Status Review of the Biodiversity Conservation in the Caucasus:

Achieving C2010 Goals

(Armenia)

1. Coordinating Conservation Actions in the Caucasus Biodiversity Hotspot

The Caucasus Ecoregion is a globally significant centre of plant and animal diversity and endemism. However, biodiversity is currently being lost at an alarming rate. A number of projects have been implemented towards coordinating conservation action in the Caucasus Ecoregion. The key examples include:

- The Critical Ecosystem Partnership Fund (CEPF) is designed to safeguard the world's threatened biodiversity hotspots in developing countries, including Armenia. The CEPF Ecosystem Profile and five-year investment strategy for the Caucasus region was developed in 2003 by coordination of WWF Caucasus Program Office.
- The German government funded development of a vision for biodiversity conservation in the Caucasus Ecoregion that served as a foundation for an Ecosystem Profile developed for the CEPF Conservation Plan;
- GEF funded capacity building activities are implemented through UNDP in the Ministry of Environment of Georgia and Ministry of Nature Protection of Armenia on preventing transboundary pollution in the Kur-Araks basin;
- WWF's projects mainly related to creation of protected areas and improving management of existing reserves, developing ecotourism, promoting environmental education and environmentally-sound policies, and conserving endangered species are underway in the region

In 2000 the Regional Environmental Centre-Caucasus (REC-Caucasus) is established in Tbilisi, which has got management body, i.e. executive director, consultative body and special representatives. From Armenian there are representatives of governmental; scientific and non-governmental organizations in the composition of consultative body. The activities of REC-Caucasus are aimed at the analysis of water resources management system in the country; evaluation of existing monitoring system, water quality and state of biodiversity. The REC-Caucasus has got Armenian branch, which is implementing environmental projects. In the beginning of 2003 "Pilot projects of Caucasus mountainous regions sustainable development–Agenda 21" project has been launched, which inter-alia aims at establishing practical grounds for the second round of Caucasus convention.

An establishment of cross-border specially protected area is envisaged for the conservation of Caucasus regional biodiversity in the border zones of Armenia and Georgia under the "Establishment of cross-border conservation zone in Javakhk plain" project which will be implemented with the support of German Rehabilitation and Development Bank.

In 2000-2004 Development Alternatives Inc. (DAI) implemented "Water Resources Management in South Caucasus" project, funded by USAID. The project targeted at Khrami-Debed river basin and is aimed at developing capacities for sustainable management of water resources through applying eco-systemic approach, which in its turn will contribute to the improvement of the environment and economic development. Under the project, with the purpose to increase the public awareness in the basin of the river Debed public hearings have been organized on the topic "Environmental problems of the river Debed". The issue of the water resources, in this case of the river Debed, has been discussed in the general context, based on the eco-systemic approach.

The implementation of "Reduction of cross-border deterioration of Kur-Araks river basin" GEF/UNDP project began in 2004. This is the first UN funded project, which is directly aimed at the managing and improving water eco-systems and includes 5 countries located in the territory of Kur-Araks basin.

In 2004-2005 within the "Support to the comprehensive management of water resources in the countries of Southern Caucasus" Eurasia foundation sub-project of the "Cooperation in the countries of Southern

Caucasus" UNDP project Akhtala public environmental information centre has been established, which gains and disseminates information about the environmental status of the river Debed.

NAKRES (Georgia) and "Environmental Survival" (Armenia) NGO have implemented a joint project "Conservation of South Caucasus arid and semi-arid eco-systems" at the border zone of two countries, which was aimed at studying of the relevant eco-systems and biodiversity, as well as increase of public awareness on environmental issues.

In 2004 together with other Caucasus republics Armenia has been included into EU "European Neighbourhood Policy" (ENP). Based on the interests of the country and priority issues Armenia has submitted its recommendations to be included into Armenia-EU Action Plan developed within ENP, where they are going to reinforce the direction of Armenian environmental cooperation with European countries.

Armenia has also participated to the following activities:

- Development of "Caucasus Environmental Outlook-2002"
- Development of "Conservation of biodiversity of the Caucasus Ecoregion" – with the support of WWF, which in March 2006 has been approved at the summit of the ministers of Caucasus countries.

It should be mentioned that in the region of South Caucasus the environmental cooperation, especially in the domain of biodiversity, proceeds with certain obstacles, due to economic and political issues. Perceiving that environmental conservations issues can have a positive impact on the expansion of practical links, Armenia is consistently leading a policy of sustainable development of relations with all the countries of the region.

2. Nature conditions

2.1. Climate and orographical conditions

The Republic of Armenia is a landlocked country with a total area of 29,740 km^2, which is located at the north-eastern part of the Armenian plateau. The territory of Armenia lies within the co-ordinates 38°50-41°18 latitude and 43°27-46°37 longitude. At its longest the country measures 400 km (north-west to south-east), and at its widest is 200 km (west to east). A narrow projection of land (Zangezour marz) extends to the south-east, and in places this strip of land is as narrow as 26km wide. In total, the borders with neighbouring countries total 1,479 km. Armenia borders Georgia in the north, Azerbaijan in the north-east, east and south-west, Iran in the south, and Turkey in the west. Armenia is located about 145 km from the Black Sea, 175 km from the Caspian Sea, 750 km from the Mediterranean Sea and 960 km from the Persian Gulf.

2.1.1 Physical Geography

Armenia is a generally mountainous country, with an average altitude of 1,850m above sea level and varying as much as 2001m in a short distance. The highest point in the country reaches 4,095m above sea level (the northern peak of the mount Aragats), while the lowest point is at 375m above sea level (near the banks of the river Debed in the north). Such altitudinal variation results in a great diversity in climates and landscapes, relative to the size of the country.

Four main geological regions can be identified in Armenia:

- Mountainous ridges and valleys in the north-east of the country (highest altitude 3101m), which occur mainly in the basin of the River Kur (including the ranges of Virahajots, Bazumi, Pambak, Gougarats, Aregouni, and Sevan) and which are subject to extensive erosion.
- Regions of volcanic origin within Asia Minor, including the mountain ranges of Ashotsk, Aragats, Geghama, Vardenis, Sunik and Mount Aragats (4095m). These areas are covered by lava of relatively recent origin (upper Pliocene). Such regions are characterised by gentle slopes, and little evidence of erosion, although larger rivers have carved out deep gorges and canyons.

- A series of ridged mountains adjacent to the River Arax (ridges on the left bank along with the Urts-Eranossian, Teksar, Vaik, and Zangezour mountain ranges, including the peak of Kapoutdjugh at 3094m) constitute the Minor Caucasian system. This area is prone to intense erosion.
- The Ararat Valley represents the lowest part of the Ararat depression (which is still undergoing tectonic movement). This area is covered with sediments of different geological origins.

Within these regions, a range of landscapes are found, reflecting the different geological substrates and histories. Furthermore, there is clear zoning of landscapes with altitude. Seven key physical-geographical zones are recognised in Armenia: Shirak, Lori-Pambak, Aghstev-Tavush, Sevan watershed, Ararat valley, Vayk and Zangezour.

2.1.2 Climate

A wide range of climatic zones have been recorded within Armenia. The country is located centrally in the sub-tropical zone, and thus is prone to arid (desert and semi-desert) conditions. However, the altitudinal variation within the country results in further variation in climatic zones, in addition to existing latitudinal clines.

In general, the country receives high levels of sunshine; ranging from 2600 hours per year (Yerevan) to 2800 hours per year (shore of Lake Sevan). The average temperature throughout the year varies geographically from 2.7°C (Mount Aragats) to 14°C (Meghri, in the north-east). The highest average monthly temperature is recorded in July-August; in low lying areas, such as the Ararat valley, average summer temperatures reach 24-26°C, while cooler temperatures are recorded at higher altitudes (averaging 15-20°C at mid-altitude, and 10-15°C at high altitude). Significant temperature variations are also recorded in winter, average January temperatures range from 0.3°C (Meghri) to -13°C (Mount Aragats). Average minimum temperatures in winter range from -18.9°C (Berdashen) to -3.1°C (Meghri), with an absolute minimum of -45°C recorded near Berdashen. Relative humidity averages around 60% (Yerevan), but varies with season and altitude. Highest levels of humidity are observed in winter (80% and above), while in summer recorded humidity is as low as 44% in some places.

Average annual precipitation is between 600mm and 1000mm, but varies in different altitudinal zones (from 250mm in semi-arid zones to 1100mm in alpine zones). Most rainfall occurs in the spring, while the second half of the summer is dry. Long-lasting snows exist on mountains over 1300m. In these places snow over may reach up to 2m in depth (for example on Mount Aragats), while snowfall is much sparser on the steppes (30-50cm deep).

2.2.Biogeographic zones

The mountainous nature of Armenia results in a series of highly diverse landscapes, with variations in geological substrate, terrain, climate, soils, and water resources. These landscapes support a great variety of habitats, which support distinctive flora and fauna, and different human use. Seven distinct altitude landscape zones have been described in Armenia: deserts, semi-deserts, dry steppes, steppes, woodlands, sub-alpine and alpine lands. The areas covered by the seven main landscape types are shown below (Table 1), along with a more detailed description of each landscape zone.

Table.1. The area of Armenia covered by different landscape types, along with their altitudinal distributions

Landscape type	**Altitude (metres above sea level)**	**Percentage cover across the country**
Deserts and semi-deserts	700-1300	10%
Mountain steppes	1300-2400	37%
Forests, thin forests, shrubs	600-2500	20%
Alpine and sub-alpine meadows	> 2100	28%

- **Deserts and Semi-deserts** occur in the Ararat Valley and adjacent mountain slopes at altitudes of 1200-1300m, in the Vayk lowlands, and the Meghri gorge. Sand accumulations in the Araks area result in a desert landscape, which are also found in saline lowlands. In these landscapes, the climate

is dry and continental, with hot summers and moderately cold winters. The soils are generally of the semi-desert grey type, and have been managed for cultivation over the last millennia..

- **Dry mountainous steppes** are found at higher altitudes than semi-deserts (above 1500m) in the Ararat Valley, and some other areas, but are also found at lower altitudes (above 800m) in the lowlands to the north-east of the country, which were originally forested. The climate in the dry steppes is characterised by warm, dry summers and mild winters. A range of soils are found, but in the Ararat Valley these lands are typically stony. Irrigation of dry steppes allows cultivation of crops, vegetables and fruit, and these landscapes have also suffered severe human impact.
- **Mountain steppes** are the dominant landscape for most of the country, particularly at altitudes above 1500m (and at altitudes up to 2000m in the north, 2400-2500m in the south). Meadow steppes occur in the highlands, while patches of forest also occur on ridge tops among steppes in the north-east and Sjunik regions. The climate is generally moderate, with warm, cool summers, and moderate or cold winters. Soils generally have a humus content of between 6-7%.
- **Forests** generally cover the mid-zone of mountains, occurring at altitudes between 500m and 2100m in the north (up to 2500m in the south). In central Armenia, forests occur in small areas rather than as a continuous zone, and forests can be found on steep slopes and other areas with limited human access. Soil types include red soil in the lowlands and forest grey soils in the highlands.
- **Sub-alpine meadows** occur at higher altitudes than steppes and forests, including highland mountain ranges. The climate is moderate with short, cool summers and long, cold winters. Much of the land here is meadow, with soils of high humus content.
- **Alpine meadows** occupy the highest altitudes above sub-alpine meadows (up to 3000m in the north and 3800m in the south). These meadows represent the principal pasturelands for the country, with meadow and alpine vegetation. Climatic conditions are severe, with long, cold winters, and annual temperatures average less than -40$^{\circ C}$. Snow cover lasts up to 9 months, and permanent snows may occur in some areas.
- **Azonal landscapes** cover over 10% of the territory of the country, and occur independently of altitude (unlike the previously described landscapes). These include wetlands, as well as saline and alkaline lands, which cover about 25,000ha, including areas in the Ararat Valley where the underground waters are close to the earth surface, resulting in water vaporisation and salt precipitation. Upland wetlands are dominated by fresh (non-brackish) water, while lowland wetlands (particularly those around the River Araks) are usually drained in summer, resulting in high salinity.

2.3 Fauna and Flora Species that requires urgent conservation measures

In Armenia, some taxonomic groups are much better studied than others. The most extensive research has been done on bacteria and other micro-organisms, as a result of their role in the food industry, and other sectors of the economy. In addition, mushrooms and flowering plants are relatively well studied. The best studied animals include amphibians, reptiles and waterfowl. A number of endemic species and sub-species are recorded in Armenia (Table 2.). Endemic species and sub-species represent 3% of vascular plants in Armenia (as compared to 1.5% more widely across the Caucasus). Furthermore, of the animal species represented in Armenia, 30% of fish, 12% of reptiles and 7% of mammals are endemic.

Table 2 The number of species, and endemic forms, from different taxonomic groups, represented in Armenia

Group	Number of species	Number of endemic species or sub-species
PLANTS		
Algae	388	-
Fungi	4166	2
Lichens	300	-
Moss	395	-
Vascular plants	3555	106
Total	**8,804**	**108**
ANIMALS		
Invertebrates	17,000	316
Fish	30	9
Amphibians	8	1
Reptiles	53	6

Birds	349	1
Mammals	83	6
Total	**17,523**	**339**

The overall species richness in Armenia is relatively high, given the size of the country, particularly with respect to lower plants and some animal groups. Although groups such as the higher plants (about 3500 species) and vertebrates (about 500 species) have been intensively studied in Armenia, little work has been done on other taxa (including invertebrates and some lower plants). The information on species richness in these groups may therefore be significantly underestimated. Further assessments are therefore needed of biological resources and of conservation status of key group. At present financial constraints severely limit scientific research in Armenia, and no funds are available to support inventories or long-term monitoring of fauna and flora.

Because of natural and human impacts, almost half the plant species present in Armenia may face some threat of extinction. To date, 35 plant species of economic importance are known to have become extinct in Armenia. A further, 386 species (12% of the flora) are listed in the Armenian Red Data Book (produced in 1988). At a regional level, 61 plant species are listed in the Red Data Book of the former Soviet Union (produced in 1984). Of critical concern are species such as sweet flag bulrush (*Acorus calamus*), a valuable medicinal herb, and the beautiful Judas tree (*Cercis griffithii*), which is endangered because of agricultural use of the land. Other examples of endangered plants include a newly discovered endemic species of saltwort *Salsola tamamschjanae,* threatened as a result of sand processing, and the regionally endemic iris, *Iris grossheimii.* In addition, the status of lower plants has not been fully assessed, but at least 15 species of mushroom are considered to be under threat.

Of around 17,500 species of invertebrate and vertebrates recorded in Armenia, approximately 300 are considered to be rare or declining. A total of 99 vertebrates are currently listed in the Armenian Red Data Book, of which 39 are also listed in the Red Data Book of the Former Soviet Union, and a number are considered internationally threatened (according to the IUCN Red List of Threatened Animals; Table 3).

Table 3.Number of vascular plants and vertebrate species listed in the Red Book of Armenia, and regional and international Red Lists. Threat categories are given for species listed in the Armenian Red Data Book (Ex = Extinct, Th = Threatened, Ra = Rare, De = declining, Dd = Data deficient).

Group	**No. in Armenian Red Book**	**No. of species**					**No. in USSR Red Book**	**No. in International Red List**
		Ex	**Th**	**Ra**	**De**	**Dd**		
Fish	2	-	2	-	-	-	1	-
Amphibians	1	-	-	-	1	-	1	-
Reptiles	11	-	6	4	1	-	7	2
Birds	67	-	20	34	13	-	19	3
Mammals	18	-	3	6	6	3	11	1
Vascular Plants	386	35	129	155	59	8	61	-
Total	**485**	**35**	**160**	**199**	**80**	**11**	**100**	**6**

However, updating the Armenian Red Data Book would be likely to lead to the inclusion of many more species (perhaps doubling the existing list). The Armenian Red Data Book for Invertebrates is not yet available, but initial assessments indicate that over a hundred species will be listed. The Red Data Book of the Former Soviet Union already lists 48 invertebrate species which are found in Armenia.

Among the vertebrate species listed in the Armenian Red Data Book are 12 amphibians and reptiles, and 18 mamma l species – many of these species are critically endangered. The threats facing these species have increased recently as a result of the effects of natural disasters and economic crisis, coupled with the lack of effective environmental legislation. Among the mammals listed, six species are at particular risk of extinction: Armenian mouflon *(Ovis orientalis gmelinii),* wild goat (*Capra aegagrus),* marbled polecat (*Vormela peregusna),* European otter (*Lutra lutra),* brown bear *(Ursus arctos),* and manul (*Felis manul).*

In addition, the striped hyaena *(Hyaena hyaena)*, and the Caucasian birch mouse *(Sicista caucasica)* are probably extinct in Armenia.

3. Status of biodiversity and main biomes

The variety in landscapes and altitudes within the country is an important determinant of biodiversity and its distribution in Armenia. The altitudes in the country range up to 3000m, and six key landscape types have been identified (deserts, semi-deserts, steppes, forests, alpine and sub-alpine meadows). These landscapes are generally associated with particular altitude zones. In addition, a series of azonal habitats (such as wetlands) exist. Each landscape represents a different ecosystem, with a distinctive group of associated plants and animals.

However, there are also some species that are found in different ecosystems. For example plants such as fescue (Festuca sulcata) are common in both steppe and meadow systems. Also, many animal species seasonally migrate between different habitats. For example, the greater horseshoe bat Rhinolophus ferrumequinum is found in steppes in summer, semi-deserts in autumn and forests during winter; Armenian Mouflon traditionally moved from winter feeding grounds on the steppes up to sub-alpine meadows in summer. Brown bears are found in forest, steppes and meadows depending on the time of year.

3.1 Deserts and Semi-deserts

True deserts only cover a small area of Armenia, and are mainly situated below 900m altitude in the Ararat Valley. The best studied desert system is that close to the town of Goravan. Among the invertebrates, distinctive fauna is recorded, including several endemic species (particularly at Goravan)

Deserts represent threatened habitats, and a number of endemic species would disappear if these habitats continue to decline. Most of higher plants are specific to deserts and relatively rare throughout Armenia. Distinctive vegetation structure and composition is associated with saline and chalk substrates in the Ararat Valley

Semi-deserts (800-1200m) commonly support wormwoods such as Artemisia fragrans and A. araxina. Semi-deserts often covered in spring by ephemeral plants. In addition, xerophytes occur in these habitats (both plants and bushes) and flowering vegetation occurs in some lowland sites

Many endemic invertebrate species occur in semi-deserts from different regions (including species of Mediterranean, Iranian, Caucasian and Crimean origin). Some reptiles are specifically associated with small patches of desert habitat with xerophyte vegetation. Over 50 species of birds recorded in total in semi-deserts.

Cultivated lands represent 80-90% of the area of the semi-desert zone, and natural ecosystems have been extensively damaged as a result of uncontrolled irrigation and agricultural intensification, which has resulted in increased soil erosion, salinity and pollution. Cultivation has required intensive irrigation, and these areas now support fruit, vegetable, flower, and wine production, but have suffered major impacts from human activities

“Erebuni” state reserve located in semi-desert arid lands as well as “Sands of Goravan” reservation are the only desert territory of the Republic included in the Protected Area system of Armenia. The conservation of endemic animal species, as well as crop wild relatives is implemented at “Erebuni” reserve; “Goravan sands” and “Vordan karmir” reservations.

3.2. Steppes

Mountain steppes represent the dominant ecosystem of Armenia, and occur throughout the country at altitudes between 1200 and 2000m (sometimes as high as 2500m). Vegetation cover is varied, but particularly important plants include fescue (Festuca sulcata) and feather grass (Stipa spp.). Main higher plant species recorded include: Stipa lessingiana, S. pulcherrima, S. capillata, Festuca sulcata, F. ovina,

Bothriocloa ischaemum, Agropyrum cristatum, Astragalus microcephalus, A. laguris, Onobrychis cornuta, Bromopsis variegatum, Phleum phleoides, Koeleris cristata. Invertebrate diversity is low, but several rare and threatened species occur. Among reptiles the most representative species are: Lacerta armeniaca, L. dahli, L. valentini, L. nairensis, L. strigata, L. agilis, L. caucasica, L. apodus, Ophisiops elegans, Vipera erivanensis, V. raddei, Coronella austriaca, Eryx jaculus, Telescopus fallax, and Natrix natrix.

More than 30 species of birds are recorded in steppes. The most representative mammal species are fox, wolf, coypu, marten, greater horseshoe bat, wild goat, Armenian Mouflon and brown bear.

Uncontrolled grazing by livestock threatens many of the natural pastures of the mountain steppes and alpine and sub-alpine meadows. Serious degradation of pastures and meadows has occurred over the last 100 years, with the most significant impacts recorded in the grasslands of Vayk, Zangezur, Mount Aragats and Pambak.

Steppes are used for agriculture (including cultivation of crops, vegetables, frost-tolerant fruit trees (in lower altitudes) and fodder plants (in highland areas).

3.3. Forests

Almost all forests in Armenia are state-owned and the Government is responsible for forest conservation, management and planting. In most forests timber extraction is strictly prohibited, however such rules are often broken. Forest cover is relatively low in Armenia, with less that 10% of the land being forested. Armenian forests are predominantly broad-leaved (97%), and are dominated by oak, beech and hornbeam. Other species occasionally found in forests include juniper, pine and yew. Forest habitats are typically found on mountain slopes between 500 and 2400m altitude, although beech and oak forests are typically concentrated at moderate altitudes (1300-1600m). A range of animals are associated with these forests, including brown bears, Wild goat, wild boar, Persian squirrel, European mole, wood mouse and forest dormouse.

Four major forest types, and associated tree species, are described below:

- **Oak forests,** represent about a third of forest cover (90,000 ha) and are widely distributed across the country. Of four oak species (Quercus spp.) found in Armenia, two (broad-leaved and Georgian oak) are typical of forests. Of these broad-leaved oak is the more frost tolerant species and is found throughout the country at altitudes as high as 2600m. In contrast, Georgian oak is typically restricted to altitudes between 500 and 1400m, and is typically found in the north and in Zangezour region. Other species which typically grow in oak forests are ash (Fraxinus excelsior), hornbeam (Carpinus betulus) Georgian maple (Acer ibericum), cork elm (Ulmus suberosus), and field maple (Acer campestre). A third oak species (Arax oak) is now declining as a result of climatic warming and human impacts.
- **Beech forests,** dominated by Oriental beech (Fagus orientalis), represent about a third of forest cover. They are widespread in northern Armenia, particularly on north-facing slopes at altitudes of 1000-2100m. Other species found in beech forests include Caucasian lime (Tilia cordata), Litvinov beech (Betula litwinow) and spindle-tree (Euonymus europaeus), and substantial grass cover is supported in these forests.
- **Hornbeam forests** are less common than those of beech and oak, and occur at altitudes of 800-1800m. Other trees found in these forests include oak, field maple, common ash, Caucasian pear (Pyrus caucasicum), and Oriental apple (Malus orientalis).
- **Dry scrub forests** are found in both north and south of the country occurring at altitudes of 900-1000m in the north, but at much higher altitude in the south (1800-2000m). These forests support around 80 species of xeric trees and shrubs, all of which are drought tolerant and light-loving. As well as thorn forests, dominated by juniper (Juniperus spp.), broad-leaved forests also occur (characterised by species such as pistachio (Pistacia mutica), Georgian maple, and almond (Amygdalus fenzlianum), among others). A range of shrubs is also found in these forests, including buckthorn (Rhamnus catharticus), cherry (Prunus spp.), and jasmine (Jasminium fruficans).

Armenian mountain forests play a critical role in preventing soil erosion and regulating water flow. Forests harbour many endemic and relic species of woody plants and herbs, and are important habitat to

rare and endangered species of birds and animals. Large predators such as the Caucasian leopard, wolf, and brown bear depend on forest ecosystems.

3.4. Grassland ecosystems

The grassland ecosystems cover the biggest territory within non-cultivated lands in Armenia and are disposed almost in all landscape zones. The main characteristics of grassland ecosystems are:

- they differ by huge diversity of plant and animal populations;
- they serve as the main natural fodder lands (grasslands and pastures);
- they serve as habitats for a big amount of wild animals;
- they prevent from land degradation and desertification processes;
- they serve as sources of natural genetic resources.

Anthropogenic factors have severely affected the pasturelands of Armenia, and a large proportion of grasslands have deteriorated in quality. Management of these lands has been poor to date, leading to substantial declines in areas suitable for grazing. Over-grazing has resulted in land erosion, formation of boggy areas and reduction in plant diversity. The area of natural pasture land has declined from 1.4 million ha in 1940 to 1012,000 ha today, and remaining areas have been degraded and have become dominated by rocks (87%), scrub (25%), and inedible (74%) or poisonous plants (47%), while diversity has declined. For example, while between 70 and 80 plant species are normally supported by steppe systems, the number of species found after intensive over-grazing drops to around 15. Similar declines in richness are reported in meadow systems (from 125 to around 25 after over-grazing). Over-grazing has also resulted in changes in species composition, with declines in populations of valuable fodder plants and increases in weeds and poisonous species (such as crowfoot, thistle, creeping thistle, as well as Euphorbia seguieriana, and Astragalus spp.). In addition the over-collection of particular species for human consumption from natural pastures has pushed these species to the edge of extinction.

The post-privatization changes in grazing regimes have led to decreases in floristic diversity in some areas where grazing has declined, but more importantly increased habitat degradation in over-grazed areas. Privatization led to complex problems of access to, and use of, common grazing lands, and consequently the use of natural pastures and hay meadows has declined substantially since then. Over 60% of hay meadows have now been privatized, while pastures are used on a lease basis. Despite the declines in livestock populations since privatization, over use of remaining pastures is still an important problem. Although grazing has been reduced in the highlands (alpine and upper sub-alpine meadows), a two-to three-fold increase in grazing pressure has been recorded in lowland sub-alpine meadows and steppes. The likely intensification of livestock grazing with economic recovery, coupled with the current lack of regulation, means that the issue of over-use of pastures is likely to grow in importance over the coming years. Regulation will be essential to ensure that natural grasslands remain areas where traditional grazing practices can coexist with the protection of natural communities and their inherent genetic diversity.

3.5. Sub-Alpine and Alpine meadows

Meadows are typically found above 2000m altitude, and support a wide floral diversity. Sub-alpine meadows often support a distinct assemblage of grasses, particularly in northern regions. Alpine meadows (over 2700 m) are rich in Poaceae (such as Poa alpina) and the carpet vegetation of such meadows represents an unusual and interesting habitat. The higher plants recorded include Festuca varia, Poa longifolia, P. alpina, Phleum alpinum, Trifolium, Onobrychis transcaucasica, Dactylis glomerata, Festuca gigantea, Linum hypericigfolium, Sibbaldia parviflora, Myosotis alpestris, Alchemilla, and Carex.

Distinctive invertebrate fauna are found in these areas with many national and regional (Caucasian) endemics, including Carabus stjernvalli, C.tamsi, Dorcadion spp., Deltomerus khnzorian, Trechus armenus, T.dzermukensis, as well as Bombus spp., Terymus auratus, and Trichia armenica.

Between 10 and 15 species of birds are recorded many of them are Red data Book species. The most representative species are Caspian snowcock (Tetraogallus caspius), choughs (Pyrrhocorax graculus, P. pyrrhocoraxi), Lammergeier (Gypaetus barbatus), accentors (Prunella ocularis, P. collaris), wallcreeper (Tichodroma muraria), snowfinch (Montifringilla nivalis).

In the past the alpine zone meadows of all mountain chains were in poor state due to overgrazing. At present in Geghama and Pambak mountain chains, as well as in Aragats the situation has even worsened. In Tashir, Megri, Kapan, Goris, Sisian regions the overgrazing issue is not that acute and one can observe a rehabilitation process of deteriorated areas.
The extensive development of land use, overgrazing; irregular harvest of industrial plants; insufficiency of the legal framework have lead to extreme degradation of these ecosystems; steep reduction of the type composition and even extinction of some species.

3.6. Freshwater ecosystems

The rivers in Armenia are mountainous. Only 14 rivers are longer than 35 km. Out of about 200 other streams and brooks less than 10 km long, many are not permanent. A number of surface waters and rivers are transboundary. Armenia lies completely in the Kura River basin. The Araks River marks the border between Turkey and Armenia, and further between Iran and Armenia, before flowing into Azerbaijan, where it flows into the Kura River. The Araks river basin covers 22 790 km^2 in Armenia and drains 76.6% of the territory through the Ahurjan, Kasakh, Metsamor, Hrazdan, Azat, Vedi, Arpa and Vorotan rivers. The tributaries flowing directly into the Kura River in the north-east (i.e. via the Debet, Pambak, Agstev, Hakhum and Tavush rivers) drain less than 23% of the country. The outflow to Georgia through the Debet River is estimated at 890 million m^3/year and the north-eastern outflows through various rivers to Azerbaijan at 555 million m^3/year. In the south-east, the total direct outflow to Azerbaijan through the tributaries of the Araks River (Arpa, Vorotan, Voghi, etc.) is estimated at about 1 791 million m^3/year.

A total of 417 plant species (of 67 families) are known to occur in the rivers and lakes of Armenia. Most of these (58%, 246 species) belong to ten plant families. Not surprisingly, plant families associated with water or damp sites are particularly well represented in this flora (Cyperaceae and Potamogetonaceae).

In general, relatively few aquatic plants are found in the rivers and lakes of high mountains (only 10% of the aquatic flora is recorded above 2700m), most are found at mid- (1200-2700m) or low- (<1200 m) altitude (50% and 40% of the flora, respectively). Studies of the distribution of aquatic plants in Armenia have identified some key sites for these plants:

- Lakes of mid-altitude and in steppes are particularly rich in water and marshland plants.
- Many rare species (such as Nymphaea alba, Salvinia natans, and Carex bhemica) are found in the relict lowlands lakes in Lori region.
- The Metsamor (Sevajur) river supports many aquatic and marshland species, including nationally and regionally rare species. This is partly explained by its high water quality and slow speed.
- The Lake Sevan basin supports flowering water plants in its upper waters (above 6 m), while algae flourish at greater depths.
- Despite the large-scale drainage and destruction of marshland in vicinity in Lake Sevan, some populations of reeds, rushes, (Juncus), reed mace (Typha) and sedge (Carex) can still be found close to springs and emerging groundwater.
- A limited number of aquatic plants are found in forest lakes. Ponds in shady woodlands (such as those of beech and oak) tend to be dominated by algal blooms, and where flowering aquatic plants do occur, their cover is relative sparse.

A range of planktonic invertebrates are found in Armenia's water systems (total 124 species), including 46 species of rotifers (Rotatoria) and 78 crustaceans (Crustacea). In addition, a wide range of benthic species are found in Armenian water bodies (316 spp).

Nine species and sub-species of fish are endemic to Armenia. These include the endemic species of Sevan trout (Salmo isshkhan), and its four races or sub-species (winter bakhtak S. ischchan; gegharkuni S. ischchan gegarkuni; bojak S. ischchan danilewskii; and summer bakhtak S. ischchan aestivalis), which occur in Lake Sevan and surrounding rivers. In addition, the following sub-species of fish are also endemic to Armenia, a roach (Armenian karmrakn, Rutilus rutilus schelkovnikovi); a schneider species (Armenian tarekhik, Alburnoides bipunctatus armeniensis); Sevan koghak (Varicorhinus capoeta sevangi); a barbel (Sevan beghlou Barbus lacerta goktschaicus); and a white bream species (Armenian goustera (Blicca bjoerkna derjavini).

Populations of trout (Salmo trutta), which until recently was found in all rivers in Armenia and Wels catfish (Silurus glanis) have reduced significantly as a direct result of human activities such as intensive poaching, reservoir pollution, unlimited water use and uncontrolled fishing.

Freshwater ecosystems contain the most threatened habitats in the region due to intensive negative impact from mismanaged irrigation, unsustainable water use, and wetland drainage for agriculture. Overfishing, infrastructure development, and pollution also seriously threaten the integrity of freshwater habitats. Pollution from agriculture and industry has impacted freshwater systems and breeding bird and fish populations

Industrial and mining operations have had a significant impact on water systems of the country. The release of polluted water and industrial effluent directly into some rivers has resulted in widespread loss of natural vegetation and animal life (for example, the lower stream of the River Debed, and the basin of the River Voghji have been affected in this way). Natural ecosystems are affected by both chemical and thermal pollution from industrial plants, and polluted water is also finding its way into irrigation systems, thus affecting agriculture and threatening human health.

3.7. Lake Sevan

The threats to wetlands in Armenia are clearly illustrated by the changes in Lake Sevan. This large, alpine lake is one of the most endangered ecosystems of the Republic of Armenia, which contains more than 80% of the country's water resources. The lake is characterized by unique fish world; there are 3 endemic species in the lake – trout with its 4 sub-types; kogak and beglu. Because of the decrease of the lake's level the ecosystem's balance has been fully destroyed; as a result of drying of the places for spawning the lake biotypes of the endemic fish types are on the verge of extinction.

Lake Sevan is extremely important to Armenia, in terms of its water resources, ecological role, and unique fauna and flora. Lake Sevan effectively represents an important reservoir of water for Armenia and the wider Southern Caucasus region. The Lake Sevan is one of the most endangered ecosystems of the Republic of Armenia, which contains more than 80% of the country's water resources. The lake is characterized by unique fish world; there are 3 endemic species in the lake – trout with its 4 sub-types; kogak and beglu. Because of the decrease of the lake's level the ecosystem's balance has been fully destroyed; as a result of drying of the places for spawning the lake biotypes of the endemic fish types are on the verge of extinction.

Since the 1930s the development of the industrial, agricultural and energy sectors have relied on the water resources of Lake Sevan. Off-take of its waters supplied irrigation systems for agriculture and hydroelectric power stations downstream. Water from the lake irrigated around 100,000 ha and generated more than 2.5 million kW of electricity, thus providing an important contribution to the socio-economic development of the country. However, such extensive off-take of water also resulted in a serious ecological disaster, with significant falls in the level of the lake. Since 1933 the level of the lake fell by 19m, and its overall volume decreased by 42%. As a result the average temperature of the lake increased, oxygenation levels fell, resulting in eutrophication and algal blooms. The first signs of the lake's eutrophication were recorded in 1964, when green and blue algae blossomed in the lake.

In 2002-2005 annual plan for the rehabilitation, preservation, reproduction and use measures of the Lake Sevan's ecosystem a special attention is drawn to the increase of the lake's level, which is the main precondition for the rehabilitation of lymnosystem.

With a purpose to solve the issue in 2002 there has been around 40% reduction of the water outlet from the lake for the irrigation purposes. At the same time around 300.6 million cubic water has been channelled to the lake through Arpa-Sevan canal, which is 30% more that the similar indicator of 2001. During 2003-2005 as a result of the relevant measures the level of the lake went up by 174cm.
The coverage by the water the forest areas as a result of increase of the water level of the Lake Sevan is another concerning issues. The latter is harming not only the forests, but is also a serious danger from the point of view of lake's pollution. At present as a result of the level increase of the Lake Sevan around 410

ha area (of which 215 ha covered by forests) is already under the water. By and large in case of 6 m increase of the lake's level additional 3288 ha forests territories will be under the water.

The decline in water levels also affected the whole of the Sevan watershed. Around 10,000ha of surrounding wetland and semi-wetland areas dried out.

The drainage of the lake also had significant effects on the biodiversity of the lake and surrounding areas. Populations of around 60 species of plant are considered to have declined as a result of the draining of Lake Sevan. Within the lake, the principal breeding sites for Sevan trout were lost, and populations of this and other endemic fish species, have declined. The Sevan wetlands were previously used by up to 160 species of migratory birds, only 50 of which are now recorded. Today the numbers of birds using the whole Sevan watershed are lower than those recorded on Lake Gilly alone in 1939, and water bird populations continue to decline. The populations and diversity of mammal and reptile species in the area have also declined significantly, and a number of spaces are considered to be threatened.

4. Existing threats to Biodiversity from main economic activities

While the importance of the biological resources of Armenia is clearly recognised, equally obvious are the threats to these resources. A variety of anthropogenic effects now threaten the plants, animals and ecosystems of Armenia, and increased population pressure is further increasing these impacts on biodiversity. Historically, low human population densities and regulated use of natural resources protected the balance of ecosystems. However, over the last 1000 years human impacts on the land have increased, mainly through deforestation and increased use of pastures.

The biological resources of Armenia have undergone permanent change as a result of both internal and external factors. The most important threats to Armenian biodiversity include habitat loss and direct destruction of species, which have resulted in population declines in a number of plants and animals.
The greatest threats to biodiversity result directly and indirectly from human activities.

The key threatening processes that can result in declines in populations of animals and plants, loss of species and degradation of ecosystems, include:

- habitat loss and modification;
- over-use of biological resources;
- pollution;
- effects of introduced and non-native species; and
- climate change.

In Armenia, the growth of the agricultural, industrial, construction and energy sectors have led to extensive habitat change across all landscape types. Urban and industrial areas have grown, while forests have been logged and over 20,000ha of marshes and wetlands have been drained. This has led to the destruction of natural habitats, and has brought a number of species close to the brink of extinction. Habitat degradation is likely to be exacerbated in future as a result of land privatization.

Direct use of biological resources is common in Armenia, including the use of pastures and meadows for grazing, collection of wild plants, fisheries and hunting. The current levels of use for a number of species appear to be unsustainable, and population declines have been recorded in some species. Continued overuse is likely to result in species extinctions, and changes in ecosystems.

Outputs from the industrial, energy and transport sectors have resulted in substantial levels of air, soil and water pollution in Armenia. The legacy of Soviet industry is clear in heavy metal levels still recorded in soils today. Such levels of pollution have direct impacts on the health of species and integrity of ecosystems.

4.1. Industry (including extraction industry)

Extensive industrial growth took place in Armenia between the 1920s and the 1980s, with the development of more than 200 industrial sites, including a number of gigantic industrial plants, at altitudes up to 2000m. Industrial growth relied on extensive use of the natural resources of the country, with little environmental regulation. Industrial development therefore had significant effects on the ecosystems and biodiversity of the country, including (1) habitat loss as a result of construction; (2) degradation of natural habitats; and (3) pollution of soils, water and air.
Within Armenia, metallurgical and chemical industries were particularly important, but represented major polluters of the environment, releasing dangerous substances into the air and into water systems. Despite industrial decline, pollution continues from four remaining plants, and from stored industrial waste and tailings. In addition, cement works pose a danger to the environment, through the widespread emission of dust, which affects natural habitats. The cement works are not currently operational, however economic revival may lead to the recovery of this industry and thus increased pollution from this source.

Prior to economic crisis substantial pollution was produced by the country's industrial centers, totaling around 245,000 tones annually (54,400 tones of solid particles and 190,900 tones of liquid or gaseous emissions). This included around 50 different pollutants, including sulphate anhydride (58%), nitric oxides (15%) and oxides of carbon (14%). At present only a small proportion of industries remain operational (10-30%), and emissions of pollutants have dropped dramatically to 15,000-20,000 tones per year. However, pollution continues to have negative impacts on both natural ecosystems and agricultural lands in the country. Nitrogen-containing compounds (ammonia, nitric oxides) released from the Vanadzor chemical plant have affected up to 22% of surrounding forests (703.7 ha within a 5km radius). The emission of fluorides and chlorides from the 'Nairit' Research Association has resulted in direct damage to crops within a 2km radius and reductions in productivity and quality.

Currently the industry of the Republic is in process of revitalization. Of great concern is the continued release of toxic waste, including heavy metals (annual outputs in 1980 were equivalent to 18,000 tones), and the effects of this pollution are still evident. For example, heavy metal levels in crops around the Alaverdi metallurgical plant are between 20 and 40 times above the maximum allowable level.

Substantial amounts of accumulated industrial waste exist in the country, mainly as a result of mining (estimated as hundreds of millions of m^3 of waste). Even during the current period of reduced industrial outputs, almost 300,000m^3 of industrial waste (including slag) was produced by mining operations in 1996 alone. A number of tailings from extractive and processing operations remain in the country, totalling around 220 million m^3 (including 30 million m^3 from Zangezour copper-molybdenum plant, 12 million m^3 from Ararat gold refinery, and 3 million m^3 from the now closed Dastakert copper-molybdenum plant). There is a particular risk of pollutants from these tailings leaching into water systems.

Industrial and mining operations have had a significant impact on water systems of the country. The release of polluted water and industrial effluent directly into some rivers has resulted in widespread loss of natural vegetation and animal life (for example, the lower stream of the River Debed, and the basin of the Voghji river have been affected in this way). Natural ecosystems are affected by both chemical and thermal pollution from industrial plants, and polluted water is also finding its way into irrigation systems, thus affecting agriculture and threatening human health. Figures in 1997 indicated that over 130 mining enterprises existed in Armenia, of which all but four involved open-cast mining. Mining operations affect an area of 9,700 ha, including 8,275 ha which have undergone direct disturbance, and 1,400 ha covered by tailings or slag. Many mines are situated at relatively high altitudes (including copper and gold mines at between 2000 and 2500m), and thus represent a direct threat to fragile mountain ecosystems, and also affect lowland habitats downstream from such mines.

4.2. Transport

The transport system in Armenia is extensive, covering 800km of rail track and 13,000km of roads (of which 12,000km is tarmac road). Transport systems affect biodiversity in a number of ways:

- destruction of natural habitats during construction;
- degradation of surrounding habitats;
- pollution (local and air pollution);
- barrier to dispersal resulting in fragmentation of populations;

- direct mortality of wildlife.

Vehicle emissions are a major contributor to pollution in Armenia, representing 94% of total emissions (an increase from 67% of emissions in 1987). In particular, exhaust fumes contain oxides of nitrogen and carbon , which contribute both to local pollution of natural ecosystems, and to global warming. At present laws regulate several pollutants in vehicle emissions, however overall assessments of pollution from road transport are difficult to quantify accurately from the data available. However, it is clear that pollution level dropped significantly during the energy crisis in the early 1990s, but has now risen dramatically again

The direct degradation of habitats on the verges of roads is a major problem, since efforts have been made to mitigate impacts through habitat enhancement (tree planting, etc.). A greater issue has been the destruction caused by off-road vehicles (four-wheel drives and caterpillar trucks), particularly in alpine and sub-alpine meadows. There is increasing vehicle use and road development in these fragile environments, resulting in destruction of vegetation and soil, and increased erosion and water run-off.

4.3. Infrastructure

Construction work has increased dramatically in Armenia over the last half century, in line with industrial development and human population growth. Around 90 000 ha, or 3% of the total land is now covered by urban or industrial construction. Such areas support few species and construction affects biodiversity directly, through the complete destruction of natural habitats. In addition, areas in the vicinity of construction work are affected by habitat degradation and by long-term damage with construction wastes that are not properly removed.

Infrastructure is mainly concentrated in and around large cities, far from rural areas. Several dams for hydroelectric stations and reservoirs have altered natural river systems and flooded forests and steppes. Since infrastructure and regional development is mostly concentrated near urban centres, many of the outlying regions of the countries are largely unscathed by large-scale infrastructure projects and development. Border regions of the countries, which are usually the most distant areas from administrative centres, harbour large swaths of intact natural habitats. As a result, much of the biodiversity in the Armenia has been preserved in the bordering regions that did not face military conflict.

4.4. Agriculture

Agriculture remains the largest sector in Armenia. More than half the total land is devoted to agricultural or forestry use and agricultural use in lowland areas is as high as 80-90% of the land. Agriculture impacts biodiversity in a number of ways:

- habitat change and destruction of natural ecosystems;
- over-grazing (affecting vegetation composition of pastures);
- land degradation (including compaction of soils and increased salinity) and reduction in productivity;
- pesticide use and soil pollution;
- soil erosion (and increased risks of landslides);
- pollution of water sources;
- increased spread of disease through livestock populations.

The effects of over-grazing have been discussed in previous section, along with its impacts on alpine and sub-alpine meadows, forests, and steppes. Another impact of such grazing has been increased erosion and soil compaction, and increased loss of organic compounds from soils, particularly on mountain slopes. In addition, major centralised livestock breeding centres also affect biodiversity through the effects of their construction and through impacts on water resources through over-use by livestock. The concentration of livestock at limited watering sites, not only results in competition for water with wildlife, but also increases the risks of disease transmission, among livestock, wildlife and humans.

Although privatization of agricultural land in Armenia represents an important change for farmers, it may have significant adverse impacts on natural resources. Prior to 1992 over 75% of agricultural land was used by state or collective farms, however post-privatization the land has been divided between 130,000

farms, as well as a number of non-agricultural organisations. Privatization and land ownership has resulted in new legal and social conditions relating to land use, and in the absence of effective state regulation this may result in increased degradation of newly privatized lands, along with further reductions in productivity given the lack of environmental guidance in sustainable land use. Poor land management is likely to affect not just natural ecosystems but also the productivity of the land and the levels of pollution from chemical applications. In some areas unregulated land use may greatly increase the risk of desertification.

The state of the natural pastures and grasslands is extremely concerning in Armenia. Those occupy around 1012,900 ha, out of which 127,800 ha are grasslands, 885,100 ha are pastures (according to Government Resolution #2243 of 22.12.05); The natural pastures and grasslands are on 700-3700 m above sea level, in six different eco-geographical zones from desert-semi-desert up to sub-alpine and alpine. The vegetation of the natural pastures and grasslands of the republic is quite abundant and comprises around 1090 species of flower plants, which belong to 462 genes and 88 families. In most cases the dominants of natural pastures and grasslands are representatives of cereals. At present the biodiversity of natural pastures and grasslands of the republic has been subjected to significant changes in regard of the population's number and individual species. As a result of measures implemented by Ministry of Agriculture aimed at the easing of pastures at the proximity of settlements there has been a decrease of loss dynamics of pastures' ecosystems deterioration and fodder plants.

4.5. Forestry

The extent of forest use and deforestation in Armenia, as a result of timber extraction, grazing, industrial use, and fuel requirements during the energy crisis, have already been described. Loss of forests has a number of effects on biodiversity and natural ecosystems:

- loss and change of forest habitats;
- increased erosion with loss of tree cover;
- increased silting and eutrophication of water bodies;
- collapse of natural hydrological systems associated with forests;
- gradual forest succession as a result of changed water balance (from primary forest, to secondary growth, to scrubland and eventually to desert).

Forests are one of the most seriously threatened ecosystems in Armenia. Today, forests cover less than 10% of the land surface of Armenia. Forests are now concentrated in the north-east of the country, and in some areas, such as the Ararat valley, Vayk and Sevan regions, only small scattered patches of forest remain. These isolated patches are prevented from regenerating due to the pressure of uncontrolled felling and their use as pasture land. Further forest declines in some areas (such as Vayk and Sevan) have resulted from increases in forest pests and changes in the hydrological regime of forests.

Forests are also an important part of economic development in the country and forest communities depend on fuel wood for heating and cooking. Yet, logging practices are unsustainable and generally inefficient. Additionally, illegal logging accounts for a large share of the timber harvested. Fragmentation and degradation of the region's forests are escalating at an alarming rate. Deforestation on mountain slopes leads to erosion and pollution of waterways.

Extensive deforestation in Armenia took place between 1992-1995, during the period of economic blockade and energy crisis. A combination of poor forest management and illegal felling resulted in damage to around 40,000 ha of forest, including the total clearance of around 7000 ha. During this period, the forests around Yerevan, Gegharkunik, Lori, Kotayk, and Armavir were the most severely damaged. According to estimations of international and local experts, total timber production is amounted to 847,000 m^3 in 2003, out of which 63,000 m^3 are the official data on forest logging. Major illegal logging is being implemented by the local population of the 230 communities located adjacent to the forests (within 5km)

4.6. Fishery

Commercial fishing is implemented only in Lake Sevan. Water, fish products and crayfish are of commodity value in the natural resources of the water ecosystems. In recent past the Lake Sevan and

rivers flowing into the lake were rich of fish species, which would meet the food needs of the population. Because of reduction of the river flow; contaminations of the water systems and poaching the fish reserves have gone drastically down. If in 1996 the total fishing of white fish was 3100 tones, then in 2004 it was 420 tones. Changes in the ecology of the Lake Sevan have resulted in declines in the species of previous commercial importance (Sevan trout, Salmo ischchan and kura kogak), and an increase in the catches of whitefish or Coregonus lavaretus sevanicus and Carassius auratus. Amateur fishing is open in all water bodies, expect those in protected areas.

5. Ways of halting the loss of biodiversity at the transition to sustainable nature resource use.

5.1. Industry (including extraction industry)

The reduction of industrial activities at present is an important factor contributing to slowing down the dynamics of deterioration of the natural habitats. However, from the other hand the negative human impact on ecosystems and biodiversity has also grown. The damage incurred to the nature as a result of unmanageable exploitation of bioresources (especially logging) is connected with dire socio-economic conditions of the republic; energy crisis and destitution of a large walk of population. The privatization of the land; considerable expansion of civil works during last years; tangible activation in agriculture, tourism development also have a negative impact – not only reducing the habitats of the biodiversity components, but also leading to their deterioration.

As by 2003 data in Armenia 300 million m^3 of waste water is generated annually, approximately 60% of which without any purification flows into open reservoirs ant the rest 40% is subjected to only mechanical purification. The waste waters generated in the basin of the Lake Sevan are channelled to the Lake Sevan without purification and decontamination. The main industrial sectors of the basin used to be: machine tool; chemical; food; wood processing and textile industries. Today those enterprises are not functioning or functioning at lower capacities. However, deteriorated substances; chlorines; sulphates; azoth reactions; oil products, phosphates; iron; copper, etc. are channelled to the lake through unpurified streams.

There are many settlements on the shore of the Lake Sevan, include 4 large towns. The rural areas do not have water waste systems. Only the towns have sewerage systems in the littoral area, the waters of which are not purified in urban station. The study of the state of water waste and sewerage water purification in the basin of the Lake Sevan; evaluation of biological contamination in the littoral area of the lake identified poor state of hygiene – with violation of hygiene norms.

Based on the evaluation of the accumulation, removal, decontamination study of industrial and solid domestic wastes and degree of contamination of littoral areas in Gegharkunik marz development program they have included recommendations about building up economic-domestic and industrial wastewater purification stations and processing enterprises for solid wastes.

In the republic some studies are being implemented aimed at the gauging the impact of various contaminants on the environment (heavy metals; chemical materials, etc). The overwhelming part of those surveys is being implemented on the borders of the settlements and less outside of their borders. So far there have been no complex surveys, based on which one could evaluate the impact of the contamination on the biodiversity.

“Environmental Survival” NGO has implemented “Reduction of negative impact of tanning industry on the ecosystem of the river Hrazdan” sub-project, within which they studied the water world of the river Hrazdan; evaluated the impact of the industrial enterprises on the biodiversity of the river and rehabilitation of purification station has been done for “Kashi” CJSC.

“Environmental Impact Monitoring Center” SNCO of the Ministry of Nature Protection every year regularly performs the monitoring of water quality in more than 40 rivers of Armenia.

The assessment of environmental impacts in Armenia is implemented by “Environmental Expertise” State Non-Commercial Organization under the Ministry of Nature Protection according to the “Law on

Environmental Impact Expertise" (adopted in 1995). Examples of assessment of the environmental impacts of certain projects on the protected areas, including restriction of the construction of gold mining plant in Sodk. In 2004 "Ararat Gold Recovery Company" initiated the process of construction of a gold mining plant in Sodk (located within the territory of "Sevan" National Park in order to replace the existing gold mining plant of Ararat marz. The proposal has been submitted for environmental expertise to assess the ecological impacts of the activity. As a result of independent expertise the proposal was rejected.

5.2. Infrastructure

Ecological expertise on the possible harmful impact of proposed projects upon the biodiversity is implemented according to the "Law on Environmental Expertise" adopted in 1995. The following Laws and Government Resolutions contain direct or indirect provisions on mandatory environmental impact assessment in above mentioned cases:

- Government Resolution #608 (May 2, 2003) "On approving procedures for development, expertise, approval and changing of the construction proposal"
- Government Resolution #96 (February 2, 2002) "On approving procedures for expertise of urban construction documents"
- Government Resolution #1788 (December 11, 2003) "On approving zoning documents for Lake Sevan coastal areas subject to priority construction "

Distinct inventory of ecological consequences of national programs and policies that can cause harmful impact on biodiversity has not implemented yet. One of the reasons is lack of mechanisms for post-project assessment of ecological impacts although respective provisions are included in the "Law on Environmental Expertise"

In the framework of Armenia-Iranian economic cooperation, based on mutual agreement, preparatory works are being implemented for construction of Iran-Armenia gas pipeline. Scope of works, selection of location, and distribution of the junctions of the pipeline is implemented by participation of local and international specialists. This promotes reduction of the pipeline sections crossing forested areas, which, consequently leads to minimization of harmful impact on biodiversity not only in Armenia but also outside of its borders

5.3. Agriculture

Within the framework of "ICARDA – regional program of agriculture of development of mountainous countries" the have developed a range of new technologies for the surface and root improvement of natural fodder fields with the purpose to improve the pastures in the fodder diversity and extremely burdened state. The surface improvement technology is applied for the improvement of the worst pastures in Gegharkunik and Tavush marzes.

Within the framework of "Natural resources management and poverty reduction" project in 9500 ha pastures of 59 communities of the republic they apply the sustainable management methods. The use of the pastures is implemented on the system of shift grazing. As a result of project implementation the pastures and grasslands of 3300 ha will be improved. At present in 1770 ha pastures and grasslands they have already implemented fertilizing measures. With the training purposes in 20 communities they have identified the worst state pastures, where for 1-2 years the grazing is prohibited. With a purpose to efficiently use the far pastures and ease the pressure on close pastures and forests they envisage to rehabilitate and build up 200 watering points. At present the activities have been completed in 45 communities.

5.4. Forestry

The preservation and sustainable use of the forest resources is considered as one of the priorities of the state. To regulate the aforementioned areas in 2003-2005 the Armenian Government has adopted a range of legal documents, in particular "National Forest Policy and Strategy"; "National Program of Armenian Forests" and "Action plan for mitigating actions to help address the problems associated with illegal logging" developed within the framework of "Natural Resources Management and Poverty Reduction" program. All the aforementioned documents contain measures aimed the rehabilitation of the forest areas

and development of sustainable forms of forest use.

In "National Forest Program" they have included identification and mapping of etalon ecosystems (districts) for the conservation of unique and exterminating species of forest biodiversity; activities aimed at prevention of natural habitat loss of individual types of forest biodiversity and conservation of pivotal bio-types. The fostering sustainable use of the forest reserves is tightly interconnected with the development and introduction of forest entities management plans, which is stimulated by the Forest Code adopted by the National Assembly in 2005 and envisaged by National Forest Program (adopted in 2005).

"National Forest Plan" envisages implementing the following measures:

- support to the storing growth of timber forest products in overall forest use volumes: a/ increase of volumes of efficient use of forest products and b/ development of hunting farms;
- development of the national forest inventory passport standard;

The sustainable use of forests can be implemented in forest ecosystems managed in a sustainable manner. With this purpose within the "Natural resources management and poverty reduction" project in a range of forest farms they have registered the forest resources and inventoried the biodiversity. The development management plans for 5 forest farms are in the process. According to Government Resolution #7 (15.01.2004) in the area of forests conservation, maintenance, reproduction and use Ministry of Agriculture is the authorized state body and the supervision is performed by Ministry of Nature Protection.

By the Government Resolution #96 dated 29.01.2004 forest management agency was established in the structure of Ministry of Agriculture. In Ministry of Nature Protection the forest inspection is performed the forest supervision division of Environmental state inspection.

In "National Forest Policy and Strategy"; "National Forest Program"; "Action plan for mitigating actions to help address the problems associated with illegal logging" documents a range of complex measures have been envisaged, which are aimed at the conservation of the forest biodiversity; reduction of logging; rehabilitation of forests and planting of new forests.

In recent years there has been a reduction of irregular use of forest resources, especially connected with the improvement of electricity supply and development of gas supply infrastructure. To prevent the illegal use of forest resources in 2003 adjacent to Ministry of Nature Protection they have established a board to support the solution of issues connected with illegal logging and after the Government Resolution "On introducing the state monitoring system of forests" (2005) it has been replaced with a new entity, i.e. state forest monitoring board coordinating the fight against illegal logging in Armenia.

In 2004 and 2005 forest inventory has been implemented on 45,000 and 125,000 ha territories respectively. Forest management plans have been developed for 5 forest enterprises. Centre for Forest Monitoring has been established within the Ministry of Agriculture.

5.5. Fishery

The sustainable industrial fishery mechanism of the Lake Sevan is based on the registration and evaluation of the fish reserve and identification of the fish reserves. The regular registration of the industrial fish reserves in the lake has been conducted up to 1999, after which due to financial difficulties it was not performed for 5 years. As a result due to scientifically unjustified overuse the quantity of white fish has been drastically reduced.

Since 2004 upon the order of the Government the research of industrial populations of the Lake Sevan and evaluation of reserves have been restarted ("Registration of the Lake Sevan fish and crayfish reserves" and "Registration of industrial fish species in the Lake Sevan" projects), which came to prove the fact of the white fish reserves reduction.

In the annual program of rehabilitation, conservation, reproduction and use of the Lake Sevan's ecosystem (2002-2006) they have included "Replenishment of fish reserves" action, within framework of which the implement "Provision for reproduction of valuable and rare fish species".

The ex-situ conservation of the Lake Sevan's trout (gegharkuni and summer bakhtak sub-species) gene pool is implemented within the framework of "Collection, incubation, receipt of caterpillars from the mother body grown in artificial conditions of summer bakhtak and release of spawns to the Lake Sevan" project. In artificial conditions they have created a stable reserve of sub-species that are on the verge of extinction, thanks to which their status has been tangibly improved. Though serious measures are undertaken for reproduction of disappearing fishes, however, the results can be expected only in case of their natural reproduction in the lake.

Within the framework of the World Bank and Global Environmental Facility financed "Natural resources management and poverty reduction" project's "Management of protected area and biodiversity conservation" component they have studied the fish-fauna composition of the Lake Sevan and determined the quantitative indicators of industrial fish species

The Government Resolution # 1380 dated 22.08.2002 "On approving the order for issuing licenses to use the sites of fauna with the purpose of agriculture and industry and concluding contracts" regulates the industrial fishing in the Lake Sevan and decree No84-N dated 18.03.03 Minister of Nature Protection has approved the composition and working procedures of professional commission issuing the licenses to use the natural animal reserves.

Within the framework of USAID DAI "Armenia agriculture small and medium enterprises market development" project they have identified the possible role of small fisheries in the fish export development. After saturating the internal market Armenia can export up to 4000-5000 t of fish.

To protect and rehabilitate the reserves of industrial fish species in 2005 the minimal industrial fishing rate has bee established for the white fish and from July 1, 2005 up to December 25, 2005 they have banned to white fish in the Lake Sevan.

6. Action Plan for Halting Biodiversity Loss by 2010

In order to combat the threats to biodiversity and guarantee long-term conservation of globally important ecosystems the following measures should be taken:

- Prepare, adopt and implement a strategy and framework for developing an Eco-Regional Econet, including forest, freshwater, and high mountain Econets for the Caucasus;
- Build and strengthen the biodiversity monitoring capacities in protected areas throughout the Ecoregion;
- Establish transboundary protected areas and additional corridors;
- Ensure Sustainable management of freshwater habitats of the Ecoregion;
- Ensure effective conservation of representative freshwater habitats and associated biodiversity within networks of protected areas and linking corridors (Econets);
- Grant protection status (IUCN I-IV) to all Important Bird Areas
- Ensure conservation of endangered species of fish and reduce their illegal fishing
- Preserve representative forests and associated biodiversity in networks of protected areas and linking corridors (Econets);
- Ensure effective management of forests and conservation of their biodiversity, reduce illegal logging;
- Implement sustainable forestry practices for commercial forests in the Ecoregion;
- Certify forests of the Ecoregion according to international standards;
- Identify alternatives to timber production for conservation of forest communities;
- Develop ecotourism as a viable source of income in forest communities;
- Improve the management of the existing protected areas

7. Conclusions: proposal for further cooperation

The further cooperation should be emphasized at the following directions:

- social-economic: ensuring poverty reduction, raising public awareness, etc.
- political: strengthening transboundary cooperation, harmonizing legislation, etc.
- institutional: improving coordination and communication among institutions, strengthening knowledge and research, etc.

The strategies in the Caucasus Ecoregion addressing the above-mentioned directions of cooperation can be developed and achieved in the framework of “The Caucasus Convention”.