</th><th>Individual characteristics</th><th>General characteri-stics</th><th>PNT name</th><th>Individual characteristics</th><th>General characteri-stics</th><th>PNT name</th><th>Individual characteristics</th><th>General characteristics</th></tr>
<tr><td rowspan="2">1. Natural nurseries</td><td rowspan="2">Regime without strict limits allowing interference</td><td rowspan="6">Unified regime for all territory</td><td>1. State reserves</td><td>Limitation of impact from adjacent territories.</td><td rowspan="7">Common regime for the whole territory</td><td>1. Natural parks</td><td></td><td rowspan="7">Different regimes for separate zones.

Outside zones play a role of protected zone.</td></tr>
<tr><td>2. Integrated (landscape) game reserves</td><td>Limitation of impact from adjacent territories.</td><td>2. Resort natural territories</td><td></td></tr>
<tr><td>2. Formation zones</td><td>Regime without strict limits allow-ing operation.</td><td>3. State nature heritage</td><td>Limitation of impact from adjacent territories on the protected object.</td><td>3. Recreation zones</td><td></td></tr>
<tr><td rowspan="2">3. Fish indus-try zones</td><td rowspan="3">Regime without strict limits al-lowing operation of protected resources.</td><td>4. Game reserves</td><td>Limitation of impact from adjacent territories on objects and complexes.</td><td>4. State biospheric reserves</td><td></td></tr>
<tr><td rowspan="2">5. Riverside</td><td rowspan="2">Water-protective zones play a role of protected zones.</td><td rowspan="2">5. Water-protective zones</td><td rowspan="2">Riversides and sanitary control zones of water objects play a role of internal zones.</td></tr>
<tr><td>4. Forestries</td><td>6. Sanitary control zones of water objects</td></tr>
<tr><td>5. Hunting grounds</td><td colspan="2"></td><td colspan="3"></td></tr>
<tr><td colspan="3">PNT
 
PNT has the established boundary inside which its own regime operates.</td><td colspan="3">PNT Protected zone
 
PNT has the established boundary inside which its regime operates as well as its protected zone surrounding it with its boundary inside which poorer regime of protected zone operates providing limited impact from adjacent territories.</td><td colspan="3">PNT its zones
 
PNT has the established boundary inside which the boundaries of a few zones are established, each of them has its own regime.</td></tr>
</table>

Regional Appraisal report on industrial and residential waste management

Content

The appraisal report on a problem "Waste Management in Central Asia" has been prepared in accordance with the decisions of ISDC of March 2, 2006 and results of the meeting of environment protection ministers of Central Asia countries at the 9th specialized session of the GEF Board of Governors, with the support of UNEP and at the initiative of Surendra Shrestha (Director of UNEP Regional Resource Center for Asia and the Pacific (UNEP RRC. AC, Bangkok. Thailand)), within the proposals on REAP priority "Waste Management".

The aim is to present the state-of-waste management problem in Central Asia countries and define rationale of the necessity of WM system improvement in view of ecological stability, and development of country and regional strategies on introduction of effective mechanisms of integrated management of industrial and residential wastes.

The report will probably be a useful guide to government decision-makers, scientists, ecologists, representatives of public.

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Introduction

Over a long period of economic activity in Central Asia countries there has been accumulated the huge quantity of industrial and residential wastes containing radioactive nuclides, salts of solid metals (cadmium, lead, zinc, sulfate, etc.). The current situation in Central Asia in the matter of formation, disposal, utilization and burying of wastes leads to non-sustainable use of natural resources, dangerous pollution of environment and becomes a real threat to the health of present and further generations.

The current organizational structure of waste management system in Central Asia countries does not meet the requirements providing the introduction of low-waste technologies, stimulating the development of wastes processing infrastructure, introduction of complex territorial schemes of sanitation and so on. The existing WM system is unwieldy and ineffective. For the purpose of timely solution of the WM problems it is necessary to improve and harmonize the scheme of the state system of WM in consideration of the peculiarities of economic development of the countries and create the single regional scheme of WM for Central Asia countries.

1. Analysis and assessment of waste management problem

1.1. The situation analysis and identification of the problems of environment pollution with solid industrial and residential wastes

Over the long period of economic activity, in the territory of Central Asia, hundreds of millions tons of indust-ral and residential wastes have accumulated in mining dumps and sludge pits, SRW dumps, unauthorized landfills *(Pictures 1-5)* among which the ecologically dangerous toxic wastes constitute

Pic. 1 Dumps of Kutessaisk pit, Kyrgyzstan

a significant share formed over the so-called "soviet" period. From the early 1990s, the issues of collection, disposal and burial of solid industrial and residential wastes are solved in a very unsatisfactory way. The current state of the problem of pollution of environment with industrial and residential wastes in Central Asia countries is characterized by the absence of a system of separating collection and utilization of wastes, absence of rubbish processing and rubbish incineration factories.

Industrial wastes

The main quantities of these wastes come from mining and processing industries. The accumulated volume of industrial wastes in ***Kazakhstan*** makes 40 billion tons; ***Kyrgyzstan*** – 1 billion tons; ***Tajikistan*** – 210 million tons, ***Turkmenistan*** – 165 million tons, ***Uzbekistan*** – 1.3 billion tons.

In ***Kazakhstan***, over 40 billion tons of mining industrial wastes have been stored at the area of 129 thousand hectares. Annually, the formation of industrial wastes makes about 4 billion tons, of which 7% at least are used, and of 150 million tons of toxic wastes only 17% are used. In the territory of Republic, there are 118 dumps of stripping rocks, non-standard ores and wastes of radioactive ores processing making in total 56 million m (the area is 1412 hectares), the radiation background of which is from 35 to 300 mkr/hour.

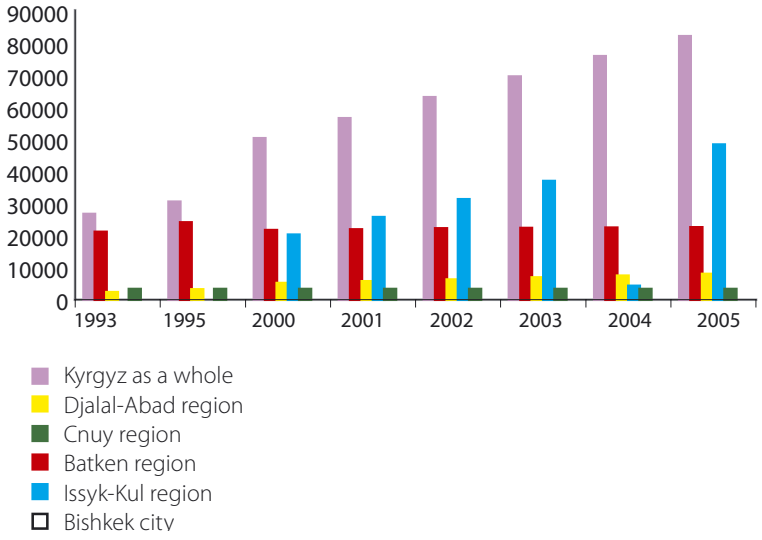

Fig. 1. Availability of toxic wastes in the territory of Kyrgyzstan

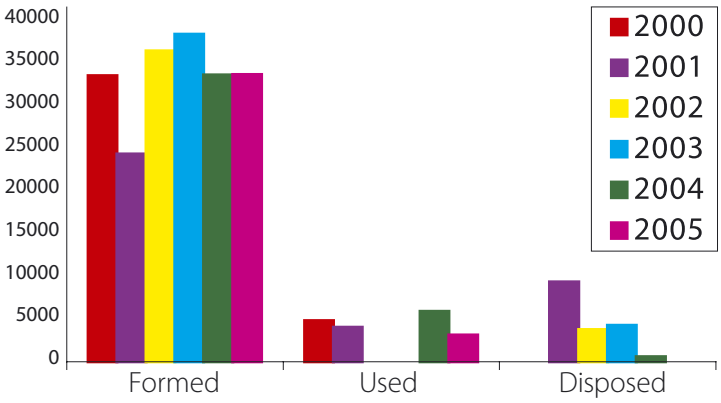

Fig. 2. Formed, used and disposed toxic wastes (tons). Turkmenistan

In ***Kyrgyzstan***, over the latest decade, 57.0 million tons of toxic industrial and residential wastes have accumulated, of which 4.0 million tons were utilized, 0.55 thousand tons (0.1%) were fully disposed and 81.9 million tons were buried, including the wastes accumulated before 1995. The wastes not subject to utilization and processing have been sent for storing and burial. More than a half of 44 statistically reported areas with buried wastes do not meet the current normative rules.

The dangerous (toxic) wastes the quantity of which reaches 81946.1 thousand tons adversely impact the environment. The total area of territories exposed to radioactive pollution has reached 6 thousand hectares where 145 million tons of radioactive wastes are concentrated. The radioactive tailings and dumps located in the region of Mailuu – Suu town cause a big concern. Some part of them runs the risk of destruction by landslides and washout by water currents. The capacity of tailings is 75 million m. The total volume of mining dumps is 620 million m; the covered area is 1.950 hectares. The dynamics of formation, location of toxic wastes is shown at *Figure 1*.

In ***Tajikistan***, the accumulation of industrial wastes exceeds 210 million tons. The degradation of 11 tailings of radiation burials in a volume of over 50 million tons continues to take place in the Sugdsk district. The condition of 3 tailings and dumps near Taboshar town and Adrasman town is mostly unsatisfactory. The threat of ecological catastrophe at these objects and adjacent territories is aggravated by the destruction of tailings and dumps in a result of mudflows and water flows, wind erosion. The operating Digmaisk tailing (Chkalovsk town) is exposed to the active wind erosion. The assessments conducted by the Production Association "Vostokredmet" have a small effect, as the absence of necessary facilities does not permit to liquidate the above mentioned negative facts regarding the conservation of tailings and the deviations from the norms of exploitation of these objects.

In ***Turkmenistan***, over 1 million tons of industrial and residential wastes appear every year. The toxic industrial wastes require a special organization of storing and burial. There are 4 organized grounds for toxic wastes: Mary, Dashoguz, Akhal, Lebap velayats, where mainly the useless poisonous chemicals and pesticides are buried. Practically, there are no places of special organized storing and burial of industrial wastes. Therefore, the enterprises remove the toxic wastes to the SRW dumps or to the special places of their industrial zone. Now, 32.3 thousand tons of toxic industrial and residential wastes are available in storages, special grounds, dumps, and 93% of this volume is concentrated in the Balkan velayat. Over 90% of toxic wastes are formed from oil sludge. In 2004, 1062.6 tons of toxic wastes were formed. The oil sludge (92%) is the main component of toxic wastes. *Figure 2* shows the indicators of accumulation and use of toxic wastes in dynamics.

Over 100 million tons of different wastes are available in the territory of ***Uzbekistan***, over 14% of which is referred to the toxic ones. The share making 0.08% of annually occurring toxic wastes is utilized, 0.11% are transferred to other organizations on an agreed basis (Vtorchermet and so on) and the rest ones are sent to the places of organized storage. Only 0.2% of total quantity of wastes is returned to the production as secondary resources, the main mass is collected in the sludge storage, tailings, at the territories of enterprises. The places of burial of waste mostly have no an engineering system preventing the penetration of wastes to the environment or these preventive systems are not in a good condition. About 2 billion tons of solid wastes have accumulated in the dumps, tailings, sludge pits, landfills. Every year, 90 million

Pic. 2 The Actyuz tailing of toxic wastes, Kyrgyzstan.

tons of stored wastes contain the rocks of stripping, tails of flotation concentration, various slag and clinkers. About 300 thousand tons of slag occur in nonferrous and mining metallurgy every year. These wastes are the direct threat of environment pollution. The uncontrolled and unregulated formation of wastes deteriorates the sani-tary-epidemiological situation of human settlements.

Residential wastes

Over 15 years, about 56.3 million tons of SRW have accumulated in ***Kazakhstan***. The volume of SRW is 2.2 cubic meters per resident a year (*Figure 3*). The yearly formation is about 7 million tons. The main mass of wastes without separating into components is delivered and stored at open landfills, 97% of which do not correspond to the requirements of nature conservation and sanitation. Only 5% of SRW is utilized. In conditions of limited financial resources the unauthorized landfills become the cheap and acceptable method of continuous burial of residential wastes. The existing landfills need radical upgrading in accordance with technical requirements of their construction.

SRW cause a big problem and unfavorable ecological situation in ***Kyrgyzstan***. The annual formation of SRW is about 6 million tons. In 2005, 1384 thousand m of wastes were brought to the landfills. Over the last years, the regular collection of municipal wastes in cities and villages notably reduced.

According to the NEAP (1995), the municipal garbage collection was regularly performed only in 39 cities and 95 villages, while in 770 villages these services were provided as requested. About 155 areas of SRW storing exist in the whole country and only one of them completely meets the hygienic requirements. Now, there exist 31 landfills of SRW (according to the information of Republican SES) of which over a half (55%) do not correspond to sanitary norms. The current containers and special auto transport do not satisfy the needs of the cities. The system of separating collection of wastes does not work. The system of cleaning the territories from SRW is not perfect, the sorting and using of wastes as a secondary raw material is not performed, and the wastes processing is absent. The upward tendency of formation of wastes and reduction of volumes of their delivery to the areas of burial are shown in *Figure 4*.

There are about 70 landfills of SRW in ***Tajikistan***, 5 of which are managed, the rest ones belong to the type of spontaneous ones. There are decisions of local authorities for allocation of land plots only for 36 landfills, while for 27 landfills the official documents are so far at the stage of drawing up. The total territory of these areas is 300 hectares. Over 90% of landfills do not meet the modern requirements of construction and sanitary norms.

The annual formation of SRW is more than 3 million tons. Over the last years the morphological composition of SRW significantly changed where the wastes of polymeric materials and electronic products prevail.

About 1 million tons of different kinds of wastes accumulate every year in ***Turkmenistan***. Mainly, it is the food wastes, glasses, plastics, metals and construction refuses. In 2001, these indicators reached 1287.0 thousand tons, and in 2003 they decreased to 992.7 thousand tons (*Figure 5*). By present time, the burial at the landfills is the only method of waste disposal in Turkmenistan. In perspective, this tendency will remain, with exception of Ashgabat city where the construction of rubbish processing factory is planned. The toxic waste is the largest danger for the environment.

Before 2001, there existed the system of sanitary cleaning of territories of the cities and towns in ***Uzbekistan***, which was regulated at the state level by Ministry of Municipal Services. The whole municipal infrastructure of rural areas was under the Ministry of Agriculture. The collection and disposal of wastes was fulfilled by the specialized auto enterprises responsible for sanitary cleaning of territories in the cities and towns. The total quantity of SRW at the places of burial decreased after a number of years. The Ministry of Municipal Services conducted the single technical policy for collection, disposal and utilization of SRW. For instance, 9510 thousand m^3 were collected and disposed in 1996, and in 2004 – 3489.2 thousand m^3, 50% of which fell to Tashkent city. In 2004, less than 60% of wastes were disposed by the enterprises of sanitary cleaning. The warehousing of wastes is done at 160 landfills occupying the area around

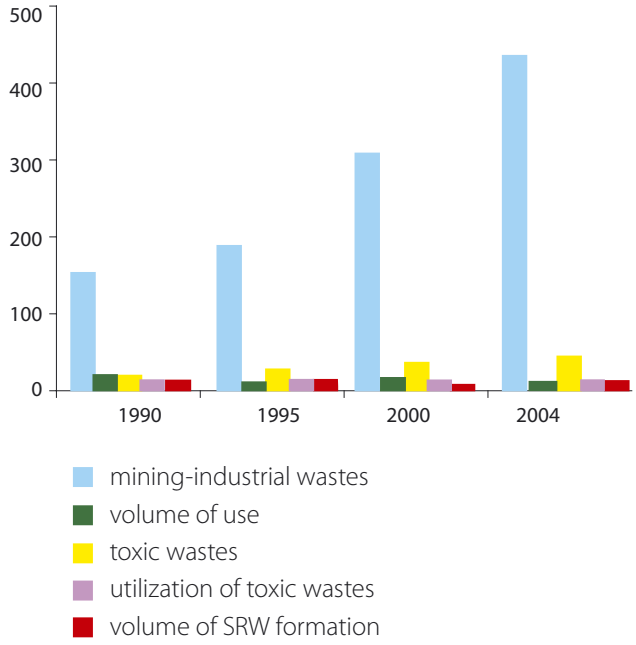

Fig. 3 Availability of industrial wastes including toxic SRW and volumes of their use in Kazakhstan (thousand tons)

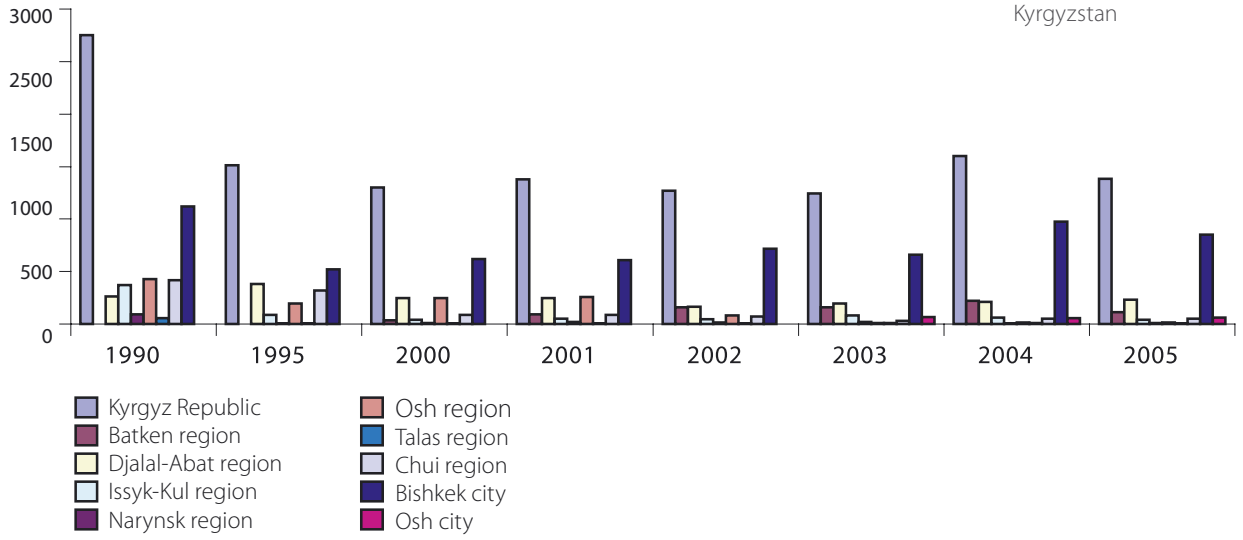

Fig 4. SRW removed to landfills (thousand cubic meters), Kyrgyzstan

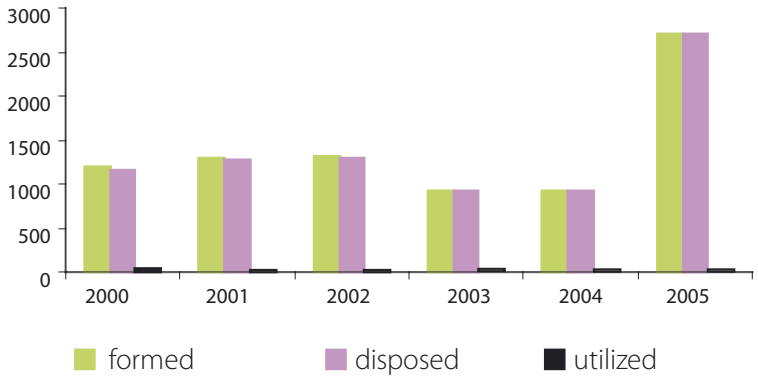

Fig 5. Formation and disposal of residential wastes (thousand tons), Turkmenistan

2 thousand hectares. Over 90% of dumps are in unsatisfactory condition. They all are organized without duly measures of engineering protection. Their impact on environment is controlled insufficiently. As for the morphological composition of the wastes, of total volume of SRW collected and brought to the landfills by special transport enterprises in 2003, around 850 thousand m^3 was wastepaper, 100 thousand m^3 – metal, 140 thousand m^3 – textile, which in the presence of necessary technologies and equipment could be processed to respective products and involved into national economy process (according to data of the survey conducted by "Maks Aiher" (Germany) within the project of World Bank in Tashkent city). The agricultural wastes come from cotton growing (oil-cake, residues of planting mass), livestock breeding (manure, residues of fodder mass, bedding materials). These wastes are used by people for the household needs.

In CA countries there is no comprehensive ecological policy of development in the sphere of waste management at the stage of formation, disposal, utilization, monitoring and so on. The absence of real mechanisms on prevention of the growth of solid residential and industrial wastes and also of legal and economic mechanisms at all levels does not permit to create the system of stimulation of the nature users to reduce the volumes of wastes formation and provide their safe treatment. The acute shortage of financial resources, the weak performance of laws, lack of inter-agency coordination, absence of complex integrated analysis of situation of socioeconomic and ecological problems cause the low level of implementation of decisions taken in the sphere of WM.

1.2. Waste management regulation at the state level

Now, there is no a single coordinating structure in WM sphere in Central Asia region. Licensing, state control, monitoring and reporting are the main basis of the state regulation.

The WM problems, with taking into account of whole complex of components such as formation, collection, transportation, utilization, processing of secondary materials and SRW, monitoring, etc., in Central Asia countries become more complicated due to non-rational use of minerals, insufficient quantity of specialized techniques, absence of rubbish processing industry, insufficient use even of existing possibilities to process the separate components being the secondary raw material and so on.

1.2.1. Monitoring system (formation, collection, accumulation, transportation, burial and utilization)

Monitoring is one of principal conditions for implementation of control over changes in volumes and quality of wastes and their influence on the health of people and environment. The governments of Central Asia countries, with the support of international organizations should:

- elaborate and apply the wastes monitoring methodology of other countries that would meet the level of other countries;
- conduct the collection and analysis of data, establish national indicators and control their implementation;
- appraise the ecological effectiveness of national policy in the sphere of waste management which should serve as the basis for realization of measures on improvement of current situation;
- provide the information for inclusion into the global informational system of Central Asia countries.

In Central Asia countries, the institutional structure of management and coordination of interdepartmental activity in the issues of monitoring of natural environment is not perfect yet and rather often the functions are duplicated. The priority directions of environment and objects subject to monitoring are determined not completely.

In ***Kazakhstan***, the level of development of the state system of waste management monitoring does not meet the modern requirements, and moreover, it is far from the elementary statistical reporting. The attempt to solve this task by the method of an economic branch does not bring any positive results.

In ***Kyrgyzstan*** there is no the single system of monitoring of formation, collection, piling, transportation, burial and utilization of wastes. Monitoring is conducted according to the state program and theoretically on the basis of standard methods and norms. Monitoring is organized at the national, regional and municipal levels. Monitoring of radioactivity is carried out through three separate nets: the State Agency on Environment Protection and Forestry, the Sanitary Epidemiological Station (SES) and the State Agency on Geology and Mineral Resources. SES is responsible for the monitoring over radioactive pollution of foodstuffs and water. The nets are not united.

The system of state statistical reporting and monitoring of data on the volumes of wastes formation, their structure, the level of impact on environment and people's health is not available in ***Tajikistan***. The waste management system is regulated in the territory of Republic by the sanitary rules and norms developed in early 1980s.

The formation, collection, piling and disposal of wastes, as well as the monitoring is mostly provided at the level of piling and transportation in ***Turkmenistan***. The Sanitary-Epidemiological Station and Ministry of Nature Protection control the observance of rules on collection, piling and storing of industrial wastes. The administrative penalties are the main measure to combat the violation of rules. The absence of legal base stimulating the reduction of wastes formation hampers the elaboration of technological solutions directed on reduction of wastes volumes. It is also necessary to note the insufficient monitoring of environment condition directly at the SRW landfills.

In ***Uzbekistan***, 30% of all industrial wastes are referred to the dangerous ones, 1.5%-2% are the wastes related to secondary material resources (steel scraps, ashes, oil-cake and so on), the others are the wastes not covered by statistics, which are mainly the wastes of mining industry (dumps and soon). By present time, there has been fulfilled the large quantity of work on inventory of wastes of enterprises which is used only for development of limits of placement at the enterprises. The clear system of monitoring can be created only within the single system of accounting and reporting and also the strict state control over observance of relevant legal acts.

1.2.2. Accounting and reporting system

Availability of the reliable, impartial, timely information is an important component of the state-of-environment assessment. This basic link in formulation of a sustainable environmental policy requires the essential reform as the current method of collection, processing, assessment, analysis and presentation of information is not quite perfect.

In ***Kazakhstan*** the situation is complicated by absence of information for many sources of pollution (dumps, tailings, slime pits, burials, etc) about the volumes of warehoused waste, its location, method of utilization, the content in wastes of harmful and toxics elements. Now the "3-toxisc wastes" reporting form is available in the official statistics and another 2 reports were introduced in 2006: #1 waste – "Report on municipal waste" and # 2 waste – "Report on sorting and storing of waste".

In ***Kyrgyzstan*** the statistical information is collected on the basis of the law "On state statistics" defining the main principles of collection, storing, analysis, summarizing, presentation and publication of data about events and processes taking place in the economic and social spheres of Republic and is compulsory for observance by all government authorities, enterprises, institutions, organizations, irrespective of ownership form, departmental subordination and also by physical persons. The statistical reporting refers not to all kinds of waste. There are two forms of statistical reports – "Report on landscaping and sanitation measures in cities and human settlements" and "Report on formation and handling of toxic industrial and residential waste".

Tajikistan. Since 1993, the system of state statistical recording and monitoring in this sphere stopped

due to the absence of users of information on waste formation volumes, their structure and level of impact on environment and on people's health.

The system of statistical reporting on wastes was absent in ***Turkmenistan*** until 1998. Now, the state statistics agencies ("Turkmenmillihasabat") jointly with the Ministry of Nature Protection have elaborated and introduced the form #1-DZ and the annual form "Report on formation and handling of toxic waste". All enterprises, organizations, institutions being the sources of toxic waste or responsible for the treatment or disposal of these wastes submit reports under the form #1 – ZG. Storages, dumps, landfills where the wastes enter become dangerous for people's health and environment. The agencies of Ministry of Nature Protection and Ministry of Health Care and Medical Industry of Turkmenistan define the list of particular reported objects in consideration of the criteria of reporting on formation and disposal of toxic wastes under the form #1-ZG.

In ***Uzbekistan*** the statistical data on wastes are prepared at the enterprises in accordance with the law of Republic "On state statistics". These are two forms of reporting: form #3 – toxic wastes (form #3-TO) existing since 1993, and forms on secondary material resources (loss of raw material in the process of production and wastes). All these forms are completed in accordance with the instructions approved by the Ministry of Macro Economy Statistics of Uzbekistan. The system of SRW recording and reporting is based mainly on calculations (in accordance with Sanitary Regulations and Norms of Uzbekistan #0068-96 the average accumulation of SRW per 1 resident is assumed as 1.2 kg/day (0.0032 m^3).

In CA countries there is no the single system of standardization, recording of formation and using of wastes, as well as of methods of statistical processing of information on wastes.

2. Indicators of waste management

There are no regional indicators on waste management in Central Asia countries. In national statistics of some Central Asia countries there are indicators which do not cover the accumulation of all kinds of wastes, first of all industrial, and do not reflect the real situation of waste management. The introduction of proper indicators to the national statistics has the priority significance for monitoring and taking of measures to solve this problem in the region.

3. Financial provision

In ***Kazakhstan*** the investments to WM over 2001 - 2004 made 11147 million tenge. Over this period the current expenses equaled 24037 million tenge and increased from 3862.5 million tenge in 2001 to 8339.8 million tenge in 2004, i.e. 2.2 fold. In 2002 there was sharp reduction of investments – 406.5 million tenge against 7049.4 million tenge in 2003, or 17 times. The investment expenses for WM from total investment to environment protection varied from 1.9% in 2002 to 26.4% in 2003 and made 6.5% in 2004 and their contribution to the creation of fixed assets equaled 0.04% and 0.2% in 2002 and 2004 accordingly.

The Republic spent 6009.4 million tenge for treatment, processing, recovery and disposal of wastes, which to current expenses for environment protection accounted for 26.3% on average and reached 29.1% by 2004. Expenses for total waste management in 2001 and 2004 increased also, making 4818.4 million tenge and 11075.1 million tenge accordingly. Over these years the percentage of these expenses of overall public expenditures for environment protection increased from 12% to 16.8% (*Figure 6*).

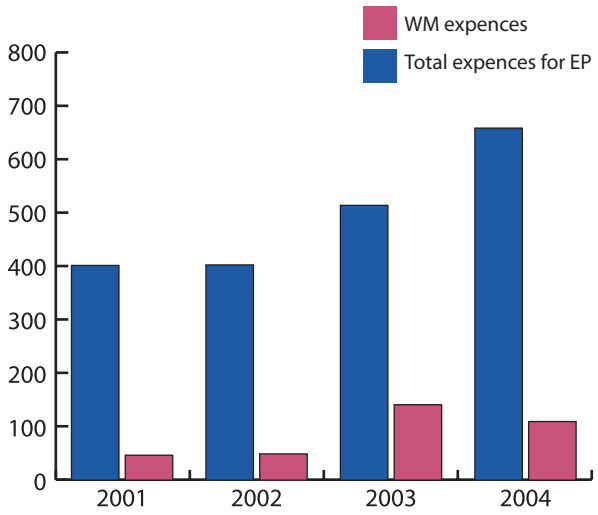

Fig. 6. Expenses for environment protection and waste management in Kazakhstan

Without any program planning for this problem it is impossible to estimate any expected investments and operational expenses on solution of WM objectives. Therefore, this information is not used during the elaboration of the national policy. Now, the institutional capacity of management of the state resources in a part of WM is weak from the point of view of nature protection activity efficiency in the considered sector of management effectiveness.

There is the system of ecological funds on collection of payments for pollution of environment in ***Kyrgyzstan***, including the pollution with wastes, but these payments are not effective in the aspect of stopping of pollution and inducement of the prevention of pollution. The mechanism of recoverable financing on reconstruction of disturbed ecosystems does not work appropriately. The low priority of WM problems in the national development agendas hinders the increase of ecological and financial assistance. The government in the state natural protection sphere is limited with the budget process and program of state investments. It happens because of misunderstanding of real economic value of efficient WM. There is no the system of encouragement and privileges stimulating the introduction of cleaner technologies, minimization and repeated use of wastes.

Some sources of financing for WM have been defined in ***Tajikistan***. The domestic sources include the state and local budgets, also the extra-budgetary state and local specialized ecological funds. The state financing of the WM projects is extremely limited. The main part of financing of WM is done at the enterprises at the expense of tax collected from individuals and enterprises for the services on collection, transportation and disposal of municipal wastes. Now, the extra-budgetary specialized ecological fund is not able to finance sufficiently the solution of priority ecological problems because of small amounts received from nature users. There is the interest of international organizations in financing the issues of wastes handling. USAID does a big job. They had chosen three pilot districts: Kanibadam, Uratube, Hodjent to support with grants the organization of areas for SRW burial. They provide assistance in acquisition of specialized techniques and equipment on collection, transportation and burial of SRW. EBRD implements in Dushanbe

city the project on SRW management. The project is aimed at providing the techniques and constructing the rubbish processing plant.

In ***Turkmenistan***, the financing of measures on WM is provided from the state budget and also at the expense of payments from enterprises, institutions and households. Every year, it makes over 13 billion manat (US$2.6 million). The assistance in a form of grants was not provided.

The UNDO project on introduction of cleaner technologies is implemented in ***Uzbekistan***. There have been developed the technologies with differential approach for some kinds of production, and they are approbated now at large enterprises.

The irrelevant to requirements structure of expenses hampers the increase of results in WM activity. Even the existing environmental programs of territorial level mentioning the WM do not define the priorities and are not oriented on the final result. There is no the analysis of expenses efficiency, instruments of realization of this problem and realistic financial plans. Investments from business structures do not provide effective incentives for their implementation by these partners. As a result, the small resources are distributed too unclearly between the projects and programs at the territorial level and as a rule these measures are not financed and fulfilled.

The weak system of financing of WM in Central Asia countries leads to low performance of financial expenses for solution of WM problem. The non-efficient state regulation by nature protection expenses on WM deprives this sector from large volumes of these financial resources.

4. Measures taken by the states to reduce industrial and residential wastes formation

4.1 Processing, secondary use of wastes

The wastes processing today could become the huge source of raw materials for manufacturing of necessary products. It is necessary to provide the legal, economic and material-technical base for this matter.

Kazakhstan performs processing of different kinds of industrial wastes of joint-stock company "Kaztsink", Aksusk and Aktubine factories of ferroalloys. Within the last 7 years, the joint-stock company "Kaztsink" has been providing the treatment of all polluting discharged waters. Seven new water rectification facilities were built. Now, 24 kinds of wastes (67%) are utilized. There have been reconstructed and built eight areas for wastes storing. The new dust and gas catchers were put into operation. The environmentally safe technologies are successfully introduced. In 1997-2003, total investment of "Kaztsink" to environment protection equaled 22 billion tenge. In spite of the increase of slag formation volumes at the Aksusk factory of ferroalloy, the processing of ferrochromium slag increases every year, from 288.5 thousand tons in 1998 to 871.334 thousand tons in 2004. The volumes of slag output and processing equaled to each other in 2001 and from that time the processing of their dumps turns to good products – crushed stone, metal concentrate and rubble stones. In 1997-2005, the new technologies directed on increasing of environment quality have been elaborated at the Aktubine ferroalloy factory.

The wastes of metallurgical enterprises are the essential technogenic source of various raw materials for industry. The priority of introduction of integrated environmentally safe technologies is determined by the tonnage and toxicity of formed pollutants, with taking into account the efficient operation of existing today treatment facilities. That's why the construction of such technologies should be realized on the following directions simultaneously:

- perfection of current and elaboration of new technologies;
- elaboration of rational methods of wastes utilization.

Kyrgyz Republic does the certain work in processing and disposal of wastes, secondary use and extraction of valuable components (mining enterprise Kumtor, Karabaltin ore plant, Makmal gold extracting factory, Haydarkan mercury factory and so on) that promotes the reduction of wastes and prevention of environment pollution. Besides, they introduce the biogas technologies of wastes processing (the private livestock farming), work over the treatment of effluents and using of treated water in the agriculture and also over the secondary use and processing of wastepaper, plastic, glass.

Tajikistan. Over the period of the 1980s, the separating wastes collection had the priority character. The state procurement enterprises of former Gossnab and Tajikpotrebsoyuz produced consumer goods from 22 kinds of processed wastes. In 1986, there has been developed the state program on secondary resources using that stipulated investments to construction and reconstruction of objects for wastes processing. Now, such policy in the sphere of WM stopped to exist.

The technological wastes accumulated in the tailings at the enterprises of gold mining (JV "Zeravshon"and JV "Aprelevka") and silver mining (Adrasman mining concentrating factory) formed large volumes of "technogenicfields" containing the compounds of rare land elements, copper and other useful components. The preliminary assessments of their further processing prove the expediency of their using with the attraction of modern technologies. The wastes formed at the Tajik Aluminum Plant are the valuable secondary material both for the plant itself and for other industrial enterprises. Fulfillment at this plant (since 1997) of the program on inclusion of wastes into recycling production reduced the volumes of their piling by 76% and permitted as a whole to improve the ecological situation in the adjacent area.

The positive tendency has been noted in inclusion of wastes of ferrous metals to production of armature, cast-iron alloys. This direction of activity is based mainly on organization of joint enterprises with China. The same tendency is noted in utilization of wastepaper and metal plastic, which is used for the production of various goods for residential sector.

Turkmenistan. The processing and secondary use of wastes is one of the important components of rational use of resources. The system of collection and processing of wastepaper and glass items works appropriately. The wastes of cotton-spinning and textile enterprises are utilized. The wastes from fertilizers production (ph-osphogypsum) are used for the improvement of sandy soil quality. The construction of metallurgical factory is planned where the recycling of scraps of ferrous and non-ferrous metals is envisaged. NEAP of Turkmenistan stipulates the deep processing of oil sludge and ground containing the oil and petroleum products.

4.2 Introduction of "clean" technologies

The industrial wastes are the sign of imperfection of technology and production organization. Minimization of wastes through utilization paves a way to the policy of wastes formation prevention and their recycling. In this connection, the creation of low-waste and "clean" technologies is the important direction of the sustainable use of nature resources.

In ***Kazakhstan*** the measures aimed at neutralizing the aftereffects of waste formation assume the extensive methods of economy. Expenses on such measures often exceed the expenses on introduction of advanced low-waste technologies. At a number of enterprises, the expenses on disposal and storing of wastes account for 15% of products prime cost and

10% of investments provided for the production development. The inefficiency of traditional nature protective measures essentially decreases the effectiveness of total investments.

The introduction of clean technologies is defined in NEAP in Kazakhstan. However, the insufficient financing and imperfect environmental legislation hamper the implementation of the planned measures.

The introduction of "clean technologies" is defined in NEAP in ***Turkmenistan***. The introduction of environmentally safe technologies meeting the international standards is planned in the system of Ministry of Oil and Gas of Turkmenistan. They also conduct modernization of the Turkmenbashi Refinery, develop the technical project of utilization of oil sludge and oil-containing grounds under the territory of the Turkmenbashi Refinery, in particular the system of oil waste treatment on the basis of "Stetfield" complex was introduced by the"Emerol Ltd" company.

In ***Uzbekistan***, the processing and secondary use of wastes is one of the directions of WM and minimization of wastes transportation to landfills. Now, the joint-stock companies and private sector realize the secondary use and processing of such wastes as scrap metals, wastepaper, plastics, glasses, rubbers.

The low-waste and "clean" technologies are introduced in Central Asia countries not intensively. It is necessary to revise the priorities of regional and national policy in the sphere of resource conservation, nature management and wastes utilization. The funds should be mainly directed not on pollution consequences combating, but on prevention of wastes formation.

4.3. Transboundary aspects of dangerous wastes management

The state regulation of transboundary matters of dangerous wastes management in Central Asia countries is carried out in accordance with the Basle Convention (March 22, 1989) "On control over transboundary transportation of dangerous wastes and their disposal" ratified by Central Asia countries (except Tajikistan).

In ***Kyrgyzstan***, the management of transboundary dangerous wastes at the state level is regulated by the laws "On environment" (1999), "On industrial and household wastes management" (2001), "On licensing" (1997).

In accordance with the law "On licensing", the license is granted for the transboundary regulation of dangerous wastes: the transportation of wastes (including transboundary ones) of toxic substances production.

The list of licensed organizations and experts of licensing of export of specific goods is approved by the Government Resolution of October 29, 1998 #709. The licensing mechanism is established by Government Resolution of May 31, 2001 # 260 "On licensing of certain kinds of entrepreneur activity".

In ***Tajikistan***, the law "On foreign economic activity" defines the policy in the sphere of dangerous wastes handling within the transboundary context. The law mandates the entities of foreign economic activity to observe legislation and other legal norms covering the territory of the country and also international norms and rules on submission of findings of expertise on correspondence to sanitary, ecological and other requirements of works, surveys and projects fulfilled within the international cooperation; on receiving the license for implementation of separate kinds of foreign-economic activity, the list of which is defined by Government of the country.

Moreover, the transboundary management in dangerous wastes handling is defined by the law of Tajikistan "On state regulation of foreign trade activity" specifying:

- the mandatory observance of standards at whole territory of the country and the criteria of safety for people's health when importing

the goods (including dangerous wastes) and observance of control rules;

- the procedure of export and import of splitting, poisonous, explosive, toxic, psychotropic substances and also the order of their use;

- the protective measures, prohibitions for export and import of a commodity in accordance with the laws of the country and international agreements, in view of national interests including the protection of people's health, fauna and flora and environment as a whole.

In ***Turkmenistan***, in accordance with the Decree of President of Turkmenistan of March 1, 1999 # 4091 there was issued the Regulation "On Establishment of State Committee to Guarantee Implementation of Turkmenistan's Commitments Arising from UN Environmental Conventions and Programs". This document mentions that Turkmenistan, as a country Party to the Basle Convention on control of transboundary transportation of dangerous wastes and their disposal with the purpose of reduction of risk of damaging the people's health and the environment, undertakes to provide control over tranboundary transportation of dangerous wastes.

In ***Uzbekistan***, the state regulation of transboundary WM is the responsibility of the Cabinet of Ministers of Republic of Uzbekistan.

The significant legal framework on regulation of transboundary WM is available in Central Asia region, but the normative mechanisms have not been worked out appropriately.

5. Public awareness and ecological education of the population with regards to wastes treatment

The efficient solution of environmental problems in Central Asia countries with regards to WM is possible only in close cooperation of government authorities, production sector and public. The level of public awareness and ecological education is rather low in the aspect of WM, mainly owing to the absence of traditional participation of the community in decision-making and also the lack of materials for discussion. The Central Asia countries, except Uzbekistan, ratified the Aarhus Convention on access to information and participation of public in decision-making and on access to the justice in ecological issues.

In ***Kazakhstan***:

a) The access to information. In addition to the provisions in Chapter 14 of the law "0n Environment", the Aarhus Convention grants the right of public for the information and possi-

Pic. 3 Degmaisk tailing pit of radio-active wastes, Tajikistan

ble participation in discussion of the plans of future activities that can impact the environment.

b) The voluntary agreements (memoradumms) are necessary for enhancement of possibility of implementation of WTO decisions and EU resolutions.
c) The ecological education of public has the significant effect in formation of values and makes easy the cooperation of all interested parties (Government, NGO, business structures). However, it is at the initial stage.

The Aarhus Convention in ***Kyrgyzstan*** is considered first of all as the instrument of further democratization, strengthening of regional agreements on cooperation and of adequate solution of the actual issues of environment protection. The access to the information is singled out to the separate clause in the list of national priorities as this direction is important for creation of the sound basis of participation of public in decision-making on the issues of environment protection.

The norms on attraction of the public to decision-making in the sphere of dangerous wastes management and other issues concerning environment protection are defined in the national legislation (the laws "On environment protection", "On ecological expertise" and so on).The mechanisms are developed for conduction of regular public attending for new laws and national programs covering the condition of EP, including WM.

In ***Tajikistan***, the legislation provides the right for information, including the ecological one. These are the main laws mentioning the access of public and all the population to the information on environment:

- "On nature protection"
- "On information"
- "On ecological expertise"
- "On hydro meteorological activity"
- "On state statistics"
- "On information protection"

The law "0n nature protection" stipulates the right of citizens for ecological information that means the citizens have a right to receive timely, full and reliable information on the condition of environment. This right is provided with proclamation and public discussion of projects, ecologically important decisions, realization of voluntary ecological expertise, projects. Tajikistan is the Party to Aarhus Convention. It provides additional legal possibilities for involving the wide circles of public to the solution of EP issues, to information about its condition and use of nature resources.

In ***Turkmenistan***, the public awareness and the ecological education of the population concerning the wastes handling is conducted within the topic of environment protection.

In ***Uzbekistan***, the wide-ranging measures on increase of awareness of the population in a form of short-term seminars, round-tables, competitions on reduction of wastes formation and their rational use, edition and distribution of booklets and visual aids are regularly organized by the State Committee of Nature, environmental agencies and non-governmental organizations.

The ecological departments in higher education and vocational institutions are set up to teach the future specialists to the issues of WM.

The level of public awareness and ecological education in Central Asia countries remains insufficient in the aspect of WM.

6. Legislation, policy and institutional base for the waste management

Since 1996, the Government of ***Kazakhstan*** introduced a number of law-based measures to solve the problems of industrial and residential SW management. At the national level:

- The development strategy of Kazakhstan until 2030;
- The strategy of industrial-innovation development until 2015,
- The conception of environmental safety until 2015,
- The Sustainable Development Board;
- The Fund of Sustainable Development "Kazyna";
- Eurasian Development Bank;
- The draft conception of transition of Republic to sustainable development.

In ***Kyrgyzstan***, some documents directed on effective WM were adopted with the purpose of environment improvement and provision of ecological sustainable development – the National Environmental Action Plan (NEAP) (1995), the Conception of Environmental Safety (1997), the Strategy of Sustainable Development of (1997), the National Environmental Action Plan on Hygiene (NEAPH) (1999), the Complex Basis of Development until 2010, the State Program of Waste Management until 2015 (2005), the Program of measures on rehabilitation of tailings and dumps accumulated in a result of mining activity.

In 2005, the Government approved the package of documents on WM, including the State Program on WM and State Cadastre of Wastes to implement the law "On Industrial and Residential Wastes".

In ***Tajikistan***, dozens of environmental legal acts including the Law on Industrial and Residential Wastes (2002), the State ecological program and State program on ecological education were adopted with the purpose of achievement of sustainable development.

Thus, the implementation of a complex of measures on utilization of industrial and residential wastes, construction of rubbish processing factories, and creation of economic and legal incentives for the maximum involving of urban wastes to the economy turnover is specified in the Program of Economic Development of Tajikistan until 2015.

In 2006, the adoption of NDS until 2015 is planned. The MDG is the basis of this strategy. The goal 7 of MDG "Provision of ecological sustainability" objective 9 "To include the principles of sustainable development to the national strategies, programs and reverse the process of loss of nature resources" served to be one of the sections of NDS. The measures on creation of new legal mechanisms of implementation of the law "On Industrial and Residential Wastes", perfection of economic mechanisms of incentives in treatment of wastes from the point of view of environment pollution prevention and maximum involvement to economic turnover are stipulated with regards to WM.

The NEAP of Tajikistan approved in 2006 stipulates fulfillment of a complex of measures connected with rehabilitation of wastes burial areas and wastes disposal.

Dump of SRW (Alamedin region , Kyrgyzstan)

In ***Turkmenistan***, the concrete institutional and investment measures are planned in the NEAP (December 2, 2002 # 6007), and particularly:

- the formation of utilization system for SRW collection in Ashgabat city;
- the construction of a factory to process SRW in Ashgabat city;
- the completion of construction of highly toxic wastes burial area.

In ***Uzbekistan***, the main principles of ecological policy in the sphere of wastes handling are stated in the NEAP of 1998 and the NDS issued in 1999 and approved in October 30, 1999 (minutes #2) by the National Commission for Sustainable Development. These documents define the strategy of new state policy meeting the recommendations of UN Environmental Conference in Rio de Janeiro.

In accordance with the abovementioned documents, the ecological policy of the state in the sphere of wastes handling stipulates two directions of actions:

- solution of current socioeconomic tasks connected with the inevitable formation of industrial and residential wastes with realization of adequate measures on protection of environment from pollution with these wastes;
- implementation of specified in the Law of RU "On nature protection" of the citizens' right "to live in natural environment favorable for their health and health of future generations, to be protected from the unfavorable influence of environment".

6.1 Legal framework

The legal base of Central Asia countries in the sphere of WM is based on the laws "On wastes" (for each country except Kazakhstan), "On environment protection" and some other laws and by-laws.

Kazakhstan. The laws "On environment protection", "On ecological expertise", "On air protection", "On radiation safety", "On emergency situations of natural and human-caused character", "On sanitary-epidemio-logical safety", "On compulsory ecological insurance".

Kyrgyzstan. The laws "On environment protection" (1999), "On industrial and residential wastes"(2001), "On tailings and mining dumps"(2001),"On mineral resources" (1997), "On radiation safety of the population" (1999), "On state ecological expertise"(1999),"On licensing" (1997), "On local self-government and local state authorities" (2002).

Tajikistan. In the field of waste management the following laws take a key point: the Laws "On environment protection", "On industrial and residential wastes", "On ecological expertise", "On licensing of certain kinds of activity", in particular in the aspect of dangerous wastes handling, "On radiation safety".

The laws regulate the relations arising in the process of collection, storing, using, transportation, disposal and burial of wastes, and also in the aspect of the state management, supervision and control over the wastes handling. The laws are directed on reversing of negative influence of industrial and residential wastes on environment and people's health, on involving of wastes to economy and production as the additional source of raw materials.

Turkmenistan. The Laws "On nature conservation" (1991), "On ecological expertise", "On state ecological expertise" (1995), the Sanitary Code (1992) and the Land Code (2004).

Uzbekistan. Given the importance of solution of WM problem, in 2002, the Law "On wastes" was approved at the 8th session of Oliy Mazhlis establishing the legal, organizational and economic grounds of regulation of relations in WM.

The realization of a single regional strategy in WM, the liquidation of environment pollution with wastes, the conservation of natural resources through the maximum involving of wastes into production process are the main aims and objectives of laws and by-laws in creation of WM system built on the basis of organizational, legal, economic, informational and control regulators.

Conclusions and recommendations

In Central Asia countries the environmental issues connected with wastes formation, disposal and using are among the main issues of nature protection activity. On the one hand, these problems are characteristic to all spheres of human activity and on the other hand, they provide the essential influence on environment and on life of the society.

The present situation with collection, processing, disposal and burial of industrial, residential, toxic and radioactive wastes does not respond to the requirements of EP. The situation in the region in the sphere of WM leads to the dangerous pollution of environment, irrational use of natural resources and significant economic losses.

While analyzing the main problems connected with WM in Central Asia countries, it is can be noted that: the state policy in the sphere of WM is not efficient;

- effective state policy in the sphere of waste management is not perfected;
- common authorized agency in the sphere of waste management is not available;
- the current legislative base requires perfection as it does not refer to real mechanisms of WM and resource conservation: economic, technical, normative, legal, organizational and informational;
- there is no clear distribution of responsibilities between ministries and agencies involved in waste management activity;
- there is no economic incentive of the wastes handling activity;
- the system of selective collection of wastes is destroyed;
- the low-waste and non-waste technologies are introduced not actively;
- the practice of public and population attraction to decision-making in the sphere of WM is not appropriate;
- there is no single system of monitoring of the condition of objects of collection, piling, disposal and burial of wastes and their influence on the environment and people's health;
- the international standards, laws and by-laws in the system of WM harmonized with the norms of EU are not used enough;
- there is no practice of ecological insurance of environment damages for the financing of measures on its rehabilitation in case of liquidation of enterprises;
- there are no automated informational systems for taking the decisions in the sphere of wastes handling;
- there are no rubbish treating facilities operating at transboundary territories;

Solution of main ecological problems implies the comprehensive use of mechanisms of WM and rational nature use.

To provide the ecological sustainability in Central Asia, improve the system and elaborate the efficient mechanism of integrated WM it is recommended:

- to develop National Strategies and Regional Programs of WM;
- to establish the authorized agencies for coordination of the state policy in the sphere of wastes handling;
- to introduce the advanced international experience in the sphere of WM;
- to improve the legal regulation of WM;
- to strengthen the interaction of state and municipal services;

- to work up and introduce economic instruments promoting the development of low-waste production;
- to introduce the mechanism of economic incentives promoting the reduction of waste formation;
- to promote the development of medium and small business in the sphere of WM, maximally possible wastes utilization, their environmentally safe processing and secondary use;
- to improve the system of state accounting and control of collection, transportation, disposal and storekeeping of wastes;
- to define the main criteria of WM state monitoring;
- optimize the tariffs of collection, transportation and utilization of SRW;
- to establish exchanges of secondary raw materials for solution of WM problem;
- to bring into consistency the mechanisms of WM realization with the requirements of environmental legislation, the matters of licensing and issue of different documents with the requirements of environmental norms and standards providing the observance of environmental legislation;
- to elaborate the programs of sectoral development in the issues of integration of ecological policy in WM sphere.

Pic. 4 Kolter Lake, Kyrgyzstan

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Lands degradation

Content

The appraisal report for CA REAP priority "Lands Degradation" has been prepared in accordance with the decision of ISDC of March 2, 2006, under direct coordination of activities by FP and SIC ISDC of Central Asia countries.

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Introduction

Desertification and drought represent in many respects one of the global environmental problems impeding a sustainable development of the society. Territories that are potentially vulnerable and prone to desertification occupy nearly 52 million sq. km in the world, and annual economic losses from desertification are estimated as US$42 billion. The "desertification" phenomenon emerges as a result of irrational use of natural resources of arid lands.

According to the UN Convention (1994) the term "desertification" implies lands degradation in droughty, semi-droughty and dry sub-humid areas occurring due to various factors, including climate change and human activity. Lands degradation means decrease or loss of biological productivity of arable and pasture lands, and forests.

Processes of desertification in Central Asia cover extensive sandy, clay and saline plains and foothills. Overall picture of this problem in Central Asia countries can be inferred from the "Map of anthropogenic desertification of arid territories of the USSR" (1987) and "Map of anthropogenic lands degradation of the Aral Sea basin" and "Explanatory note" to this map (1993).

With the purpose of achievement of ecological safety, the states of Central Asia have joined the UN Convention to Combat Desertification and take active part at all stages of its implementation.

In all countries of Central Asia the National Action Programs to combat desertification (NAPCD) have been developed and significant material and human resources have been attracted for their implementation.

In 2003, the Sub-Regional Action Program to combat desertification in the Aral Sea basin was approved, and the countries of the sub-region have started its implementation within the project "Central Asia Countries Initiative for Land Resources Management (CACILM)".

CACILM block is the most important in respect of the problems related to processes of biological balance of components of environment, the restoring of which is essential for a sustainable development of all major sectors of Central Asia economies.

Natural and anthropogenic factors of "lands degradation" are especially closely connected with the large-scale land development in arid conditions. According to Professor V.A. Kovda (1977), the processes of fertility decline, degradation and destruction of soils comprise tens and hundreds of various local and zoning forms of their manifesting. The most widespread are pasture digression and overgrazing, formation of drift sand, washout and irrigational erosion of soils, secondary sa-linization of soil, excessive consolidation and pollution of soils with toxic compounds, technogenic desertification, and others.

At the session of UN Economic and Social Commission for Asia and Pacific Ocean Countries (UN ESCAP) dedicated to regional cooperation in the field of ecology that took place in February of 2000 in Teheran the ministers of environment protection of Central Asia countries have declared the necessity of development of Regional Environmental Action Plan (REAP). Experts of Central Asia countries have defined the basic ecological priorities, five of which were included into the Regional Action Plan. Ministry of Nature Protection of Turkmenistan (MNPT) was entrusted to develop the problems block "Land Degradation", and National Institute of Deserts, Flora and Fauna of MNPT was named to be the Center of Cooperation.

In 2001, REAP was prepared and issued within the UNEP RRC.AP financed project. This document includes: summary description of processes of lands degradation on national and regional level; description of the analysis of basic reasons and sources of identified processes of lands degradation, including transboun-dary aspects; appraisal of damage arising from lands degradation; list of necessary measures to resolve the problem, and others.

Many priority aspects of land degradation combating have come to light more precisely and more spe-

cifically over the last years, since approval of REAP; many urgent issues have emerged demanding immediate consideration. In this connection, in 2006, the ministers of environment protection of Central Asia countries have addressed UNEP RRC.AP with the request to support the development of appraisal reports on REAP priorities and urgent issues, and this request was supported by UNEP. The Appraisal Report on Lands Degradation (similarly to appraisal reports on other priorities of REAP) specifies the necessity of updating the indicators on lands degradation, defining the requirements for capacity building in solution of lands degradation problems, developing a plan of action on capacity building and implementation of proposed recommendations and actions both at national and regional levels, and also proposals major problems of lands degradation for their financing and implementation.

1. Land resources

The total area of agricultural lands in Central Asia in 2004 equaled 294.2 million hectares (150 million hectares), 43.4 million hectares of which were arable lands. The area of hayfields and pastures was 220.1 million hectares, and irrigated lands- 10.08 million hectares. The total area of 37.6 million hectares of lands was prone to salinization and water logging of different degrees.

In ***Republic of Kazakhstan*** the area of agricultural lands totals to 222.5 million hectares, of which 187.9 million hectares (82.2%) are the pastures, 22.3 million hectares – arable lands, 7.1 million hectares – fallow lands. The lands suitable for irrigation – 23.3 million hectares, saline and alkali lands- 94.4 million hectares, 30.5 million hectares are covered with erosion. Development of desertification processes leads to reduction of agricultural lands.

In ***Kyrgyz Republic*** the general area of the lands is 17 million hectares (2005), of which 10.5 million hectares are agricultural lands, including 1.3 million hectares of arable land (860 thousand hectares-irrigated land, 440 thousand hectares – dry farming). If we calculate this area in respect of the population of the country (5 million), then for the 2005 it will be 0.1 hectare per capita, which is much lower than the international standard (0.22 hectare per capita). In the last years, the lands degradation processes have intensified. Out of 10.5 million hectares of farmland 88% is recognized as degraded.

The part of low productive pastures of 8.69 million hectares has been transferred to the category of reserve lands. The area of the irrigated lands has dwindled. Now, their total area equals 813.5 thousand hectares. Besides, during the same years (1998-2004), 60 thousand hectares of dry farming land was transformed to the category of reserve lands, which in favorable years had a yield similar to irrigated lands.

In ***Republic of Tajikistan***, the land fund makes 14.3 million hectares, of which farmland-4.3 million hectares including 0.69 million hectares of arable lands; 101.9 thousand hectares of perennial plantings, 21.5 thousand hectares- fallow lands, 23.8 thousand hectares- hayfields, 3.7 million hectares- pastures. In Tajikistan, the irrigated lands equal 0.11 hectares

per capita. Mountains occupy over 93% of territory. Over 44% of estimated flow for the Aral Sea basin is formed on territory of the country.

In ***Turkmenistan***, the overall area of all categories of the lands makes 49.4 million hectares, of which farmland is 40.1 million hectares making up 82% of total territory of the country. Out of these lands about 5% fall to irrigated lands, about 95% – to pastures. The suitable lands for a prime irrigation equal around 7 million hectares. Now, the area of irrigated lands is about 2 million hectares, 96% of which is to some extent saline. Weakly saline irrigated lands make up 28%, mid-saline – 57%, severely saline – 11%. 70% of the territory of the country is occupied with sand, 7% – with stony mountains, 5% – saline soils (solonchak), 5% – clay surfaces.

In ***Republic of Uzbekistan*** arable lands make 26.7 million hectares, 4.2 million hectares of which are irrigated and provide 95% of all total agricultural products of the country. Land resources suitable for irrigation constitute 7-10 million hectares and comprise gray-meadow soils (16%), meadow soils (44%), gray soils (30%) and takyr-meadow soils (10%).

Grain and technical crops prevail in the structure of agricultural crops in Uzbekistan, Tajikistan and Turkmenistan, while in other states mainly grain is cultivated.

2. Natural and anthropogenic factors of lands degradation

Lands degradation occurs as a result of joint impact of natural and anthropogenous factors.

The natural factors of lands degradation involve climatic ones (rainfalls, temperature, wind, drought), mudflows, landslips, terrain slopes, initial natural stocks of salts in deposits of alluvial plains, karstic and subsidence processes, water erosion, deflation of light soils, forest and steppe fires, air transfer of salts, dust and greenhouse gases. In the last years these processes have aggravated due to frequent recurrence of droughts and dry winds, growth of salt aerosols carry-over from dried up seabed of the Aral Sea and due to expansion of an area of their spread. The mentioned occurrences can be met in almost all countries of Central Asia *(Table 1)*.

Table I. Principal natural factors of lands degradation in Central Asia

Causes of lands degradation	Kazakhstan	Kyrgyzstan	Tajikistan	Turkmenistan	Uzbekistan
Removal of soils nutritious elements	+	+	+	+	+
Increase of weed and decrease of fertile vegetation in pastures	+	+	+		+
Subsidence and karstic processes	+	+	+	+	+
Salt aerosols carry-over from dried up seabed of the Aral Sea	+	+		+	+
Frequent recurrence of droughts and dry winds	+	+		+	+
Deflation of light soils	+	+		+	+
Forest and steppe fires	+	+	+	+	+
Landslips and mudflows	+	+	+	+	+
Air transfer of sands, salts, dust and greenhouse gases	+	+	+	+	+

Anthropogenic activity contributes largely to the processes of lands degradation. Physical ageing of irrigation and drainage systems, inappropriate irrigation technique, prodigal use of water and exhaustive structure of crops lead to deterioration of lands ameliorative condition, progressing salinization of soils, reduction of a stock of nutritious elements. Reduction of assimil-ator crops, first of all lucerne, can be mentioned as another reason of decrease of lands fertility, productivity of agricultural crops and deterioration of agricultural products. The analysis of existing structure of sown area shows that annually in Uzbekistan 1900 thousand hectare crops of cotton, grain and forage crops are in unfavorable soil and climatic conditions. The deficiency of agricultural crops proves it. The similar situation is also in Turkmenistan, Tajikistan.

The anthropogenic factors leading to emerging and developing of degradation processes in Kazakhstan include mainly the overgrazing, farming, mining, construction and exploitation of industrial, military and civil objects, irrigation and line structures. Degradation is also the result of irrational felling of trees, uproot of bushes and other plants as forage for cattle and as a fuel; forest and steppe fires, landfills around human settlements, pollution of soils and groundwater with toxic substances, impact of transport.

Transboundary drains in the irrigated zone of collector-drainage waters formation have negative impact on ecological situation, mainly, on man's health; reduce productivity of agricultural crops and profitability of animal husbandry. Pastures are destroyed as a result of impact from transport, power engineering and oil-and-gas complex and other enterprises. Low level of land treatment leads to appearance of saline soils as the malicious factor resulting in lands degradation.

Pasturable burden per unit of the area increases within last years under the influence of natural and anthropogenic factors, removal of soils nutritious elements by irrigating and rainwater reduces, impurity of water and soil increases and felling of wood and shrub vegetation grows.

The main causes and sources of identified factors of lands degradation can be presented in the following order:

- Natural sources: sharply continental climate, natural stocks of salts in deposits of alluvial plains, soils deflation and erosion, mudflows, salt and dusty aerosols from dried seabed of Aral Sea and others.

- Industrial sources: liquid and solid emissions from industrial enterprises and oil-and-gas sector, emissions from transport and radiochemical pollution, waste products of a military- space complex, emissions of greenhouse and ozone-destructive gases, waste products in areas of extraction of minerals, oil and gas and the building of line and pointed facilities, which are not accompanied with recultivation;

- Agricultural sources: pollution of soil with chemicals, secondary salinization, single-crop and excessive stabilization of soils, de-ulmification, wastes of cattle farming, pollution of farmland by industrial and residential waste products and discharges ofcrude sewage and collector-drainage waters, overgrazing and deforestation, etc.

- Irrigation and meliorative sources: discharges of crude sewage and CDW to water sources, growth of salts concentration in the rivers and the water basins used for watering of agricultural crops, etc.

3. Processes of lands degradation

Out of used or potentially suitable lands of Central Asia 77% are exposed to degradation of their vegetative cover, 9.1% are salted as a result of irrigation, 3.6% are prone to salinization caused by drying up of the Aral Sea, 5.9% – to water erosion, 1.5% – to deflation, 2.4% – to technogenic desertification.

In ***Kazakhstan*** the area of agricultural lands is 222.6 million hectares, of which 187.9 million hectares (82.2%) are pastures, 22.3 million hectares – arable lands, 7.1 million hectares – hallow lands. Lands under treatment make 47.0 million hectares. The suitable lands for irrigation – 23.3 million hectares, saline and alkali lands – 94.4 million hectares, while 30.5 million hectares is covered with erosion. The area of irrigation occupies 1.5 million hectares. Development of desertification processes leads to shrinking of farmland areas.

When developing the virgin lands in Kazakhstan (1954-1960), the huge areas of alkali land (8 million hectares) and soils with light mechanical structure (12 million hectares) have been involved into a category of an arable land. In 1970-1980, 11 million hectares of additional low-productive lands have been reclaimed. Thus, by 1990, in Kazakhstan the area of the agricultural lands made 47 million hectares (36 million hectares – arable lands and 11 million hectares – lands of radical improvement):

- the area of lands degraded due to salinization and flooding makes 34.3 million hectares;
- de-ulmification of different degrees takes place on the area of 4.5 million hectares (2.5 million tons of nutritious elements are alienated annually from an arable land);
- Pasture lands make up 85% of territory of the country;
- mean and highly eroded lands occupy11.3% of all territory. Only in Almaty region 5.8 million hectares are eroded (35% of farmland area of region). In the Southern Kazakhstan region – 4.1 million hectares (39%), in Atyrau region – 3.2 million hectares (34.4%), in Jambul region – 3.2 million hectares (34.2% of farmland area of the region);
- out of 2.3 million hectares of irrigated lands 50% of soils require meliorative improvement because of salinization;
- pastures and hayfields make up 87% of total area of the country;
- the area prone to erosion – 30.7 million hectares;
- Aral and Kazalinskiy regions have most degraded vegetation;
- the radius of action of salt and dust carryover arising from the Aral Sea equals 150... 300 (500) km, and the area of dust subsidence – 25 million hectares;
- after regulation of flows of rivers Hi, Chu they reduced, the level of groundwater has lowered, soils started to become salty;
- 12.3 million hectares are covered with forest, of which 22.5% is under protection;
- 181.3 thousand hectares are prone to technogenic desertification;
- desertification along the modernized roads – 96.5 thousand km;
- desertification in vicinity of oil and gas pipelines-21 thousand km;
- adverse impact of space military ranges on ecosystems and on a man (6% of territory of Republic).

Deterioration of a condition of irrigation and drainage networks has led to salinization of soils (up to 50% of irrigation water is lost on filtration). The collector-drainage water is discharged into natural water sources and it causes environmental contamination, diseases of the population. Because of irrational use of water resources in basin of the rivers Amu Darya – Syr Darya the degraded lands area makes about 2 million hectares. Land degradation (salinization, flooding) happens due to using of water of the river Irtysh in the Eastern Kazakhstan, Pavlodarand Karaganda regions. Annual losses because of lands degradation in Kazakhstan are about US$6.2 million:

In ***Kyrgyzstan***:

- arable lands – 5.6 million hectares (1.04 million hectares are in private property, 4.5 million hectares – in the state ownership);
- pasture lands – 902 million hectares;

- the farmland area – 10.8 million hectares (arable lands- 1.345 million hectares, the irrigated lands- 0.91 million hectares, boghara arable lands- 0.43 million hectares, perennial plantings- 0.065 million hectares;
- out of 10.8 million hectares of farmland 88% are in different degrees of degradation; 260 thousand hectares are prone to salinization; 30 thousand hectares are excessively wetted; 500 thousand hectares are excessively compressed;
- out of over 5 million hectares of farmland 0.97 million hectares of arable lands, 4.54 million hectares of pastures, 0.9 million hectares of hayfields are prone to erosion (water and wind erosion);
- the lands with stones and shingle total 4.021 million hectares;
- the area of erosion impacted lands makes up over 85% of territory of Republic;
- about 2 million hectares of lands are polluted with radioactive substances; Irrigational erosion covers 97% of the irrigated lands;
- 28 thousand hectares are not used because of close laying of groundwater and 42 thousand hectares – because of salinization;
- From year to year the pasture herbage is worsening because of overgrazing: productivity of herbage is reducing and quality of pasture forage is declining;

With privatization of fixed assets in pasture farms the significant area of pastures and hayfields have remained unclaimed, the mass of not eaten weed plants increases (75-80%). It worsens quality of forage and leads finally to soils erosion.

Soils degrade when lands are allotted for industrial and civil construction, construction of roads, water reservoirs, power transmission lines, at extraction of useful ores, as a result of military manoeuvres, etc.

In ***Tajikistan*** the arable land makes 720.2 thousand hectares, of which 502.8 thousand hectares are irrigated that accounts for 8.0% of the total territory:

- excessively compressed soils are met everywhere in an irrigated zone;
- meliorative condition of 80 thousand hectares of lands is unsatisfactory;
- the area of saline and alkali soils – 21 thousand hectares, they are not in agricultural use more;
- silting of drainage network promoted landslide process in Yavan-Obikiik valley, in Hojamastone (6 thousand hectares of irrigated lands);
- drainage is available at 311 thousand hectares, 34% of which is in unsatisfactory condition;
- the area of lands prone to desertification makes 4.33 million hectares including those prone to erosion – 2.63 million hectares (the upward tendency);
- 58.8% of territory of the country is prone in a different degree to water erosion (mainly high-mountainous meadow, mountain light brown soils);
- wind erosion is usual for Mountain – Badakhshan autonomous region (40%), Vakhsh zone (24%), Sogdinskaya area (21%). About 1.0% of the area of Republic is prone to irrigational erosion. Frequently occurring mudflows, avalanches, flooding and landslips strongly degrade soil cover;
- the species composition of plants changes at 90% of territory of pastures with herbage, thus reducing efficiency of pastures (5-10 times);
- degradation of arable lands on the territory of 720.2 thousand hectares;
- about 1 million hectares of land are affected during development of mineral resources deposits, geologic and exploration and construction works;
- about 1 million hectares of lands are subject to re-cultivation;
- 142 human settlements are exposed to constant flooding, 490 – to seasonal flooding;
- intensity of lands degradation leads to annual shortage of grain crop by 500 thousand tons and of raw-cotton – by 100 thousand tons.

The degradation of lands is caused by impact of water, wind and pasture digression, by salinization, flooding, etc.

In ***Turkmenistan***:

- high salinity of irrigation water (up to 2.0 gram/liter);

Table 2. Anthropogenic factors of lands degradation in Central Asia

Causes of lands degradation	Kazakhstan	Kyrgyzstan	Tajikistan	Turkmenistan	Uzbekistan
Close bedding level of groundwater in irrigation process	+	+	+	+	+
Soil salinization and waterlogging	+	+	+	+	+
Irrigation with water of higher mineralization	+	+		+	+
Rise of level of alkaline ground water	+	+			
Irregular irrigation	+	+		+	+
Insufficiency and absence of CDN	+	+	+	+	+
Unsatisfactory work of irrigation and reclamation networks	+	+	+	+	+
Flooding and excessive moistening	+	+	+	+	+
Exposure of soils to irrigation erosion	+	+	+	+	+
Excessive stabilization of soils		+	+	+	+
Pollution of soils with application of agro-chemicals	+	+	+	+	+
Imperfection of methods of application of irrigation technique and technology	+	+	+	+	+
Uncontrolled livestock pasture	+	+	+		+
Reducing of organic substance (de-ulmification) in soil	+	+	+		+
Felling of woody-bushes vegetation	+	+	+		+
Pollution of soils in oil and gas production region	+			+	+
Loss of soils in a course of launching of space rockets and military training	+	+			
Discharge of untreated CDW to water sources	+	+	+	+	+
Drainage, salt accumulation and salinization of soils as a result of flow regulation	+	+		+	+
Ploughing up of poor productive lands (solonetz, sandy and saline soil)	+	+	+	+	+
Insufficient reclamation of degraded lands	+	+	+	+	+
Insufficient application of crop rotation and pasture rotation	+	+	+	+	+
Wastes storekeeping	+	+	+	+	+

- more than 60% of territory under irrigation is exposed to average, strong and very strong salinization;
- Over 50% of territory is prone to erosion and deflation;
- in mountains (high, average, low) 87% of the area is eroded (mountain ecosystem);
- in the Central Garagum desert about 60% of territory is prone to strong, 20% – to mean and 20% – to weak deflation;
- territories with inadmissible depth of groundwater (1-2.5 m) make up 23.1%;
- degradation of a vegetative cover and a deflation of sands along the oil and gas pipelines;
- annually 600 thousand tons of salt and dust aerosols from dried seabed of the Aral Sea fall down to the territory of Dashoguz velayat, 70% of them fall to areas of irrigated agriculture, human settlements.

In ***Uzbekistan***:

- the saline lands make up 51% (1938 thousand hectares) of irrigation areas comprising those with light salinization – 30%, with mean salinization- 17%, and with high salinization – 4%;
- the area of pastures is 21.2 million hectares, of which 19.4 million hectares are full up with water, 1.6 million hectares are prone to digression;
- more than 15.1 million hectares of lands are not used in economy (slopes, ranges, sands, dumps, etc.);
- from 20 to 40% of irrigated lands area is prone to deflation;
- 2.8 million hectares of pasture require watering;
- more than 160 thousand hectares are prone to technogenic influence;
- 75% of total number of mudflows in Central Asia falls to Uzbekistan.

3.1. Basic forms of land degradation

Natural and climatic factors and human activity lead to desertification and land degradation. Their principal and widespread forms in conditions of Central Asia comprise:

- desertification, deforestation and other processes;
- secondary salinization, flooding and excessive moistening in conditions of irrigated agriculture;
- water and irrigational erosion of soils in mountain and foothill areas;
- deflation and pasture digression in areas with intensive pasturing animal husbandry;
- technogenic desertification at the time of agricultural and industrial land development;
- pollution and loss of soils fertility in case of application of agricultural chemicals, release of industrial and residential wastes, in case of monoculture;
- salinization of soil caused by drying up of the Aral Sea and settling of salt and dust aerosols, etc.

3.2. Desertification

Exacerbating of desertification processes to a great extent occurs as a result of:

- using new lands without meliorative preparation;
- insufficient introduction of crop rotations in agriculture, use of monoculture;
- irrational use of irrigation water, their release to collector-drainage networks;
- inappropriate application of water-saving equipment and of irrigation technology;
- CDN insufficiency;
- flooding of irrigated soils and pasture lands;
- irrational use of mineral fertilizers and pesticides in agriculture;
- use of water with high mineralization for irrigation;
- felling of forests and bushes;

- discharge of untreated CDW and sewage to water sources;
- infringement of pasture turnover system;
- inappropriate use of agricultural methods at cultivation of crops;
- inappropriate application of the methods of lands agro-forest-melioration;
- intensity of development of network of roads, irrigation, communication, unregulated flow of rivers;
- enlargement of the area and scales of use of mineral and raw resources;
- transboundary movement of salt and dust aerosols from the dried seabed of the Aral Sea, water and wind erosion.

These factors to a different extent influence the condition of lands and degrees of their degradation.

In ***Kazakhstan***, desertification proceeds more actively, which is connected with mass plowing from 40 to 80% of virgin lands in 1950-1970. It led to development of water and wind erosion, decrease of humus potential of steppe soils.

About 4.5 million hectares of arable lands are covered with processes of de-ulmification to a smaller extent, 5.2 – with moderate, 1.5 million hectares of soil – with strong such processes. Process is aggravated with application of not suitable for these territories agro-technical methods and measures in agriculture; pasture loading on the remaining virgin lands is 2-6 times above norm.

Pastures are accumulated in less efficient saline lands (alkaline lands, lakeside falls and hollows). Steppe cereal vegetation has been replaced with halophytic vegetation. The area of persistent saline lands has been extended. Pastures adjacent to rural settlements were exposed to degradation to the most extent.

Rates of desertification grow in Eastern Aral Sea region where as a result of CDW release and increase of mineralization of water in Syr-Darya the saline soil areas have extended. At the same time, the efficiency of natural pastures in Kazakhstan declines. Under influence of wind erosion 60% of territory of Kazakhstan is prone to processes of desertification.

Over 40 years of use of virgin and saline lands 1.2 billion tons of humus was lost as a result of water and wind erosions and efficiency of land resources (black earth) declined from 24 centner/hectares (1957 – 1960) to 17 centner/hectares (1998). In the irrigated area of 2.3 million hectares 50% of territory requires meliorative improvement.

In ***Kyrgyzstan***, during an agrarian reform 18.5% of land resources were distributed to private sector. At the same time lands degradation processes aggravated because of budget deficit. More than 90% of territory of Kyrgyzstan is exposed to desertification.

In ***Tajikistan***, desertification of lands is characterized by water and irrigational erosion arising as a result of felling of woods, development of minerals deposits and development of over 10° steep slopes. Wind erosion is most typical both for Mountain-Badakhshan and Sogdiyskaya regions and Vakhsh zone. The area of lands under desertification during the last decades has grown to 4.33 million hectares or by 1.3 million hectares compared to 1990.

Over 68% of the irrigated lands of ***Turkmenistan*** are classified as soil with mean and severe salinity. About 36% are in condition of close bedding (up to 2 m) of groundwater and are exposed to secondary salinization. About 80% of territory of Turkmenistan is represented by the sandy landscape sensitive to deflationary processes. The deflation is severe at about 297 thousand hectares (wind erosion) and it is weak at 253 thousand hectares. This process is mainly seen in the Central Garagum desert, southwest areas of oil and gas exploration and along transport ways.

Overgrazing is the principal cause of degradation of pastures. The animal husbandry is concentrated around the human settlements and these territories suffered from overgrazing of pastures by cattle and lands degradation in these territories.

Soils of hillsides are mainly exposed to water erosion. Total area of lands exposed to water erosion is 690 thousand hectares. Erosive processes are mainly typical for slope lands.

Before the 90s of the last century forest lands significantly reduced because of mass deforestation in particular, juniper, maple and others that reduced

almost twice their territory and the area of tugai forests reduced to 26 thousand hectares.

The Government launched appropriate measures for solving problems and having prohibited deforestation since 1991 provided the population with free natural gas and promoted establishment of favourable conditions for natural reforestation.

In ***Uzbekistan***, the prevailing role in desertification belongs to water and wind erosion and degradation of pastures. Rates of secondary salinization grow.

3.3. Deforestation

In ***Kazakhstan***, shrinkage of the area and deterioration of forests are connected with degradation of flood-land ecosystems, pasturable pressure and felling of forest for construction and fuel purposes. The forest fund lands account for 1.0% of the area of the country.

In ***Kyrgyzstan***, the area of forest fund makes 2.66 million hectares today. It decreased a little in comparison with year 2000 (2.86 million hectares). The area covered with a forest rounds to 849.5 thousand hectares. The ageing of forests in the country causes concern and requires taking of particular measures on their rejuvenescence through restoring, cutting down of old tress and bushes and planting of new trees.

In ***Tajikistan***, the forest fund area reaches 570.9 thousand hectares, 20-23% of which is occupied with forest plantations. Over 90% of forests are in state ownership. The felling of trees is intensive and covers annually over 6000 hectares. In this regard, the area of forests is gradually reducing from 392.1 thousand hectares in 1988 to 171.5 thousand hectares in 2000. Due to high cost of fuel (coal, wood, gas and electrical power) the population has to fell forests destroying herbaceous vegetation. As a result of human economical activity as well as under the impact of such natural phenomena as clay flow, avalanche, flood and landslides erosive processes are activated.

The total area of forest fund of ***Turkmenistan*** is 9.9 million hectares including those covered with a forest – 2.2 million hectares. 6.6 million hectares out of total area of forests are provided to peasant associations and live farming for a long-term use for pastures. Felling of trees has been forbidden since 1991 (only sanitary deforestation is authorized). Supply of the population with free natural gas is a favorable factor for natural renewal of forests and pastures.

The main part of forest fund making nearly 9 million hectares relates to desert forests. Mountain forests occupy 524.7 thousand hectares. Tugai forests in river valleys occupy 44.5 thousand hectares including 20.0 thousand hectares covered with woods.

Moreover, artificial zones of forest plantation are created on sands of area of 684.5 thousand hectares. On mountain sides artificial forestlands are created on area of 37.3 thousand hectares including 36.4 thousand hectares of pistachio and 860 hectares of juniper.

Sowing and planting of desert forests are launched on separate parts of Transkarakum railway Ashgabat-Karakumy-Dashoguz. In the outskirts of Ashgabat city the rates of planting of forest under program "Gyok-Gushak" (Green Belt) intensify and it creates favorable ecological conditions for people's health and enrichment of biodiversity.

In ***Uzbekistan***, the total area of forest fund makes 8 million hectares (2004), and the area covered with a forest occupies 2314 thousand hectares. Specialists in forest melioration sow different sand-binding plants such as saxaul, saltwort, kandym and other kinds of psammophyte to protect irrigated areas and industrial objects, high-tension transmission lines and gas pipelines and other constructions from drift sands. Moreover, sands gradually overgrow and grazing lands are enriched with vegetation. The total area of afforestation works equals 5.3% of territory of the country, of which the areas covered with forest comprise such types of territories as mountains – 831.0 thousand hectares; steppe – 7001.5 thousand hectares; valleys – 164.3 thousand hectares; tugai – 113.7 thousand hectares. It is planned to create on

a contract basis the forest-field-protecting cultures of 23.0 thousand hectares, of which 369 km will be on terrace-like steep slopes. The considerable area (87%) is referred to forests of deserted (steppe) zone.

As it is known, green plantations prevent fast air movement reducing its rate by 30-60%, promote cleaning of air from smoke and gas, decrease a degree of carbone oxide concentration by 210-215 times. They catch a dust up to 58% in a spring-summer period and up to 37% – in summer.

In irrigated area field-protection forest belts create rather favourable microclimate due to which crop capacity is considerably increased.

3.4. Soil erosion and deflation

Processes of soil erosion and deflation are the main elements of lands degradation.

Over 60% of the lands in ***Kazakhstan*** are prone to natural processes of desertification. The lands with light mechanical structure, where as a result of wind erosion the yield has decreased by 20%, occupy a special place in this aspect. The excessive ploughing up, afforestation and irrigation of plough-lands, lack of care for haymaking and pastures, low level of management culture led to loss of the most important soil property – self-regulation – and spreading of wash-out, erosion and blowing of fertile layer as a result of wind and water erosion. In structure of farmland the medium and severely eroded lands occupy 11.3%. More often the eroded agricultural land is seen in Almaty (5.8 million hectares), Southern Kazakhstan (4.1 million hectares), Atyrau (3.2 million hectares) and Jambul (3.2 million hectares) regions.

In ***Kyrgyzstan*** the most eroded lands are in Narynskaya, Issyk-Kul and Chuiskaya regions (85%) where the yield of agricultural crops is reducing by 20-60%.

In ***Tajikistan***, the water erosion is mostly spread in the high-mountainous meadow (94.5%) and mountain light brown (92.8%) soils. Here, the slightly washed out soil equals 14.8%, medium washed out-20.1% and severely washed out – 23.9%. The erosive processes are activated under the impact of natural calamities such as clay flow, avalanche and landslides especially while developing steep slopes more than 10°. Ravine (line) erosion occurs.

Wind erosion is especially typical for Gorno-Badagshan region (40%), Vakhsh zone (24%) and Sogd region. It causes the considerable damage to agricultural lands.

The large part (80%) of ***Turkmenistan's*** territory is represented by sandy landscapes of the Garagum desert for which intensive deflationary processes are typical. They are especially bright in areas of wide industrial-transport development (oil and gas exploration and production areas, construction of roads and railways, around line and point objects) where the natural and techn-ogenic factors affect the soil and vegetative cover and deflationary processes are very strong.

In mountains, 87% of their area is the eroded soil, which is mainly spread in Akhal and Balkan velayats.

In ***Uzbekistan***, more than 50% of deserted zone soils are prone to wind erosion including Ferghana valley, Bukhara oasis, Hungry steppe, Karshin and Sherabad steppes. Lands with light mechanical structure in Karakalpakstan, Khorezm region are deflated (15% of irrigation area). Deflationary processes are observed in that areas where wind speed reaches 20 m/sec and higher. Lands of Bukhara, Navoi and Ferghana regions suffer from deflation, where 65-98% of farmland is subject to deflations. This area includes 15% of irrigated lands. Pasture lands are mostly exposed to deflationary processes where as a result of uncontrolled cattle pasture the vegetation covering becomes poor.

Increase of a burden on mountain pastures entails degradation of vegetation and soils, which leads to strengthening of downpour flows and reoccurrence of mu-dflows. Out of total number of mudflows registered in Central Asia, over 70% falls to a share of Uzbekistan. Most dangerous mudflow basins are in mountains of Ferghana valley, Kashkadarinskaya and Tashkentskaya regions.

Irrigation erosion is observed in foothill and submountain plains of Central Asia (in light and dark sierozem) where severely eroded soils are 31%, medium eroded – 17%, noneroded – 3.5%.

3.5. Overgrazing

Overgrazing on pastures is the most aggressive factor in land degradation. This occurs as a result of irrational use of pastures (overload of pastures, infringement of seasonal grazing, etc.). It is necessary to permanently pay attention to mountain and sandy landscape and especially around water wells and human settlements where reduction of specific structure of vegetation can take place faster. In this case it is necessary to introduce hayfield and pasture turnovers, forbid grazing on pastures downtrodden by cattle, to sow perennial grasses.

In ***Kazakhstan***, pastures make up 85% of all agricultural land. Distant-pasture grazing takes place on wide areas. Winter pastures are in sandy deserts, summer pastures – in mountain areas or in steppe zones, which in the past were highly productive. The high livestock and inefficient control have led to lands degradation that now amounts to 24 million hectares (13.2% of all pastures). As a result, due to lack of winter forage the livestock reduced but over the last years it stabilized and began restoring.

Steppe and semidesert ecosystems are degraded: vegetation covering is impoverished; water and wind erosion and illegal felling of saxsaul take place.

Pastures degrade under influence of 3 factors:

- overgrazing on pastures;
- eradication of bushes, semi-bushes and trees;
- abandonment of extensive pastures in dry steppe and semidesertic zones, increase of the area of soils covered with lichen.

In ***Kyrgyzstan***, the area of natural pastures (basically for sheep breeding) totals 9.2 million hectares (86.8% of all farmland).

Privatization of fixed assets in pasturable farms has led to reduction of livestock; loading on pastures reduced to the extent that has led to the increase of weed vegetation (not eaten grasses) at 75-80%. The state of pastures is considered to be unsatisfactory as out of 9.2 million hectares only 2.7 million hectares is referred to conditionally pure.

In 1990, loading per 1 hectare of pastures was 1.94 conventional sheep, in 1996 – 1.07, in 2003 – 1.18 sheep. The condition of pastures is directly connected with water and wind erosion, deflation and human-caused factors.

In ***Tajikistan***, the uncontrolled and excessive grazing on pastures is one of the most threatening factors of land degradation. Summer pastures are degraded for 90%, winter pastures – for 92.5%. Productivity of pastures has decreased 5-10 fold. In 2006, the area of pastures for agricultural purpose made 3797.6 thousand hectares, that is 22 thousand hectares less, compared to year 1996. The area of irrigated cultivated pastures as compared with 1996, when it was 3.6 thousand hectares, reduced to 3.3 thousand hectares in 2006.

In ***Turkmenistan***, degradation of pastures occurs because of overgrazing, flooding, water erosion in mountain pastures, as well as due to the work of transport vehicles, oil-gas complex, geological prospecting works, etc.

Pastures of ***Uzbekistan*** occupy 22.4 million hectares (half of all territory), of which 17.4 million hectares are deserted, 4 million hectares are in foothill deserts, 10 million hectares in mountains, 0.6 million hectares are high-mountainous pastures. As a result of unbalanced use of pastures during the last 15-20 years in distant-pasture cattle breeding, overgrazing and other anthropogenic impacts their fodder capacity has been lost (digression). Out of 22.4 million hectares of pastures 16.4 million hectares (73%) are exposed to digression, including that on the area of 9.3 million hectares the fodder capacity was lost by 20-30%, on 5 million hectares- by 30-40% and on 2.1 million hectares- by over 40%.

As a whole, more than 70% of pastures are subject to digression, and about one third of these pastures manifest severe digression. Increase in loading on

mountain pastures occuring everywhere results in degradation of vegetation that leads to increase in mudflow and recurrence of clayflows. Therefore, processes of clayflow formation are significantly developed.

3.6. Monoculture

The monoculture is one of the factors lowering natural fertility of irrigated soils, especially in the cotton growing regions. Cotton was a dominating culture in irrigated agriculture in the states of Central Asia during the Soviet Union times, practically there was no system of crop rotation, and the input of organic and mineral fertilizers to the lands was very small.

Multiple passing of farm tractors on a cotton field (about 10 times per season) caused condensation of soils, especially on depth of 25-50 cm where the volumetric weight exceeds 1.45 g/cm^3, and so-called "sole shoe" is formed. In these cases the porosity in soils reduces, aeration and their biological activity worsens. Penetration of root systems into deep layers is considerably impeded, the feed zone of plants is contracted, and the humus content reduces by 0.8-1.0 t/hectare per year (Kazakhstan). Similar negative factors are clearly emerged in soil profile of irrigated light sierozems of submountain valley of Kopetdag (Turkmenistan).

Growing of cotton monoculture in irrigated agriculture (absence of crop rotation and under-winter ploughing, etc.) causes soils degradation; humus content decreases by 20-45% in arable lands, productivity of cultures declines, etc. In separate regions of Uzbekistan, for example, the monoculture has reached its maximal size in the 1980s when the share of cotton in the structure of crops reached 75%. So far, such negative process in cotton growing countries of Central Asia has not been overcome completely.

In Turkmenistan, the share of cotton in structure of crops in 1991 made up 48.7%, and in 2004, in connection with grain farming development in the country, it decreased to 32.2%. Change of crops structure has taken place due to enlargement of the areas of farming the wheat and leguminous cultures (from 19.4 to 49.6%).

In Uzbekistan the area of cotton has decreased from 51.4 to 41.7%, and the area of grain has increased from 17.6 up to 39.3%. The area of forage crop has decreased from 25.5 to 11.3%, including lucerne – from 17.6 to 5.7%.The similar facts take place in Turkmenistan.

3.7. Salinization

Salinization is the most important factor of soil degradation in conditions of irrigated agriculture. It emerges due to close bedding of the level of groundwater to original ground and the extent of this water mineralization. Very critical depth of waters is when their level is on depth up to 1 meter; critical – 1-2 m; less critical – 2-3 m; safe – 3-5 m.

The basic sources of groundwater formation are filtrati-onal waters from sprinklers and irrigated fields.

Salinization worsens soil properties, reduces efficiency of use of chemical fertilizers, and depresses growth of plants especially with salt composition containing natrium, magnesium chloride and sodium chloride. Exceeding salt contents by 0.3-0.5% of dense residuum upsets physiological function of cultivated plants, decrease yield and quality of crop.

4 stages of secondary salinization are typical for irrigated soils it Central Asia: small spotted, spotty, big spotted and continuous.

By the content of salts in the top layers the soils can be highly degraded- 0.8-1.0% and of denser residuum soils, mid-degraded- 0.5-0.8%, slightly degraded- 0.3-0.5% of the dense residuum per 100 g of soil. The main meliorative objects in Central Asia are mid- and highly degraded lands.

The irrigated lands of the south of ***Kazakhstan*** are exposed to salinization as a result of regulation of flow of the river Hi (Kapshagaiskoe water reservoir)

and Chu (Tashutkulskoe water reservoir). Reduction of the flow in downstream of these rivers has lowered the level of groundwater, has strengthened the processes of desertification and salinization.

In ***Kyrgyzstan***, the area of the saline lands amounts to 1180.8 thousand hectares, of which soils with slight salinization – 480.6 thousand hectares, mean salinization – 399.1 thousand hectares, severe salinization – 301.1 thousand hectares, alkali – 471.2 thousand hectares.

Good quality lands reach 0.97 million hectares (91.5% of common irrigation area), while the lands of unsatisfactory quality comprise 0.09 million hectares (8.5%).

They are mainly on the territories of Chuiskaya (26%), Narynskaya (15%) and Talasskaya (11%) regions.

In ***Tajikistan*** the area of the saline and alkali lands makes 18.5 thousand hectares, that is a little bit lower than the level of 2001 (22.9 thousand hectares). Non-saline lands occupy 85.05%, slightly saline – 10.48%, mid-saline – 3.56%, severely saline – 0.96%.

The lands of Beshkentskaya and Vakhshinskay valleys, Big Ashta and Karadum are exposed to salinization. In 58.8% of area of the country mineralization of ground waters makes up 1 g/l; in 36.91% – up to 3; in 2.94% – up to 5; in 1.38% of area – more than 5 g/l.

The area of the lands with close bedding of groundwater has increased by 64%. During the period from 1990 to 2003 the area of irrigated lands with unsatisfactory meliorative condition increased from 61.5 thousand hectares to 80.5 thousand hectares (more than 30%). The agro-technical and ameliorative measures are not applied appropriately to increase soil fertility.

Saline soils of ***Turkmenistan*** are concentrated in flat, deltoid-valley areas where soils are mainly bedded with sediments of heavy mechanical compositions and relief slopes are insignificant. On a plain relief there are practically no regional flows of groundwater and they are bedded close to soil surface. The groundwaters dynamics is regulated by evaporation and transpiration. In vegetation period 35% of water supplied for irrigation of cotton is lost due to evaporation, and water–soluble salts are transferred from deep layers of soil to surface.

The irrigated land with a critical depth of groundwater bedding (up to 2 m) in Turkmenistan is over 60%. The most critical regions with regard to reclamation state of lands that require carrying out of measures on their recovery are Lebap and Dashaguz velayats as well as Murgab zone of Mary velayat, Tedjen and Badaikhan etraps of Akhal velayat. The area of saline lands makes 1145.2 thousand hectares (66.9%). In consideration of slightly saline soils, about 80% of irrigated territory in Turkmenistan is saline in this or that degree.

Rates of development of re-salinization are very high. Nearly 40-80% of all area under crop are solinized in particular etraps of Turkmenistan. In the Karakum river around 80% of arable lands are crutial for development of irrigation.

According to the rough data due to salinization of soil more than 200-300 thousand tons of raw cotton is lost in Turkmenistan annually. Practically, in slightly saline soils the yield of raw cotton is low by 15% than in non-saline lands; in mid-saline – by 30%, in severely saline – more than by 50%. The rate of damage from re-salinization caused to irrigated agriculture in economy as a whole is evidence of necessity to thoroughly study a nature of soil salinization, conditions of its formation, and dynamics in seasonable, annual and long-term cycles.

In the Turkmen part of the Aral Sea zone the salinization of irrigated lands is connected with salt transfer from the dried up seabed of the Aral Sea.

In ***Uzbekistan*** 51% of irrigated territory (1938 thousand hectare) is classified as saline: 30% – slightly saline, 17% – mid-saline; 4% – severely saline. During the last 10 years the area of saline lands has increased by 120 thousand hectares, of which 43 thousand hectares are severely saline. Severely and mid-saline lands have increased by 57% in the basin of Amu Darya, by 78% – in the basin of Syr Darya. The area of lands with groundwater level above 2 m has increased in the basin of Amu Darya by 21%, in the basin of Syr Darya – by 65%. As a result of progressive salinization the yield of agricultural cultivation is reduced. Thus, the yield of raw cotton in Khorezm region re-

duced from 39-41 to 29-33 centners/hectares and in Karakalpakstan it reduced from 30-40 to 14-24 tons/hectares. The annual "increment" of salts in irrigated lands of Karakalpakstan totals 10-30 tones/hectares. The salinization is typical for lands of Bukharskaya, Navoiskaya and Syr Dariynskya regions.

The necessary measures to combat salinization of irrigated soils in Central Asia are as follows:

- agro-technical and ameliorative methods of desalination of irrigated lands by means of autumn-winter flushing and leveling;
- improvement of existing structure of sowing and methods of cultivation of agricultural crops;
- more effective crop rotation structure, soils chemicalization, etc;
- sowing of plants-developers on saline soils and applying of advanced water saving methods of irrigation and drainage;
- effective and rational use of unproductive arable lands;
- provision of appropriate length of CDN able to remove not less than 25-30% of total water supply, etc;
- Reconstruction of irrigation systems and regulation of water supply for irrigation.

3.8. Waterlogging

Waterlogging occurs as a result of groundwater level surge and excessive irrigation. Superfluous humidifying of root-inhabited soil layer causes soil waterlogging and salinization; reduces productivity of agricultural crops.

In ***Kyrgyzstan***, the area of waterlogged lands made 44.8 thousand hectares in 2001, in 2004 it decreased to 30 thousand hectares.

In ***Tajikistan***, the zone of waterlogging occupies about 50.0 thousand hectares, which is a little higher in comparison with 1996 (30.9 thousand hectares).

In ***Turkmenistan***, mainly the lands of Lebap (60% of irrigated territory), Dashoguz (62.3%) velayats and lands in a zone of large collector (Ozerny, Daryalyk) and irrigating systems are prone to flooding. Such lands in Mary velayat make up 46.5% of irrigated territory. Waterlogging also takes place in Akhal velayat (Tejen oasis, Foothills of Kopetdag).

In ***Uzbekistan***, the area of waterlogging occupies over 20% of territory. In republic Karakalpakstan, Khorezm, Navoiskaya regions more than 40% of the area, in Fergana valley and the Samarkand region – 30-40%, the Tashkent, Syr-Darya, Dzhizak and Bukhara areas – 20-30% of the irrigated lands are prone to waterlogging. The reason of waterlogging in many tracts of irrigation is the development and irrigation of the high relief lands.

For prevention of processes of waterlogging it is necessary to lower the level of groundwater through:

- the increase of CDN;
- clearing of hydraulic engineering facilities from silt, observance of agro-technical actions;
- rational use of water and land resources.

3.9. Pollution

Pollution of the natural environment occurs as a result of man-caused (industrial) wastes disposal and using of chemicals in agriculture.

Superfluous input of mineral fertilizers (nitrogen, phosphorus and potassium) provides suppressive impact on soil microorganisms, condense the ground and worsen its quality. Application of pesticides also leads to the poisoning of soil fauna and reduce biological activity of soils.

In ***Kazakhstan***, the total amount of industrial wastes makes more than 20 billion tons, residential wastes – 14 million cubic meters, the major part of which is thrown at unorganized landfills. Since 1986, the volume of mineral fertilizers use reduced 2.5 times, organic fertilizers – 2fold.

In ***Kyrgyzstan***, environmental contamination occurs basically with waste products of mining industries

(130 objects); in the structure of waste products there are unhealthy salts of heavy metals. In 49 tailings and sludge dumps about 75 million cubic meters of waste products are over-stored. There are many overburden mining wastes dumps, which contain toxic substances in huge amounts.

In 1995, 1146 tons of pesticides and 34.6 thousand tons of mineral fertilizers were supplied to ***Tajikistan***. Pesticide loading averaged 0.3-0.8 kg / hectare, compared to 48 kg / hectare in former years. Volumes of waste products grow annually. More than 200 million tons of waste products are stored, including toxic and radioactive ones. Industrial wastes account for 77%, while the rest are solid residential wastes and other waste products. Standard landfills are absent.

Annually, about 20 thousand tons of pesticides are used in agriculture of ***Turkmenistan***, one third of which accumulates in components of environment. Pesticide loading averages 9.5 kg/hectares. Therefore, it is anticipated to reduce their use. Pollution of soils and waters occurs as a result of residential, municipal and industrial objects, and also the chemical enterprises emissions.

In ***Uzbekistan***, the main pollutants are chlorine and organic pesticides- DDT and its metabolites. In 1999-2004, the downward tendency of average level of pollution by residual amounts of DDT was observed. The excessive quantity of MPC (maximum permissible concentration) in waste samples has decreased from 39.2% to 21.1%, and the average level of pollution is less than MPC limit and equals 0.85.

The highest level of soil pollution by residual amounts of DDT is emerged in Ferghana region (2.4-6.1 MPC). Pollution of soil by residual amounts of DDT, teflan, thiodan, phosphamide and phazalon in all regions did not exceed MPC. In spite of the measures taken around 11.7 thousand tons of expired, unused and prohibited for use pesticides requiring their destruction or utilization are accumulated in Republic.

3.10. Wastes storekeeping

In Central Asia, the industrial and residential (solid and liquid) wastes are stored within the territory of each separate state. As far as there are no respective plants or factories, the wastes are handled not sufficiently; they are stored at special areas becoming the pollutants of environment.

In ***Kyrgyzstan***, the total area requiring rehabilitation makes approximately 2 thousand hectares (industrial grounds, sludge pits, dumps).

In ***Tajikistan***, the area under various kinds of wastes equals 1100 hectares, of which 12 hectares are under the solid residential wastes and liquid industrial wastes, while the wastes of mining and processing industries occupy 800 hectares.

The industrial wastes are not available in big volumes in ***Turkmenistan***. The residential wastes prevail, but they are not sorted. The Lebap chemical enterprise can serve as a positive example, as it provides utilization of their production wastes such as phosphogypsum; and new kinds of organic and mineral fertilizers are developed and produced.

In ***Uzbekistan***, every year, more than 100 million tons of industrial wastes is formed, over 45% of which are toxic. They are kept at special ground areas. The unit weight of solid residential wastes supplied for reclamation increased by 1.5%. The area under various kinds of wastes makes 10128.9 hectares: 1112.8 hectares – solid and residential wastes, 56.7 hectares – pesticides, 8959.4 hectares – mining, processing and other wastes.

3.11. Transboundary aspects of the problem

Transboundary impacts on land degradation processes mainly include:

- the atmospheric transfer of salts, dust, sand, greenhouse gases, etc.;
- the exhaustion and pollution of largest transboundary water reservoirs, etc;
- complex of ecological problems (deforestation, exhaustion, mineralization and pollution of water);
- placement of storages of radioactive wastes, the dumps of rocks and tailings.

The issues of transboundary aspect can emerge in the use of water, land resources, pastures, pollution of water reservoirs, land salinization, etc. The interstate issues require their all-round mutually beneficial solution for the avoidance of various kinds of conflicts. Kazakhstan, Turkmenistan and Uzbekistan should implement the desertification combating in the zone of the Aral Sea ecological disaster. Over the period of the Soviet Union, the storages of radioactive wastes, dumps of rocks and tailings pits were placed at transboundary territories of Uzbekistan (Mailuu-Suu – Kyrgyzstan; Kadamjai, Sumsar, Shahontar, Degmai and others – Tajikistan).

3.12. Estimation of damage

The processes of degradation boost the decline of pastures and irrigated lands productivity. When estimating the economic damage from land degradation, the direct losses (missed income) and indirect losses (expenses for restoring of productivity of lands) are taken into account. Economic damage from salinization of irrigated land of Turkmenistan has been estimated by main agricultural crop of the country-cotton. For example, in 2001, the direct economic damage at the lands with different levels of salinity in consideration of the planned yield and sale cost of product made US$141.6 million. At the same time, the expenses on restoring of degraded lands (CDN construction, flushing of saline soil) amounted to US$64.7 million (NEAP of Turkmenistan, 2002).

In the conditions of grain growing farms of Uzbekistan, when burning the straw stubble at one hectare, the economic damage to the soil depending on a yield class of soil is estimated within US$31.9-77.3.

According to estimations, in Kazakhstan, the damage from pasture degradation, tillage erosion, secondary salinization and other reasons amounts to nearly US$2350 million (Conception of ecological safety of Kazakhstan for 2004-2015). It is impossible to estimate the total economic damage from all forms of land degradation, as it is very difficult to take into account all indicators of undersupplied product and expenses on restoration of land fertility and productivity of forest-pasture lands.

4. Legislation, policy and institutional base for land resources management

The laws of CA countries concerning nature protection stipulate the provision of publicity in solution of nature protection tasks, close cooperation with non-governmental organizations, observance of requirements of nature protection legislation and bringing to account for its infringement. The basic tendencies in the sphere of environment protection are as follows:

- perfection of all kinds of relevant activity for effective nature management;
- development of scientific provision for the environmental policy;
- ensuring environmentally safety development of economy;
- further enhancing of ecological education;
- ensuring sanitary-and-epidemiologic safety of population;
- effective international cooperation on issues related to nature protection.

The law "On Nature Protection" of each of these countries defines the strategy in the sphere of nature protection – the rational use and reproduction of natural resources, environment rehabilitation, national tasks, and the moral duty of each citizen.

The observance of the Land Code and the Water Code adopted in each country are of great importance. They stipulate further development of agriculture, perfection of production relations, and increase in production volumes of agricultural products at the account of increase in efficiency of land and water use, significant improvement of well-being of rural population.

Kazakhstan has a comprehensive legal base providing mainly the needs in balanced nature use and desertification combating. The following laws and other legal acts concerning the rational use and protection of land resources were issued in the country:

- the law "On nature Protection";
- Land Code;
- Forest Code;
- Water Code;
- the law "On specially protected natural territories";
- Conception of ecological safety of RK for 2004-2015;
- the Law "On farm keeping";
- "On state regulation of agro-industrial complex and rural territories develo-pment"and some others.

The Kazakh legislation treats the land as a natural resource, universal means of production and a territory basis for any labour process. The land legislation of Kazakhstan is based on the following principles: preservation of land resources; protection and rational use of land; purposeful land use; priority of lands of agricultural purpose; state support to measures on use and protection of land; averting the damaging of lands or removal of consequences of brought damage; provision of ecological safety and paid land use.

The land legislation of ***Kyrgyzstan*** is directed on the creation of conditions for protection and rational use of lands, reproduction of soil fertility. The land reform is under implementation. The private property on land is introduced; the farms are formed, the land lease holding is introduced, etc.

The main laws of Kyrgyzstan connected with the land reform, protection and rational use of land resources include:

- Land Code;
- the law "On land reform";
- the law "On farm keeping";
- the Decree of President on the national land fund;
- the state program "The land" until 2005;
- the law "On pesticides and plants protection";
- the Decree of Government on urgent measures to safeguard the land fertility;
- the Decree of Government on monitoring of agricultural lands;
- the law "0n Environment Protection";

- the Decree of Government on financial penalizing for land spoiling and other documents.

The following laws were issued in ***Tajikistan*** in respect of development of various forms of farming, creation of conditions for equal development of various forms of land use, establishment of economic incentives for land users, as well as in respect of safeguarding and increasing the land fertility:

- "On nature protection";
- "On mineral resources";
- "On lease holding";
- Land Code;
- "On specially protected natural territories";
- Forest Code;
- Administrative Code;
- "On land reform";
- "On payment for land";
- "On land assessment" and other legislative acts.

The law "On Nature Protection" in ***Turkmenistan*** specified the strategy of the Government in the sphere of nature protection. To implement the NEAP recommendations there were adopted the Codes of Turkmenistan "On Land" and "On Water" that defined the ways of sustainable land management, including the measures in economic sectors. The Code of Turkmenistan "On Land" defines in accordance with the Constitution and national socioeconomic development programs the legal basis of realization of government policy in the sphere of land relations and is directed on creation of conditions for rational use and protection of land, for introduction of various forms of land using, stimulation of entrepreneurship in the territory of Turkmenistan.

The Code of Turkmenistan "On Water" stipulates the increase of significance of rational use and protection of water resources. Along with the measures of organizational, legal, economic and educational impact it will promote a formation of water-ecological law and order and provision of economic security of the country. The following adopted main laws are as follows:

- "On nature protection",
- "On strengthening of punishment for ecological violations";
- "On specially protected natural territories";
- "On protection and rational use of flora";
- "On protection and rational use of fauna";
- "On hunting and keeping of hunting grounds";
- the Land Code of Turkmenistan;
- the Water Code of Turkmenistan and other legislative acts.

In ***Republic of Uzbekistan***, the national legal framework favors the actualization of sustainable land management. The laws relating to issues of land management are based on the provisions of the Constitution of the country and cover a significantly wide scope of tendencies. The policy of reforming of agriculture and also obligations undertaken in accordance with Global Rio Conventions will promote the realization of reforms based on over 80 legal and regulatory acts concerning the environment.

The main laws concerning the land relations are as follows:

- the Land Code;
- "On nature protection";
- "On specially protected natural territories;
- "On water and water use";
- "On forest";
- "On protection and use of flora";
- "On protection and use of fauna";
- the Administrative Code;
- the Criminal Code;
- the Civil Code and other documents.

Regrettably, most of the laws are not the documents of direct action and require development of many by-laws at different levels of governance such as rules, instructions, regulations and strategies. There are no concrete by-law acts concerning the sustainable land management. This fact complicates the legal base regarding the achievement of sustainable land management aims.

The frequent change of legal documents impedes the achievement of proper sustainability in management, while insufficient information about these changes and not widely open access to these documents create the certain problem for the work of rural land users.

The proper institutional base was created in all CA countries for efficient implementation of prevailing legislation related to sustainable land resources management. Mainly, these are the Ministry of Agri-

culture, Ministry of Water Management and Ministry of Nature Protection, the State Committees (or Services) on Land Resources and their subdivisions in provinces, the local administrations at the levels of regions, (oblast), districts (rayon), self-government bodies and non-governmental organizations.

It should be noted that the Ministries of CA countries the activity of which is connected with nature protection are the agencies regulating inter alia the relations in sphere of protection and rational use of natural resources including the land and water resources. The tasks to be entrusted with them are as follows: elaboration of proposals and carrying out common policy in the sphere of environment; development of strategic tendencies and programs on environment protection and rational use of natural resources; control over their implementation; putting forward proposals for resolving priority environment problems, practical implementation of measures stipulated by programs of social and economic development of the countries on protection and restoration of natural resources; development of hunting grounds; coordination of activities of ministries, departments, local administration, research and design institutions for implementation of the said measures.

5. Capacity building needs for problem solving

The needs assessment

The NEAP documents of CA countries and other subregional programs, including the REAP, SRAPCD and CACILM provide the conformity between economic development and base of natural resources. However, the analysis of issues connected with desertification is not always based on the latest data and does not stipulate enough the institutional, strategic, regulating and other incentives that provide the favorable situation for the land and water users in land degradation combating. They also do not identify the capacity building need. Although, the countries have finalized their NEAP documents, many of the proposed measures are still realized rather poorly at the level of separate economic sectors. In this connection, the additional measures should be introduced, including in the aspect of land resources.

Components of the needs:

Strategy

- analysis and monitoring of land resources condition;
- increasing of productivity of arable and forest-pasture lands, restoring of fertility of degraded land;
- envisaging of changes and improvements in further sustainable land resources management in conditions of transition to market economy;
- strengthening of international cooperation and mechanism of coordination of actions in land degradation combating;

- promoting of public awareness concerning new technologies and of advanced experience of the countries. "The problems of desert development" magazine could be very helpful in this aspect (financial support is required).

Legislation

There should be developed particular regulatory acts in the matter of sustainable land management including land and water use, pastures and agrarian policy, and these acts may particularly cover:

a) the procedure of introduction of state land cadastre;
b) the procedure of compensation of losses to land owners, farmers and losses of agricultural production;
c) the procedure of reclamation and restoring of lands; removal, keeping and rational use of fertile soil layer;
d) the procedure of temporary leading outfrom the economic use of disturbed lands for the period of renewal of their fertility;
e) elaboration and introduction of compulsory ecological insurance and ecological audit in the sphere of land resources;
f) consideration of the possibility of creation in the countries of special government body on management in the sphere of use, irrigation and protection of forest-pasture lands.

Institutional building

- elaboration and introduction of flexible economic mechanism for the purpose of environmentally sustainable land use;
- introduction into the practice of land use of compulsory preliminary science-based environmental impact assessment and ecological expertise of objects on new lands under development;
- strengthening of participation of local administrations and land users in sustainable land resources management;
- provision for land users of necessary services and consultations at the local level;
- creation of organizational structures that would provide for the farmers more easy access to the market, resources, equipment and credit financing;
- creation of national centers on desertification combating and rendering of technical and financial support for their permanent functioning.

Monitoring and information on land resources

- receiving of new information, elaboration of modern informational systems adapted to the conditions of market economy;
- elaboration and creation of national systems of land resources monitoring for the long-term planning and sustainable management;
- providing of national centers and their subdivisions with modern equipment and GIS technologies;
- training of qualified personnel in the sphere of land resources management and monitoring;
- creation of information exchange system at national and regional levels;
- elaboration of the system of indices on land resources condition and introduction of these indices into practice of socioeconomic planning and state statistics;
- early warning on drought and other extreme situations, on condition of irrigated lands, pastures and forests.

Scientific and engineering

The scientific and technical capacity of all groups of specialists engaged in management, programming, distribution, use and studying of land resources, as well as the professional education of all levels require their further development. In this aspect, it is necessary to note the necessity in various and adapted approaches to development of the capacities of farmers being the most numerous group of land users, of course with taking into account their interests. The current educational programs for the land users re-

quire reviewing in the aspect of capacity building and they should include, for example, as follows:

- the benefits and costs of sustainable land resources management (SLRM) methods,
- SLRM technology adapted to local conditions;
- monitoring of condition of land degradation;
- the economy of farms;
- marketing of agricultural products;
- juridical, tax and accounting requirements, the conditions of extension and repayment of loan;
- learning of the advanced experience of arid countries;
- training of farmers to new approaches and technologies concerning the use and rehabilitation of degraded lands, including the development of alternative methods of farming, etc.

The special programs are required to support the decision-makers of local and national levels in the aspect of capacity building. The capacity building is necessary for all parties interested and participating in the process of land use, since rather often they are not aware of their rights and obligations in new conditions of activity.

The insufficient provision with modern technology and information, education, financing of research and project works, as well as the need in national specialists are the main obstacle often for all institutions performing management and monitoring of land resources. There is no sufficient information in the sphere of agriculture and electronic libraries. It is impossible to manage the land and water resources without appropriate mechanisms of control.

Research

The analysis of materials presented by the experts of the countries showed that there is no a specialized research center on issues of desertification and land degradation combating and no proper coordination of this work in CA countries. Different ministries and agencies (ministries of agriculture and water management, ministry of nature protection, state committee and services on land and forest resources, hydro meteorological services, research institutions, etc.) perform scientific studies and monitoring of the condition of land resources, and this departmental disconnection leads to weak coordination in the issues of land resource monitoring. In our opinion, the Desertification Combating Centers established in all countries under the aegis of the national coordinators of UN Convention to Combat Desertification and also CA REAP in the light of accomplishment of CACILM, SRAPCD, REAP, NEAP and Framework Environmental Convention for CA Sustainable Development could coordinate the issues of implementation of projects being performed now under the leadership of FP and ISDC. In this connection, the basic directions of land degradation issue researches shall include:

- the scientific and theoretical studies of processes of desertification and land degradation, and working out of measures on lands rehabilitation;

- the development of land resources monitoring system and land cadastre of integrated in a single system monitoring of environment and nature resources;

- the development of new adapted (landscape-adapted) to the conditions of regional environment farming systems meeting the requirements of agrarian infrastructure and new form of working;

- the studying and analysis of processes of degradation of irrigated, pasture and technogenic lands and delta-flood-lands of river ecosystems;

- the elaboration of atmosphere and soil drought monitoring system, as well as the system of forecast of carry-over of salt and dust aerosols from the Aral Sea and early warning of the respective organizations of countries – founders of IFAS;

- the cartographic inventory (with using of space aerial photographs) of forest-pasture lands degraded as a result of release of CDW and sewage to the desert areas of CA, and the elaboration of measures on their rehabilitation;

- the studying and forecast of erosion process, saltinization, waterlogging and soil pollution at the transboundary territories, and elaboration of measures on prevention of their negative impact on the environment;

- the cooperation with Sub-Regional Training Program in preparing the materials for the educational institutions of all levels;

- the preparation, publication and distribution of books, brochures and other informational materials (including the international scientific-practical magazine "The problems of desert development") concerning the methods of desertification combating and reversing.

6. Programs and projects on the rational use of land resources

The problems of land degradation in CA countries are stated in the following main programs of national and regional levels:

- The regional environmental action plan (REAP);
- The national action programs to combat desertification (NAPCD);
- The national environmental action plans (NEAP);
- The sub-regional action program to combat desertification in CA (SRAPCD);
- The national framework programs prepared within the Central Asia Countries Initiative for Land Management (NFP CACILM).

NAPCD is the main instrument in implementation of commitments of the country arising from the Convention to Combat Desertification (UN CCD). NAPCD describes the condition of environment and nature resources in the country, the socioeconomic development, the anthropogenic desertification, the strategy and action plan and priority measures to combat desertification.

The implementation of NAPCD began with realization of land degradation combating project and capacity building needs self-assessment project supported by UNDP and Ministry of Nature Protection. The preparation of national environmental action plans (NEAP) became the main direction for the sustainable land resources management. These programs have got support of UNDP and World Bank. NEAP identifies the main forms of land degradation and suggests the set of indicative strategies and measures (institutional and investment) for natural resources degradation combating, although many of these measures are not financed yet.

In accordance with the NAPCD and NEAP and other documents, the CA countries outlined at the national

levels the following near-term tasks in the sphere of land degradation:

Kazakhstan

- transition to the sustainable systems of agricultural production;
- permanent reproduction of land fertility based on the organic or ecological farming;
- protection of agricultural lands from the wind and water erosion, drought and dry wind by means of creation of field protective forest lines and protective forest plantations at the area of 3 million hectares;
- implementation of the National Program to Combat Desertification of 2005-2015 directed on prevention from processes of desertification and reduction lands degradation scale, development of economic mechanisms to combat desertification, creation of basis for establishment of optimal ecological parameters of land management;
- fulfillment of the tasks of Conception of Ecological Safety of Republic of Kazakhstan for 2004-2015.

Kyrgyzstan

- radical amelioration including the grass growing, crops rotation and hydro-technical reclamation and correct soil treating;
- inventory of the present condition of soil degradation;
- differential regime of irrigation that will ensure the irrigation water saving;
- implementation of a complex of ameliorative works (manure and organic and mineral fertilizers inputting, salt removal measures in line with optimal drainage and so on) with taking into account the nature peculiarities of particular landscapes and structure of vertical zoning;
- elaboration of National Conception of land use in new conditions of market relations;
- restoring of pastures potential and development of pasture cattle-breeding as the ethnic form of farming in mountains;
- finalizing, approval and implementation of National Action Plan to combat desertification;
- amending of all programs and conceptions of agriculture development, water management and environment protection and elaborating on their basis of concrete measures on preserving and increasing the soil fertility.

Tajikistan:

- improvement of ameliorative condition of irrigated lands;
- upgrading of irrigation systems;
- rehabilitation of water-eroded lands;
- creation of conditions for the equitable development of various forms of farming;
- regulation of grazing and increase of the productivity of pasture lands;
- reclamation of damaged lands;
- working up of Conception of Republic of Tajikistan on rational use of land resources.

Turkmenistan:

- implementation of National program of improvement of social and ecological situation at the Aral Sea-impacted territory of Turkmenistan;
- implementation of a complex of works to plant trees around Ashgabat city and other human settlements of the country (the program "Green Belt");
- implementation of measures stipulated in NEAP of Turkmenistan to combat soil secondary saltinization, waterlogging and deflation;
- construction of Turkmen Lake to collect CDW from all the velayats of the country, thus ceasing their discharge into the Amu Darya River;
- implementation of GEF project within the framework of CA REAP "Growing of halophytes to increase productivity of degraded pastures at saline lands".

Uzbekistan:

- radical reconstruction of irrigation and ameliorative facilities;
- implementation of a set of agro-technical, organizational-economic, forest-ameliorative and hydro-technical measures at the irrigated lands;
- increase of fertility of eroded irrigated, dry-farming and pasture lands and their return to the agricultural using;

- elimination of the threat of transboundary pollution of environment by dangerous wastes of mining enterprises;
- elaboration and introduction of non-emaciating system of farming to provide the favorable balance of humus in the soil.

It is necessary to note that NAPCD and NEAP do not provide enough time and resources for the achievement of defined aims and objectives in harmonic development and use of natural resources, including the land degradation combating. In this connection, the Global Mechanism of UNCCD initiated the development of Agreement on Strategic Partnership for implementation of UNCCD in CA and this initiative joined together GM, ADB, Canadian International Development Agency (CIDA), GTZ (Germany), Swiss Agency on Development Cooperation (SDC), IFAD, ICARDA, UNDP, UNEP, GEF. In 2003, in Tashkent, there have been elaborated the grounds of Tashkent platform for UN CCD implementation and creation in each CA country of the group on development of partnership for UN CCD implementation. The Central Asia Countries Initiative on Land Resources Management (CACILM) is the multilateral and donor partnership to support development and implementation of national Framework Programs with the purpose of more comprehensive and integrated approach in the sphere of sustainable land resources management (SLRM) in the region as a whole and each country of this region. CACILM will follow the National framework programs (NFP) elaborated in each country (2006).

These programs are directed on the systematized, coordinated and integrated execution of those parts of NAPCD and NEAP that relate to land and water resources degradation, as it is stipulated in CACILM and then submitted to GEF for consideration. Thus, the priorities defined in NAPCD and NEAP and the larger part of projects stipulated in them are included to CACILM framework.

The set of short-term (until 2007) and long-term (until 2012) joint actions (Table3) has been developed for the purpose of cooperation at the regional level.

Indicators

1. The arable land per capita, in hectares.
2. The structure of lands (the share of irrigated lands, pastures, forests and specially protected natural territories,%).
3. The structure of sowing of agricultural crops (the share of areas under cotton, grain and forage crops, including lucerne,%).
4. The using of fertilizers and pesticides, kg/ha.
5. The density of collector-drainage network at the irrigated lands, m/ha.
6. The level of drainage provision, in% of estimate).
7. The level of soil salinity (the share of non-saline, weakly saline, medium saline and severely saline soils,%).
8. The water use efficiency coefficient;
9. The salt inflow together with irrigation water, t/ha;
10. The share of CDW diversion from water in take at the irrigated massifs,%;
11. The mineralization of drainage water dive rted outside the irrigated massifs, g/l;
12. The livestock per one hectare of pastures;
13. The level of pasture degradation (the proportion of weak, mid- and strong levels of degradation);
14. The level of eroded lands in a result of def lation and water erosion, in comparison with the area of agricultural land,%;
15. The monitoring of irrigated land condition (the level of salt, and level of fertility and so on);
16. The monitoring of forest lands, desert and mountain pastures;
17. The monitoring of salt and dust aerosols coming from the Aral Sea.

Actions and measures proposed to improve the degraded lands of Central Asia:

- development, approval and implementation of Framework Environmental Convention for the sustainable development of CA;
- implementation of projects on priority directions of REAP and NEAP;
- implementation of the regional program "Central Asia Countries Initiative on Land Management";
- implementation of the Sub-Regional Action Program to Combat Desertification;
- implementation of the Sub-Regional Training Program on Sustainable Land Management;
- implementation of National Action Programs to Combat Desertification in CA countries;
- perfection and harmonization of nature protection legislation with the purpose of creation of institutional capacity for the successful desertification and land degradation combating;
- renewal of the network of monitoring of irrigated land and forest, pasture lands, environmental impact assessment of desertification processes and introduction of distance monitoring methodology;
- creation of network of monitoring of salt and dust aerosols coming from the Aral Sea;
- rehabilitation of eroded lands, fulfillment of agro-technical, organizational and economic, forest melioration and hydro-technical anti-erosion measures;
- rehabilitation of severely degraded pastures; introduction of pasture rational use methods;
- creation of specially protected natural territories and normalization of economic burden on ecosystems;
- forest-phyto-melioration of the dried up bottom of the Aral Sea and zone of salt and dust aerosols impact;
- re-cultivation of technogenic lands;
- restoring of mountain, desert and flood-land forests with the purpose of fastening of slopes, stabilization of river flow and production of timber;
- reversing of salinization, pollution, waterlogging, deflation and erosion of irrigated lands;
- pasture inventory through implementation of comprehensive geo-botanical researches and preparation of appropriate maps.

The current projects of CA REAP related to "Land Degradation" problem

1. Growing of halophyte to increase productivity of degraded pastures at saline lands (2005-2007, US$55.000, implemented in Turkmenistan).

Pilot projects approved by ISDC

1. Development of biological rectification of collector-drainage waters methodology for the conditions of the CA Aral Sea zone (Turkmenistan, Uzbekistan and Kazakhstan). Period of fulfillment – 2 years. Budget – US$250 000. Country-applicant – Turkmenistan.

The pilot projects recommended for consideration by ISDC

1. Conduction of comprehensive phytomelioration works in the dried up part of the Aral Sea and in the zone of influence of salt and dust aerosols in the South and Southeast part of the Aral Sea zone. (Kazakhstan, Turkmenistan, Uzbekistan). Period of fulfillment– 4 years. Budget – US$1.200.000.

2. Organization and support of the regional network of stationary points of desertification monitoring. (Kazakhstan, Kyrgyzstan, Tajikistan, Turkmenistan, Uzbekistan. Period of fulfillment – 5 years. Budget – US$500.000.

3. Restoring and rational use of forest-pasture resources. (Kazakhstan, Kyrgyzstan, Tajikistan, Turkmenistan, Uzbekistan). Period fulfillment – 5 years. Budget – US$2.500.000.

4. Development and drawing up of a desertification map of CA on the basis of space photos of scale 1:1000000. (Kazakhstan, Kyrgyzstan, Tajikistan, Turkmenistan, Uzbekistan). Period of fulfillment – 3 years. Budget – US$ 2.500.000.

5. Fixing and afforestation of drift sands around the engineering objects of the transboundary zone. (Kazakhstan, Turkmenistan, Uzbekistan). Period of fulfillment – 4 years. Budget – US$1.500.000.

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Table 3. Plan of implementation of short-term and long-term actions on "land degradation" problem

№	Actions	Terms of implementation	Executors	Expected results
Short-term actions (2005-2007)				
1.	Analysis of existing action programs and plans to combat lands degradation	2006	Cooperation center on REAP priority "Lands degradation"	Document showing strong and weak points of existing programs and plans will be used for strategic planning
2.	Perfection of national structures of desertification process monitoring	2005–2007	Turkmenistan, Uzbekistan, Kazakhstan, Tajikistan, Kyrgyzstan	
3.	Development of Sub-regional Education Program (SREP) on resources management	2006–2007	National center of desertification combating of Turkmenistan and national coordinators UN CCD CA countries	Regional network and communication mechanism to identify training programs as well monitoring and SREP evaluation is created
4.	Establishment of Secretariat SREP on NIDFFMNPT	2006	National center of desertification combating of Turkmenistan in cooperation with Global Mechanism UN CCD	Permanently functioning SREP Secretariat analyses needs in education and gets in touch with SREP Advisory Commission
5.	Establishment of SREP Advisory Commission (AC) to be included in National Coordinators UN CCD in Central Asia	2006	National center of desertification combating of CA countries and members of Strategic Partnership Agreement on UN CCD	SREP AC in cooperation with Secretariat develops training programs taking into account needs of target groups
6.	Preparation and conduction of actions to combat desertification (within the framework of the international year of deserts)	2006	Ministry of Nature Protection of Turkmenistan, REAP jointly with UNDP	Public significance of desertification and lands degradation problem is increased. Regional and international cooperation is established and strengthened.
7.	Implementation of GEF project "Growing of halophyte for increase in productivity of degraded pastures on saline lands"	2205–2007	Cooperation center at REAP on problem "Lands Degradation" within the framework of implementation of REAP	Results of research will be used in national economy of the country and on a regional scale
8.	Implementation of Subregional program to combat desertification	2006–2012	National centers of desertification combating of CA countries.	Regional cooperation desertification combating is strengthened
9.	Conduction of Subregional training courses to combat desertification	2007–2012	SREP Secretariat and Coordination Commission	Filling a gap in knowledge, method, technologies and approaches for sustainable use of land resources in the region

№	Actions	Terms of implementation	Executors	Expected results
10.	Support of existing information resources for exchange of advanced experience and technologies (SIC ISDC)	2007–2012	SIC ISDC	
11.	Research work of Institutes of Central Asia	2007–2012	Turkmenistan, Uzbekistan, Kazakhstan, Tajikistan, Kyrgyzstan	
13.	Distribution of advanced experience of CA countries to combat desertification through international research and practical journal "Problems of desert development"	2007–2012	REAP	The Journal is a platform for exchange of experience in the region to combat desertification
14.	Making up and publication of map of CA desertification on the basis of aerial photography 1:1 000000 scale 00	2007–2009	Turkmenistan, Uzbekistan, Kazakhstan, Tajikistan, Kyrgyzstan	Updated data on a status of processes of desertification are used to fulfill national programs and plans
15.	Sand fixation and afforestation of drift sands of dry seabed of the Aral Sea	2007–2010	Turkmenistan, Uzbekistan, Kazakhstan	Sources of transfer of drift sands and dust are reduced, productivity of pastures and capability of local population to combat drift sands are strengthened
16.	Rational use of pasture resources, restoration and enrichment of degraded forest-pasture lands	2008–2012	Turkmenistan, Uzbekistan, Kazakhstan, Tajikistan, Kyrgyzstan	Mechanism of sustainable use of pastures is developed and in operation. Capability of cattle-breeders is strengthened for their participation in planning of pasture use
17.	Rehabilitation of eroded lands, implementation of agrotechnical, forest amelioration and hydrotechnical erosion-preventive measures	2007–2010	Turkmenistan, Uzbekistan, Kazakhstan, Tajikistan, Kyrgyzstan	Sectors of improved lands are created with application of advanced technologies
18.	Irrigated lands degradation combating	2007–2012	Turkmenistan, Uzbekistan, Kazakhstan, Tajikistan, Kyrgyzstan	Mechanism of sustainable use of irrigated lands is developed and in operation. Land users' capability is strengthened for their participation in land management planning
19.	Development, approval and implementation of measure stipulated in Framework convention on environment protection of for sustainable development of Central Asia		Turkmenistan, Uzbekistan, Kazakhstan, Tajikistan, Kyrgyzstan	Package of measures on priority ecological CA problems including lands degradation is developed and implemented

Atmospheric air pollution in Central Asia countries

Content

Appraisal report on priority "Pollution of atmospheric air in Central Asia countries".

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Introduction

The appraisal report on priority "Atmospheric air pollution in Central Asia countries" has been prepared by a working group of experts from Uzbekistan, Tajikistan, Kazakhstan, Turkmenistan and Kyrgyzstan with UNEP support within the framework of CA REAP project.

The information on the state of air basin of CA countries and actions on atmospheric air both at regional and national levels are presented in this report.

When preparing the appraisal report, there have been used the materials received from all ministries, agencies and organizations of Central Asia countries the activities of which are connected with air protection both at regional level as a whole and at national level, as well as from the authorities carrying out the state control over observance of laws on atmospheric air protection.

The information in the appraisal report is based on the statistical reports coming from enterprises and organizations to the state statistical agencies, as well as from ministries and agencies the activity of which is connected with ecological control and atmospheric air protection.

The appraisal report analyzes the integration of air-protection aims and objectives to all economic sectors of CA countries, having drawn the particular attention to a number of problems in the sphere of atmospheric air protection ranging from management and coordination of the activity of controlling bodies in the sphere of atmospheric air protection up to the issue of transboundary pollution of atmospheric air. In view of all these problems, the CA countries considered it was necessary to create both at regional and at national level the appropriate capacity, as well as to strengthen mechanisms of air-protection measures introduction and of state control carried out in many CA countries with transition economy.

One of the main conclusions of the analysis suggested in the appraisal report is that the certain serious problems in the sphere of atmospheric air protection still continue to remain. Pollution of air from stationary sources declined due to a number of reasons, however, the air pollution from mobile sources in many CA countries increased significantly as a result of rapid growth of transport fleet.

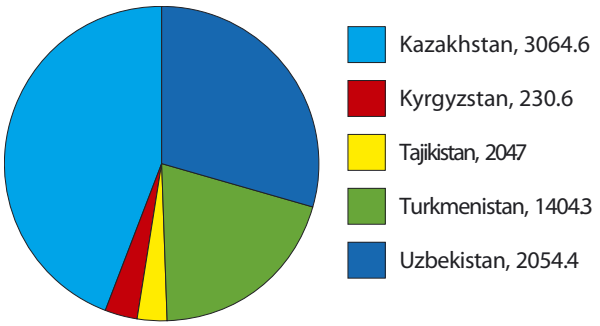
Comparison of damage caused by any anthropogenic factor adverse for the air confirms the idea of ecological problems priority. Comparison of losses or expected results and costs for required measures provides a possibility to define the priority actions. Finally, the direct correlation of costs and results provides the basis for prioritization of the most effective air-protection projects.

The problem of atmospheric air pollution needs permanent attention, as far as the expected economic growth of CA countries can, undoubtedly, change the situation. Here, we need to take into consideration the solution of two objectives: first, inclusion of ecological problems to the baseline of the development policy of urban transport; secondly, provision of adequate control over emissions from large enterprises, particularly heavy industry enterprises concentrated in human settlements.

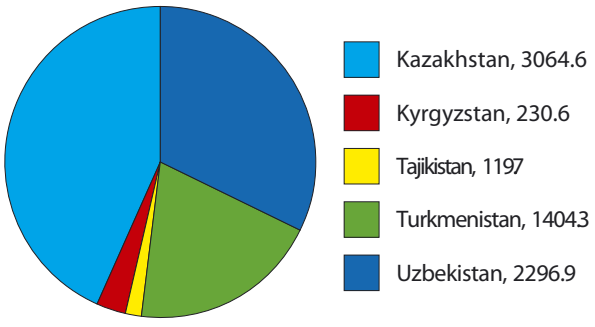
Natural sources of air pollution in Central Asia region include Kyzylkum and Karakum Deserts, as well as the dried up seabed of the Aral Sea from which the large masses of salted dust are transferred by the wind from west to east.

1. Environmental policy in CA countries

Almost all CA countries have worked out the new directions of national air-protection policy within the period of transition to market economy. The target spheres and the goals of new directions distinguished with a large variety, and it was not always possible to define on their basis clear priorities of financing and realization of planned measures. Many CA countries have prepared their national action plans that include inter alia the measures directed on reduction of emissions of polluting substances. Directions of air-protection policy are not financed to a sufficient extent, and this problem, particularly in the aspect of introduction of air-protection measures, is the main one and general for all sectors of the state policy in CA region.



Polluting substances, 2005



Polluting substances, 1999

Pic. 1. The ratio of emissions of solid substances and gaseous and liquid substances changed a little.

The considerable quantity of emissions of contaminants to atmosphere comes from motor transport. Motor transport fleet in CA countries grows rapidly. All this leads to the increase of concentration in the atmospheric air of anthropogenic polluting substances which strongly impact the global climate, cause the negative effects: greenhouse effect, depletion of ozone layer, acid rains, photochemical smog, etc.

The enlargement of motor transport fleet in all CA countries leads to growth of atmospheric air pollution from mobile sources. The main problem for today is a long period of exploitation of the vehicles.

Unfortunately, some countries, because of shortage of financial resources still apply obsolete technologies for introduction of air protection measures.

In almost all countries of CA the industrial enterprises and other large polluting objects are required to receive the permission from nature protection authorities, and in almost all CA countries the procedures of environmental impact assessment connected with the system of issue of permissions for enterprises and polluting objects has been introduced. This measure allows establishing the system of accounting and analysis of emissions of polluting substances into atmospheric air. The legislation and EIA standard in most of the countries envisage the access of public to the projects under implementation.

In many nature-protection structures of CA countries the ecological funds have been established for particular nature-protecting investments, including air-protecting investments, to channel them to solution of the objectives such as development of municipal infrastructure, strengthening of control over atmospheric air pollution, introduction of new technologies for prevention of atmospheric air pollution, educational activity, establishment of monitoring systems. Money arrives from numerous sources, including compensation payments for environment pollution, fines for nature-protection law violation, etc.

1.1. Ecological intensity and main characteristics of air basin pollution

As far as the CA countries are situated in arid zone and their population steadily grows, the anthropogenic impact on atmospheric air also grows. This creates additional ecological, economic and social burden for the densely populated territories of CA countries.

Over the last 45 years the level of the sea declined by more than 22 meters, the area of water territory reduced more than 3.5 fold, volume of water reduced from 1060 cubic kilometers to 115 cubic kilometers, salt level of water reached 70 g/l. The area of dried seabed made over 4 million hectares and became a source of sandy and salty aerosols transferred to the bordering territories.

From the naked salty seabed of about 40 thousand square meters up to 100 million tons per annum of salty dust is blown out by the wind and thrown away outside the Aral Sea. This dust contains mainly the aerated particles in a form of aerosols with admixture of agricultural pesticides, fertilizers and other harmful components of industrial and residential effluents.

Pic. 2. Aral Sea in various periods. The large-scale photos of the Aral Sea (1957-2000)

The trains of dust make 400 kilometers long and 40 kilometers wide, radius of dusty storms makes over 300 kilometers. Annually, the atmospheric air here accepts from 15 to 70 million tons of dust. Since the early 1980s the storms were observed here over 80 days per year.

At present time, in CA countries, owing to the economic buoyancy, some obsolete technologies are changed for the advanced ones, which pollute less the atmospheric air and operate on cleaner kinds of fuel.

Gradually, in many CA countries the production and other spheres of the life begin to use the alternative sources of energy (particularly, solar energy).

In the whole region the industrial objects and households switch to alternative sources of energy (especially natural gas) less polluting the atmospheric air.

Many thermal power stations (main polluting objects) of the region begin to apply the cleaner kinds of fuel that provide a possibility to reduce the emission of polluting substances into atmospheric air.

The quality of refined petrol products increased, because in many countries of CA the new technologies were introduced and provided a possibility to compete successfully with other countries. In all CA countries the first efforts are undertaken to introduce such renewable energy sources as biomass, wind energy; the hydroelectric energy and solar energy are also used successfully.

1.2. Impact of pollution sources of CA countries on the state of atmospheric air

In the region as a whole, the downward tendency is observed for the polluting emissions from stationary sources. In 1999, the emissions made 7116.1 thousand tons, by 2005 this figure reduced to 157.5 thousand tons or by 2.2%.

Emission of polluting substances in 2005 made 695-8.6 thousand tons. Over the period under review, the maximal input into average general volume of polluting substances to atmosphere falls to Kazakhstan – 44%. The share of other CA countries is distributed as follows: Uzbekistan – 29.5%, Turkmenistan – 20.3%, Kyrgyzstan – 3.3% and Tajikistan – 2.9%.

On average, over the period of 1999-2005, the maximal input into general volume of emission of polluting substances from stationary sources came in a form of gaseous and liquid substances – 70%.

Against the background of production recession and reduction of volume of emissions into atmosphere from stationary sources in CA countries the share of emission from motor transport in general volume of emissions increased to 65-70%, especially in large cities.

There is the tendency to reduction of emissions of some main admixtures (dust, sulfur gas, hydrocarbon oxide, nitrogen oxide) connected to a larger degree with processes of fuel combustion.

The main input to general pollution of atmosphere came in a form of aerated particles and sulfur dioxide – 35% and 30.5% respectively. The share of hydrocarbon oxide made 14%, nitrogen oxides – about 10%.

The character of downward tendency of emission of the main group of polluting substances depends on intensity of energy, industrial and transport complexes operation in CA countries. The studies of urban air pollution on the territories of the republics showed that the list of cities with the largest level of atmosphere pollution should include:

- Kazakhstan: Almata, Jambul, Zyryanovsk, Temirtau, Ust-Kamenogorsk;
- Kyrgyzstan: Bishkek, Osh; Tajikistan: Dushanbe;
- Turkmenistan: Charjou
- Uzbekistan: Almalyk, Angren, Navoi, Tashkent.

Data on main contaminants of the air from stationary and mobile sources are shown in *Table 1*.

The main mass of polluting substances in CA countries arrives to atmosphere from fuel combustion (including motor fuel) and from generation of heat and electric energy.

In those countries that had a possibility to make investments the larger share of money was directed into such spheres as reconstruction of motor roads or improvement of quality and construction of highways. This also was considered as contribution to the process of development of international transport corridors. All CA countries received as a legacy the well-developed road and other transport infrastructure. However, because of small financing for maintaining of this infrastructure it deteriorates and consequently leads to aggravating of ecological problems such as pollution of large cities of the region with dust.

1.3. Problems of ozone layer depletion

A number of factors promoted a success of strategies directed on reduction of ODS consumption are as follows: development of alternative substances and production processes, application of scientific evaluation for making changes to Montreal Protocol, if required, recognition of principle of "overall but differential" responsibility.

One of the obvious successes of Montreal Protocol is the fact that approximately by 2050 the ozone layer will have restored to level existing before 1980. The analysis of ODS use proves that according to this index Central Asia countries at present time observe Montreal Protocol and all Amendments to it.

As of today, the issues related to ratification, joining, adoption or approval of documents on the ozone layer protection are resolved as follows:

Uzbekistan: in May of 1993 Vienna Convention and Montreal Protocol were signed, in 1998 London and Copenhagen Amendments to the Protocol was ratified. In September, 2006 laws "On Ratification of Amendment to Montreal Protocol concerning substances destructing the ozone layer (Montreal, September 17, 1997)" and "On ratification of Amendment to Montreal Protocol concerning sub-

stances destructing the ozone layer (Beijing, December 3, 1999)" were signed.

Tajikistan: in May, 1996 Vienna Convention was signed; in January, 1998 – Montreal Protocol and London Amendments to the Protocol were ratified.

Kazakhstan: in August, 1998 Vienna Convention and Montreal Protocol were signed.

Turkmenistan: in November, 1993 Vienna Convention and Montreal Protocol were signed; in March, 1994 London amendments to the Protocol were ratified.

Kyrgyzstan: in May, 2000 Vienna Convention and Montreal Protocol were signed.

1.4. Transboundary pollution of atmospheric air

Convention on transboundary air pollution at large distances

This document laid the foundation for restriction of emission of particular polluting substances through working out protocols being of an obligatory legal force. Over period since 1984 eight protocols have been adopted. Protocols are directed on decrease in emission and trasboundary flows of sulfur (sulfur dioxide), nitrogen oxide, volatile organic compound (VOC), heavy metals and persistent organic polluting substances.

The very similar geographical, economic and social conditions of CA countries cause the common transb-oundary ecological problems in the sphere of atmospheric air protection. Thus, the tasks, action programs directed on reduction of negative impact on atmospheric air of the region should be solved by joint and better coordinated efforts of all countries of the region.

Five countries of CA until recent time were not involved in the work of Convention. At present time, Kazakhstan, Tajikistan, Kyrgyzstan and Turkmenistan are the parties to the Convention and express their wish to participate more actively in its work and protocols.

Only Uzbekistan has not joined the Convention yet.

Since 1995, the State Committee of Nature of Republic of Uzbekistan has been working in respect of Convention on transboundary air pollution on large distances.

Joining of Uzbekistan to the Convention on transboundary air pollution on large distances will provide a possibility for Republic to cooperate more actively with neighboring states and international organizations in solution of ecological problems, work out and implement measures directed on reduction of emission of polluting substances, modernize existing

Table 1. Dynamics of emission of polluting substances in atmosphere on Central Asia countries in 2004-2005 (thousand tons)

№	Name	2004			2005		
		transport	industry	total	transport	industry	total
1.	Republic of Uzbekistan	1310.9	646.5	1957.4	1372.887	681.692	2054.479
2.	Republic of Tajikistan	128.0	36.0	164.0	170.3	34.4	204.7
3.	Republic of Kazakhstan	–	3016.5	–	–	–	–
4.	Republic of Turkmenistan	–	529.2	–	–	–	–
5.	Kyrgyz Republic	–	36.7	–	–	34.5	–

technologies and, finally, will result in improvement of ecological situation in the country. In addition, signing of Convention will allow solve the problems related to pollution of atmospheric air of Uzbekistan by emissions from bordering states, particularly to reduce the negative impact of Tajik aluminum plant on environment and health of population residing in vicinity areas of Sukhandarya oblast of Uzbekistan.

At present time, Uzbekistan works over the issue of joining to Convention on Environmental Impact Assessment in transboundary context. The relevant documents containing the generalized suggestion on expediency of joining are prepared and submitted to the structures concerned.

1.5. Ecological education

The ecological situation in CA countries has an unavoidable impact on human health and is accompanied by economic losses, and therefore, provision of ecological safety is one of the strategic tasks of Central Asia region states.

In all CA countries, when drafting the complex programs, the important role is given to creation of the network of specialists working in the sphere of ecological education together with representatives of various ministries, agencies, non-governmental organizations and scientific institutions.

For instance, the mass media in ***Uzbekistan*** cover the ecological topics and issues of sustainable development, just in the capital city of Republic over 20 mass media work with ecological issues. With the purpose to create incentives for reporters – ecologists the journalism festivals are conducted. The round tables for journalists and ecologists are convened regularly. Many books of ecological focus are published in Republic now. More and more often the editions reflect ecological problems, explain the rights of people for healthy environment, including clean air.

The magazine "Ecological Bulletin" is published regularly. Over 10 web sites of ecological focus have been created.

To provide assistance to the teachers of Uzbekistan in efficient use of new technologies at the lessons, support democratic reforms in schools and promote civil education development the program "Internet in schools of Uzbekistan"is realized, which announced about establishment of over 60 Internet Centers. The special inter-agency committee to finalize the conception of continuous ecological education was established in Republic. In many secondary schools of Republic there appears the trend of introducing the ecological topics to many educational subjects and disciplines. In Tashkent, 7 higher educational institutions prepare ecologists: ecologist-technologist, teacher-ecologist, biologist-ecologist, lawyer-ecologist, ecologist-engineer, etc.

The State Committee of Protection of Environment and Forestry of ***Republic of Tajikistan*** provides the government authorities, enterprises, organizations and the population of Republic with information on nature phenomena and environment pollution, systemizes the ecological information and literature, develops the national ecological information network and provides information on international cooperation in the sphere of environment protection.

At present time, the national information legislation of Tajikistan includes the laws "On press and other mass media" (1990), "On publishing" (1994), "On communication" (1994), "On TV and radio broadcasting" (1996),"On informatization"(2001).

In ***Kazakhstan***, within the last years, the political, legislative and institutional grounds for activity of various organizations, especially non-governmental environmental organizations develop intensively. The laws "On environment protection", "On ecological expertise", "On voluntary organizations", "On mass media" define the basic rules of participation of public, of access to information and justice. Cooperation between Parliament and non-governmental environmental organizations and joint preparing of draft laws brings the positions closer and promotes the unity of approaches of legislative, executive power and non-governmental organizations.

Turkmenistan ratified in 1999 the Aarhus Convention on access to information, participation of public in decision-making and access to justice on envi-

ronment protection matters, including atmospheric air protection that opened the new possibilities in development of rights of civil society for participation in formulation of environmental policy and in promoting its implementation.

To promote public awareness the Ministry of Nature Protection of Turkmenistan monthly publishes the information and analytical bulletin "Nature Bulletin" featuring the issues of nature protection in Turkmenistan. The issues of research of potential of various natural territories, the scientific studies of approaches to their protection and rational development are considered in the international scientific and practical journal "Problems of Desert Development".

In 1992, in ***Kyrgyzstan*** the law "On mass media" was approved. During the referendum (1998) there was approved the inclusion to the Constitution of Republic of norms prohibiting any legal initiatives directed on restriction of freedom of speech and freedom of press. Republic has the laws on protection of professional activity of journalist, on guarantees of free access to information. At present, over 400 publishing mass media are registered in Kyrgyzstan, over 90% of which are newspapers. Ecological information is delivered to general audience through mass media.

At the same time, in CA countries, when introducing programs and projects in the sphere of ecological education, the certain problems appear the solution of which could be a useful add-on to reduction of adverse impacts on environment, particularly, on atmospheric air of the region.

These are mainly the following problems:

- not always true information on ecological situation (quantity of emissions of polluting substances, reduction of emission of polluting substances, etc.);
- lack of system of continuous ecological education in schools and "Ecology"subject in schools curricula;
- imperfection of re-training and improvement of qualification of specialists working in the sphere of atmospheric air protection;
- absence of teaching materials in the state languages and insufficient technical assistance in schools;
- weak financial base of non-governmental organizations;
- insufficient use of mass media as main lever for realization of policy in the sphere of ecological education.

2. State and protection of atmospheric air in Uzbekistan

2.1. Quality of atmospheric air

As a whole, since 1991, the pollution of atmospheric air has acquired a downward trend. First of all, it is explained by decline of industrial production. However, despite the reduction of air pollution with industrial emissions, the quality of air in separate cities and districts did not improve because of increase of pollution with substances thrown by mobile sources.

Data on emission of main polluting substances from stationary and mobile sources are shown in *Table 2.* and *Fig. 3.*

Table 3 shows the atmosphere pollution indicators (API) over the period of 2000-2005 in 15 cities, and Table 4 shows data on emissions by main economic branches of the country.

Information on reduction of emissions as a result of implementation of large air-protection measures and suspension of the activity of violating objects is shown in *Table 5.*

The main share of 31.3% into emission from stationary sources in Uzbekistan falls to power engineering sector.

The main polluting substances are: sulfur dioxide, nitrogen oxides, solid dust particles, hydrocarbon oxide and vanadium pent oxide and benz(a)piren. In addition, thermal power stations and heat and power plants throw out the largest quantity of sulfur dioxide (over 100 thousand tons) both by the sector – 57.6% and by Republic-44.16%.

2.2. Oil and gas industry

Oil and gas industry of Uzbekistan is one of the largest branches of heavy industry that for 93% provides the energy system of Republic with primary fuel resources.

The general results of extraction and recycling of refrigerants due to "National Program of Recycling and Extraction" are shown in *Table 6.*

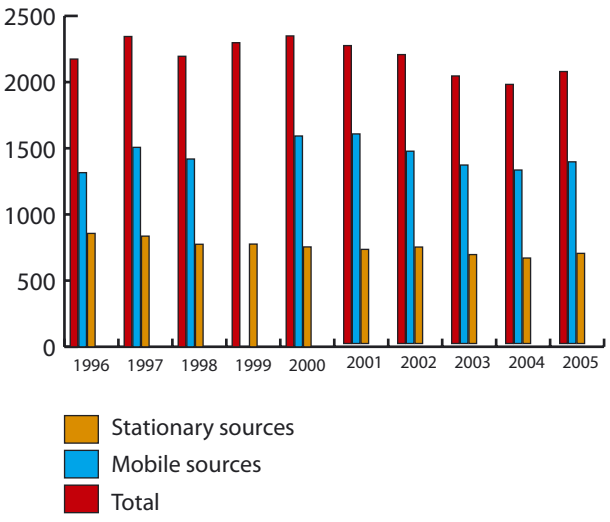


Fig. 3 Dynamics of emission of polluting substances in Republic of Uzbekistan, 2000-2005

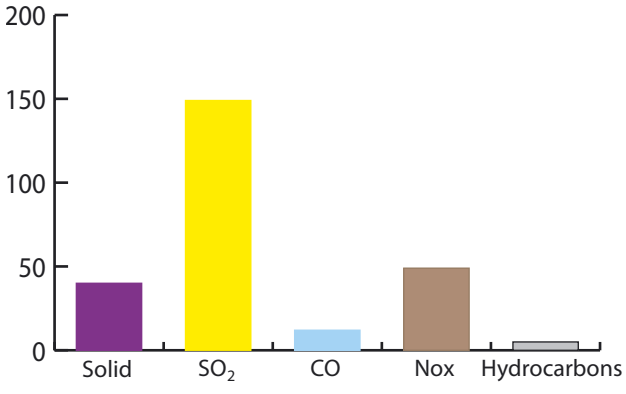


Fig. 4. Dynamics of emission of polluting substances coming to the air basin from mobile sources.

Table 2. Dynamics of emission of polluting substances in Republic of Uzbekistan, 1996-2005 (thousand tons)

Years	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
Total	**2173.7**	**2344.1**	**2194.7**	**2 296.9**	**2348.5**	**2250.3**	**2182.4**	**2021.1**	**1957.4**	**2054.5**
Stationary sources	857.5	836.9	775.5	776.9	755.5	711.8	729.4	672.6	646.5	681.7
Mobile sources	1316.2	1507.2	1419.2	1 520.0	1593.0	1583.5	1453.0	1348.6	1310.9	1372.8

Table 3. Air pollution (API) in large cities and human settlements of Republic of Uzbekistan, 1996-2005

Cities	1996	1997.	1998	1999.	2000	2001	2002	2003	2004.	2005
Almalyk	7.45	6.98	5.44	4.75	5.52	5.08	4.83	4.67	4.46	4.46
Bukhara	4.74	5.48	6.08	4.71	4.48	4.09	3.56	3.22	3.04	3.94
Samarkand	5.18	4.39	4.41	3.30	3.51	3.77	3.06	3.02	3.06	2.65
Tashkent	5.62	5.65	6.38	6.48	5.92	5.95	6.68	6.36	5.52	5.22

Table 4. Dynamics of emission of polluting substances by main economic branches of Republic of Uzbekistan, 1999-2005 (thousand tons)

Years	1999	2000	2001	2002	2003	2004	2005
Republic of Uzbekistan	**776.952**	**755.519**	**711.841**	**729.477**	**672.577**	**646.510**	**681.692**
Power industry	259.264	255.474	211.310	229.475	210..636	200.224	163.303
Oil and gas industry	259.627	241.253	247.842	222.371	192.972	186.884	183.750
Metallurgy	118.244	123.585	120.997	119.842	121.556	130.463	127.386
Municipal economy	31.843	27.025	32.871	59.571	50.186	43.456	67.465
Chemical industry	18.947	20.013	18.000	16.723	17.565	18.555	13.172
Building industry	32.966	27.563	27.520	22.382	19.579	20.460	22.507

Table 5. Reduction of emission of polluting substances over last 3 years (tons)

Period	Total	including:	
		At the cost of suspension of objects operation, etc..	At the cost of introduction (implementation) of measures
2003	3025.7	142.0	2883.7
2004	17881.3	486.0	17395.3
2005	20360.1	580.13	19779.97

3. State and protection of atmospheric air in Tajikistan

The main principles of nature protection law are specified in the Constitution of Republic of Tajikistan. Requirements on atmospheric air protection are defined in the law "0n nature protection"(1993) and law "0n atmospheric air protection" (1996). The law "On atmospheric air protection" makes the basis for realization of organizational and legal principles of atmospheric air protection.

The main sources of atmospheric air pollution of anthropogenic character are the enterprises: of mining and refining branches of industry – Production Company "Vostokredmet", joint Tajik-British enterprise"Zaravshon" Adrasman and Anzob ore-mining and refining plants; of chemical industry- Joint-Stock Company "Azot" Yavan Electrochemical and Isfari Chemical plants; of textile industry- joint Tajik-South Korea enterprise "Koobul Tajik Textiles", Joint-Stock Company "Abreshim" Production Association "Tajiktextile"; enterprises of non-ferrous metallurgy- Isfari hydrometallurgical and Tajik aluminum plants; enterprises of fuel and energy complex – Dushanbe and Yavan thermal power plants; cotton-processing factories, etc. These industrial branches deliver 88% of total emissions of polluting substances from stationary sources in Republic as a whole.

The largest quantity of specific polluting substances is thrown out by the enterprises of chemical industry: Joint-Stock Company "Azot" (about 95% of ammonia); Yavan Electrochemical Plant (about 98% of chlorine); enterprises of non-ferrous metallurgy: Tajik aluminum plant the share of which makes 70% of total emission of polluting substances in Republic as a whole, about 99% of fluoride of hydrogen and solid fluorides; joint enterprise "Zaravshon"(almost 100% of hydrogen cyanide and arsenic oxide), Anzob ore-mining and processing plant (about 90% of antimony).

The enterprises of Republic allocate annually 38-58 million Somoni for air-protection measures.

Fluoride salts are the main raw material for aluminum production from which fluoride hydrogen is formed. Expenditure coefficients for fluoride salts, in comparison with 1993, were reduced by 61 kg per ton (by 137.7%) that provided a possibility to diminish the quantity of emission of fluoride hydrogen from 154.4 tons to 121.4 tons in 2003 or by 32.6 tons with the same output of aluminum.

Within the last years, the aluminum plant performed a big number of measures directed on reduction of emission of harmful substances and improvement of environmental situation. These measures included:

- replacement of drop-gathering gas refining facilities of II and IV series of electrolysis;
- introduction of gas refining plants with capacity of 135 thousand cubic meters per hour in 4th block of anode roasting plant;
- replacement of outdated ventilators for smoke-catchers at 8 lines of gas refining facilities of III series;
- reconstruction of gas-refining facilities at two blocks of gas refining of IV series (dry gas refining) on the basis of imported equipment;
- annually the lateral covers and sidewalk shields in a quantity of 8-10 thousand pieces are produced and mounted on existing electrolytic baths, and many other measures are undertaken.

In 2005, the share of emission of polluting substances into atmospheric air from motor transport made 83%- 170.3 thousand tons of total volume of polluting substances arriving into atmosphere in Republic as a whole.

Motor transport at present time is a main source of emission of polluting substances into surface layer of atmosphere: it adds into atmosphere nearly 60% of sulfur dioxide, 83% of hydrocarbon oxide, 93% of nitrogen oxide, 90% of compounds of lead and almost 100% of volatile hydrocarbons.

The most polluted cities of the country are Dushanbe, Kurgantyube and Tursunzade. Observation over atmospheric air pollution in the early 1990s was regularly conducted by control and analytical services in 7 cities of Republic: Dushanbe, Kurgantyube, Hojent, Yavan, Tursunzade and Kulyabe, where 21 pollution observation posts were located. Determination

Table 6. Data on extraction and recycling of CFH, HCFC and ozone-safe substances, kg

Period of time	Extracted				Recycled CFH-12
	CFH-12	HCFC-22	HFH-134a	Mixture «MILE»	
2001	47438.76	8505.13	–	–	1755.40
2002	23875.84	7508.08	–	–	0.00
2003	10922.69	4522.17	24.00	2000.00	89.60
2004	10724.03	3723.20	1134.64	2995.00	1979.30
2005	4982.95	6598.8	410.1	491.0	314.6
For 1st half year 2006	1344.75	1168.5	74.0	205.0	339.6

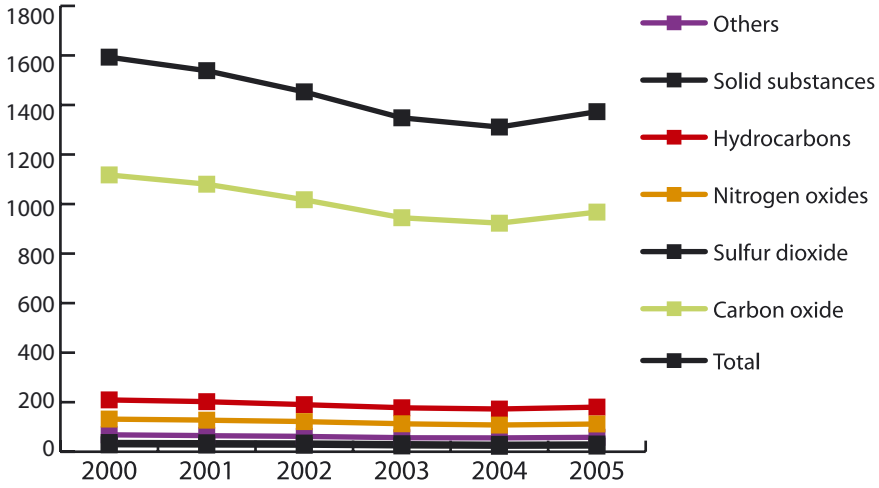


Fig.5. Dynamics of emission of polluting substances in Republic of Uzbekistan 2000-2005 (mobile sources)

of 21 ingredients contained in air was conducted. At present time, the observation system strongly reduced. The observations are performed in Dushanbe (3 observation posts) and Kurgantyube (2 observation posts). In Dushanbe, the measuring is done for concentrations of oxide of nitrogen, sulfur and hydrocarbon, hydrogen sulfide, formaldehyde and aerated particles (dust), in Kurgantyube – dioxides of nitrogen and sulfur, ammonia.

4. State and protection of atmospheric air in Kazakhstan

The basic principles of the state policy in the sphere of environment protection were laid in "Conception of Ecological Safety" approved by the Order of President of Republic of Kazakhstan of April 30, 1996. The Conception specified the ecological priorities of transition period, necessity of establishment of nature-protective law system, state control and expertise, economic mechanisms of nature use, environment monitoring.

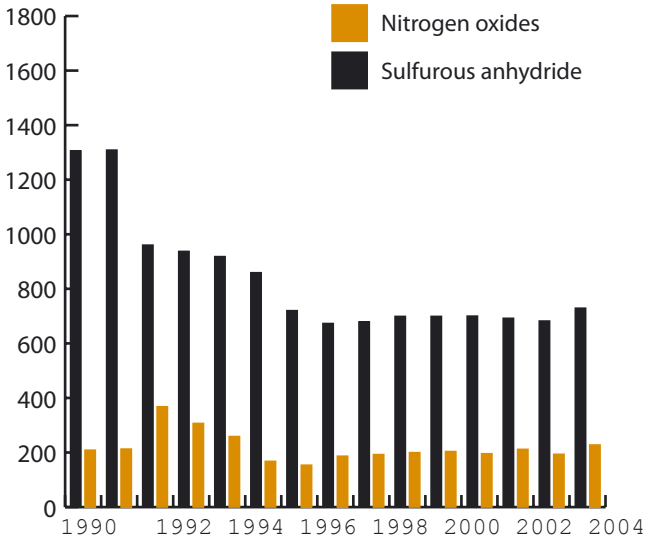
Since the moment of approval of this Conception in Republic the serious changes have happened in social development of the country. There have been worked up the strategic documents of state development, as well as the grounds of nature-protective law (in 1997- the Law "On environment protection" was adopted, in 2002 – the Law "On atmospheric air protection", etc.). Also, 19 international environmental conventions have been signed and the system of nature-protective activity governance has been established.

However, the status of Kazakhstan as of the state with ecologically vulnerable territory and unsolved ecological problems still remains. In connection with above-mentioned, at present, the Conception of ecological safety for 2004-2015 is worked out and approved by Decree of President of Republic of Kazakhstan of December 3, 2003, # 1241. With the purpose of realization of the Conception, the Decree of Government of Republic of Kazakhstan was issued on February 3, 2004, #131 to approve the respective Action Plan for 2004-2006.

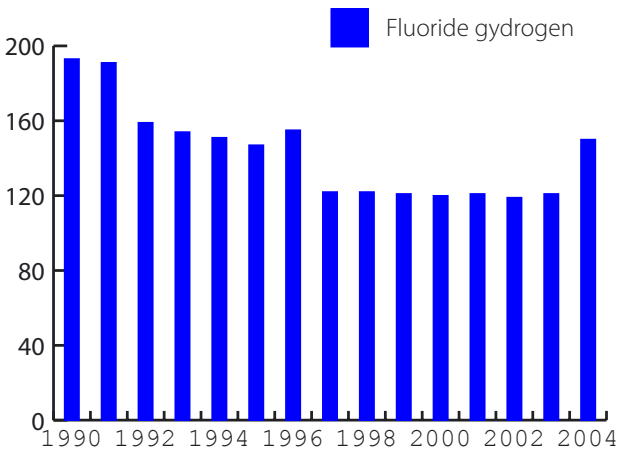
The main goal of the state policy in the sphere of ecological safety, including atmospheric air quality is to reduce on a stage-by-stage basis the pollution level (2004-2007), stabilize the quality indicators (2008-2010), improve air quality and achieve a favorable level of ecologically sustainable development of the society (2011-2015).

In accordance with the law of Republic, the central executive body in the sphere of environment protection and local executive bodies organize the state monitoring of the air quality. Territorial subdivisions of the central executive body in the sphere of environment protection define a list of enterprises and institutions that should carry out the production monitoring of atmospheric air. The state bodies and organizations of sanitary and epidemiological service also conduct monitoring of atmospheric air.

Accounting and reporting on observations of atmospheric air pollution are performed in accordance



Pic. 6. Dynamics of change of quantity of emission of sulfurous anhydride and nitrogen oxides, by years



Pic. 7. Dynamics of change of quantity of emission of fluoride hydrogen, by years

with the forms of medical documentation approved by the Order of Minister of Health Care of Republic of Kazakhstan of October 20, 1993, # 437.

Hygienic norms of polluting substances in atmospheric air are regulated by sanitary-epidemiological rules of "Sanitary-epidemiological requirements for atmospheric air" approved by the Order of Acting Minister of Health Care of Republic of Kazakhstan of August 18, 2004, #629. This document was registered in Ministry of Justice on September 18, 2004 under #3076.

Ministry of Nature Protection, Ministry of Health Care and some other ministries of Kazakhstan conducted a number of meetings with participation of international experts, representatives of non-governmental organizations, mining enterprises. At these meetings they discussed the concept of Ecological Code, and in conclusion there was taken the decision on necessity of radical reforming of governance system in nature protection sphere with the aim to make it appropriate for the market economy in consideration of the experience of European Union countries.

At present, in accordance with the ecological law reforming conception approved by Government of Republic of Kazakhstan, the job on working out of Ecological Code goes on to issue it until the end of 2006.

In Central Asia, the drying seabed of the Aral Sea is one of the most powerful sources of arrival into atmosphere of natural aerosols. In the 1960s... 1980s, only the parts of seabed consisting of sand and subsand soils were blown out; now the grounds consisting of silt sediment rocks are also blown out. They consist mainly of mineral grains (quartz, feldspar, mica, etc.) of 0.005...0.1 mm (5...10 mkm). Silt rocks are also easily blown out as the sandy ones because they contain the same small parts of 70... 100 mkm most easily moved with the wind.

Average many year carry-over of mass of sandy and salty aerosols from dried up area of the seabed of the Aral Sea in Kazakhstan over the period of observations from 1966 to 1979 makes 7.3 million tons with 5% supply and 1.6 million tons with 50% supply. There has been identified the availability of considerable climatic fluctuations in the intensity of wind-borne processes. In the 1980-1990s the significant wind activity reduction was observed. This led to decrease of mass of aerosols brought out from Aral Sea within these years that to a certain degree reduced the ecological burden on the region. The digital modeling of carry-over of heavy small parts in the bordering layer of atmosphere implemented by I.V. Kaipov was an important step in solution of the problem of studying of aerosols carryover from the Aral Sea seabed.

Towards the north and in the south of Kazakhstan the average duration of droughts over the season falls down to 40 days. The highest temperatures in droughts period happen in July and reach 42-43° C in western and northern regions, 45-46° C in central and southern regions and up to 40° C in eastern regions. Relative moisture of air within 13 hours period of observations declines to 8-9%, in certain regions to 3-4%. In the period of atmospheric droughts on the larger part of Western Kazakhstan the southeast winds prevail, in Northern Kazakhstan- southwest ones. In Eastern Kazakhstan during atmospheric droughts the western winds prevail, in desert regions of Central and Southern Kazakhstan – eastern ones. Atmospheric droughts in Kazakhstan are accompanied by moderate wind speeds from 3 to 10 meters per second, in separate cases to 15 meters per second and more.

Table 7. Emissions of substances polluting the atmosphere from stationary sources (thousand tons)

	1990	1995	2000	2001	2002	2003	2004
Republic of Kazakhstan	4677.2	3097.4	2429.4	2582.7	2529.3	2884.3	3016.5

Table 8. Quality of atmospheric air of cities *)

City	Index of atmospheric air pollution							Branches of industry affecting air pollution
	1990	1995	2000	2001	2002	2003	2004	
Aktau	9.1	7.5	4.6	4.4	4.8	5.4	4.4	chemical
Aktobe	7.5	8.6	10.0	8.5	9.5	9.0	9.6	ferrous metallurgy, chemical
Almaty	7.9	12.3	9.9	13.1	11.7	11.3	15.0	power engineering, motor transport
Astana	1.8	2.1	1.7	1.3	2.6	3.9	3.1	power engineering, motor transport
Atyrau	2.7	1.0	2.5	1.8	2.0	1.2	1.6	oil-refining
Balkhash	16.8	3.6	3.3	2.2	2.4	2.7	3.8	non-ferrous metallurgy, power engineering
Zhezkazgan	6.7	4.9	7.5	7.9	6.8	5.1	5.0	non-ferrous metallurgy, power engineering
Karaganda	7.5	4.4	4.6	4.6	6.5	11.8	12.5	power engineering, coal-mining, motor transport
Kostanai	3.2	1.9	2.9	3.2	3.4	3.6	3.5	power engineering
Ridder	17.1	8.1	10.0	10.3	11.3	8.3	7.4	non-ferrous metallurgy, power engineering
Pavlodar	2.5	2.1	2.3	2.7	1.5	1.3	1.2	oil-refining, power engineering
Petropavlovsk	7.3	3.9	6.8	5.1	3.4	3.9	4.5	power engineering, instrument-making
Semipalatinsk	9.5	6.3	4.0	3.3	2.6	3.6	4.1	power engineering, building materials
Taraz	14.7	4.5	7.8	6.7	7.3	7.2	8.0	chemical
Temirtau	13.9	5.4	6.9	7.8	8.8	7.3	7.4	ferrous metallurgy, chemical
Uralsk	2.4	2.5	1.4	1.2	1.2	0.7	1.2	power engineering
Ust-Kamenogorsk	21.8	8.6	17.8	14.2	16.0	8.9	7.0	non-ferrous metallurgy, power engineering
Shymkent	13.9	6.1	10.0	11.8	9.5	13.6	15.1	non-ferrous metallurgy, chemical, oil-refining
Ekibastuz	3.6	2.1	1.7	1.4	1.9	1.9	1.3	power engineering, coal-mining

Table 9. Emissions and catching of air-polluting substances from stationary sources

Years	Emission of air-polluting substances in atmosphere, million ton	Caught and neutralized air-polluting substances	
		million tons	in percentage of total number of emitted air-polluting substances from stationary sources
1990	4.7	29.2	86.2
1995	3.1	22.8	88
2000	2.4	17.3	87.7
2001	2.6	18.1	87.5
2002	2.5	17.7	87.5
2003	2.9	18.8	86.7
2004	3.0	21.3	87.6

5. State and protection of atmospheric air in Turkmenistan

Natural climatic factors play in geographic conditions of Turkmenistan an important role in forming of air structure. Climate is sharply continental and very dry. The atmospheric air pollution is determined by arrival of polluting substances from natural and anthropogenic sources, as well as by physical-geographical and climatic conditions.

One of the causes of accumulation of undesired admixtures in the atmosphere of cities is frequent reoccurrence of weak winds (51%) and dusty storms (33 times per year on average). Air inversions also promoting the accumulation of admixtures are observed mainly at night and in the morning. One of the most negative events of trans-border transfer of polluting substances is the carry-over of salt and dust from the dried seabed of Aral Sea to the territory of Turkmenistan. Thus, according to estimations of P. Esenov, to the territory of Dashoguz velayat, over 0.59 million tons of solid aerosols fall down annually. Precipitations and low air temperatures promote the decrease of concentrations of polluting substances in atmosphere.

With the purpose of analysis of atmosphere pollution there were used the data of observations over the last 10 years (1996-2005). The received results show that the level of air pollution for the country as a whole remains rather low. The concentrations of main polluting substances (dioxide and oxide of nitrogen, sulfur dioxide) in all large cities of Turkmenistan on average do not exceed the level of maximum permissible concentrations (MPC) (See *Table 13*).

The enlarged concentration of hydrocarbon oxide (CO), on average 2.0-6.0 MPC, is typical just for main crossroads in all cities with intensive transport movement, especially in summer period in conditions of very high temperature of air and inversion. The concentration of toxic gas by motor transport in Ashgabat accounts for over 80% of total emissions volume including hydrocarbon oxide – 82%, nitrogen oxide – 36%, hydrocarbons – 39%.

However, within the last years, the concentration of dust declined to some extent, in connection with intensive planting of trees around cities, increase of green plantings in cities, regular wetting of main roads.

The larger part of harmful chemical substances arrives in atmosphere as a result of economic activity of a man. The rapid development of economy of Turkmenistan, especially of oil and gas sector and power engineering and steady increase of quantity of motor transport within the last years lead to the growth of atmospheric air pollution. In 2003, in

a whole, to atmosphere of Turkmenistan there were emitted 442.3 thousand tons of harmful substances from stationary sources, of which 10.8 thousand tons were solid ones, 12.1 thousand tons of sulfur anhydride, 57.4 thousand tons of carbon oxide, 20.1 thousand tons of nitrogen oxide, 331.4 thousand tons of hydrocarbons, 9.9 thousand tons of volatile organic compounds, other gaseous and liquid substances – 0.6 thousand tons.

Increase of emission of polluting substances into atmosphere from stationary sources is connected, first of all, with growth of oil and gas mining in the country. Emissions from oil and gas complex made in various periods from 75% to 90% of total emission over 1995-1997 and amounted to 416 thousand – 1356 thousand tons. Their volume in Balkan velayat grew 4.4 fold within period of 1997-2004. Mainly, it was caused by the increase of emission of hydrocarbons as a result of intensive development of new fields of oil and gas.

In such large cities of Turkmenistan as Ashgabat, Turkmenbashi, Turkmenabat, in addition to dust of natural and industrial character, the atmosphere is polluted with such chemical substances as carbon oxide, nitrogen oxide, sulfur anhydride, phenol, formaldehyde, fluoride hydrogen, ammonia, etc. As a consequence of high development rates of all economic branches (especially of oil and gas and chemical industries) and increase of quantity of transport vehicles, the concentration of certain polluting substances in the atmosphere of cities exceeds slightly the sanitary norms. It has a negative effect in respect of the health of people, quality of land and water resources, fauna and flora and cultural heritage, and can result in appreciable social and economic losses.

Thus, the following basic factors promoting the atmospheric air pollution can be mentioned at present time in Turkmenistan:

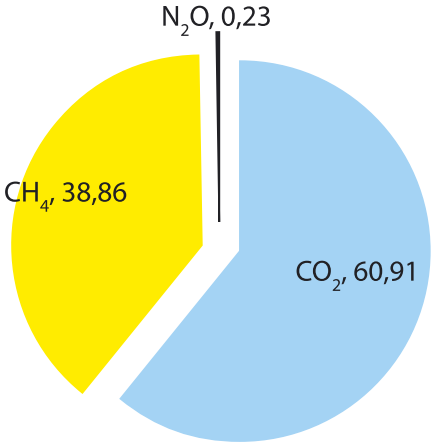
- emissions from motor, railway, river and air transport, growth of quantity of motor transport vehicles;
- wear and tear of transport vehicles;
- emissions from large industrial enterprises;
- use of ineffective dust and gas purifying equipment by old enterprises;
- emission of hydrocarbons when mining, transporting and refining the hydrocarbon raw materials;
- carry-over of solid, dusty small particles into atmosphere as a result of wind erosion of soils.

According to the data of inventory of emissions of greenhouse gases into atmosphere in 1994, being the reference year, the emissions made 52305 thousand tons of CO_2 equivalent; of which 31859 thousand tons were represented by CO_2.The percentage of emissions of main greenhouse gases is shown in *Picture 8*.

The energy production activity, the share of which was equal to 48914.9 thousand tons of CO_2 equivalent (93.5%) in 1994, is the most important source of greenhouse gases emission.

The analysis of data suggests the evidence of the change of stationary sources quantity over the last years that constitute the large atmosphere pollutants in Turkmenistan. This quantity reduced from 5510 sources in 1997 to 7032 in 2000. In 2003, there were 6702 such sources, of which 5170 were organized ones. The total emission into atmosphere of polluting substances in 1999 made 1404.3 thousand tons, in 2003 – 442.3 thousand tons.

In the atmosphere of Turkmenistan the small dust particles prevail by their mass, which is first of all predetermined by natural causes. In 2003, emission of dust (solid) small particles from stationary sources made just 10.8 thousand tons. Hydrocarbons prevail among chemical substances, the emission of which from stationary sources varies within 70-90% during



Pic. 8. Emission of greenhouse gases in 1994

the last years. The enterprises of oil and gas mining and refining industries located on the west of Turkmenistan are the main sources of hydrocarbons emissions.

Table 10. Volume of air polluting emissions from stationary sources, thousand tons

Substance	1999	2000.	2003.
Total	**1404.3**	**1034.7**	**442.3**
Solid	14.3	11.5	10.8
Sulfur anhydride	9.0	7.8	12.1
Carbon oxide	62.6	76.1	57.4
Nitrogen oxide	11.4	16.5	20.1
Hydrocarbons	1292.4	908.8	331.4
Volatile organic compounds	14.1	13.0	9.9
Others	0.5	1.0	0.6

Table 11. Dynamics of polluting substances emission by main economic sectors in 2001-2005 (thousand tons)

Main branches	Years				
	2001	2002	2003	2004	2005
Khyakimliks of velayats and Ashgabat city	7.7	7.7	8.6	8.6	–
Ministry of power industry	11.6	17.2	18.1	17.4	–
SC"Turkmen neft"	597.7	300.2	278.6	311.2	–
Ministry of construction and building materials	5.9	4.5	4.2	3.7	–
SC "Turkmegas"	72.4	68.1	74.9	130.6	–
STC "Turkmenneftegas"	61.9	56.4	43.1	42.8	–
JSC "Turkmendokun"	4.2	7.2	6.0	6.9	–

6. State and protection of atmospheric air in Kyrgyzstan

6.1. Atmospheric air quality

Kyrgyzstan, a continental country of Central Asia, is divided into two parts – north and south – by Tien-Shan mountain range. The northern part includes Talass, Chui, Issyk-Kul and Naryn regions and a capital city Bishkek and the southern part includes Ferghana valley. The country is very mountainous, 94% of its territory is lies on the height of over 1000 meters above the sea level, of which 40% is higher of 3000 meters above sea level. The region is very active in seismic aspect, with frequent earthquakes and clay flows.

Climate is continental: cold winter and hot summer, with large local deviations depending on the height.

Industrial growth accounted for 3.2% on average in 2003-2005. The share of mining industry in structure of industrial production makes 1.5%, manufacturing industry – 78.6%, production and distribution of electric energy, gas and water – 19.9%.

The total growth of industrial production leads to its larger and larger impact on environment, including the atmospheric air. Influence of transport on the environment is determined to a larger extent by intensity of transportation and technical state of motor transport fleet, development of certain kinds of transport services.

The main sources of atmospheric air pollution in Kyrgyzstan are enterprises of energy, construction materials production, communal services sector, mining and processing branches, private sector and motor transport.

Arrival of polluting substances into atmospheric air depends mainly on position of economic branches influencing on the environment to the largest extent and position of housing service agencies of the ci-

Table 12. Dynamics of harmful substances emissions from stationary sources in 2001 -2005, by ingredient (thousand tons)

Name of ingredient	Years				
	2001 (total)	2002 (total)	2003 (total)	2004 (total)	2005 (total)
Nitrogen oxide	18.3	22.2	20.1	19.1	–
Sulfur dioxide	11.2	11.2	12.1	8.1	–
Carbon oxide	146.5	57.7	57.4	147.9	–
Hydrocarbons	571.1	356.5	331.4	333.0	–
Solid substances	10.8	9.9	10.8	9.9	–
Volatile organic compound	10.1	9.8	9.9	10.4	–
Others:	0.6	0.7	0.6	0.8	–
Total:	**768.5**	**468.0**	**442.3**	**529.2**	**–**

Table 13. Dynamics of the change of atmosphere pollution index (API) in cities of Turkmenistan in 2001 – 2005.

Cities	Years				
	2001	2002	2003	2004	2005
Ashgabat	2.0	2.2	2.3	2.7	2.6
Mary	1.1	0.9	0.9	0.9	0.9
Turkmenabat	2.0	1.3	0.7	1.4	1.2
Dashgouz	1.3	1.3	1.0	1.3	1.3
Turkmenbashi	1.3	2.0	2.0	2.7	2.7
Balkanabat	0.8	0.8	0.9	0.5	0.6

Table 14. Dynamics of atmospheric air pollution levels in 2001-2005

Name of ingredients	Years				
	2001	2002	2003	2004	2005
Dust	2.0	1.6	1.6	1.8	2.0
Phenol	1.3	1.3	1.3	1.7	1.7
Ammonia	–	–	–	–	–
Nitrogen dioxide	>1.0	1.0	1.0	1.0	1.0
Sulphur dioxide	>1.0	1.0	2.0	2.0	2.0
Formaldehyde	4.3	5.3	5.7	6.3	6.0
Carbon oxide	1.3	1.0	1.3	1.0	1.0

Table 15. Data on extraction and recycling of CFH, HCFH and ozone-safe substances

Ozone-depleting and ozone-safety substances	Years				
	2001	2002	2003	2004	2005
Extracted					
CFH-12	1.5 т	1.9 т	1.2 т	0.7 т	0.5 т
HCFH-22	–	–	–	–	–
HFH-134	–	–	–	–	–
Mixture "MILE"	–	–	–	–	–
Total:					
Recycling					
CFH-12	0.5 т	0.6 т	0.5 т	0.4 т	0.4 т

ties. Moreover, because of absence of own reserves of natural gas, the majority of private households had to return to using the fossil fuel of local origin containing rather low calorie and high ashes.

Structure of fuel and energy complex in Kyrgyzstan characterized by small volumes of coal and oil mining and refining, generation of larger part of electric energy at the hydroelectric power stations, as well as by considerable share of use of natural gas at the thermal power stations restrained up to now the adverse impact of power engineering on the environment.

Emission of polluting substances from stationary sources in 2004 increased in Republic as a whole (in comparison with 2001-2003) and made 36.7 thousand tons. In 2005, emissions reduced and made 34.5 thousand tons. However, it is because not all enterprises have reported.

Over the last 5 years, the emission of contaminants into atmosphere from stationary sources made 7 kg per capita on average in Republic.

Atmospheric air quality in cities is controlled by regular stationary observations in Bishkek, Kara-Balta, Tokmok, Cholpon-Ata, where 13 observation posts are established, of which 7 – in Bishkek, 2 – in Karabalta, 2 – in Tokmok, 2 – in Cholponata.

The observations over pollution level of atmospheric air in cities are organized in accordance with the State Standard GOST17.2.3.01.86 "Protection of nature. Atmosphere. Rules of control of air quality in human settlements". The observation post is the chosen place where a pavilion equipped with respective devices is installed. The observation posts are divided to three categories: stationary, routing and sub-flare. Within the recent time, only the stationary posts were used for observations in Republic. Stationary post is intended for provision of ongoing registration of content of polluting substances or regular sampling of air for analysis.

In the cities of Kyrgyzstan the stationary posts are equipped with the laboratories special for conduction of regular observations over atmosphere pollution and meteorological parameters showing the dispersion of admixtures in atmosphere.

Representation of observations over atmosphere pollution in city depends on correct location of the post on the studied territory. Stationary posts are located in housing units near main pollution sources, in central parts of cities on open areas aired from all sides. The choice was done on the basis of results of surveys of pollution of air environment in cities by industrial and transport emissions. The program of each observation post was developed separately, in consideration of its closeness to emission sources and their structure.

Number of stationary posts was defined depending on number of the population of the city. At present time, in connection with active migration processes, which took place in the country, the quantity of existing posts does not correspond to the number of the population.

List of polluting substances to be measured at the stationary observation posts is determined on the basis of information on structure and character of the emissions in a city and on meteorological conditions of dispersion of admixtures. The substances emitted by enterprises of a city are determined and possible excess of MPC of these substances is estimated.

Before the year 2000, In the atmospheric air of the cities the content of dust, sulfur dioxide, nitrogen oxide and dioxide, carbon oxide, formaldehyde, ammonia, dissoluble sulfates, 3.4 benz(a)piren was determined.

On the basis of the received information on actual air pollution the phone concentrations of harmful substances in atmosphere of cities and human settlements are calculated.

The government environment protection bodies implement control over industrial emissions of polluting substances in atmosphere from stationary sources. They do it by means of examination and analysis of implemented air-protecting works and on-site inspection of all industrial technologies connected with emission of harmful substances into atmosphere.

In emitted gases the control is performed in respect of polluting substances qualified by World Health Organization as "classic" polluters: lead, carbon mon-

oxide (CO), sulfur dioxide (SO_2), nitrogen dioxide (NO_2), as well as solid emissions (dust), nitrogen oxide, sulfuric acid, aerosol of caustic alkalis, formaldehyde, chrome, hydrogen chlorine, ammonia, phenol and hydrogen cyanide.

As of today, at the prevailing majority of industrial enterprises the environment protection divisions were liquidated and this regard the current control of departmental monitoring was practically lost. At present time, at some reviving enterprises, the functions of departmental control over impact on atmospheric air are restored.

Kyrgyzstan joined the Vienna Convention on Protection of Ozone Layer and the Montreal Protocol on ozone depleting substances on May 31, 2000. The consumption of ozone depleting substances in Republic was determined on the basis of registration data received from State Customs Inspection, contacts with actual and potential consumers, as well as data from territorial nature protection bodies.

Motor transport remains to be the most intensive and permanently growing pollution source for atmosphere of cities of Kyrgyzstan. Car emits together with waste and carter gases vapors of fuel and lubricants about 200 substances with toxic, carcinogenic, mut-agenic and narcotic and other contaminants. Over a quarter of cars are exploited with excess of toxic and smoking norms. Exploitation of cars with excessive toxic and smoking content takes place because of their very long period of service cycle, weakness of systems of technical inspection and technical service.

Thin-dispersed aerosols stand next after the lead (by damage for health of urban residents). Aerosols with particles of size less than 10 mkm and, especially with particles less than 2.5 mkm often cause the respirator infections.

6.2. Legal framework

At present the strategy of atmospheric air quality management is regulated by a number of baseline documents:

1. Constitution of Kyrgyzstan;
2. Law "On atmospheric air protection" of 13.05.1999;
3. Instruction on conduction of state control over stationary sources of atmospheric air pollution;
4. Instruction on conduction of state control over protection of atmospheric air from emission of polluting substances by motor transport;
5. Conception of ecological safety;
6. State Action Plan on Environment Hygiene;
7. Hygienic requirements to provision of atmospheric air quality in human settlements, and others.

At present, in Republic the laws "On environment protection" (1999), "On atmospheric air protection" (1999), "On ecological expertise" (1999), "On charges for environment pollution" (2002) constitute the legal base for reduction of pollution level and regulate the relations in sphere of use and protection of atmospheric air. The draft law "On state regulation and policy in sphere of emission and absorption of greenhouse gases" has recently been submitted to the Parliament of Republic for consideration.

Non-traditional renewable sources of energy in Republic in consideration of their possibilities can quite fully compete with traditional sources. Kyrgyzstan on average receives from the Sun 4.64 billion MW/h of solar energy annually, as the average annual duration of sun shining makes 2900 hours.

6.3. Indicators of the problem under review

- State of emissions of polluting substances (including those of transboundary character) in CA countries;
- State of level of atmospheric air pollution in large CA cities;
- Quantity of pollution sources (including the mobile ones) and their technical state;
- Quantity of dust and gas purifying equipment and their technical state, as well as the need for them;
- Emission of greenhouse gases;
- Using of ozone depleting substances.

7. Estimation of the need of problem solution

7.1. Mechanisms of strategic direction and their realization

Structural reforms in the economic sectors of CA countries under conditions of a transition period undoubtedly contribute to the level of use of atmospheric air and level of air basin pollution in the region.

CA countries have developed important organizational and legal measures for provision of ecological safety in the sphere of atmospheric air protection. These measures allowed reduce the level of atmospheric air pollution and attract international organizations to resolution of regional problems in sphere of atmospheric air protection.

The following strategic directions constitute the priority in reduction of adverse impacts on atmospheric air of CA countries:

1. When implementing the particular tasks in sphere of atmospheric air protection the scientific potential of the region should be used with maximal effect. It is necessary to provide within the frames of common system the advanced development of scientific and engineering researches on mostly important problems concerning the reduction of negative impacts on atmospheric air and the sustainable development. Working out of principally new technologies for gas purification providing a possibility to purify the gases effectively (up to 95%) is of special importance.

2. Working out and use of technologies for receiving of alternative kinds of energy (especially solar energy, wind energy, biogas, etc.),

use of ecologically safe kinds of fuel, especially in transport sector (extraction of lead from gasoline, replacement of gasoline with gas, electrification of railways, etc).

3. More efficient work on providing the coordination of activity of ministries and agencies responsible for atmospheric air protection, intensification of the work on inspection and analytical control of atmospheric air pollution, including emissions of transboundary character.

4. Further efficient integration of ecological policy of CA countries, establishment of mechanisms to raise the economic interest of industrial objects in rational use of natural resources, particularly of atmospheric air and in atmospheric air protection, provision and accumulation of financial resources directed on reduction of emission of polluting substances into atmospheric air.

5. Working out public awareness and professional training of specialists it is required to work out the system of comprehensive, ongoing ecological education. In this process the mass media should play a large role.

7.2. Priority strategic directions – recommendations directed on reduction of emission of polluting substances into atmospheric air including emissions of transboundary character.

The ecological safety of CA countries should be provided in each region in consideration of peculiarities of environment, specifics of economic activity, level ofte-chnogenic burden. For realization of these objectives it is required, first of all, to form the Central Asia Regional System of Ecological Safety. First of all, in accordance with the above it is necessary to resolve and prevent the global and regional ecological threats, having defined the regional vitally important interests, priorities and strategy of integration in the sphere of environment protection, particularly, of atmospheric air protection.

To this end, it will be necessary to:

- precise the process of interaction of CA countries in ecological safety sphere;
- coordinate the national action plans, particularly concerning the pollution of transboundary character;
- establish common information and analytical network providing a possibility to reveal transboundary ecological problems, challenges and threats;
- carry out permanent monitoring;
- harmonize legal base on atmospheric air protection for CA countries;
- work out regional register of emissions and transfer of polluting substances (CAR RETPS);
- perform inventory of emissions of persistent organic contaminants (POP) in CA countries.

Particularly:

- to increase fuel quality and first of all reduce the use of and in future refuse from leaded gasoline;

- to optimize the structure of consumable fuel, first of all, switch to gas fuel (compressed natural gas and liquefied petrol gas);
- to improve the systems (especially automatic ones) of monitoring of atmospheric air quality in urban and rural areas;
- to resolve the issue on installation and use of clean technologies and production processes as one of conditions of privatization process;
- to introduce energy-conservation technologies;
- to use ecologically safe energy sources, especially the sun energy;
- to modernize dust and gas purifying plants and bring their effectiveness to the established technological requirements;
- to organize and keep systematic departmental and production control over emission of polluting substances;
- to gradually switch the stationary sources: industrial, communal and housing sources of heat and energy from coal and mazutto alternative kinds of fuel (natural gas, etc.), promote the use of ecologically clean technologies;
- to introduce automatic system of control over atmospheric air pollution.

Education

- to work over the issue of adaptation of methodical developments of industrially developed countries in sphere of ecological education to the existing education system of the country;
- to establish the data base for studying programs and methods, studying literature and other studying resources existing in the country;
- to determine the new ways of estimation of studying processes and results;
- to realize the principle of continuous education in system of retraining and improvement of qualification of specialists, teachers and experts in environment protection sphere;
- to prepare highly qualified staff-ecologists of various profile, especially in economic branches, management and audit;
- to conduct regularly studying courses and develop advance courses for improvement of qualification of teachers-ecologists;
- to attract the civil society to discussion, decision-making and realization of ecological measures, especially at local level;
- to develop in Republic the legislation with the purpose of participation of civil society in adoption of respective procedures on ecological problems of regional, national and local levels.

In the aspect of reduction of adverse effect from emission of polluting substances of transboundary character all CA countries it would be necessary to:

- exchange the information on state of atmospheric air pollution of border districts, including large industrial objects located on bordering territories and adversely impacting the atmospheric air;
- jointly conduct research (monitoring) of level of atmospheric air pollution in bordering districts;
- develop a system of early warning and informing in case of threats of atmospheric air pollution at industrial and other objects located on bordering territories;
- monitor the emission of polluting substances from large industrial enterprises in transboundary aspect (the example is Tajik aluminum plant and Bekabad industrial zone);
- identify the effect of transboundary transfer of polluting substances (the example is the unique biosphere territory of Issykkul).

Uzbekistan and Kazakhstan: It is necessary to work out and introduce the measures (planting of trees, etc. – "green wall") for prevention of dusty storms, including salt transfer from seabed of dried Aral Sea.

Kazakhstan, Turkmenistan and Kyrgyzstan: It is necessary to organize accounting and analysis of emissions from mobile sources.

Assessment of efficiency

- Harmonization of legal framework on atmospheric air protection for CA countries;
- Development of regional register of emissions and transfer of polluting substances (CAR RETPS);
- Inventory of sources of emissions of persistent organic contaminants POP in CA countries;
- Monitoring of polluting substances emissions from large industrial enterprises in trans-

boundary aspect (the example is Tajik aluminum plant and Bekabad industrial zone);
- Identification of effect of transboundary transfer of polluting substances (the example is unique biosphere territory of Issyk-Kul);
- Creation of conditions for development and introduction of alternative and renewable energy sources;
- Establishment of regional network of interaction of offices on the ozone layer.

№	Project name	Countries-participants	Project objective	Planned measures	Expected results	Budget in US Dollars
1.	Monitoring of persistent organic pollutants (POP) in CA region in 2002-2007	Kazakhstan Kyrgyzstan Tajikistan Turkmenistan Uzbekistan	Monitoring of emissions of POP in CA region for development of action plans on their reduction.	1. To identify location of sources of persistent organic pollutants in CA countries (within the framework of Stockholm Convention on POP. 2. To carry out emissions monitoring and transboundary POP carrying-over. 3. To develop special action plan on reduction of POP emissions in CA countries.	1. POP inventory of CA region. 2. Action plan on reduction of missions.	**1 200 000**
2.	Monitoring of transboundary industrial emissions 2002-2007 гг.	Uzbekistan Tajikistan	Creation of monitoring system of polluting substances at large industrial enterprises in view of transboundary aspects of aspects of emissions	1. To upgrade system for monitoring transboundary carrying-over of polluntants and to improve monitoring system. 2. To evaluate transboundary carry-over and pollutants and economic damage caused in accordance with the Program on EMEP emissions reporting. 3. To introduce advanced technologies of treatment and reduction of emissions of pollutants at industrial enterprises. 4. To carry out joint researches and technological developments in the field of atmosphere, to create interactive data base for information exchange.	1. Documentation of emissions of pollutants in two sectors. 2. Action plan on reduction of emissions. 3. Guiding principles on reduction of emissions.	**1 800 000**
3.	Monitoring of transboundary industrial emissions	Kazakhstan Kyrgyzstan Tajikistan Turkmenistan Uzbekistan	Development of research and methodic basis for establishment of regional monitoring system of atmosphere brown cloud and dust and salt carrying- over in CA and their implementation in monitoring network	1. To selection locations of regional network of ABC-observatories in CA. 2. To set up ABC- observatories and to equip them. 3. To develop common methodology for data measurement and processing, to conduct ABC monitoring and dust and salt carrying-over.	1. Establishment of regional monitoring in CA. 2. Transfer of aerosol and transformation of its optical, physical, and chemical and radiation characteristics.	**3 800 000**

Note: Proposals from other CA countries are required!

Abbreviations

ADB	Asian Development Bank
BWRA	Basin water resources management
BCD	Biological consumption of oxygen
CIDA	Canadian International Development Agency
WB	World Bank
HEI	Higher educational institution
GIS	Geographical Information System
GB	Global mechanism
GTZ	German agency on technical cooperation
GEF	Global environmental fund
LR	Land resources
ICARDA	International Center of Agricultural Researches on Aridity Development
IFAD	International fund for agricultural development
WPI	Water Pollution Index
CACILM	Central Asia Countries Initiative for Land Resource Management
IWRM	Integrated Water Resources Management
UNCCD	UN Convention to Combat Desertification
CDW	Collector-drainage waters
CDN	Collector-drainage network
CE	Coefficient of Efficiency
KR	Kyrgyz Republic
ISDC	Interstate Sustainable Development Commission
IFAS	International Fund of the Aral Sea
SRI	Scientific and Research Institute
NIDFFMNPT	National Institute of Deserts, Flora and Fauna of Ministry of Nature Protection of Turkmenistan
SIC ISDC	Scientific Information Center of Interstate Sustainable Development Commission
NAPCD	National Action Plan to Combat Desertification
NEAPH	National Environmental Action Plan Hygiene
NEAP	National Environmental Action Plan
NGO	Non-governmental organization
NFP	National Framework Program
NDS	National Development Strategy
RAP	Responsible authorized person
UNO	United Nations Organization
NP	Nature Protection
E	Environment

TF	Treatment Facilities
APAS-2	Action Program for implementation of ecological and socioeconomic situation in the Central Asia basin in 2003-2010.
MPC	Maximum Permissible Concentration
PA	Production Association
UNDP	United Nations Development Program
RK	Republic of Kazakhstan
REAP	Regional Environmental Action Plan
RT	Republic of Tajikistan
RUz	Republic of Uzbekistan
SRM	Sanitary Rules and Norms
SRTP	Subregional Educational Program
SPARCD	Subregional action plan to combat desertification
SPA	Agreement on Strategic Partnership
SRW	Solid Residential Wastes
WM	Waste Management
SWM	Sustainable waste management
CA	Central Asia
MDG	Millennium development goals
CC REAP	Cooperation Center of Regional Environmental Action Plan
UN ESCAP	UN Economic and Social Commission for Asia and Pacific Ocean Countries
UNEP	United Nations Environment Program
UNEP APR	UN Asian and Pacific Ocean Region

Tables and illustrations

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Degradation of mountain ecosystems

Regional Appraisal report on industrial and residential waste management

Lands degradation

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