# CHAPTER 2. STATE OF THE CAUCASUS ENVIRONMENT AND POLICY MEASURES: A RETROSPECTIVE FROM 1970 TO 2000

## 2.1 Landscapes and Biological Diversity

### 2.1.1. Landscape Diversity

The Caucasus is located at the junction of temperate and subtropical climate zones. The border between them is well-delineated by the Main Caucasus Range, which determines the climatic difference between the North and South Caucasus. Therefore, climatic factors causing latitudinal zonality of the Caucasus landscapes are closely connected with orographic (relief) factors and they should be considered jointly.

In the Caucasus, the first level oroclimatic differentiation of landscapes, connected with the Main Caucasus Range and Trans-Caucasus Sub-meridian upland, is relatively well-known. Less information exists on the second level, in which an essential role is played by relief features, being climate-determining factors of the second order. The "sectoral" differentiation of the Caucasus landscapes, significant difference in regional moisture distribution and a degree of continentality of the climate are connected with them.

Overall, oroclimatic factors and high hypsometric (altitude) peculiarities determine the types and zonality of the Caucasus landscapes.

In the Caucasus, the distribution of landscapes is closely connected with development history. In the Quaternary period, with cooling of the climate two refugiums (shelters): Colchian and Girkan were established there. With the warming of the climate, the representatives of Colchian and Hircan flora have started to spread. Due to this, the landscapes with the great participation of ancient flora were called Colchian and Hircan.

Relief and geological peculiarities determine the distribution of a number of specific landscapes in the Caucasus. First of all, the distribution of karst landscapes, connected with cones of limestone and carbonate rocks should be mentioned.

Volcanic landscapes are most characteristic of the Armenian Highlands. Here they occupy considerable areas and high elevation lava plateau and volcanic cones are connected with them. On the Greater Caucasus, volcanic landscapes are met more seldom, presented in the form of isolated volcanic masses, such as Elbrus and Kazbegi.

Differentiation of plain, elevated and mountainous landscapes is connected with geological and morphological factors. Thus, separate species of landscapes are of the following types: depression-plain accumulative, pre-mountainous-hilly, denudation-accumulative and denudation-erosive, low mountainous arid-denudation, erosive-denudation, denudation paleo-glacial, and other landscapes.

At present, anthropogenic activities are one of the most important forces driving transformation of landscapes. As a result of human activities new natural-agrarian territorial units are being formed, and the landscapes are connected with selitebic (inhabited) parts, industrial and transport constructions, recreation, etc.

Caucasus Landscapes are described at the level of type. In addition, major sub-types and enumerated numbers of landscape genera according to the Landscape Map of the Caucasus (1979), the monograph "Caucasus: Landscapes, Models, Experiments" (1995) and the Study Report Biodiversity of the Caucasus Ecoregion (2001) are given. In all, there are 2 classes, 20 types, 40 sub-types and 152 genera of landscapes in the Caucasus.

In terms of the number of landscapes, Georgia is distinguished by the greatest diversity at the level of class among other Caucasus countries and the countries of the Black Sea region. In the meantime, Azerbaijan occupies the first place by the amount of landscapes types and sub-types. This is connected with the fact that Azerbaijan, firstly, has a larger territory, and secondly, it involves the Nakhichevan autonomous republic. Thirdly, Azerbaijan better presents a spectrum of arid and moderate landscapes. From the regions of the North Caucasus, the most varied landscapes are presented in Krasnodar kray and Dagestan.

## Caucasus landscapes


*Fragment of landscape maps compiled by Beruchashvili N., 2001, 1995, 1979*

| | | Humid | Sub-Mediterranean | Semi-Humid | Semi-Arid | Arid |
|---|---|---|---|---|---|---|
| Plains and Hilly landscapes | Subtropical | A1 A2 | B1 B2 B3 | | D1 | E1 |
| | Thermo-Moderate | | | F1 F2 | | |
| | Temperate | | | | G1 | H1 |
| Mountainous landscapes | Subtropical | I1 I2 | J1 | | L1 | |
| | Thermo-Moderate | M1 M2 M3 M4 M5 M6 M7 | | | O3 | |
| | Temperate | Q1 Q2 | | R1 | S1 S2 S3 | T1 T2 |
| | Cold-Temperate | U1 U2 | | | | |
| | High-Mountain | V1 V2 V3 V4 W | | | | |

## I. Plain and Foothill Landscapes

**A. North Subtropical Humid**

A1. Colchic Lowland landscapes with swamp alder forests and sphagnum bogs and foothill landscapes with hombearn-oak forest alternating with beech-chestnut, oak-zelcova and polydominant forest with evergreen underwood

A2. Hyrcan plain landscapes with grassland-shrublands and Hyrcan forest

**B. Sub-Mediterranean Semi-Humid**

B1. Novorossiisk foothill landscapes with oak, pine and juniper forest and open woodlands alternating with beech forest and fragments of Mediterranean shrublands (maquis)

B2.Pontic (transitional to Colchic) plain and foothill landscapes with Pitsundian pine, oak and polydominant forest and fragments of Mediterranean scrublands (maquis)

B3. South-east Caucasian sub-Mediterranean (transitional to moderate-thermophitic semi-humid) foothill landscapes with hornbearn-oak forest and woodlands and botriochloa steppes

**D. North Subtropical Semi-Arid**

D1. East Georgian foothills' landscapes with botriochloa and stipa steppes, dry shrubland (shiblyak), dwarf-shrub (phrygana) vegetation and semi-deserts

**E. North Subtropical Arid**

E1. East Caucasian lowland and foothill landscapes with artemisia, halophytic deserts and semi-deserts

**F. Thermo-Moderate Semi-Humid**

F1. East Trans-Caucasian (Kakhetian) plain landscapes with oak and oak-zelcova forest

F2. Kuban hilly plain landscapes with oak forest and forest-steppes

**G. Temperate Semi-Arid**

G1. North Caucasian lawland and hilly plain landscapes with mixed herb-grass steppes and meadow-steppes

**H. Temperate Arid**

H1. Terek-Kuma lowlands landscapes with artemisia, salsola and halophytic deserts and semi-deserts

**I. Hydromorphic and Sub-Hydromorphic**

I1. Lowland landscapes with wetlands

I2. Delta and floodplain landscapes with wetlands, swamp forest and grasslands and solonchaks

## II. Mountainous Landscapes

**J. North Subtropical Sub-Mediterranean**

J1. Novorossiisk (transitional to Colchic and moderate thermophitic) low-mountain landscapes with oak and pine forest and juniper open woodlands

**L. North Subtropical Semi-Arid**

L1. Southeast Caucasian low-mountain landscapes with juniper woodlands, dry shrublands (Shiblyak) and dwarf-shrub vegetation (Phrygana)

**M. Thermo-Moderate Humid**

M1. Colchic low-mountain landscapes with hornbeam-oak and hornbeam-beech-chestnut forests mainly with evergreen unserwood, partly alternating with oak-pine forests

M2. Colchic middle-mountain landscapes with beech forests mainly with evergreen unserwood

M3. Hyrcan low-mountain landscapes with chestnut-oak, oak-parrotia and hornbeam-oak forests

M4. Hyrcanic middle-mountain landscapes witch beech and oak forests

M5. East-Georgian (Kakhetian) low-mountain landscapes with hornbeam-oak partly alternating with chestnut forests

M6. Southeast Caucasian (transitional to semi-humid) low-mountain landscapes with hornbeam-oak, oak forests and secondary dry shrublands

M7. Southeast Caucasian middle-mountain landscapes with beech forests alternating with hormbeam-oak, partly with pine forests and secondary grasslands

**O. Thermo-Moderate Semi-Arid**

O3. Front Asian middle-mountain, plateau and upland landscapes with steppes, dry shrublands and dwart-shrub (phrygana) vegetation, partly alternating with stony deserts

**Q. Temperate Humid**

Q1. North Caucasian low-mountain landscapes with mixed broad-leaved-oak and hornbeam-beech forests

Q2. North Caucasian middle-mountain landscapes with beech, partly beech-hornbeam and hornbeam-oak forests

**R. Temperate Semi-Humid**

R1. North Caucasian middle-mountain landscapes with meadows, meadows-steppes and steppes, partly with beech and hornbeam-beech forests, dry shrublands and dwarf-shrub vegetation

**S. Temperate Semi-Arid**

S1. South Caucasian (transitional to moderate-thermophitic) middle-mountain landscapes with steppes, dry shrublands and dwarf-shrub vegetation, partly with mountain semi-deserts

S2. Javakhety-Armenian highland volcanic plateau landscapes with steppes and meadows-steppes in combination with wetlands

S3. North Caucasian mountain landscapes with steppes, dry shrublands and dwarf-shrub vegetation

**T. Temperate Arid**

T1. Armenian low-mountain landscapes with semi-deserts, dwarf-shrub vegetation and partly with shrublands

T2. Ararat mountain flat terrain landscapes with stony type deserts, semi-deserts and dry dwarf-shrub vegetation

**U. Cold-Moderate**

U1. Caucasian middle-mountain landscapes with beech-dark coniferous and dark coniferous (spruce-fir) forests, partly with evergreen underwood

U2. Caucasian upper-mountain landscapes with birch and pine forests

**V. High-Mountain Meadow**

V1. Caucasian sub-alpine landscapes with combination of meadows, tall-herb communities, sub-alpine woods and thickets

V2. Front-Asian high-mountain landscapes with meadow-steppes and fragments of sub-alpine meadows

V3. Caucasian alpine landscapes with grasslands and rhododendron thickets

V4. High-mountain landscapes with plant micro-communities, mosses and lichens

**W. Glacial**

**Caucasus landscape diversity**

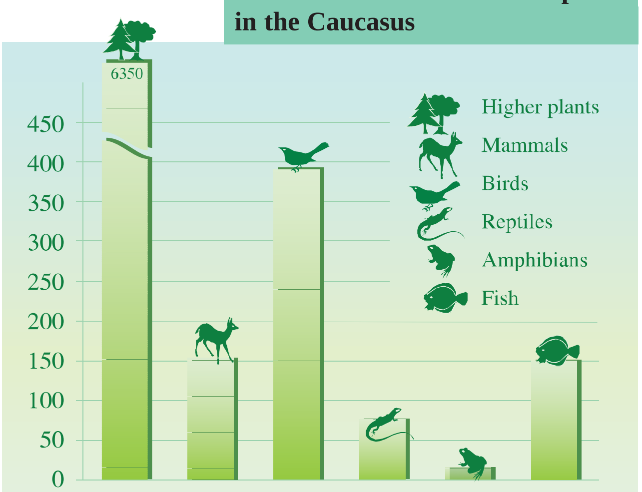
| Country/Region | Landscapes | | |
|---|---|---|---|
| | Type | Subtype | Genus |
| ***Armenia*** | **8** | **14** | **28** |
| ***Azerbaijan*** | **18** | **25** | **53** |
| ***Georgia*** | **16** | **22** | **72** |
| ***Russia (N. Caucasus)*** | **76** | **107** | **149** |
| *Krasnodar Kray* | 12 | 15 | 25 |
| *Stavropol Kray* | 6 | 6 | 15 |
| *Adigea* | 6 | 19 | 13 |
| *Chechnya* | 9 | 11 | 17 |
| *Dagestan* | 9 | 12 | 21 |
| *Ingushia* | 9 | 10 | 14 |
| *Kabardino-Balkaria* | 8 | 12 | 15 |
| *Karachai-Cherkessia* | 8 | 13 | 18 |
| *North Osetia* | 9 | 9 | 11 |
| **Total Caucasus** | **20** | **140** | **152** |
| **Black Sea Region** | **19** | **54** | **281** |

*Source: WWF, 2000*

### 2.1.2 Flora and Fauna Diversity

**Caucasus Flora.** The level of biodiversity in the Caucasus is relatively well-known. Based on recent data, there are 6,300-6,350 plant species in the region. In this regard, the Caucasus is the richest floristic region among the regions of temperate climate zones. Countries of the tropical climate zone, however, have higher indices of floristic diversity. Milder climate conditions and an abundance of relict plants dated from cretaceous formations may serve as indicators for this. A unique richness in vascular species, with 15 endemic genera, however, makes the Caucasus a centre of global biodiversity (IUCN, 2000).

**Number of flora and fauna species in the Caucasus**




*Source: World Resources, 2000-2001*

In terms of endemic species, the Caucasus is between the highly endemic islands and low endemic regions. There are 1,600 endemic species in the region, making up about 25% of the total number of species. Of the total number of plant species, the share of relict species is the largest. All these species are related to two basic refugiums: Colchic and Girkan. Many of species of Tertiary flora survived in these refugiums.

**Caucasus Fauna.** Caucasus fauna is also rich in biodiversity. Total fauna consists of 152 species of mammals, of which 32 are endemic. Birds make up 389 species (3 endemic species), reptiles 76 species (21 endemic species) and amphibians 13 species (WWF, 2001).

**Agrobiodiversity.** The Caucasus is one of the oldest and richest centres of agro-biodiversity. Agricultural activities here date back to the 5-6th millennium BC, when the first sedentary tribes with farming, animal husbandry and simple infrastructure (adola architecture and irrigation) appeared in the Eastern Tran-Caucasus, on the right bank of the Kura river and the lower courses of the rivers Algeti, Khrami and Debed (UNEP, MoE, NACRES, 1997, Tbilisi). The first farming communities began to grow wheat, barley, oat, rye and grain legumes, e.g., pea, fava bean, etc. and fruit species: plum, cherry, grapes, etc. By the 5th millennium a diverse agricultural economy had already been established with farming and animal husbandry: goats, sheep and cattle breeding. Diverse ecosystems, mild climate and resource abundance enabled small families to populate all zones from lowlands to high mountains. This vertical zonality is preserved in the sub-region to date. More than 300 varieties of grapes together with up to nine major domestic animal breeds are found in the Caucasus (Gokhelashvili at al. 2000).

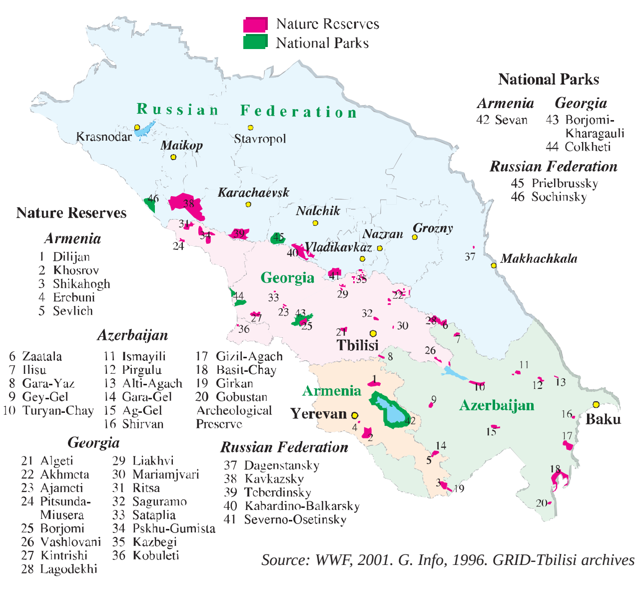
### 2.1.3 Caucasus Protected Areas

During Soviet times, there was a network of nature reserves ("Zapovednik"). Historically, the Caucasus region contained an unusually number of protected areas in proportion to its relatively small area (only 2% of FSU land area). In 1988, there were 37 nature reserves functioning in the Caucasus (14 of them had two or more components and thus the total number of protected areas consisted of 60). The total area of nature reserves was 898,000 ha, or 2% of the Caucasus area. The number of natural reserves for the North Caucasus in 1998 was five (1.86%), for Georgia - 14 (2.4%), for Azerbaijan - 14 (2.2%), and for Armenia - four (2.3%). (Natural Reserves of the Caucasus, 1990)

The land was first protected in the Caucasus in 1910, when a grove of Eldari Pine on the slopes of Mt. Eldar-Oukhi on the border of Georgia and Azerbaijan was declared preserved. In 1912 the Lagodekhi area and Pitsunda Pine (Pinus Pityuza) grove in Georgia, the Maziani gorge in western Azerbaijan, and a forested lot in Teleti range close to Tbilisi were also declared preserved. In the 1920s - 30s, the development of so-called managed nature reserves or sanctuaries ("Zakaznik") was broadly practised. Many reserves were shut down in 1951. For instance, out of 28 nature reserves in Georgia only one reserve, Lagodekhi survived this campaign. Starting from 1957 Soviet authorities attempted to restore some of the old reserves.

However, many could not satisfy their conservation goals or failed to prevent high rates of tourist flow (Pitsunda-Miusera, Ritsa, Sataplia, Gey-Gel, Gobustan, Dilijan). Some of the reserves were located close to traditional cattle breeding areas or densely populated areas, where their preservation was extremely difficult to maintain.

## Caucasus protected areas




*Source: WWF, 2001. G. Info, 1996. GRID-Tbilisi archives*

In the 1990s, circumstances became even more complex, when due to economic difficulties many reserves failed. Some were used not only for poaching, but also as illegal pasture zones for local people. What is most unfortunate is that unique woodland areas in some reserves have been used for logging purposes.

However, official records show that the total area and number of nature reserves continued to grow in the 1990s (though many reserves existed on paper only). This is due to the efforts of WWF offices and parliaments of some Caucasian countries, which passed new Laws on Protected Areas increasing the number of types of protected areas. For instance, the Law on Protected Areas passed by the Georgian Parliament in 1996 increased the number of categories to six: National Park, State Nature Reserve, Sanctuary, Nature Monument, Protected Landscape, and Area of Multiple Use.

According to the "Biodiversity of the Caucasus Ecoregion" compiled and published by WWF in 2001, the number of protected areas in the Caucasus is 46, with a total area of 13,035 km2 (about 3% of the whole territory). Of these, three reserves (Strict Nature Reserves) and two National Parks (Sevan, Dilijan) are in Armenia with a total area of 931 km2 (3.1% of total land resources); 14 reserves are in Azerbaijan (1291 km2, 1.5% of total land resources); 16 nature reserves and two national parks (Borjomi-Kharagauli and Colkheti area) are in Georgia. Protected areas there make up 2,466 km sq., which is equal to 3.5% of total land resources.

There are three national parks (Alania, Prielbrusye (Elbrus foothills), and Sochinsky) and three nature reserves in the North Caucasus. Among them the Kavkazsky Strict Nature Reserve (Caucasus biosphere reserve) is the largest in the Caucasus, with an area of 2,803 km sq. The total area of protected territories in the North Caucasus is 8,345 km sq. (3.3% of whole region). One should also take into consideration the number of sanctuaries. In Georgia alone, there are five sanctuaries with a total area of 590 km sq.

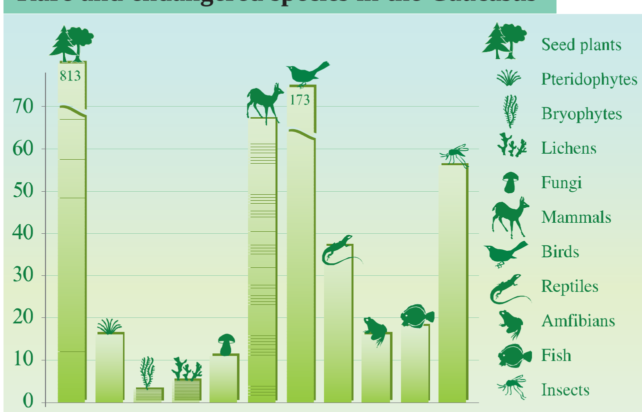
In addition to the network of reserves managed by departments of Protected Areas, there are a number of protected sections managed by other departments. In Georgia, for instance, the Forestry Department owns resort forests (1,185 km sq.), green-zone forests (2,684 km sq.), rocky and steep-slope forests (6,8213 km sq.), sub-alpine forests (322 km sq.), and flood-land forests (127 km sq.) with a total area of 11,131 km sq. If all types of protected areas in Georgia are added together, it amounts to 20% of the whole territory, a rather high ratio. Unfortunately because of economic difficulties, many protected areas in Georgia and other Caucasian states still exist only on paper, and many kinds of illegal activities (poaching, cattle pasturing logging) flourish there. However, the number and areas of reserved territories in the Caucasus is generally increasing and, importantly public interest in them is also increasing.

### 2.1.4 Threats and Current Status of Caucasus Biodiversity

Over the last thirty years, the biodiversity in the Caucasus has been affected by extensive anthropogenic activities. Natural pressure from active geodynamic processes is an important factor also.

Immediate threats to the Caucasus biodiversity are the loss of species and habitats, as well as habitat fragmentation and modification. Many flora and fauna species have become endangered or threatened and are listed in the IUCN as well as the USSR and National Red Books.

**Rare and endangered species in the Caucasus**




*Source: WWF, 2001*

Other threats to biodiversity are as follows:

- Uncontrolled harvesting of flora and fauna;
- Economic development: agriculture, industry, construction, tourism and recreation activi ties, etc.
- Intrusion of alien species;
- Armed conflicts;
- Climate change

From the above list, the last two threats have emerged only recently. Armed conflicts were never envisioned before the break-up of the Soviet Union. Similarly, climate change has only recently been recognised as a threat to the global environment, including biodiversity. Other factors have existed since the early years of the development of the Soviet Union, although current impacts significantly differ from those of the Soviet era in terms of the impact, extent and type.

Historically, agriculture was the major economic sector in the Caucasus. As a result of extensive agricultural development over the last 50 years, many natural ecosystems have been transformed into arable lands, pastures and hay fields, which in turn resulted in:

- Change and even loss of some natural habi tats and ecosystems, e.g., semi-desert, steppe, forest and wetland habitats;
- Environmental pollution from extensive usage of fertilizers and agrochemicals: soil and water pollution with heavy metals, POPs and river and lake euthropication from organic materials and biogenic substances, etc;
- Land degradation, erosion, desertification, soil compaction, salinization, bogging and fertility loss;
- Over-grazing, affecting the vegetation cover of pastures.

At present, uncontrolled use of fertilisers and pesticides, over-grazing of forest and lowland areas, especially around settlements, as well as obsolete irrigation infrastructure still pose significant threats to the Caucasus landscape and biological diversity.

Forestry as an economic sector had, historically, some impact on the Caucasus forest ecosystems and biodiversity in the 1970s-80s. Forest problems are discussed in detail in Forestry sub-chapter.

Activities in the fisheries sector have also had significant impacts on Caucasus aquatic species of both fresh and marine waters during the 1970s and 1980s. As a result, many commercial and valuable fish species have declined. Since the break up of the Soviet Union, commercial fishing has reduced. This has not resulted in a significant stabilisation of fish stocks. Currently, poaching is a serious problem, explained by the general economic fall and people's dependence on local resources as well as weak capacity of law enforcement officers and low public awareness. The use of unsustainable methods for catching continues. For example, mussel harvesting frequently is conducted through scrapping the seabed, resulting not only in the overexploitation of mussel stocks, but also other marine species. In addition to this, game fishing is not regulated, causing overcatching of fish populations.

Historically, hunting was strictly regulated in the Caucasus, especially in mountainous zones. Special sanctuaries were established for hunting of certain species. Commercial hunting was not allowed at all and licenses were required for game and sport hunting of many species. At present, although these laws and regulations still exist, they are not enforced due to the lack of a legal and administrative framework and financing for rangers who could detect illegal activities. The population's easy access to weapons makes the situation more uncontrollable. At present, even a tourism industry related to the harvesting of certain animal species has been emerged. For example, in Azerbaijan a number of cases of illegal hunting of Djeiran by bikers in semi-desert landscapes have been detected (IUCN, 2000). Regarding plant species, the population freely utilises plant and wood resources. Collection of medicinal plants and flowers listed in the Red Data Book is still conducted.

Industry, energy, transport, mining and infrastructure construction activities had serious impacts on the Caucasus biodiversity in the 1970s and 1980s, particularly in the late 80s, which were characterised by highest growth rates in the above sectors. At present, major industrial pressures come from mining operations as well as gas and oil production. The manufacturing sector has lower impact, due to its reduced capacity. In turn, transport impacts have been increasing and will continue to do so in the short to medium term, as freight turnover increases along the TRACECA corridor. Recent developments related to the construction and operation of gas and oil pipelines from Azerbaijan through Georgia pose a threat to sensitive areas such as the Colchian wetlands, which are important sites for many migratory and resident birds as well as endangered mammals. Because of that, contingency plans for potential oil spills and other disasters are of the utmost importance.

Tourism and recreation activities also imposed significant pressures on natural ecosystems of the Caucasus during the 1970s and 80s, when the flow of visitors was high. However, in the late 1980s and early 1990s, due to a series of armed conflicts and economic decline, the tourism infrastructure deteriorated and the tourist flow reduced. Since 1996, a revival of the sector, particularly mountain tourism, has been observed. At present, most recreational activities are not properly managed, imposing a threat to local biodiversity in terms of direct destruction of vegetation, littering and waste dumping, etc.

Alien species were and still are the threats to the Caucasus biodiversity. During the Soviet era, some species were accidentally introduced into the Caucasus; others were intentionally introduced for "enrichment". Some of the species came from neighbouring countries. Certain introduced species could not survive, while others prove successful. For example, in 1939 American Mink (Mustela vision) were brought to Georgia and released in Kvareli region. The species could not survive in the alien environment. However, racoon dog (Nyctereutes procyonoides) introduced in different parts of Georgia spread widely and posed a treat to Galliformes species. Racoon introduced in Georgia from Azerbaijan also could spread widely, imposing the threat to Galliformes (UNEP, MoE, NACRES, 1997).

In addition to all above pressures, new threats in the form of armed conflicts emerged in the Caucasus in the late 1980s and early 1990s. The effects of military conflicts are diverse, though there is a lack of basic information on environmental implications for all conflict areas (The effects of military activities are described in more detail in chapter 3.0).

Finally, climate change must be considered a factor that may significantly affect the Caucasus landscapes and biodiversity in the next 30-50 years. Recent studies conducted in the South Caucasus countries under the UNFCCC have shown that climate change, though of non-uniform structure, is already felt in the region. In the case of temperature increase by 1.5-2$^0$C degree, which is expected for the Caucasus region, the following changes may occur: xeropitization - expansion of vegetation, preferring arid conditions, mostly in Northeast Caucasus, Eastern Georgia, Armenian-Javakheti Highlands, etc; adventization - expansion of advented or cultivated species, in the passage of Trans-Caucasian depression most of all, in Colchian lowland and relatively elevated parts of the depression; mediterraneazation - expansion and domination of Mediterranean climate elements in the Black Sea Coastal zone and foothills; laurophilization - invasion and expansion of evergreen broad-leaved species expected in the mountains of Colchida, especially in South Colchida, with dominant number of laurophilous species. These changes in temperature and precipitation may lead to the rapid extinction of flora and fauna with spotty and restricted areas of distribution (UNDP/GEF-Georgian Government, 1999).

There are some other fundamental factors having indirect effects on the biodiversity status, which are listed among six fundamental factors of biodiversity loss in the Global Biodiversity Strategy. These are: the economic and political systems that fail to value natural resources; inequity in ownership and access to natural resources, including the benefits from the use and conservation of biodiversity; inadequate knowledge and inefficient information use and finally, legal and institutional systems, promoting the unsustainable natural resource use.

### 2. 1.5 Policy Measures and Responses

In general, while analysing the last 30-year history of policy pertaining to environmental and biodiversity protection in the Caucasus region, two distinct periods should be mentioned: the Soviet and post-Soviet. The Soviet period can be divided into two periods: one longer period - from early 1970s to early 1980s, and a shorter one covering late 1980s. The early 1970s and 1980s were characterised by increased interest in environmental protection, including natural resources/biodiversity protection. Various legal and regulatory documents pertaining to wildlife, forestry, fisheries use and protection were developed and adopted. Designated bodies at the all-union, national and local levels were established. An environmental chapter, with specific sub-chapters covering wildlife and forestry etc. was included into the State Master Plan to be the major policy document for the entire country. Some economic tools such as per unit taxes, deterrent taxes for the use of forestry resources and damage compensation fees were introduced. Traditional activities aiming at conserving natural resources continued. In-situ biodiversity conservation included the enlargement of existing or the establishment of new specially protected areas, e.g. natural reserves: "zapovedniks", sanctuaries: "zakazniks" and national parks. Ex-situ conservation practices included the establishment and maintenance of botanical gardens, herbaria and zoos. Various scientific institutions extensively conducted studies on Caucasus biodiversity. Data for national and all-union Red books, designed for listing rare and endangered species were collected and regularly updated.

Nevertheless, the 1970s and early 1980s were periods of using sector-based approaches to environmental protection. Sectoral ministries and committees responsible for managing individual resource had no co-operation with each other, and did not take into consideration the interdependence of all the components of environment during the decision-making processes. The major focus for conserving natural resources was on species of special economic value, while the biological value was not taken into consideration. In practice, policies and tools aiming at protection and sustainable use of natural resources were not implemented, even though legislation, though not complete and perfect, existed for this.

In the late 1980s, attempts to introduce a holistic approach to environmental protection were made. The need for developing and adopting a framework law on environmental protection and setting specific environmental body was understood. During this period, the State Committee for Nature Protection with regulatory, managerial and law enforcement functions was established. In addition, a special environmental examination body was set up under the Committee to make environmental valuation of development plans/project/programs. All protected areas previously managed by different agencies, were united under the single management of the above-mentioned Committee. This series of actions was a positive step at that time.

It is impossible to talk about national biodiversity protection policies and legal-institutional arrangements for each of the Soviet republics, including the Caucasus countries, since their role was insignificant in decision-making processes during the Soviet era. However, after independence, the South Caucasus countries and the Russian Federation started building up their national capacities and adapting their laws and institutions to those of the EU. New environmental protection laws became the basis for protecting environment, including biodiversity. Environmental media-specific statutes and codes were also adopted aimed at wildlife and forestry resources protection and establishment of protected areas systems, close to IUCN classification. Environmental impact assessments (EIAs) and state ecological examinations (SEEs) became mandatory for large-scale development projects having significant potential impacts, with a right for public participation built into all stages of EIAs. National Environmental Action Plans have been developed in all South Caucasus countries and the Russian Federation. As the Russian NEAP does not have specific regional features, some RF administrative regions located in the North Caucasus have adopted their own (regional level) EAPs. NEAPs have identified biodiversity conservation as one of the priority issues in the environmental and natural resources protection field and set short- to medium goals.

Licensing systems for the use of natural resources, including wildlife, have also been established and environmental taxes for the use of natural resources introduced in all subjects of the Caucasus. Specific environmental bodies, either ministries or committees, became the key biodiversity policy-making, regulatory and management agencies. For better control and management of protected areas, special Protected Areas Services with local branches have been established in some of the South Caucasus countries, either as separate bodies or as structural units of environmental ministries. However, all these agencies are still in the process of forming their structures and responsibilities. For example, the Azerbaijan State Committee for Nature Protection has recently been transformed into the Environmental and Nature Protection Ministry and has subordinated the previously independent forestry, fisheries and geologic departments and hydro meteorological service for increased efficiency, as well as to avoid overlapping responsibilities and conflicts of interests. In Armenia and Georgia, in turn, there are various parallel structures in the field of biodiversity protection and management, frequently competing, but not co-operating with each other. In Armenia, for example, six sanctuaries (Managed Protected Areas) are under the responsibility of the Ministry of Agriculture. Others are managed by the Ministry of Nature Protection, which is a key environmental agency in Armenia. In Georgia, apart from the Ministry for Environment, the State Forestry Department, State Department of Protected Areas, Nature Reserves and Hunting Management and the Ministry for Food and Agriculture are all engaged in biodiversity protection and management activities (Gokhelashvili at al. 2000).

In the North Caucasus administrative districts, local and municipal governments carry out biodiversity management and control functions. Federal, republican and local level laws and regulations represent the legal framework here. Apart from federal programs, local authorities have their own programs aiming at local biodiversity protection. In those parts of the North Caucasus specifically, in high mountainous regions where state institutions are practically non-existent, local communities play a key role in biodiversity management. In Chechnya, for instance, there is no state environmental policy and the state has completely withdrawn from nature protection. Traditional practices of natural resource use are based on a subsistence economy controlled by informal groups of rural communities, especially village elders. Shariat courts have also been gaining more power for establishing state order in this republic (IUCN, 2000).

In general, because of financial and technical shortages, the lack of appropriate expertise and presence of inefficient, old-style management, the capacity of all agencies involved in biodiversity protection and management activities is very low, though varying on a country-to-country basis. The high level of corruption found in all FSU countries hinders the effective implementation of appropriate policies. The lack of baseline and current information on biodiversity status also serves as an impediment in the decision-making process. Modern environmental monitoring and information technologies such as GIS and remote sensing techniques are not used by appropriate agencies. Overall, these features are common in all the agencies that are directly or indirectly involved in environmental management.

The role of academic institutions in biodiversity conservation is to support decision-makers with scientific knowledge and data and develop appropriate academic curricula. However, at present these institutions lack financial and technical resources to conduct field studies and collect current data. Only a few individual scientists are engaged in biodiversity conservation activities under different internationally funded programs/projects and co-operate with government agencies on an ad-hoc basis. With regard to curricula, although general courses such as botany, zoology, ecology, etc. are taught at academic institutions and universities, such courses as natural resource conservation and management, environmental economics and policy are of limited use or not taught at all.

Regarding the involvement of NGOs in biodiversity conservation activities, the NGO network is more developed in the South Caucasus than in the North Caucasus. There is very little international support in the North Caucasus, while it is extensive for South Caucasus countries. Many of the NGOs there have been receiving financial and technical assistance from a number of agencies. The only international conservation NGO having a permanent program in the Caucasus is the World Wide Fund for Nature (WWF), operating through its Tbilisi office. WWF-Tbilisi has supported the concept of developing a protected areas system in Georgia and participated actively in the establishment of Borjomi-Kharagauli National Park. The WWF through its Georgian affiliate has invested more than $4.2 million for conservation activities in Georgia since 1991, including over $2.5 million for the establishment of Borjomi-Khragauli National Park (WWF, 2001). Other areas of WWF's interest are sustainable forestry, environmental education, community-based resource management etc. The NGO has recently conducted a biodiversity investment portfolio study for the entire Caucasus. Other NGOs in Georgia are widely involved in all aspects of biodiversity conservation, including endangered species conservation. NGOs in Armenia are more engaged in public advocacy and environmental awareness. Azerbaijan has the least developed NGO sector, including environmental NGOs. These organisations are mostly staffed by concerned scientists who realise the need for an independent voice for environmental protection. In addition, most NGOs in Azerbaijan are focused on Baku's problems and do not cover other areas. In the North Caucasus region, state bodies have established many pseudo-public environmental organisations for supporting certain activities of state bodies. The most powerful NGOs, nevertheless, are: the Social and Ecological Union of the Western Caucasus, operating in Krasnodarsky kray, Adygeya and Karachaevo-Cherkessia; the Azov-Black Sea NGO network, part of the international Black Sea NGO network, based in Krasnodarsky kray, Adygeya and Rostovskaya oblast; and the Independent Ecological Service for the North-Western Caucasus, based in Maikop (IUCN, 2000). WWF also has an office in Russia that carries out species conservation and habitat protection activities, promotes sustainable practices in natural resources management, and works to establish protected areas or strengthen existing ones. Regional co-operation at the inter-state level in the field of landscape and biodiversity protection is largely limited to occasional consultations and information exchange. Although the South Caucasus countries have signed bilateral agreements on co-operation in the environmental field, there are no national activities and programs supporting such co-operation. An idea for a transboundary protected areas establishment, e.g. between Georgia and Dagestan, has not yet gained significant interest. At the same time, there are several ongoing regional projects between NGOs. Noah's Ark for the Recovery of Endangered Species (NACRES) has been implementing a transboundary project on conservation of arid and semiarid ecosystems; the Georgian Centre for the Conservation of Wildlife (GCCW) established the Caucasus Environmental NGO Network (CENN) in 1998 that publishes monthly bulletins and arranges regional meetings and workshops. The Regional Environmental Centre (REC) also supports regional co-operation among the South Caucasus countries. United States Agency for International Development (USAID) funded regional water project for Kura-Araks basin. Nevertheless, co-operation among the Caucasus countries, especially between the North and South Caucasus regions is low, caused by poor electronic communications, differences in legal-institutional arrangements and existing political conflicts of interests.

All South Caucasus countries, though at different levels, participate in global processes. The North Caucasus participates in international activities as a part of the Russian Federation. All subjects of the Caucasus are parties to the global Convention on Biological Diversity (CBD) and enabling activities there are supported by the GEF. Biodiversity Country Studies have already been conducted and Biodiversity Strategy and Action Plans (BS-APs) were adopted under the framework of the above convention. In addition, the CBD enables countries to raise funds for major conservation activities defined in BS-APs. Two other major conventions are CITES (Convention on International Trade in Endangered Species of Wild Fauna and Flora), ratified by Azerbaijan and Georgia and the Russian Federation; and the Ramsar Convention (Convention on Wetlands and International Importance Especially as Waterfowl Habitat), signed and ratified by all Caucasus states. However, there are some problems with implementing CITES this convention, related to the low capacity of national bodies to establish compliance assurance and control systems. Customs offices as the major law enforcement body lack specific knowledge in species diversity. Other conventions related to biodiversity and landscape diversity are the Convention concerning the Protection of the World Cultural and Natural Heritage (World Heritage Convention, Paris, 1972), ratified by all South Caucasus countries and the Russian Federation, the UN Convention to Combat Desertification ratified by South Caucasus states (UNCCD), and the UN Framework Convention on Climate Change (UNFCCC) ratified by all subjects of the Caucasus. Only Georgia has ratified the Convention on the Conservation of Migratory Species of Wild Animals (CMS, Bonn Convention, 1979). Georgia also participates in agreements of CMS such as ACCO (2001) and CURL (1994). Azerbaijan is not yet a party to CMS, but participates in the CSM agreement concerning conservation of Siberian Crane (SIBE). Finally, the Convention for the Protection of the World Cultural and Natural Heritage (1972) has been ratified by all South Caucasus countries and the Russian Federation.

The most active international agencies funding biodiversity conservation activities within the region are the GEF, WB, UNEP, UNDP, FAO, EU/TACIS, USAID, KFW and the Swiss Agency for Development and Cooperation. In addition, various private foundations such as the George Soros Fund, McArthur Foundation, Eurasia Foundation, ISAR, etc. finance different environmental activities, including biodiversity protection, at national and regional levels. The largest investments so far in the Caucasus have come from the WB and GEF. The WB financed the development of a forestry strategy for Georgia and is now assisting in implementing specific programs under this strategy. GEF funded the establishment of Kolkheti National Park and two other parks, and assisted in capacity building for managing protected areas in Georgia. The GEF provided core support to strict nature reserves in the North Caucasus under the project "Conservation of Biodiversity in Russia" (WWF, 2001). However, donor co-ordination remains a problem for the region, leading to duplication and overlapping of activities, and inefficient allocation of financial resources.

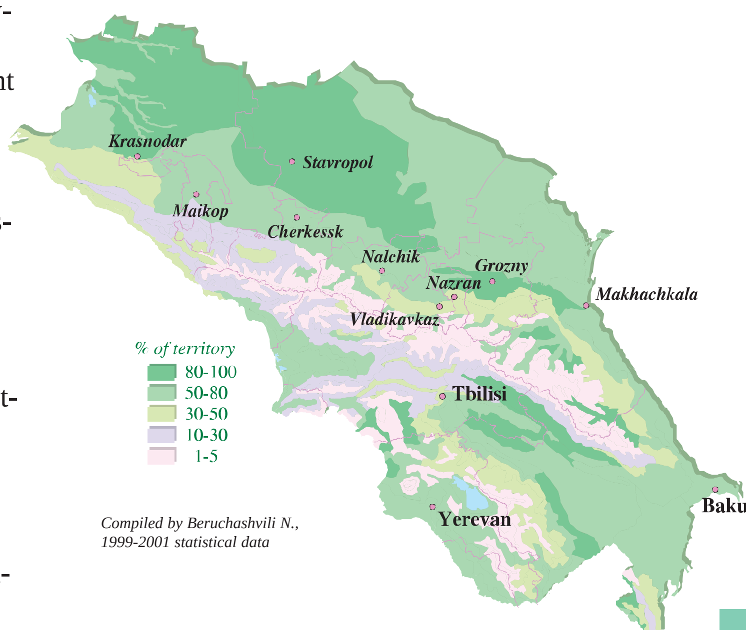
Regardless of the positive changes which have occurred at institutional, legal and policy levels, all the Caucasus entities face similar difficulties of financial, technical, legal and institutional character which make it difficult to implement full-scale reforms in the biodiversity protection and management field. Economic systems and policies still fail to reflect resource scarcity into prices. Institutions are weak and lack knowledge in advanced biodiversity conservation study methods, e.g. Gap Analysis, IBA (Important Bird Areas), etc. and management approaches. For example, in all the South Caucasus countries as well as in the North Caucasus krays and autonomies, most existing protected areas used for in-situ conservation are typical Soviet period "zapovedniks", where all human activities are prohibited. These areas are equivalent to "Strict Nature Reserve," a protected areas management category of IUCN. Other types of protected areas, such as reservations and hunting farms are equivalent to IUCN category VI - Managed Resource Protected Areas. Most of these protected areas were established in order to protect one or several species, based on productivity or potential value criteria, and the majority of reserves are aimed at protecting sub-alpine forests and alpine grasslands. Other unique landscapes are under-represented. Frequently, the boundaries of protected areas are set arbitrarily and are not congruent with natural boundaries. Usually, they conform to land use or administrative boundaries, especially in the North Caucasus (IUCN, 2000).
Although some efforts have been made to introduce new models for biodiversity conservation, e.g. a protected areas system in Georgia, implying the transformation of several reserves into broadly protected area landscapes with different management regimes, selection criteria still tend to be political (it is easier to enlarge an existing reserve rather than to establish new one) and economic (donor's preference and aesthetic value). Criteria such as species rarity, richness, endemism, habitat uniqueness or vulnerability are not taken into consideration. Additionally, very little attention is paid to wildlife management and sustainable use of natural resources outside protected areas.
In general, there is a lack of baseline information on species and their relation to different land use management practices. Because of that, there are no systematic approaches for prioritising national conservation efforts (selection of conservation areas, identification of species conservation status, development of management guidelines for vulnerable species and habitats, policies for sustainable resource use, recovery plans for endangered species, etc.) (Gokhelashvili, Scott, Millington, 2000). The general public is mostly unaware of biodiversity protection issues and public involvement in decision-making processes is very low. There are no incentives for local communities to manage local resources in an environmentally sound manner. Because of that, community-based management practices together with environmentally sound traditional economies have to be encouraged. Finally, regional co-operation has to be strengthened through information exchange, study tours, regular consultations and bi- or multilateral agreements.

## 2.2 Land Resources

### 2.2.1 Land Estate and Land Uses

**Agricultural land use**. The total land area of the Caucasus consists of 44,019,400 ha. Agriculture is a major land use in the Caucasus, amounting to about 54% of total land area. The majority of such lands are located in plain areas. These lands produce almost the entire agricultural output in the Caucasus. The shortage of agricultural lands is particularly acute in mountainous regions.

**Agriculture areas in the Caucasus**



The largest agricultural areas are spread in the Kuban-Azov plain, Stavropol plateau in the North Caucasus, and in the Alazani-Agrichay Valley and Lenkoran lowland in the South Caucasus. There, more than 80% of lands are cultivated. Large agricultural areas are also located in other parts of the Caucasus such as the Kura-Araks lowland, Caspian coastline, the Ararat Valley, Colchian lowlands and foothills of the Greater and Lesser Caucasus.

Most of arable lands in the Caucasus are located in the Kuban-Azov plain, the Stavropol plateau in the North Caucasus, and the Kura-Araks lowland and the Ararat Valley in the South Caucasus.

Traditionally, cultivation of cereals, fodder, fruit, tea, tobacco production and vegetable gardening were major agricultural sectors. Perennial crops occupied the large areas in the South Caucasus: Colchian foothill, Shida Kartli plain, Alazani-Agrichay Valley, Lenkoran lowland and Ararat Valley.

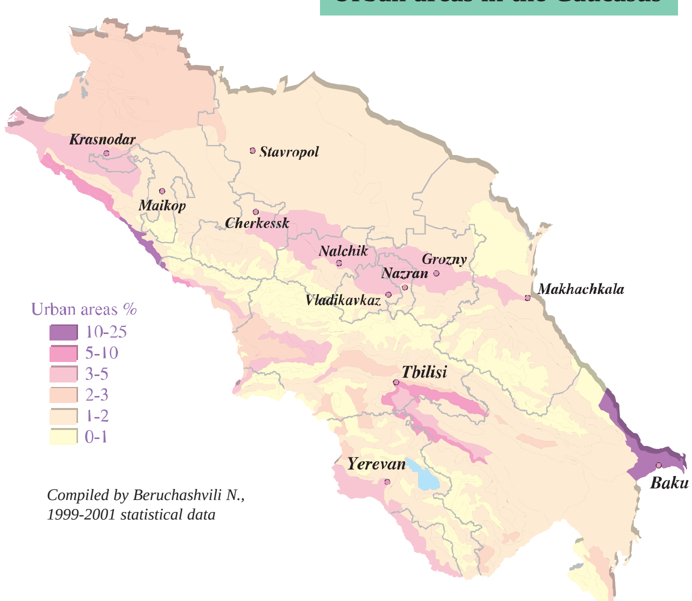
Historically, summer pastures were located in high mountains of the Greater and the Lesser Caucasus and winter pastures mostly in plains of East Caucasus: the Terek-Kuma plain and the Kura-Araks lowland.

In the 1970s and 80s, highly subsidised large-scale collective farms, either for livestock raising or land cultivation, produced the total agricultural output. Increased productivity was achieved by the use of huge quantities of foodstuff for livestock raising, and the intensive use of fertilisers and other agricultural chemicals for crop production.

Since the break-up of the Soviet Union, land use, agricultural production and trade patterns have dramatically changed in the Caucasus region, as in other FSU regions. The break-down of traditional economic ties among the Soviet republics caused the loss of markets for both agricultural inputs (chemicals, food grain for livestock, fuel, machinery and spare parts) and outputs, leading to reduced amounts of arable lands and livestock and hence, a general fall in agricultural output. Large-scale collective farms were no longer sustainable and began to disappear. Individual farmers gradually became the main producers of agriculture output, changing land uses, agriculture practices and adapting to local markets. The natural (subsistence) economy has become stronger in agriculture and brought about increased grazing and hay production. In the South Caucasus countries almost all collective livestock farms have stopped functioning. This had a detrimental effect on pastures near villages, promoting erosion and land degradation of lowlands (IUCN, 2001). It is worth noting that publicly owned large-scale farms have proven to be more long lasting in some North Caucasus republics (Dagestan, etc.) compared to the South Caucasus, where the land privatisation process has fostered the establishment of private enterprises and small farms.

**Urban land use.** In the Caucasus, urban land development is not the major land uses. Urban territories occupy small areas in the region. Major concentrations are the Baku-Sumgayit agglomeration and along the Black Sea coastline from Sochi to Tuapse, where urban areas vary from 10 to 25% of total landscape areas. Urban territories also are Yerevan, Ganja, Tbilisi-Rustavi agglomeration, Kutaisi-Zestaphoni agglomeration, Nalchik, Vladikavkaz, Grozny and Makhachkala and Derbend.

**Urban areas in the Caucasus**



Historically, many environmental problems of the 1970s-80s in urban areas were related to poor town planning/town-building and land zoning system. Environmental considerations were largely neglected during the planning and construction processes. An even less controlled situation exists now. Illegal construction of residential blocks and commercial buildings, even in green zones, are not rare in the cities.

## 2.2.2 Land Degradation and Soil Erosion

Degradation and pollution of land resources rank high among the major environmental issues in the Caucasus region. These priorities are underlined in NEAPs of each country. At present, it remains very difficult to take preventive or corrective measures, since severe budgetary constraints do not allow for planning and/or taking large-scale land reclamation and soil protection measures.

Both natural and anthropogenic pressures contribute to land degradation. Among the natural factors, wind and water erosion, landslides, mudflows, flooding, etc. are important driving forces in the region, since the whole region is prone to active geo-dynamic processes. Among anthropogenic factors, bad agricultural practices (intensive land cultivation, over-use of agricultural chemicals, slope ploughing, intensive irrigation, over-grazing) as well as unsustainable forestry practices, urbanisation and other activities affect land resources.

Soil erosion is one of the most widespread natural phenomena in the Caucasus and is the most dangerous for the republics short in arable lands, such as Georgia and Armenia. Erosion here is connected with climate and relief peculiarities as well as anthropogenic factors: irregular woodcutting, unsustainable irrigation and drainage practices, open-pit mining, intensive grazing, land cultivation (especially on steep slopes), etc. Erosion results in reduction of land fertility and degradation of vast land areas, which not only reduces crop production but also worsens the environment condition.

Erosion is also dangerous for highland meadows and steppes, where surface wash out is

**Caucasus arable lands**


**Caucasus perennial plantations**


**Caucasus pastures**


*Compiled by Beruchashvili N., 1999-2001 statistical data* intensively expressed. It may be presumed that erosion processes are one of the reasons for the degradation of environment in highland zones, where a considerable number of pastures and hayfields are concentrated.

Wind erosion is especially prevalent in the East Caucasus, where the climate is relatively dry and strong winds during cold periods form favourable conditions for wind erosion. It incurs great damage to agricultural lands because in the recent years many windbreaks were cut down. In East Georgia about 1,000 kmsq. of land area is prone to wind erosion (Beruchashvili, 1996).

The total area of eroded lands has been increasing since the 1980s. In Armenia, for example, a 1.9% increase in total eroded area was observed during the last 20 years and the damage from land erosion amounted to 7.5% of the gross agriculture product (UN-ECE/MNP of Armenia, 2000). At present, about 45% of total area is affected by erosion in the country, and of these, agricultural lands account for about 60% (UN-ECE/MNP of Armenia, 2000). Annual loss of fertile lands makes up 8 million tons and more than 80% of arable lands experience erosion of different types (MNP of Armenia, 2001; UNDP, Armenia 1999).

In Azerbaijan, about half of the total land area is affected by erosion (State Committee of the Azerbaijan Republic on Nature Protection, 1993). Nearly 35% of agricultural lands are susceptible to water and wind erosion in the country. (UNDP, Azerbaijan, 1999). In result of water activity over 516 m3 of land per each hectare is influenced by erosion annually (UNDP, Azerbaijan, 1998).

In Georgia, over 20-year period, the area of eroded lands reached 1 million hectares, 33% of the entire area of the republic (Tsereteli, 1987). At present, there are more than one million ha of eroded lands in Georgia, 380,000 ha are arable lands and 547,000 ha are pastures and hayfields. In the 1980s it was only 300,000 hectares, from which 200,000 hectares experienced water erosion, and 100,000 hectares wind erosion. About 87,000 ha along the Black Sea coastal zone have been eroded by rivers, where the riverbanks are not protected (MoA of Georgia, 1998). Soil erosion is a very serious problem in the North Caucasus as well. In Kabardino-Balkaria, for example, about 56% of agricultural lands are subject to wind and water-induced erosion, and during last 15-17 years the area of eroded lands has more than doubled (IUCN, 2000). Geo-dynamic processes together with bad agricultural practices (slope ploughing and overgrazing) and intensive logging are underlying reasons for severe land erosion in the region. The problem is aggravated by the fact that protective measures against wind and water erosion, like the construction of windbreaks, are not taken due to the lack of finances.

Technogenic activities such as open-pit mining operations also have adverse effects on land resources, causing land degradation and depletion. For example, in Krasnodarsky Kray, according to 1999 data, about 2,801 ha of degraded mountain land and 1,498 ha depleted land were registered, brought about by extraction of different types of construction materials, facing and coloured stones, as well as gas and oil operations (IUCN, 2000).

Soil salinization is another major issue pertaining to land resources in the Caucasus region. Soils in dry steppe and semi-desert zones in the region are naturally saline. Hence, cultivated soils in such zones need intensive irrigation and drainage. Unfortunately, since the break-up of the Soviet Union the total area of irrigated lands has been declining in the region. For example, in Armenia, irrigated areas have declined from 311,000 ha in 1985 to 280,000 ha in 1995 and 217,000 ha in 2000 (UN-ECE/MNP of Armenia, 2000).

In the region, most irrigation systems are inadequately lined. In addition, they are not properly maintained and need major repairs and/or replacement. Water losses are high, although it is impossible to give exact numbers, and contribute to an increase in the water table and hence, soil salinization. Regretfully, the countries lack finances to rehabilitate the systems or plan for new irrigation projects. Irrigation systems need in proper drainage as well, without which water logging and secondary soil salinization can occur. Many irrigation systems in the Caucasus region do not have drainage systems or have inefficiently operating ones. The systems were destroyed during the last decade and there is a lack of funds to repair or rehabilitate them. Thereby, the secondary salinization of soils is a serious problem at present. In Armenia, for example, salinised soils occupy approx. 42,000 ha in the Ararat Valley. According to the Azerbaijan NEAP, for example, about 1.2 million ha are affected by salinazation (State Committee on Ecology and Control of Natural Resources Utilization, Baku, 1998; UNDP, 2000). About 8.8% of the total area in Krasnodarsy kray suffers from salinization (IUCN, 2000).

Construction of large dams and reservoirs without due consideration for physico-geographic and environmental characteristics, also causes soil salinization and flooding. For example, the building of Krasnodarsky reservoir resulted in the water table rise and hence, salinization and flooding of large territories in Krasnodarsky Kray (Ministry of Environment and Natural Resources Protection, 1998).

The problem of salinization is also very acute in Caspian Sea coastal areas as well. Sea-level rise in recent years, for example, caused a rise in mineralised ground water above the critical level and the flooding of thousands of ha of agricultural lands in coastal areas of Dagestan (IUCN, 2000).

### 2.2.3 Soil Pollution

Soil pollution is a serious concern for the Caucasus. During the Soviet era, such pressures as intensive use of mineral fertilisers and agricultural chemicals together with industrial activities, mining, oil and gas operations, traffic emissions, and the dumping of municipal and toxic solid wastes affected the soil quality in both urban and rural areas.

Presently, despite the general decline in use of agrochemicals, the problem of soil pollution still exists. First, agro-chemicals do not easily degrade and heavy metals are still accumulated in soils. Second, the uncontrolled import and use of fertilisers and chemicals by individual farmers pose a threat to environmental quality, along with obsolete pesticides stored in inadequate warehouses. In Georgia, for example, about 400 tons of obsolete pesticides and 3,500 tons of mineral fertilisers are stored in warehouses that do not meet health and environment requirements (TACIS/MoE of Georgia, 1998). In Krasnodarsky kray up to 1,000 tons of obsolete pesticides are stored (Ministry of Environment and Natural Resources Protection of the Russian Federation, 1998).

There are limited data on soil pollution by agrochemicals. Historically, the Hydrometeorological Services (HMSs) in the Republics conducted soil sampling and analysis. Measurements were sporadic and the methods of sampling and analysis employed by HMSs might include unacceptable errors. For example, in Armenia, 3,560 soil samples were taken in 1977-1983 from arable lands and orchards, and only 21 samples showed high pesticide concentrations. High concentrations of DDT and DDE were found in 20% of soil samples taken from arable lands of the Ararat Valley (UN-ECE/MNP of Armenia, 2000, UNEP/MNP of Armenia, 2000). Similar studies conducted in Georgia have not revealed an excess of allowable concentrations (TACIS/MoE of Georgia, 1998). In Azerbaijan, the State Sanitary and Hygienic Service toxicological laboratory studied approximately 2,819 food and soil samples from 1988-91. The residual quantity of pesticides was found in 7% (184) of these samples and of these, limits were exceeded in 96 cases (State Committee of the Azerbaijan Republic on Nature Protection, 1993). Studies conducted in Krasnodarsky kray show that nitrates pollute about 4.1% of Kray's territory, and pesticides at a level from "moderately dangerous" to "dangerous" (IUCN, 2000).

Soil pollution by heavy metals and oil products is a concern in urban and industrial areas. Heavy metals and oil products released into all environmental media from specific industrial activities, mining operations and fuel combustion, pose a high threat to environmental quality. Before the transition, road traffic accounted for about 60% of soil pollution in urban areas. At present, this figure exceeds 85%, since industries work at a minimum level. In Georgia the cities of Tbilisi, Rustavi, Kutaisi, Zestaphoni, Chiatura and Batumi, which have a high concentration of heavy industry, steel, manganese, ferro-alloys, machinery manufacturing and oil refinery plants, etc. and heavy traffic were mostly affected. Additionally, copper and gold mining operations in Kvemo Kartli region were heavily polluting soils. In Armenia, about 30,000 ha of land is polluted by copper, lead and molybdenum due to mining operations in Northeast Armenia. The city of Yerevan is heavily contaminated. USAID studied soil samples from the area surrounding a thermopower utility and found contamination by polychlorinated biphenyls (UN-ECE/MNP of Armenia, 2000). In Azerbaijan, urban lands in Sumgayit, Baku, Ganja, Alybairamly and Mingachevir are the most polluted. Sumgayit is severely polluted by mercury used in chlorine-alkalin production. During the Soviet period, the mercury loss amounted to approx. 1-2 kg/ton per unit output. At present, the figure is about 300 kg/ton of chlorine produced. The soil is heavily contaminated through toxic waste dumping and air deposition (State Committee on Ecology and Control of Nature Resources Utilization, Azerbaijan, 1998). In addition, copper, lead and zinc mines in Azerbaijan cause soil pollution with heavy metals. Intensive oil and gas operations pollute the soil with oil products. The North Caucasus republics and Azerbaijan, with well-developed oil production and petrochemical industries, suffer the most. Soil contamination with oil products, for example, is extremely high in the Absheron peninsula. There, in the 1980s and 90s average soil oil content in the 0-5 centimetre gradient regularly exceeded background levels (100 ppm) up to 56 times (Ministry of Environment and Natural Resources Protection, Russian Federation, 1994). Overall, about 10,000 ha of land are heavily contaminated with oil products (State Committee on Ecology and Control of Nature Resources Utilisation, Azerbaijan, Baku 1998). In Grozny, Chechnya, soil oil content in the 20-centimeter gradient was varying from 1,200 ppm in 1986 to 2,470 ppm in 1990, with 50-ppm trace level (Ministry of Environment and Natural Resources Protection, Russian Federation, 1994). At present, in Chechnya many unlicensed and uncontrolled firms extract small quantities of oil and sell it to neighbouring countries, completely neglecting environmental considerations during mining operations.

### 2.2.4 Policy Measures

During the Soviet era, all the lands were public property and belonged to the "United State Land Fund." The Land Fund was divided into several categories based on land use: agriculture, state forestry farms, state land fund, non-agricultural lands (industrial areas, resorts and urban areas, etc).

Many of land-related problems of the 1970s and 1980s were caused by poor land use planning. Land use planning was a part of central planning system consisting of strictly centralised territorial and sector planning. The planning was conducted at all-union (central) and national levels. State Planning and Building Committees ("Gosplan" and "Gosstroy" respectively) with subordinated branches in the Soviet republics, were the responsible bodies at the central level. In addition, similar national bodies operated in the sister republics. The State Planning Committee developed master plans for the entire Soviet Union and provided the major territorial planning guidance for national republics. This agency also worked out short to long-term sector development and industry distribution plans for the entire Soviet Union. Based on these plans, similar national bodies developed national branch development plans.

In essence, the Soviet planning system was ineffective. There was no coordination between industrial planning and land use planning, local conditions were ignored, and many plans were infeasible. Master plans for urban development were based on uniform approaches and characterised by under-valuation of land, lowland development at the expense of agriculture lands and green zones, intensive industrialisation, monotonous housing projects etc.

Following their independence, all of the NIS countries, including South Caucasus states and the RF, began developing national legal-institutional capacities. In the land resources management field, new land codes, providing land classification according to planned uses, and rules and procedures for land ownership, etc. were adopted. Environmental media-specific statutes on soil protection were also passed in some of these countries.

At present, land resources management and protection responsibilities are widely spread among different agencies and the scope of work of these agencies varies on a country-by-country basis. In Armenia for example, the Ministry of Nature Protection is responsible for land resources protection. The Ministry of Agriculture is responsible for planning and management of agricultural land resources. At the same time, the State Committee of the Real Property Cadastre under the Government of Armenia is responsible for the planning and management of all lands other than agricultural. These three agencies are all responsible for some aspect of land resources planning and management. They develop regulations and general policies for land resources planning and management. The Ministry for Environment conducts monitoring of land use and is responsible for inventory of lands affected by geodynamic processes. In Georgia, the State Department for Land Resources Management and the Ministry for Environment, specifically the Department for Waste Management and Land Resources Protection, are the key agencies in land planning and management. Both of these agencies are engaged in the development of regulations and general policies pertaining to land use; soil protection from erosion and contamination, etc. Whereas the MoE is responsible for the inventory of degraded and contaminated lands, the State Department for Land Resources Management is responsible for the control over privatised and leased lands and land tenure, etc. Agriculture Ministries also play key roles in protecting and monitoring of agricultural lands. Other agencies (health ministries and their sanitary-hygiene oversight services, hydro-meteorological services, forestry departments, etc.) are also involved in land-related activities in all the South Caucasus countries. City planning is conducted by the Ministries/Departments of Urbanisation and Construction and the managerial functions are the responsibility of city municipalities. In the North Caucasus autonomies, federal, republican and local authorities carry out land-use planning and management activities. In krays, kray-level administrations are the key authorities. In some of the parts of the Caucasus, where the state legal-institutional system is weak or absent and where a long tradition of nature use exists, local communities play a significant part in land resources management.

Overall, all agencies in the land planning and management field experience similar financial and institutional difficulties, as do others involved in environmental and natural resources management. Current legislation is imperfect, especially in the field of land ownership, spatial planning and zoning, etc. Town planning practices are still based on Soviet approaches and do not reflect modern urban concepts or the special nature of transitional economies. Whereas various state plans, programs and projects pertaining to land resources management do exist, financial and implementation mechanisms are lacking or absent.

The South Caucasus and Russian NEAPs identify priority issues pertaining to all environmental fields, including land resources, and suggest legal-institutional and investment measures for solving these issues. Some of these activities are currently being implemented. For example, Armenia has developed the Agro-biodiversity Program aimed at conserving and using wild species, analogous to cultivated ones. The country also has a Program for Land Restoration as well as a National Agrarian Policy. In Georgia, GTZ, WB, UNDP, etc. funded the land estate registration project, aimed at establishing a modern user-oriented state system of land tenure by using advanced remote sensing and GIS technologies. All South Caucasus countries are parties to the UN Convention to Combat Desertification, and the first national reports have been delivered under the Convention. Currently, the countries are in the process of developing national programs against desertification and building up institutions under that framework.

Nevertheless, there are some concerns that the funded programs/projects will never be carried through, since most of them do not include sustainability components for further financial and technical resources. In addition, each of the donor organisations uses its own criteria and methodologies and has little co-ordination with other donors. For example, several donors implementing land registration programs in Georgia use different methodologies and data collection protocols that may lead to the establishment of inconsistent and incompatible land information systems within the country.

## 2.3 Forestry Resources

### 2.3.1 Caucasus Forests

The Caucasus is rich in forests. The total area of forests comprises 73,200 kmsq. or 17% of the total land area. From the total area of forests, one should distinguish the area of the "State Forestry Fund (Estate)". It occupies a vast territory and amounts to 87,100 km sq. Apart from forestlands, it also consists of glades, small arable lands, hayfields, pastures, transport and communication right-of-ways, etc.

Most Caucasus forests are located in mid-mountain zones at altitudes of about 500-2,000 meters and grow on steep slopes. There are also lowland and riparian forests. Broad-leaved forests dominate the region, representing 93% of Armenian forests, 83% of Georgian forests and 98% of Azerbaijani forests. The most important are the relic forests of the Tertiary era, located in the Caspian Sea coastal zone and Tallish Mountains, and the coastal temperate rain forests in southwestern Georgia. Well-expressed vertical zonality and climate variations determine the existence of several types of forests, such as oak forests, beech forests, hornbeam forests, birch forests, dry scrub juniferous forests and coniferous forests, with dominating species of fir, spruce and pine. Riparian forests consist of alder, lowland oaks, wing nut, etc.

**General data on the Caucasus forests**

| Country/Region | Total area Thousand ha | Percentage share | Timber volume mln $m^3$ | Registered woodcuts mln $m^3$ |
|---|---|---|---|---|
| *Armenia* | 450 | 15.1 | 45 | 0.054 |
| *Azerbaijan* | 1 214 | 14.0 | 113 | 0.045 |
| *Georgia* | 2 773 | 39.8 | 452 | 0.423 |
| *Russia (N. Caucasus)* | 2 883 | 11.4 | 520 | - |
| Total Caucasus | **7 320** | **20.1** | **1 130** | - |

*Source: Statistical services of Armenia, Azerbaijan, Georgia and Russian Federation, 2000*

Georgia has a relatively high percentage of forestlands, though it significantly lags behind other countries rich in forests. Forests cover is nearly 40% of Georgian territory. The North Caucasus exceeds Georgia in total area of forests (28,830 kmsq.), but has very low percent of forestland at 11.4%. Azerbaijan has forests 14-15% of its territory. In Armenia only 10% of total land area is covered by forests, while the State Forest Fund is almost 15%.

The total supply of timber makes up 1.130 million $m^3$. The overwhelming part of the supply (86%) comes from Georgia (40%) and the North Caucasus (46%). Azerbaijan supplies about 10% and Armenia only 4%.

Both timber supply and forestlands within the countries vary largely depending on physical and geographical conditions, agricultural development, and proximity to urban centres. In the North Caucasus, for example, forestlands vary from 6% in Stavropol kray to 23% in North Ossetia.

In the South Caucasus, much of the forest area is characteristic of the regions of the Greater and Lesser Caucasus. A small amount of forestland is in intermountain depressions, connected with the intensity of agricultural activities in the west and central part or with semiarid and arid conditions in the east. The Javakheti-Armenian Highlands, due to continental conditions, relative aridity of the climate and relatively high altitudes, has little forest cover.

### 2.3.2 Dynamics of Forest Cutting

Analysing the dynamics of forestry estate over the last 30 years is difficult. The statistics allow one to analyse only the change in total area of the State Forestry Estate. This area changed not so much due to logging, but due the transfer of territories from one agency to another in the former Soviet Union. In addition, different criteria for designating territories as forests were set in the countries of the South Caucasus following the dissolution of the Soviet Union. In Armenia and Azerbaijan, the area of the Forest Estate increased because some territories with shrubs were added to it.

Thus, data on forest estate area dynamics do not express the real picture. Neither does official data on timber supply dynamics.

Statistical yearbooks contain data on woodcuts. These data, however, are very tentative, since after the dissolution of the USSR illegal wood-

**Caucasus forests**

cutting has sharply increased. There are practically no data on the amount of this woodcutting.

Reforestation activities were conducted during Soviet times. Annually, trees were planted in the forests of the 50-60 thousand ha area. In the 90s, this was halted. However, the area of forests in some regions (e.g. in Racha, Georgia) began to increase naturally in connection with the depopulation of these regions. Pines and other aggressive, rapidly growing timber species occupied the places of former arable lands, increasing forested lands in such areas by 5% to 6%.

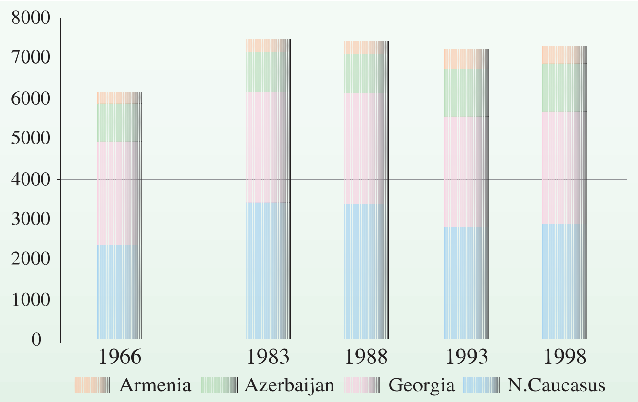
The World Bank (2001) attempted to find out the dynamics of the forest cover in the central part of the Caucasus based on comparing aerial photos made from Landsat in 1989 and 2000. The results of comparing these pictures showed that changes in the forest-covered area are not high. The most intensive cutting was noticed in the Bakuriani, Adigen and Khaishi regions. On the rest of the territories, the data on forest cover are not essential. Do the data of the aerial photos reflect a real situation? Usually, most of Caucasus forests according to Soviet regulations belonged to the I and II categories and woodcutting was fully or partially banned there. These regulations still exist even now on the countries of the South Caucasus. If now any woodcutting is conducted, it is illegal. Aerial photos show just these territories.

In recent years, selective cutting occurred in the Caucasus, when the highest quality trees were cut. During the last ten years cutting was extensive on the Saguramo-Yalon range (East Georgia), and on the outskirts of Tbilisi and Yerevan. In the forests of the state forest fund, there were no significant changes in the total forest cover, but all valuable specimens of beech and some other species have been cut. This resulted in a drastic reduction in forest quality. For example, it is estimated that over the past ten years 26% of beech forests were converted to coppice forests and only about 10% of the beech forests left have high density in Armenia. Oak forests are in the most critical condition. Mature and over-mature trees accounted for 31.3% of oak forests. The current age structure of forests (average age - 90 years, pre-mature trees amount only for 6.5% of total) also has a negative impact on the future development of forest resources (UNEP/MNP of Armenia, 2000). In Georgia, as a result discriminate logging, forest density has been significantly reduced: 0.5 and lower density groves occupy 1149.8 thousand hectares (53%); groves of average (0.6-0.7) density occupy 932.8 thousand hectares (43.0%) and groves of high density (0.8 and more) occupy only 86.8 thousand hectares (4%). It is quite clear that the area of high-density forests have been considerably reduced (WB/State Forestry Department, Georgia, 1997).

For the last ten years, the largest amount of cutting has taken place on former collective farms that had no owners following privatisation. The situation in these regions is critical. Cutting of green zones was particularly severe around urban areas of Armenia and Georgia in early 1990s, where population was forced to use forests for fuel wood because of an energy crisis. Consequently, environmental situation in these settlements has substantially worsened. In Yerevan, for instance, about 60-80 thousand trees were cut down, though they could have significantly improved the ambient air quality by absorbing and neutralising air emissions (UNEP/MNP of Armenia, 2000).

Uncontrolled grazing in forest areas is also common practice at present. This itself causes the destruction of biodiversity of underbrush woods, endemic and relic species being the

**Number of forest fires in the Caucasus, 1966-96**




*Source: State statistical services of Armenia, Azerbaijan, Georgia and Russian Federation, Year Books, 1970-2001*

most vulnerable among them. As a result, underbrush fauna migrated from their habitats and less valuable brushes began to expand.

During recent military conflicts in Chechnya, Georgia and Azerbaijan, bombing, forest fires, clear cutting for heavy military equipment have damaged the forest cover. Out flows of refugees and depopulation of the regions have reduced human pressures and created good conditions for forest regeneration.

To sum up, the problem of deforestation has not been so acute for the Caucasus as in some tropical countries, where over the last thirty years the forest cover has been considerably reduced. Overall, the area of forest cover in the Caucasus has been more or less preserved during the past 30-year period. Nevertheless, in recent years the territories near urban areas or where forest exploitation is promoted either by natural factors (easy access) or good opportunity for illegal timber export (e.g. in the Lesser Caucasus near the customs with Turkey) the forest cover structure has changed significantly. Valuable specimens of timber have been cut, and forest quality reduced.

In addition to anthropogenic activities, fires have a considerable influence on the forest cover. Nevertheless, in case of the Caucasus, the forest fires are not so common as in Siberia and Far East, for example.

Do the changes in forest cover have serious environmental impacts? Where full-scale cutting is going on there is a danger of erosion. However, still, the area of re-eroded slopes within the scale of the entire Caucasus is not so large, though in some individual cases it is of critical importance. Forest estate of the Caucasus, over last 30 years was subject to moderate changes and, thus its ecological function as the "natural lungs of atmosphere" has been preserved overall. This cannot be said of its aesthetic value, which has been sharply reduced due to unsustainable woodcutting practices.

### 2.3.3 Forestry Policy

Before the break up of the Soviet Union, uniform forestry policy was conducted in the Caucasus. All forests were public property and belonged to the "State Forest Fund" (estate). Forests were divided into various categories. Those of national importance were managed by central and local branches of the Ministry for Forest Management ("Minleskhoz"), while city forests were managed by different sectoral bodies. Other categories included forests of reserves and sanctuaries and forests of collective farms.

According to Soviet legislation, the forests fell under three categories based on their location and function. The first category forests had water regulation, soil protection, sanitary-hygiene and recreational functions. Forests of special importance, such as national parks, state reserves, reservations, etc. also belonged to this category. The second category consisted of the forests located in densely populated areas with protective and some commercial value, along with forests belonging to collective farms. The third category included the forests designed purely for commercial cutting, which served as a state forest stock. Different regimes of resource use and management were applied to these three categories of forests.

Forest cutting was usually conducted for general use (commercial cutting) and regeneration purposes (sanitary cutting). Commercial cutting was conducted when trees reached certain levels of maturity and three types of felling were used: clear-cutting, discriminate and rotational. Sanitary cutting, on the contrary, was conducted at any growth stage.

Commercial logging was not so extensive in the Caucasus, because the most forests there were managed for conservation and protection purposes and were classified as first category forests, where commercial logging was prohibited. Significant stocks of forests in Siberia and central and northern parts of the USSR were used to export timber to the Caucasus.

According to forestry regulations, all high forests were subject to natural regeneration. Reforestation was conducted annually. Special large-scale reforestation programs were implemented resulting in thousands of hectares of land area planted with new trees. For example, large quantities of trees, predominantly pines, were planted around the city of Tbilisi. These areas were practically bare at the beginning of the 20th century.

However, practices such as selective and unsustainable cutting have led to degradation of forest resources in the Caucasus. In addition, weak legal-institutional frameworks for enforcing existing legislation has hindered the effective implementation of existing rules and regulations on the use and protection of forestry resources.

In the early 1990s, each of the South Caucasus countries began to develop and implement independent national policies. Although some efforts have been made to introduce new policies and management practices, traditional forestry practices remain widely in use. New forestry codes and national strategies have been developed and adopted. Grant programs and projects have been implemented through financing by donor organisations, the World Bank being the major donor. The main goals of these projects are to establish forestry systems similar to those of western countries.

Despite this, the forestry sector in the Caucasus countries faces serious economic, institutional and technical problems. Frequently forest management and protection efforts are duplicated by different agencies. Law enforcement officers lack the capacity to detect violations and act appropriately. Most importantly, there is a lack of current data on forest resources and thus, a forest inventory needs to be conducted and modern resource monitoring and inventory systems established.

## 2.4 Fresh Waters

### 2.4.1 Water Balance

Caucasus rivers belong to the basins of the Black, Azov and Caspian seas. In 70% the territory of the Caucasus, water drains into the Caspian Sea. In terms of flow volume, the first place (56%) is occupied by the Black-Azov seas basin, located in the western part of the Caucasus where precipitation is more plentiful. The major data on main rivers of the Caucasus are given in the table.

**General data of the Caucasus major rivers**

| | River | Lenght km | Basin drainage area, m$^2$ | Average discharge m$^3$/sec | Basin height m |
|---|---|---|---|---|---|
| *Caspian Sea Basin* | **Araks** | 1 072 | 102 000 | 210 | 3 400 |
| | **Kura** | 1 364 | 188 000 | 575 | 2 100 |
| | **Sulak** | 332 | 13 400 | | 3 580 |
| | **Terek** | 600 | 43 700 | 302 | 3 199 |
| *Black Sea Basin* | **Chorokhi** | 438 | 22 130 | 307 | 1 800 |
| | **Enguri** | 213 | 4 060 | 170 | 3 050 |
| | **Kuban** | 906 | 57 800 | 425 | 3 080 |
| | **Rioni** | 327 | 13 400 | 405 | 2 800 |

*Source: Caucasus Water Balance, 1991. Water Resources of the Trans-Caucasus, 1988*

The annual average flow of the Caucasus rivers fluctuates between 1,000-2,000mm (Ajara and the Greater Caucasus) to 50mm and lower. A small amount of flow is characteristic of the Kura-Araks lowland, the Caspian lowland, the Stavropol upland and northern part of the Kuban plain. The middle mountains have a flow from 600 to 1,000 mm and low mountains from 200 to 600 mm.

**Water resources of the South Caucasus**

| Country | Area of water collection 1000 km$^2$ | Country area 1000 km$^2$ | Local flow km$^3$ | Inflow km$^3$ | Total resources km$^3$ | Outflow km$^3$ |
|---|---|---|---|---|---|---|
| *Armenia* | 59.2 | 29.8 | 5.63 | 2.08 | 8.32 | 7.71 |
| *Azerbaijan* | 217.9 | 86.6 | 7.72 | 19.4 | 28.1 | 19.7 |
| *Georgia* | 99.3 | 69.7 | 51.9 | 8.67 | 61.45 | 60.61 |

*Source: Caucasus Water Balance, 1991. Water Resources of the Trans-Caucasus, 1988*

The outflow is connected with evaporation. The amount of aggregate evaporation depends on evaporation and amount of precipitation. The amount of precipitation in the Caucasus fluctuates from 1,000 to 100mm. The greatest amount of evaporation occurs in places with a humid and warm climate. Insignificant amounts of evaporation are found either on the territories with arid climate or in highland regions with low air temperature. The table shows elements of water balance in three South Caucasus countries.

**Water balance in the South Caucasus**

| Country | Precipitation km³ | Total flow km³ | Surface km³ | Evaporation km³ | Underground flow km³ | Infiltration km³ |
|---|---|---|---|---|---|---|
| *Armenia* | 17.4 | 6.24 | 2.34 | 3.9 | 11.2 | 9.77 |
| *Azerbaijan* | 35.1 | 7.81 | 4.81 | 3.0 | 27.3 | 14.8 |
| *Georgia* | 93.3 | 52.8 | 31.1 | 21.7 | 40.5 | 45.6 |

*Source: Caucasus Water Balance, 1991. Water Resources of the Trans-Caucasus, 1988*

Overall, the Caucasus is not rich in lakes. Sevan is the largest lake in the Caucasus with an area of 1,416 km sq. It is followed by Manich-Gudilo (800 km sq.) and a few coastal salt lakes of the Azov Sea. Wetlands in the Caucasus are found in the Colchian Lowland and in the deltas and floodplains of large rivers, where hydrophilic conditions prevail.

### 2.4.2 Water Availability and Use

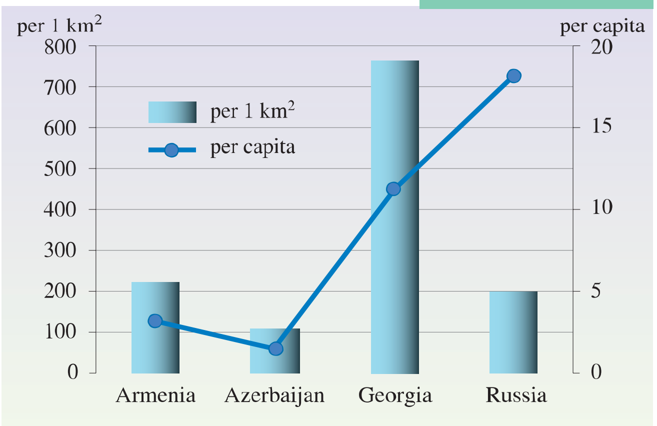
The unequal distribution of regional water resources in the Caucasus causes problems with water allocation in the region, especially in the Kura-Araks river basin. In the future, this problem may become the source of regional conflict. For example, while Georgia is the richest country in water resources among the South Caucasian countries, Azerbaijan suffers from water shortages the most.

Historically, major users of fresh water resources were agriculture, industry and households in the Caucasus region. Usage for hydropower generation and recreation was also significant. Agriculture's share of total use was higher than that of households and industry. The industrial sector used the least amount in most parts of the regions.

Inefficient water use practices were common to the region. Only a small percentage of water was recycled and/or reused. Water losses in irrigation and water supply systems were high in the 1980s. In Georgia and Azerbaijan, for example, losses in irrigation systems amounted to 29% and 33% in 1988 respectively (State Committee of the USSR of Nature Protection, 1989). Regardless of legal water quantity limits set for each enterprise, water over-consumption was frequently detected. In Azerbaijan, for example, 14 out of 17 enterprises for which the legal limits were set exceeded these limits by 18 million cubic meters; in Armenia 14 out 25 enterprises exceeded existing limits by 16 million cubic meters; and in Georgia 14 out of 22 enterprises exceeded their limits by 15 million cubic meters in 1988. Reportedly, regular water over-consumption was related to the lack of water meters (State Committee of the USSR on Nature Protection, 1989).

After the break-up of the Soviet Union, total water use has significantly decreased due to the general economic decline. In Azerbaijan, for example, water abstractions declined from 16,176 million cubic meters in 1990 to 11,968 cubic meters in 1999 (UNDP, Azerbaijan, 2000). Of the major uses, industrial usage has dropped the most dramatically and the domestic

**Availability of regional water resources (1000 m³ per year)**



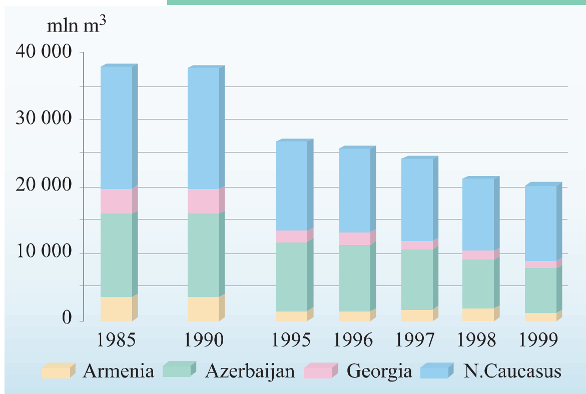

Source: HDR, Azerbaijan, 1999

usage the least. The fall in industrial water usage was more drastic in Armenia and Georgia, where due to the loss of markets for industry inputs and auxiliary parts, the sector has virtually collapsed. In the Russian Federation and Azerbaijan many industries continue to function. Therefore, the patterns of water usage have not changed very much in most of the North Caucasus republics and krays as well as in Azerbaijan.

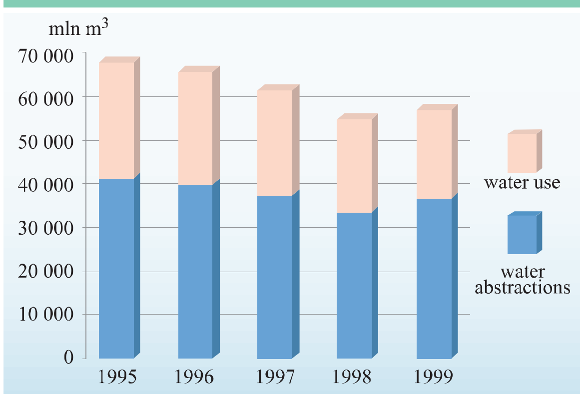
For the last decade, the Caucasus countries have faced problems related to potable water supply. This was underlined in all NEAPs. Although almost all major cities of the Caucasus have centralised water supply systems, existing water supply volumes do not meet the demands of rapidly growing urban populations. The systems themselves are inefficient, having high losses. Many rural areas do not have central water supply systems, or if such services exist, they do not operate. Hence, the rural population is urged to use water from rivers or artesian wells that might be contaminated. Existing water supply systems and intake facilities are out of date and insufficient to satisfy current demands. Lack of funds precludes repairing and expanding existing facilities or building new ones.

Over decades, uncoordinated sector-based uses of water resources, traditionally practised in the region, posed a threat to the hydrology and chemistry of downstream waters and foster the degradation of biota, nurtured in these waters. Building of large-scale dams, without providing paths for fish, had a negative impact on fish populations, greatly reducing fish stocks. For example, intensive water abstraction from the Terek River for irrigation uses, the lack of paths for the sturgeon populations in Kargalinsky dam, and non-attainment of minimum required discharges amounting to 80-100 m3/s for fish population in spring times affected fish breeding and has led to a significant reduction in Dagestan's sturgeon population (Ministry of Environment and Nature Resources Protection, Russian Federation 1996). A similar situation exists in the Azov and Black Sea basins.

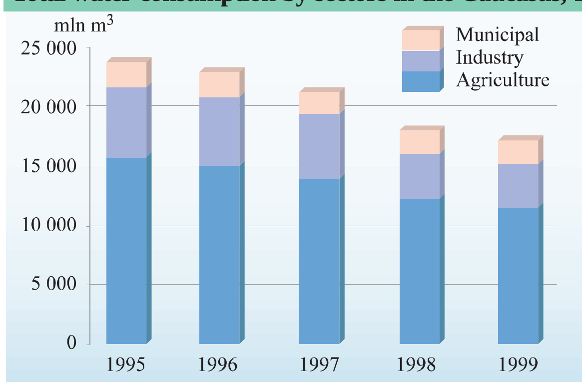
**Total Water Use in the Caucasus, 1985-99**




**Total water abstractions and uses in the Caucasus, 1995-99**




**Total water consumption by sectors in the Caucasus, 1995-99**

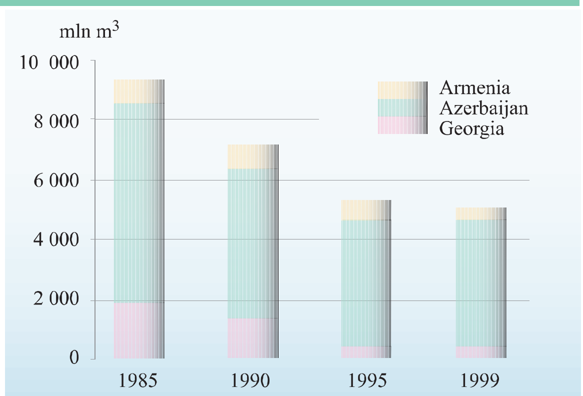



*Source: State statistical services of Armenia, Azerbaijan, Georgia and RF, Year Books, 1970-2001*

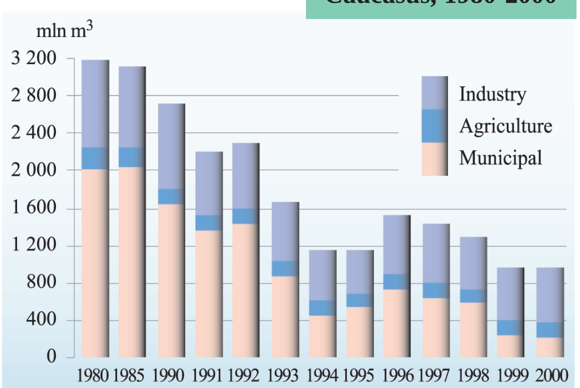
### 2.4.3 Surface and Ground Water Quality

Water quality is one of the major environmental concerns in the Caucasus. During the Soviet era, large volumes of effluents were discharged into surface water bodies from municipal, industrial and agriculture sources, causing pollution of both surface and ground waters. The largest sources of point source pollution were municipal wastewaters, which polluted rivers downstream of large cities with organic matter, suspended solids, surfactants, etc. Industrial waste-water discharges also were high, polluting surface waters with heavy metals, oil products, phenols and other hazardous substances. In Georgia, for example, large industrial facilities producing manganese, ammonia, machinery, etc. together with arsenic, copper and gold mining and processing plants, oil refineries and power plants polluted the river bodies of the

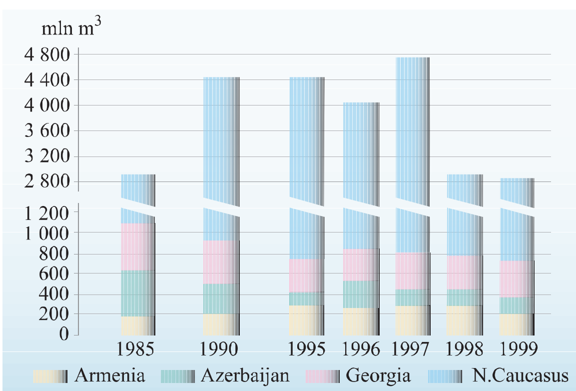
**Total waste-water discharges in the South Caucasus, 1985-99**




**Waste-water discharges from major sectors in the South Caucasus, 1980-2000**




**Untreated waste-water discharges in the Caucasus, 1985-99**




*Source: State statistical services of Armenia, Azerbaijan, Georgia and RF, Year Books, 1970-2001*

Black and the Caspian Sea basins with heavy metals, oil products, phenols and other toxic substances. In Armenia and Azerbaijan, different industries also discharged high loads of pollutants into the Kura and Araks Rivers and their tributaries. In the North Caucasus, one of the major concerns was the contamination of the Terek River and its tributaries from non-ferrous industries (Ministry of Environment and Nature Resources Protection, Russian Federation 1996). Heavy metals, oil products and phenols also heavily polluted the Kuban River. For example, in the late 1980s in the Kuban River, ambient concentrations of oil products and copper were 5-7 times as high as existing surface water quality standards (State Committee of the USSR on Nature Protection, 1989). Agriculture run-off discharged heavy loads of nutrients, suspended solids and pesticides into surface water bodies, causing eutrophication of rivers and lakes and the loss of biota. Lake Sevan, for example, suffered seriously from heavy loads of nutrients from agriculture. About 800,000 tons of 34 types of fertilisers were used in the 1980s in the Lake basin (UN-ECE/MNP of Armenia, 2000). Agricultural run-off from nearby arable lands and livestock farms discharged heavy loads of P and N and organic matter into the lake, changing its status from tropic to almost eutrophic. Therefore, its physical-chemical balance was destroyed, leading to eutrophication and the loss of valuable trout populations. In the North Caucasus, the Rivers the Kuban also was highly polluted with biogenic substances (Ministry of Environment and Nature Resources Protection, Russian Federation 1996).

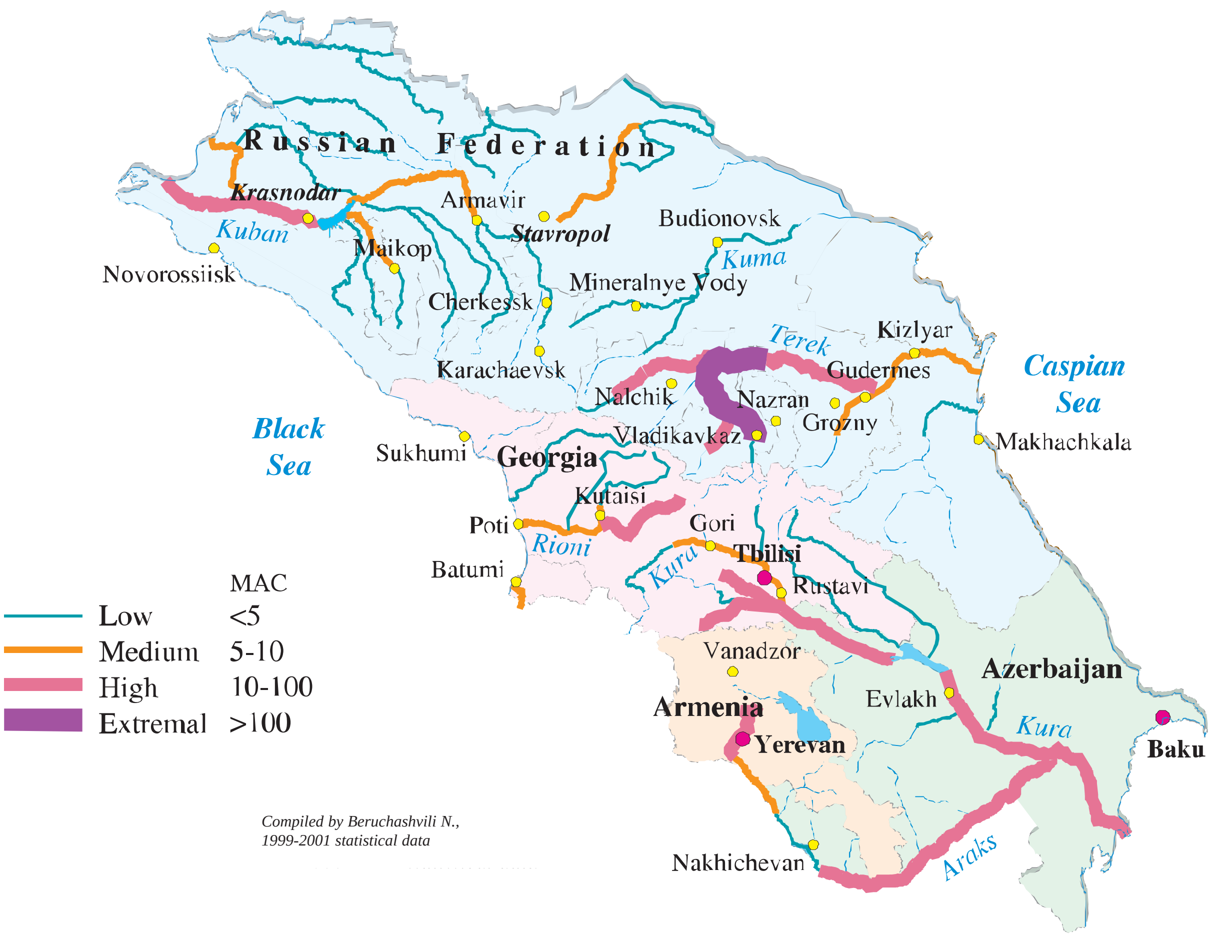
Diffused sources of pollution, other than agriculture run-off, drainage waters from legal landfills and illegal dumpsites and open-pit mining operations, etc. as well as urban run-off also posed high threat to surface and ground waters. In Armenia, for example, the Debed River, a tributary of the Kura River was highly polluted with copper and zinc discharged from the Alaverdi mine in Northeast Armenia. In Georgia, wastewaters from copper mining operations heavily polluted the Kazretula River (Kura River basin) with heavy metals. In the North Caucasus, the contamination of Terek-Kuma artesian aquifer with arsenic was and still is a problem (Ministry of Environment and Nature Resources Protection, Russian Federation 1996).

Historically, the coverage rate of the Caucasus region by sewage systems was high, amounting to about 50-60% of the urban population. The majority of the rural populations however, were not covered by sewage services and they at large relied on septic tanks. Water treatment facilities usually received more wastewater than they could treat. In many cases, industrial wastewaters were discharged directly into municipal sewage collectors. In addition, frequently rain water sewers and domestic sewage systems were connected to each other, causing overloading during heavy rainfalls.

Since the break-up of the Soviet Union, contamination of surface waters has decreased. This could have resulted in the temporary improvement of water quality. However, this is offset by the fact that the majority of wastewater treatment facilities ceased to function or work at very low levels of efficiency, causing the discharge of larger quantities of untreated wastewater directly into water bodies. The problem of industrial accidents and gulp releases is still acute in the region. For example, during 1998 in North Dagestan gulp discharges from industries located in Chechnya caused heavy contamination of the Terek River and other small river bodies with oil products, exceeding the existing water quality standards 200 to 600 times (Ministry of Environment and Nature Resources Protection, Russian Federation, 1998).

Overall, most of rivers of both the Black and Caspian Sea basins are considered polluted. However, the Kura river, being the major waterway in the South Caucasus region, has a high degree of international importance, in terms of both quantity and quality of water, since its basin covers six countries: Georgia, Armenia, Azerbaijan, Turkey and Iran and the rivers and their tributaries there are abstracted for essential uses. Whereas they are less crucial, at a national level, to Iran and Turkey, they are nevertheless important to the economy and communities living in the riparian corridors.

**The most polluted rivers in the Caucasus**



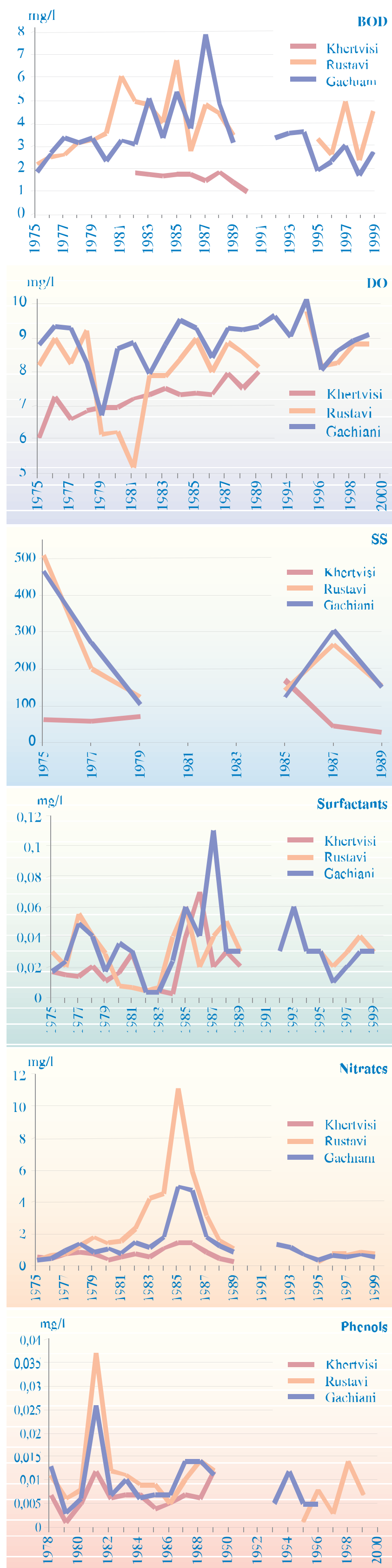
The Kura-Araks River Basin, including its two main rivers, the Kura and the Araks and their tributaries, covers three countries: Armenia, Azerbaijan, Georgia, and parts of Turkey and Iran. The total area of the basin is more than 200,000 square kilometres, with about 188,000 km sq. of catchment area for the Kura river basin and 102,000 km sq.  of catchment area for the Araks river basin. The Kura River originates in Northeast Turkey, passes through Georgia and flows into the Caspian Sea in Azerbaijan. Some of its tributaries flow from Armenia to Georgia and Azerbaijan. The Araks River originates in eastern Turkey and flows along the border of Turkey, Armenia, Iran and Azerbaijan. One branch of the Araks flows directly into the Caspian Sea. The total length of the Kura River is about 1,515 km and its main tributary, the Araks River, is approximately 1,072 km. The basin is rich in biodiversity, unique riparian forests along the Kura, and many important wetlands.

The rivers of the Kura basin are used for agriculture, domestic, industrial, and hydropower generation and recreation purposes. Whereas Armenia and Georgia have abundant underground water reserves, which are used as a major source of drinking water, Azerbaijan is almost entirely reliant on the Kura River for all types of water uses. The problems existing in the basin are related to both quantity and quality of water. Water shortage is acute for Georgia and Azerbaijan, since rainfall disappears from west to east of the basin. The average annual precipitation in Central Georgia, where the Kura enters Georgia from Turkey, is 500 mm but is 200 mm in Azerbaijan, where the river flows into the Caspian Sea. Similarly, evaporation rates soar from west to east. Drought periods in the Kura Basin are very common.  This has seriously affected the economies of Georgia and Azerbaijan. Overall, despite the efforts to manage river flow the region faces both floods and shortages. Water quality is deteriorated by raw municipal and industrial wastewaters and return flow from agriculture, imposing health, ecological and aesthetic threats. Additionally, improperly designed solid waste landfills and illegal dumpsites, drainage waters from open pit mines and urban run-off degrade the water quality. Municipal sewage contributes the highest share in pollution. The Kura River downstream of such large cities like Tbilisi and Rustavi is heavily polluted with organic matter and other pollutants. Thus, when the river crosses the border of Azerbaijan it is already heavily polluted. For example, in 1992-94, average annual concentrations of phenols and oil products exceeded existing water quality standards about 13-14 and 2.5-3 times respectively in the vicinity of village Shikhly, Azerbaijan near the border with Georgia.

At present, most wastewater is left untreated. Existing treatment facilities are out of date and work with low efficiency. Mostly, only mechanical treatment is conducted. Recently, experts from Sandia Laboratory made cost estimations for raw sewage discharges downstream of Tbilisi. Modelling results have showed that potential costs for discharging municipal sewage in Tbilisi with current discharge rates exceed US$ 100,000 at Rustavi and further fall below US$ 300 downstream the river due to self-purification capacity of the river. This means that Rustavi population would gain the most if the wastewater were properly treated.

*Sources: Phase I Report, Draft, USAID/DAI, 2000; Sandia Report, 2001; Concept Paper UNDP, 2001; UNEP/GRID-Arendal, 1995*

**Concentrations of selected components in the Kura River***




*Source: State Department for Meteorology of Georgia*

**note: Khertvisi is the most upstream and Gachiani - the most downstream river gauging site*

## 2.5 Coastal and Marine Waters

### 2.5.1 Black and Azov Seas

During the last decades, the Black and Azov Seas, which represent the one system of interconnected waters, suffered greatly from environmental degradation and pollution. Intensive anthropogenic pressures on the Seas' ecosystems, resulted in serious and sometimes irreversible environmental effects.

During the Soviet era, the Azov Sea was polluted from multiple sources. Heavy volumes of wastewater from industry, households and agriculture were regularly discharged into the Sea and the rivers of its basin. Wastewaters mostly were carrying heavy metals, chlororganic chemicals, phosphates and pesticides. In the late 1980s, the sea encountered the problem of intrusion of alien species: jellyfish Mnemiopsis, which inhabits Atlantic Ocean coastal waters in USA. The species was introduced in the Azov Sea in 1989. The jellyfish eats almost entire zooplancton, causing the change in biota. Non-sustainable use and pollution of Kuban River, which drains into the Azov Sea, destroy the natural balance of ecosystems in the basin, including marine ecosystems. Regular non-returnable water abstractions from the Kuban, without taking into consideration the minimum ecological flow hinder the natural breeding of major commercial fish species. Building of large-scale hydro projects on this river also resulted in the loss of natural breeding grounds for many valuable fish.

Overall, 10-fold decline in fish productivity has been reported for major fish breeding grounds. According to 1995 data, annual commercial catch in the Azov Sea, which in the past was one of the most productive Seas, amounts about 5 thousand tons annually, while the figure was 120-160,000 tons annually in 1935-36 years. Seal catch has been almost zero since 1992 (Ministry of Environment and Nature Resources Protection, Russian Federation 1996).
Although, Russia and Ukraine take some measures to retain existing fish stocks, without joint measures by these countries to regulate fresh water discharge and control pollution, it will not be possible to recover the fish stock to traditional levels.

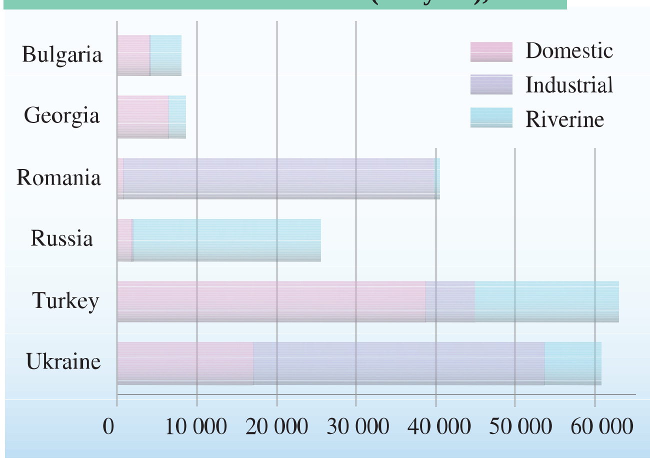
The Black Sea has an international importance, since it washes several countries and is rich in unique ecosystems. The number of total population within its basin is about 170 million. In the Caucasus, Georgian and Krasnodar kray's share the coastline of the Sea. Sea level rising together with degradation of unique marine ecosystems and water pollution is the major issue for the Sea.

The Black Sea, as a part of the World Ocean, is affected by global warming. Long-term sea level observations indicate that the Black Sea level rising has begun since 1923-1925 with a rate of 2.5 mm per year (UNDP/GEF-Government of Georgia, 1999). Sea level rise created following vulnerability to the sea coastlines: increased probability of catastrophic floods on some rivers; salinization and bogging of pastures and washing out of beaches; and damage to amenities: communications, municipal buildings and facilities. In Georgia, the most vulnerable places are Poti and Rioni delta regions. The regions have receded since the beginning of this century by up to 0.52 m relative to the sea and it is assumed the process will continue in the future. In addition to above phenomena, the trend of cooling of the Black Sea surface has been observed, which reached 10C for the last 50-70 years at the coastal zone of Georgia. This itself will result in the decline of recreation and tourism periods as well as vegetation spell for subtropical crops, such as citrus and tea, hence reducing the revenues for local population (UNDP/GEF-Government of Georgia, 1999).

The part of the Caucasus washed by the sea has serious environmental impacts on the Black Sea in terms of seawater pollution. Some of the major resorts, harbours and industrial centres are located there and have a significant impact on the sea.

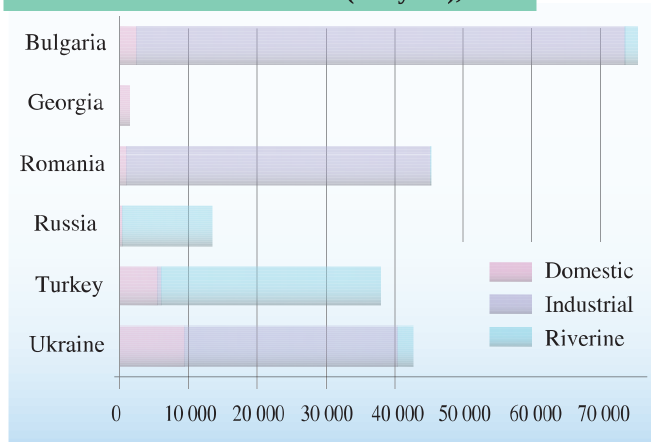
In the 1970s and 1980s, millions of cubic metres of domestic and industrial waste-waters were discharged into the sea from large cities, resorts and industries. During tourist seasons, the concentrations of BOD, COD, and surfactants were exceeding existing water quality standards several times. Water pollution by coliform bacteria was common as well. Water oil content was also high along coastal line, where

**BOD sources for the Black Sea (ton/year), 1996**



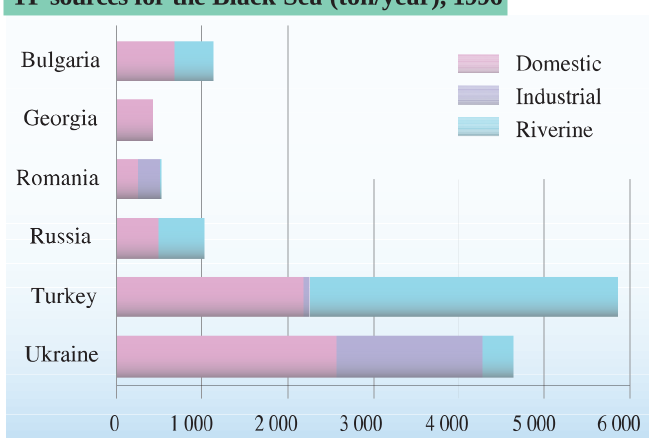

*Source: BSEP, 1996*

**TN sources for the Black Sea (ton/year), 1996**




*Source: BSEP, 1996*

**TP sources for the Black Sea (ton/year), 1996**




*Source: BSEP, 1996*

large harbours: Novorossiisk, Tuaphse, Poti, Batumi, Sukhumi, etc. were located. Different industries were developed within the basin. Wastewaters from ferrous, chemical, mechanical plants, oil refineries and mines were discharged into the rivers or directly into the sea. Batumi oil refinery alone, for example, discharged more than 500 tons of oil wastes into the sea annually in the 1980s. Gulp discharges from the plant also were not rare, bringing about 115 km sq. water surface pollution on average annually (State Committee of the USSR on Nature Protection, 1989). Agriculture also had significant impact on coastal waters. Georgia produced almost the entire citrus and tea crops of the FSU and about 90% of these products were exported to other republics of the FSU. Tea and citrus plantations were concentrated along the coastline and agriculture run-off from these areas discharged significant amounts of fertilisers and pesticides into the sea. Return agricultural flow from ploughed fields, fodder fields and perennial crops in Krasnodarsky kray also contributed highly to the pollution of surface and coastal waters.

The demise of the Soviet Union was followed by economic decline. At present, the problem of seawater pollution is mainly related to domestic sewage and oil spills from cargo ships and storage tanks. Although, industries continue working at low loads, resulting in reduced industrial wastewater loads, non-optimal operation regimes, out of date technologies and reduced control from law enforcement officers may offset the situation.

Oil products were one of the major seawater pollutants in the 1970s and 1980s and remain such at present. Studies conducted by Georgian scientists in 1993-95 showed that oil products significantly polluted the seawater in Batumi and Poti harbours. Water oil content in water samples varied from 1 to 24 times the existing water quality standard (0.05 mg/l) in Batumi and from 1 to 14 times the standard in Poti. The highest concentrations were recorded in days with high sun radiation. Phenol concentrations also were high in warm seasons and they were not only discharged from rivers, but also formed in the seawater as an intermediate product of the degradation of oil products. Sediments were also polluted by oil products and might cause the secondary pollution during high turbulence. In addition to oil products, trace levels of chlororganic pesticides and surfactant, sometimes exceeding existing limits 2-5 times, were detected. (Institute of Hydrometeorology, Georgian Academy of Science, 1998).

In the past, the Black Sea was rich in fish stocks. Over the last 30 years, the maximum catch was in 1976 and amounted to about 315,000 tons (Ministry of Environment and Nature Resources Protection, the Russian Federation, 1995). Over-catching and water pollution has significantly reduced fish populations. Currently the bulk of the commercial fishing consists of hamsa and Sprattus. The industrial catch of sturgeon has extremely reduced, while carp and bream stocks are more stable. Shamaya, pilengas and rybets became very rare (IUCN, 2000).

The problem with invasion of alien species is common to the Black Sea. In the mid 1980s, a jelly-fish-like species (Mnemiopsis leidyi), which was accidentally introduced to the Black Sea from the eastern seaboard of America in the ballast water of a ship, invaded the Black Sea. It quickly reached a total mass of 900 million tons . Though declining, Mnemiopsis continues to nourish in the Black Sea.

Finally, recent large-scale development projects for the Caspian oil transportation and the expansion of the Black Sea harbours within TRACECA project may significantly affect the Black Sea in the near future. Thus, environmental considerations should be taken into account during construction and operation phases.

### 2.5.2 Caspian Sea

The Caspian Sea is the largest inland body of water in the world. It washes five countries: Azerbaijan, Iran, Kazakhstan, Russia and Turkmenistan. A significant part of it is located in the Caucasus, shared by Azerbaijan and Dagestan.

The water level of the Caspian Sea is currently about 26.5-27 metres below the Baltic Sea level. The level has fluctuated from 6 to 7 metres during the past few centuries and about 13 metres over last 500 years. Historically, the sea accounted more than 90% of world's sturgeon and caviar output. Additionally, it has abundant oil and gas deposits and they are exploited both on- and off-shore. Major environmental issues related to the Caspian Sea are the impact of water level fluctuation on coastal settlements, decline in sturgeon populations and water pollution from oil and gas operations, industry, households and agriculture.

The water level rose over four metres between 1978-95, causing severe damage to nearby territories, populations and infrastructure. About 807 kmsq. of land was inundated in Azerbaijan. An additional 460 km sq. will be flooded if the sea level rise to -25 m (State Committee on Ecology and Control of Natural Resources Utilization, Azerbaijan Republic, 1998).

The sea level rise has resulted in significant economic, health and environmental damage to Azerbaijan and Dagestan. Communities in affected areas have suffered from increased humidity and dampness; drinking water quality has deteriorated due the salt water intrusion; communications infrastructure has been significantly damaged; flooded agricultural lands and damage to sturgeon hatcheries and fish processing industries have deepened unemployment and poverty. The rising sea has also caused the secondary pollution of marine water from oil fields either through direct flooding or water table rise and ground water seepage.

While in recent years the sea level has slightly declined, it is forecast to continue rising over the next two decades. The reasons for sea level fluctuations are not well understood. Presumably both natural and anthropogenic factors affect it. Change in water cycle and climate within the watershed have a high impact on the sea level. At the same time, non-sustainable agricultural practices, especially on the river Volga, and human-induced change in water regime contribute greatly to the sea level rise too.

Historically, the Caspian Sea water was affected by polluted river flow and direct discharges from households, industries, oil and gas operations and oil transportation through marine routes. From the territory of Azerbaijan alone more than 300 million cubic metres of wastewater were discharged into the sea in 1980s, polluting it with suspended solids, organic matter, surfactants, oil products, sulphates, chlorides, phenols and other harmful substances (State Committee of the Azerbaijan Republic on Nature Protection, 1993). From the industry sector, the oil and gas industry contributed the highest share. During the Soviet era, existing water quality standards for oil products and phenols were significantly exceeded in coastal waters of Dagestan and Azerbaijan. For example, in 1988 in Dagestan water quality standards for oil products and phenols were exceeded 4 to 6 times and in Azerbaijan about 5-16 times (State Committee of the USSR on Nature Protection, 1989). Agricultural run-off also was a significant source of the Caspian Sea pollution during the 1970s and 1980s. In the early 1980s, the intensive use of fertilisers and pesticides polluted the fresh and coastal waters with nitrogen, phosphorus, chlororganic compounds, etc. However, the use of agrochemicals has significantly declined during the last ten years, due to the overall economic decline. At present, oil extraction and municipal sector are the major sources for seawater pollution. Although industrial discharges have reduced due to the fall in economy, pollution from such activities as oil and gas extraction, oil refining and transportation, and power generation are high. Obsolete production and pollution control technologies or lack of pollution controls aggravates the situation. Inefficient and obsolete wastewater treatment facilities add to the problem.

In the past, about 11.4 billion cubic metres of wastewater were discharged annually into the Caspian Sea (State Committee of the Azerbaijan Republic on Nature Protection, 1993). Among the rivers of the Caspian Sea basin, the Volga River's share of total pollution was and still stays more than 80%. Currently, about 2.5 billion m3 of raw sewage and 7 billion m3 treated sewage is discharged into the river annually (Ministry of Environment and nature Resources Protection, Russian Federation, 1996). The Kura and Araks rivers are also historical polluters of the Caspian Sea, discharging about 522 million cubic metres annually during Soviet era, from which about 497 came from Georgia and Armenia (State Committee of the Azerbaijan Republic on Nature Protection, 1993).

At present, seawater oil pollution remains a major concern for the Caspian Sea, as it was in the past decades. Among coastal waters, waters off Absheron peninsula, where intensive oil operations are conducted and Sumgayit with concentration of petroleum, petrochemical and chemical industries were and still are the most affected. A recent baseline study of the total oil in sediments off Absheron peninsula in and around the Chirag field revealed that in the area of the oil field (contact area) the level was 19-3,860 mg/kg, near the shore sediments in Baku Bay were 270-2,100 mg/kg. One station just south of Oily Rocks showed 5,800 mg/kg. Sediment concentrations of petroleum hydrocarbons were analysed at ten stations 60-80 km off Absheron Peninsula. Levels of 4.7 to 128.5 mg/kg were recorded. An analysis of the individual hydrocarbons of the samples indicated contamination with heavily degraded crude oil, which is also seen in natural seeps (TACIS, 2000). The levels of mercury and phenols are high too, amounting to over 0.2-1.0 and 5.0-140 g/kg of sediment in Baku Bay respectively. Concentrations of oil products and phenols are also high in water column, exceeding the standards 10-30 times (State Committee on Ecology and Control of Natural Resources Utilization, Azerbaijan, 1998). The sediment concentration off Kura River is reported to contain 500-1,500 mg/kg even though it is far from any offshore installations. Also, at the Lenkoran coastal zone the level of petroleum hydrocarbons in sediment reach 200-1,500 mg/kg. As comparison the level of petroleum hydrocarbons in the Baltic Sea reached 4,100 mg/kg, and in one case close to an oil refinery 16,000 mg/kg.

In general, environmental impacts of water oil pollution are related to the loss of benthic fauna, and fish populations, using benthos as a food.  In the case of the Caspian Sea, the open water surface and eastern coast of the northern Caspian Sea is polluted, and the benthic communities have lost their stability and are in a transition state. The Dagestan coast is heavily polluted. Azerbaijan coast from Russian border to Sumgayit is polluted, and the benthic fauna varies between a stable and a transition state. The Absheron peninsula, the Baku Bay and the Sumgayit coast are extremely polluted, and the state of the benthic fauna communities ranges from a transition to a critical to a disastrous situation. The open waters of the whole Caspian Sea are heavily polluted. The fish fauna has decreased in the strongly polluted areas in Baku Bay, Sumgayit Coast and Neftyanye Kamny and they are considered "dead zones" mainly due to oil pollution. However, the very same area contains a long series of industries that discharge or did discharge numerous other contaminants into that coastal area. The disappearance of the zander in the southern part of the Caspian nevertheless, is directly related to oil pollution. The disastrous situation of the Caspian herring (shad) stocks is also the result of oil pollution. The migration routes of sturgeons have been affected by oil pollution in Azerbaijani territorial water. Earlier the sturgeons moved from the southern part of the Caspian to its middle part and back along the western and eastern coasts. Now they come across a barrier of highly polluted water near the Absheron Peninsula and have to migrate particularly along the eastern coast. The grey mullet stocks have been reduced, too, and a great number of crawfish have disappeared (TACIS, 2000).

Overall, intensive anthropogenic pressures, such as: industrial and municipal wastewater discharges and developments of large-scale hydro schemes have detrimental impacts on natural ecosystems of the Caspian Sea. A sharp decrease in the diversity of the benthic fauna of the Caspian Sea has been reported. In the northern part the diversity has decreased from 78 to 46 species, and in the southern and central part the number of species has decreased by one third. In Baku Bay and off Sumgayit crustaceans and some species of mollusks have drastically declined. Bulk stocks of commercial fish species have significantly reduced in last decades. The sturgeon population has suffered especially. Twenty years ago, about 20-25,000 tons of sturgeons were harvested in the Caspian Sea annually. Over the last 20 years, the total catch has decreased by 90% and in the last three years by factor three. In 1998, for example only 1,465 tons were harvested (IUCN, 2000).

## 2.6 Policy Measures in Water Resources Protection Field

Until the break-up of the USSR, Caucasus states had no national bodies responsible for environmental protection, including water resources protection and management, with real power at both: local and national levels. In general, the Soviet managerial system was arranged from the top down, and all the issues at national/local levels were solved based on decrees and directives issued from Moscow. The central Ministry for Melioration and Water Management ("Minvodkhoz") with similar national structures in sister republics was the major body responsible for water resources protection and rational use. Several other agencies also carried out water-related activities. Central and national HMSs were responsible for water quantity and quality data collection; standards departments developed and set surface water quality standards; health ministries set drinking water quality standards and enforced them via sanitary-hygiene services; geologic agencies conducted the geologic surveys over ground water reserves. Historically, there was little or no co-ordination among these agencies, because only a sector-based approach to environmental and natural resources management was conducted in the 1970s and 1980s. In 1988, in order to improve co-ordination among different agencies, the Nature Protection Committee was established, later transformed to the Ministry for Environment, to be responsible for the protection of all environmental media. However, the committee had no long-term record due to the break up of the Soviet Union in 1991.

The first Soviet water law was adopted in 1970, immediately followed by the development and adoption of similar national laws and regulations. For enforcement purposes, the codes of civil and criminal violations were developed during the period from 1970 to 1990. In order to implement existing legislation, Soviet regulators mostly used command and control approaches. In 1976-90, source-specific and general (activity or river basin based) water abstraction and use standards (quotas) were developed and set for major water user economic sectors, taking into consideration the quality of the water used. In the 1960s and 1970s, surface water quality standards (GOSTs) for a broad spectrum of substances were established as well. Water bodies were divided into several categories, based on some of the basic functional water uses: municipal-domestic, recreational, fisheries, etc. In order to achieve desirable water quality, in 1979 source specific effluent limitations were introduced for point sources, based on dilution effect and self-purification capacity of the river. Domestic sewage was required to enter water treatment facilities and undergo both mechanical and biological treatment. In essence, Soviet point source discharge standards were based on ambient quality and did not require a certain type of technology for pollution control, hence promoting end-off pipe pollution control approaches. Meanwhile, no standards, guidelines or management practices existed for controlling diffused source pollution.

The state statistical reporting system, introduced in the late 1980s, obliged all water users to conduct water use and discharge inventories at source, using either measurement or estimation methods and regularly report to responsible authorities. After water use and discharge data were submitted they were then aggregated and published in statistical yearbooks. The validity of reported data was checked through regular inspections. However, water inventory data were not precise, because the majority of industries lacked water metering and effluent monitoring equipment, and largely employed estimation methods.

Regardless of legal requirements, existing laws, regulations, and standards were frequently ignored or violated, because of their strictness and unfeasibility.  Besides, rent-seeking systems based on bribery and mutual services hindered the compliance assurance monitoring and control.

The Soviet Union had little experience with using economic tools in environmental fields, including water resources management. Until 1991, there were no taxes on water pollution. Only water use fees were employed. Per unit water use fees were first introduced in 1982. In essence, they served more to finance state water protection programs rather than to give an incentive to water users to conserve a resource. In addition to water use fees, environmental damage compensation fees were employed in the country. Effluent charges have been in effect since 1991. The first charge system was introduced at the all-union level. The charge rate under this program was different within and above the legal limit. In addition, the type of pollutant as well as socio-economic and environmental conditions for specific regions was taken into consideration while calculating the base charge rate.  After the disintegration of the Soviet Union, national authorities introduced "polluter pays" principles in their environmental legislations and established effluent charge systems. These systems are similar to their Soviet ancestor. Charge programs are very complicated and cover a wide range of pollutants, which cannot possibly be monitored fully. At present, these countries only have the capacities to monitor several voluminous pollutants. This partly explains low tax revenues. Tax rates themselves are low, not reflecting marginal damage and benefit costs and hence not affecting environmental behaviour. Even if the taxes were set at appropriate levels, industries have little option for reducing their emissions, due to the thin market for environmental services and goods. Increased inflation also erodes the real tax rate. Finally, taxes are not earmarked for environmental purposes. Water use fees employed by the countries are also set at lower levels and do not generate an incentive to conserve the resource. Water charges, employed for potable water consumption also are low, not allowing for recovery of O/M costs. At least, the number of pollutants has to be reduced, tax base rate set at appropriate level and revenues earmarked for environmental expenditures or for maintaining the tax system.

In the 1970s and 1980s, national HMSs maintained extensive hydro-meteorological and ambient environmental quality networks, conducting observations over surface water quantity and quality. Water quality networks were based on manual sampling. For sample analysis, the combination of both wet chemistry and automated methods was employed. After collection, the raw data were processed and stored in paper formats or non-user oriented PC-based databases. HMS published data in annual yearbooks or multi-year summaries. Usually, sister republics did not share or exchange data. Although Soviet monitoring networks provided baseline river flow and quality data, these networks were not designed for daily resource management.

The period from 1991 up to now can be considered one that for established and strengthened national environmental institutions in the FSU, including the South Caucasus countries. At present, national environmental ministries have major environmental protection and management responsibilities in South Caucasus states. In the North Caucasus autonomies, similar structures are subordinated to republican and federal governments the latter has the right to veto a republican decisions. In the kray level administrations, local governments manage environment and natural resources. Environmental ministries develop water regulations, general policies/programs, permit new developments or major modifications, issue licenses over water use and wastewater discharges and conduct compliance assurance control either through their regional branches or special environmental inspectorates. Other agencies: HMS, health, agriculture, fuel and energy ministries, geologic services, etc. are engaged in water-related activities as well. However, the duties and powers of all these agencies vary from country to country.

Presently, most water-related agencies lack financial and technical resources to implement their policies and enforce existing laws. Public financing is very poor and only allows for minimum performance. The wide distribution of environment related tasks in the government results in scattered and inefficient budgetary expenses for environment. Regarding non-public finances, environmental taxes employed are not earmarked in general. The countries lack field-financing strategies to set specific and realistic targets and implementation schedules; make cost assessments; and identify potential financial sources. However, some limited activities in this direction have already been conducted in some of the South Caucasus countries. In 1998-2000, Georgia, for example, together with some other selected NIS countries, participated into the project called "Environmental Financing Strategies, Environmental Expenditure and Use of Economic Instruments in NIS Countries". The environmental financing strategy, focused on bringing the water supply and sewage sector in line with NEAP priorities was developed by COWI.

In general, there is a little co-operation among the agencies engaged in water resources management. They do not share or exchange information due to the lack of legally binding data flow requirements. The sector-based approach to water resources management is still widely used and integrated river basin-based water management principles are not entertained region wide. However, currently there are some efforts to introduce these approaches as well as to establish specific water authorities for co-ordinated water resources management and improved performance in some of the countries of Caucasus region. In Armenia, for example, specific water authority was established under the WB funded national water project. An ongoing USAID/DAI South Caucasus Water project also aims at strengthening the co-operation among water-related agencies at all local, national and regional levels and demonstrate integrated water resources management.

The post-soviet era can be considered a productive period for drafting environmental legislation in the FSU states, including the South Caucasus countries. The majority of them have adopted framework environmental protection acts. Laws/regulations on state environmental examinations and environmental permitting, requiring permits for new developments or/and major modifications after environmental impact assessment and state environmental examination have been conducted, also were developed and passed. In the water protection field, media-specific water laws/codes have been passed, setting water protection objectives and goals, duties and powers of responsible authorities, record-keeping and reporting requirements, etc. Although new principles such as: precautionary, stand still, polluter pays, etc. have been introduced by some of the Caucasus countries, the appropriate regulatory basis has not been developed yet. Existing regulations are still based on Soviet approaches. There is no application of BAT/BAP standards. Ambient standards also need review and revision.

Regarding water quantity and quality monitoring, data collection and flow have declined greatly because of the regional financial crisis. Apart from this, existing monitoring technologies are out of date and do not meet international standards. Quality of current data is not guaranteed, due to the malfunctioning of existing QA/QC systems. Finally, there is practically little or no application of remote sensing and GIS technologies for water resources monitoring and management. Though limited, there are some such national capacities, concentrated largely in scientific and academic institutions.

At present, Georgia and Russian Federation are parties to International Convention for the Prevention of Pollution from Ships (MARPOL 73/78) and International Convention on Liability for Oil Pollution Damage (CLC 1969). Azerbaijan and the RF are parties to London Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matters (LDC 1972), and Georgia has ratified its protocol of 1996 . Georgia and Russia are parties to UN Convention on the Protection of the Black Sea Against Pollution (Bucharest, 1992). These countries also ratified the GEF Black Sea Protection Program. Under this program, for example, Black Sea Environmental Action Plan and Black Sea Program for Integrated Coastal Zone Management have been developed and launched in Georgia with GEF financial assistance. Azerbaijan participates in Caspian Sea Environmental Program, operated since the late 1990s. UNDP, TACIS, WB and USAID fund the Program. The significant output of this program is the establishment of Caspian Centre for Pollution Control and the development of GIS-friendly database.

The CITES convention, ratified by Azerbaijan, Georgia and the RF, among others concerns protection of sturgeon populations. Since 1998, international trade in all sturgeon species has been regulated under the convention, since unsustainable harvesting and illegal trade in sturgeon has a high impact on sturgeon stocks. Under the convention all littoral countries of the Caspian Sea that engage in international trade in sturgeon, their parts or their derivatives, are required to hold CITIES permit or certificate. The situation in the Caspian Sea is particularly troubling. Special focus is on the protection of Caspian sturgeon, and specific regional annual quotas of catch and trade in each specimen of sturgeon are set for littoral countries, including Azerbaijan and the Russian Federation. In addition, parties are required to report to the Secretariat on the progress made to fulfil commitments taken under the convention. Azerbaijan and the Russian Federation closely co-operate at bi- and multi-lateral levels in joint assessment of fish stocks, deriving total allowable catch (TAC) and implementing measures to enhance fish stocks. Recent assessments made by five littoral countries have shown that sturgeon populations in the Caspian have stabilised or are beginning to increase and that the age structure of the stocks is biased to younger age classes, due to the introduction of tens of millions of juvenile sturgeon over the past two decades. These results were achieved by implementing long-term fisheries re-stocking programme and drastically cutting catch limits (Management Authority for Sturgeon of the Russian Federation, 2001).

Armenia, Azerbaijan and Georgia participate in the activities within the framework of the UN Convention on Transboundary Water Courses. However, only Azerbaijan is a party to this Convention, while all South Caucasus countries ratified the protocol concerning health protection. The WB jointly with Finland, the Netherlands, Sweden and Switzerland has financed the implementation of the Lake Sevan Environmental Action Plan in Armenia, aiming to establish sustainable and integrated water management practices there. During the period from 1999-2001, the WB funded the development of Integrated Water Resources Management Plan for Armenia. USAID also is one of the active donors financing integrated water resources management activities within the Caucasus region. For example, it financed the national project for Sustainable Water Resources Management in Armenia. Currently, it implements the South Caucasus Water project to strengthen water resources management in the Kura-Araks basin, based on integrated river-basin water resources management principles. In parallel to this, TACIS launched the Joint River Management Program on Monitoring and Assessment of Water Quality on Transboundary Rivers, aimed at the prevention, control and reduction of transboundary pollution impact. The program covers four basins, including Kura river basin. In addition, regional organisations such as REC, Eurasia Foundation etc. and numerous local foundations promote the national and regional activities in the field of water resources management and protection. Recently, the Georgian office of UNDP has prepared the concept paper for large-scale regional partnership program for Kura-Araks basin to be presented to GEF. The project aims at the strengthening regional partnership and security through preventing transboundary pollution of the waters of Kura-Araks basin. The project is expected to develop institutional and legal framework for the use and protection of shared resources. The project is currently waiting approval.

Along with this, some large-scale investment projects for infrastructure rehabilitation, which were identified as priorities in NEAPs, are being implemented within the region. For example, the WB finances long-term irrigation-drainage system rehabilitation projects in Georgia and Azerbaijan, together with investment components, including capacity building for sound management of the systems, specifically, the establishment of local community-based water use associations. Similarly, the investment project on primary and secondary canal rehabilitation has been prepared in Armenia. In addition to this, the WB and other lending organizations funded or plan to invest in the rehabilitation of municipal water supply and sewage networks in many cities of the South Caucasus. Rebuilding of water treatment facilities is also among the planned investment activities.

Thus, there is a hope that all above activities will strengthen the national and regional capacities to manage shared water resources in a sustainable and integrated manner and protect them from environmental pollution.

## 2.7 Atmospheric Air

### 2.7.1 Global and Regional Atmospheric Problems

The Caucasus' contribution to global and regional environmental processes, such as climate change, stratospheric ozone depletion and acid rain, etc. is presumably insignificant, taking into account its small scale economy and the medium to low development index of its countries by the UN human development scale. The World Resources Institute's estimates show that the South Caucasus share of global and Europe's $CO_2$ emissions from 1950 to 1999 was only about 0.38% and 0.85% respectively.

A downward trend in emissions of pollutants contributing to global and regional atmospheric problems can be seen in the 1990s relative to the late 1970s and 1980s. This fact is explained by the post-Soviet regional economic crisis. In Armenia, for example, a 12-fold drop and three-fold drop were reported for $SO_2$ and NOx emissions, respectively (TACIS/MNP of Armenia, 1998). In Georgia in 1994, sulphur dioxide emissions were eleven times less and NOx emissions seven times less relative to 1988 (TACIS-MoE of Georgia, 1998). In the late 1990s, some signs of economic stability were observed, which were reflected in slightly increased emissions, including those of GHGs, $SO_2$, NOx, etc.

From an environmental standpoint, the impact of global and regional atmospheric processes on the Caucasus environment is of much interest. Whereas more or less complete information on climate change phenomena is available for the Caucasus, there is practically no information on acid deposition and its effects on ecosystems in the region. Little is known about regional background levels of pollutants and their long-range movements as well.

For climate change, national studies on climate change have been conducted under the UNFCCC in the South Caucasus countries and the trends of climate warming have been revealed. Studies for Georgia, for example, have revealed noticeable warming of up to $0.5^0$C in Eastern Georgia and slight cooling up to $0.3^0$C in Western Georgia, especially in the cold period of the year. These trends match well with global studies conducted under IPCC in 1995 that revealed the trend of warming in the Central Asian and Caspian Sea regions and cooling over the Black Sea region. Similarly, changes have been found in precipitation levels. Specifically, plain regions have seen an increase in precipitation of up to 15% and conversely, mountainous areas of the Greater Caucasus, especially the eastern slopes have seen a decrease of up to 20%. Climate specialists, based on available data, predict that a 1.5-2$^0$C increase in mean air temperature in the South Caucasus. However, sea surface cooling by another 0.5-0.7$^0$C will continue along Georgia's coastal zone (UNDP/GEF-Georgian Government, 1999).

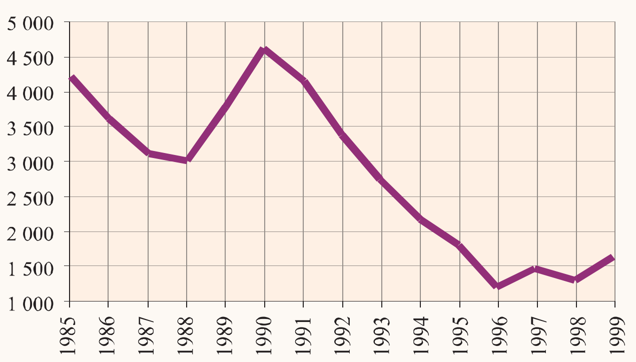
It is assumed that as the economies of FSU countries, including Caucasus states, begin to recover, both production and consumption levels will go up, accompanied by increased contribution to global and regional atmospheric problems. However, whether or not they will below or above the late 1980s levels depends on the macroeconomic development scenarios and the implementation of commitments taken under relevant international treaties and conventions.

## 2.7.2 Atmospheric Air Pollution

**Major Sources of Air Pollution and their Emissions**. During the 1970s and 1980s, transport and industry were the major sources for air pollution in the Caucasus region. Total emissions reached their peaks in the late 1980s and fell in the early 1990s due to the general economic decline. Currently, some signs of economic stabilization can be observed in the region as reflected in slightly increased emissions. However, the increase is irregular character and far below the 1980s' levels. At present, the significant share, apart from mobile and stationary sources, is from domestic heaters in many parts of the region.

**Mobile Sources.** Historically, the percentage of emissions from transport, with some exceptions, was higher than stationary source emissions in most of parts of the region. For example, whereas in Georgia, Armenia and most of the North Caucasus republics and krays mobile sources contributed over 60% of total emissions, in Azerbaijan, Chechen-Ingushetia, etc. with large industrial capacities, the figure varied from 30% to 40%.

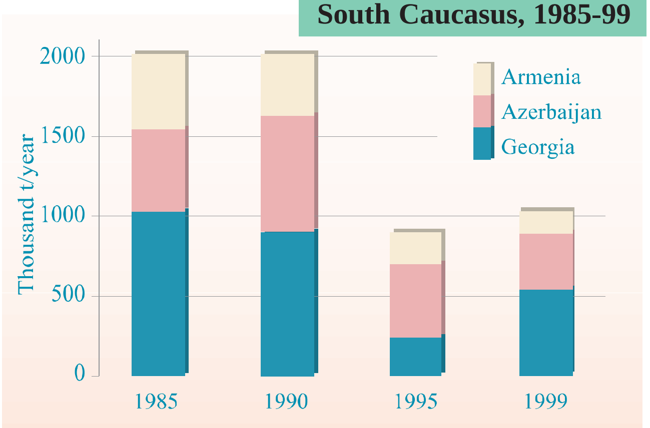
**Total air emissions in the South Caucasus, 1985-99**




*Source: Complex Scheme of Environment Protection of Azerbaijan, 1987.*
*State Committee on Ecology and Control of Natural Resources Utilization, Azerbaijan, 1993.*
*MoE of Georgia, 1996. State statistical services of Armenia, Azerbaijan and Georgia, 1986-2000*

Vehicular transport was a major concern. The early 1970s were marked by a significant growth in the Soviet car fleet. Although a higher priority was always given to public transport, the number of passenger cars significantly increased. By 1980 the annual vehicle output of existing vehicle manufacturing plants increased from 916,000 to over 2.1 million vehicles and the car fleet expanded by 3.5 times relative to 1970 (State Committee of the USSR on Nature Protection, 1989). This aggravated ambient air quality in most of parts of the country. Air quality was particularly poor in urban areas with dense populations and heavy traffic. The reasons for high vehicle emissions were heavy traffic in urban areas and high emissions from cars lacking pollution control devices.

**Air emissions from motor transport in the South Caucasus, 1985-99**



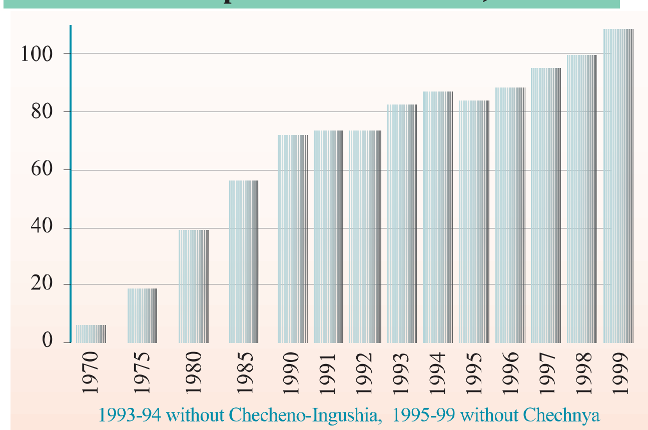

*Source: Complex Scheme of Environment Protection of Azerbaijan, 1987.*
*State Committee on Ecology and Control of Natural Resources Utilization, Azerbaijan, 1993.*
*MoE of Georgia, 1996. State statistical services of Armenia, Azerbaijan and Georgia, 1986-2000*

Vehicle emissions reached their peaks in the late 1980s in the Caucasus region, in line with general trends for the Soviet Union. Gross emissions were particularly high in large cities such as Baku, Yerevan, Tbilisi, where they varied from 150,000 to 300,000 tons per year, some of the highest figures in the Soviet Union (State Committee of the USSR on Nature Protection, 1989).
In the early 1990s, aggregated vehicle emis-

sions declined in the region. Industrial emissions declined even more dramatically, increasing the transport share of total emissions to 80%.

The number of vehicles in the South Caucasus slightly declined in the early 1990s, but this (CAID, 1998) trend was not observed in the North Caucasus. At present, an upward trend is reported for both the South and the North Caucasus. However, the countries of the region still lag behind European countries and the US in terms of number of vehicles per capita vehicle.

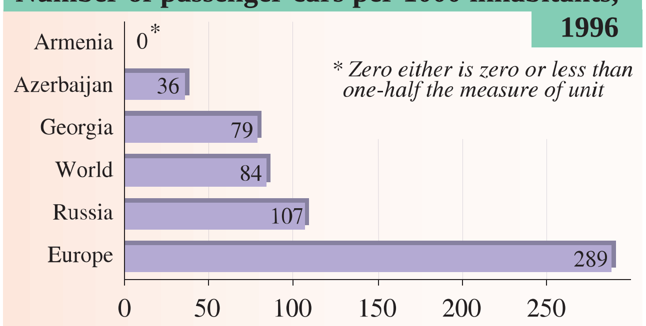
**Number of passenger cars in the North Caucasus per 1000 inhabitants, 1970-99**




*Source: State Committee for Statistics of the Russian Federation."Regions of Russian Federation", 2000. "Statistical Yearbook of Russian Federation", 2000*

The current problems of vehicle emissions are more related to high emissions per vehicle rather than high vehicle numbers. Increased per vehicle emissions are mainly related to obsolete car fleet, in which more than 90% of all vehicles are more than five years old. The average age of vehicles is around 15 years. Most vehicles are of Soviet made. The share of foreign models, used cars, has been increasing recently. Soviet models do not have catalytic converters and are higher polluters than foreign models. However, the owners of foreign models frequently use gasoline with lead additives, since there is no differentiation between the pumps for leaded and unleaded gasoline in gasoline stations. This causes the poisoning of catalytic converters and increases the vehicle emissions.

**Number of passenger cars per 1000 inhabitants, 1996**




*Source: World Resources Institute, 2000-2001*

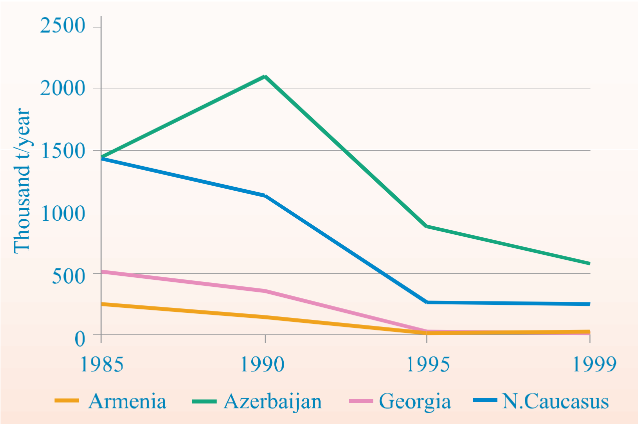
The system of vehicle inspection/maintenance is very poor. Responsible authorities lack finances, technical equipment and qualified staff to properly check vehicle emissions. Low salaries of inspectors lead to bribe-taking and falsification of records. The proper maintenance and repair of vehicles cannot be guaranteed under such conditions, which promotes the increase in the volume of gross polluters.

Fuel quality is a concern as well. Lead is needed for Soviet cars in order to reduce wearing of "soft" seat valves that most of these cars have. Hence, leaded gasoline is still widely used in the region. Even though the use of lead is banned in some of the countries of the Caucasus, frequently wholesalers and retailers illegally add lead additives to the low octane gasoline in order to enhance the octane rating and generate extra revenues. For example, a study conducted by NORCE consultants in the city of Tbilisi in 1999 revealed that the average lead level in gasoline pool was about 52 mg/l, while the legal lead content is 13 mg/l (NORCE & MoE of Georgia, 1999). There are limited studies on other components of fuel, such as sulphur and hydrocarbon.

Heavy traffic and poor road conditions also contribute to increased vehicle emissions. Lack of bypasses in most cities causes a deterioration of urban air quality there.

**Stationary Sources.** In the 1970s-80s, stationary sources were significant polluters of ambient air in the Caucasus, with the percentage share of total emissions depending on the level of industrialization. In Azerbaijan and Chechnya in the 1980s, for example, stationary source share of total emissions was more than 60%, predominantly due to the emissions from

**Air emissions from stationary sources in the Caucasus, 1985-99**




*Source: Complex Scheme of Environment Protection of S.R. of Azerbaijan, 1987 State Committee on Ecology and Control of Natural Resources Utilization, Azerbaijan, 1993. MoE of Georgia, 1996. State statistical services of Armenia, Azerbaijan and Georgia, 1986-2000*

large stationary sources located in Baku and Sumgayit in Azerbaijan and Grozny in Chechnya. In most of other parts of the region, stationary sources' share was lower than 50%.

Stationary source emissions, similar to mobile source emissions, reached their maximum levels in the late 1980s. The break-up of the Soviet Union was followed by the mass shut-down of industry in the region, resulting in a significant fall in industrial emissions. However, the extent of the fall was different for the countries of the region. In addition, there were temporal differences in the peaks of fall between the North and the South Caucasus as well as within these very regions. In the early 1990s, Armenia and Georgia, facing a power crisis, suffered the most. Stationary source share of total emissions dropped to almost 5% there. Whereas the pressures from economic sectors have fallen, those from households have increased in these countries. Due to the loss of fuel markets and disintegration of central heating systems people were forced to use alternative fuels for domestic heaters and micro-generators. This has resulted in increased low temperature emissions. Most of the North Caucasus states and Azerbaijan have retained their industrial capacities and power sector at higher levels.

Stationary source emissions have been slightly increasing since 1995. However, they are far below the 1980s' levels, as existing facilities still work at low capacities (about 15-20%) and there are few new industrial developments in the region. Currently, major pollution is from gas and oil industries, power plants and small to medium size enterprises. Although gross emissions are reduced, current per unit emissions are believed to be higher than that of the 1980s, since existing production and pollution control technologies are out-of-date and inefficient. Besides, current compliance assurance monitoring and control systems do not guarantee compliance with existing standards.

**Industrial Hotspots.** Large urban areas were targets for intensive industrial development, and gradually became environmental "hot-spots" with a broad spectrum of environmental problems. For example, the cities of Baku, Tbilisi, Yerevan, etc. became large industrial centres with diverse industries of local, regional or all-union importance. In the late 1950s, many new mono-functional cities were developed around specific industries. For example, the city of Rustavi was built around the steel manufacturing industry. The city of Sumgayit was also built as a typical Soviet industrial centre. Populations of such cities were mainly employed by the various industries there.

Current environmental problems in industrial centres are mostly related to out of date technologies, low efficiency or lack of pollution controls and the disposal/treatment of industrial wastes accumulated around the industries. The territories of many facilities have become practically "brown fields" whose clean up costs could be millions of US dollars. Among industrial centres, the city of Sumgayit can be considered an extreme case of an industrial "hot-spot".

**Urban air quality.** In the Caucasus, urban

Sumgayit was founded in the 1950s as a centre for the chemical and petrochemical industries. Soon after it became one of the largest industrial centres of the USSR. Industrial areas occupied over 34% of the city. About 88 large facilities were built, of which 10 became heavy air polluters. Annual air emissions were about 100,000 tons. Emissions per square kilometre amounted to 1,200 tons in 1990-91, while the average value for Azerbaijan was about 24 t/km2. Apart from criteria pollutants, toxic substances, mercury, chlorine, hydrogen fluoride, heavy metals, etc., were released into the ambient air, affecting the local population especially sensitive groups. Persistent organic compounds, such as dioxins and dibenzofuranes were released from petrochemical industries. The city had one of the highest morbidity rates during Soviet era. In 1992, the city of Sumgayit was declared as environmental disaster zone, although air emissions have been declined since 1990. The city was later designated a free economic zone, in order to foster economic growth and the introduction of new technologies there. However, the problems of uncontrolled emissions, persistent pollutants and the liability for past pollution remain unsolved.

*Source: State Committee for Nature Protection, Azerbaijan, 1998; UNEP/State Committee for Nature Protection, Azerbaijan, 1996* areas with dense population, high concentration of industries and traffic are environmental "hot-spots." Existing National Environmental Action Plans (NEAPs) identify urban air quality protection as one of the national priorities.

Industrialization and urbanization over the past 30 years have resulted in the deterioration of ambient air quality in urban areas of the Caucasus region. In large urban areas, existing air quality standards for $SO_2$, Dust, NOx, CO were regularly exceeded. Ambient air quality standards were exceeded for wide range of substances, linked to specific industrial activities. Cities of the region such as Baku, Sumgayit, Yerevan, Alaverdi, Tbilisi, Rustavi, Zestaphoni, Grozny, etc. were included in the list of the most polluted cities of the FSU.

Although there is limited information on ambient air quality for the last 10 years, due to decline in baseline data collection, it is assumed that in the early 1990s, ambient air quality temporarily improved in the cities of the region. Since 1996, slight increase in emissions has been observed that might become the reason for air quality deterioration.

At present, vehicular transport is a major concern in urban areas. High ambient concentrations of CO, NOx, phenol and formaldehyde indicate a significant impact from traffic. The problem with ground level ozone is a concern. Cities such as Tbilisi, Yerevan, Vanadzor, Ararat, etc. with valley type terrain or/and poor ventilation may suffer the most. However, there are practically no data on ground level ozone. Of ozone's precursors, only NOx is monitored regularly. There are no regular measurements of VOCs.  Lead is a problem, as most cars run on leaded gasoline. However, lead background measurements are very rare and irregular.

**Indoor Air Quality.** Historically, little attention was paid to indoor air quality in the Caucasus region. Very little is known about the indoor concentrations of asbestos and other man-made fibrous materials, used as building materials or insulation. Building materials and furnishings also may be the sources of such substances as formaldehyde from chipboard and hydrocarbons from paintings, cleaners, adhesives, timber and furnishing.  Levels of flue gases from domestic cooking, the products of incomplete combustion, POPs, or cigarette smoke are usually significant in indoor environments. However, there is no information for the Caucasus. Neither human health impacts nor cost estimations have been made. At present, the problem of indoor air quality may be acute for some of the parts of the region, people use domestic heaters with alternative fuels and without proper fuel combustion devices.

### 2.7.3 Policy Measures and Responses

In the early 1970s, in the USSR there were three key agencies with atmospheric air protection and management responsibilities at both the all-union and national levels. The State Inspection was responsible for inspecting stationary source pollution control equipment, the State Sanitary-Hygienic Service for setting ambient air quality standards and the Hydrometeorological Service for ambient air quality data collection. However, none of these agencies had regulatory functions. There was no special environmental protection body, with broad spectrum of managerial and regulatory responsibilities. In 1988 State Nature Protection Committee, with national branches was established, in order to improve environmental performance and enhance the coordination of activities within the field.  Although, Soviet republics and autonomies had legal right for implementing independent policies in theory, in practice they had no real autonomy and were strictly dependent on the central government.

The first Soviet Atmospheric Air Protection Act was passed in 1980 followed by the adoption of national laws and regulations. However, the Soviet Union had long experience in developing health and technical standards, regulations and methodologies. For example, in 1951 health-based air quality standards were set for up to 10 pollutants. By 1972, standards existed for 98 and by 1991 for 479 substances. These standards were based on toxicological studies and were believed to be set at levels, below which no health effects were observed. Two sets of standards were applied for all substances: 20-minute and 24-averages based on dose-response effects.

At the beginning of the 1980s, source-specific emission limits were introduced for stationary sources in order to achieve ambient air quality standards. Those were ambient, but not technology-based standards, and did not promote pollution prevention and the introduction of cleaner technologies, but rather the use of passive methods of pollution control (end-off-pipe approach). Regular statistical reporting requirement was introduced for all large stationary sources in the late 1970s. Facilities were required to report on their annual emissions using either direct stack measurements or engineering calculations. Emission calculation methodologies were based on source-category emission factors or mass balance methods.

Regardless of legally binding requirements to comply with existing standards, the standards were ignored to fulfil five-year production plans. Environmental protection was considered a low priority at the government level. As environmental protection was of lower priority than economic growth, little was spent on enforcement and monitoring, or in developing pollution control technologies and technological innovations. Industries themselves had no incentive to lower their emissions below legally binding emission levels and introduce technological breakthroughs. Therefore, there was no market for environmental services and goods.

Concerning the mobile source pollution control, in 1970, emission standard (GOST) was set on carbon monoxide emissions for gasoline-powered engines. In 1975, the standard on diesel soot content was introduced. In 1974-80, vehicle design and technical standards were developed and introduced. Standards were also developed for fuel quality. Specifically, they were set on diesel sulphur and hydrocarbon content, gasoline lead content, etc. However, between 1970 and 1990 practically nothing was done to update existing standards. Additionally, the entire system of vehicle inspection was weak and corrupted.

In the 1970s-80s, there were no economic tools for environmental pollution, including atmospheric air pollution. Only in 1991 were emission taxes were introduced for a broad spectrum of substances countrywide.

During the Soviet era, national hydro-meteorological services maintained ambient air quality monitoring networks. Almost all the stations were concentrated in densely populated and highly industrialized cities. The monitoring was based on manual sampling. There were no automated monitors. According to standard methodologies, the following criteria pollutants were monitored at all monitoring stations: TSP; $SO_2$, CO and NOx. A broad spectrum of specific substances was measured at some of monitoring sites of several major cities. There were no regular measurements of $O_3$, Pb and VOCs. There also were no stations measuring fine particles with aerodynamic diameters of less than 10 microns. Ambient air quality data were recorded in paper formats not computerized databases. Data were reported in paper format on daily, monthly and annual basis. In general, these ambient monitoring systems were more designed to detect longer-term pollution trends, rather than high pollution peaks and thus, did not assist in the daily air quality management.

Since 1991, national environmental ministries or committees with regulatory and some managerial functions have been established in the independent states of the Caucasus. However, these agencies are still in the process of developing their organizational structures and during last ten years have been expanded or cut several times. North Caucasus republics and krays do not have independent environmental bodies. Existing governmental institutions there are sub-ordinated to the federal agency. In the air protection field, media-specific departments/divisions under environmental ministries deal with air protection. They have regulatory functions to issue operation permits for stationary sources. They also are responsible for developing general policies, programs, regulations, and methodologies in the air protection field. Compliance assurance monitoring and law enforcement is conducted either by regional/district/local environmental authorities or special inspection bodies. Health ministries are responsible for developing and setting health-based ambient air quality standards. Road Police Departments are responsible for inspecting and monitoring mobile sources. Either hydro-meteorological services or environmental ministries carry out air quality monitoring responsibilities within the Caucasus countries.

After independence, all the South Caucasus countries and the Russian Federation adopted framework laws on environmental protection. Although these laws introduce new approaches, principles and standards: "polluter pays", "risk minimization", "access to information", "critical loads", BAT, IPPC, EMAS, etc. they are only statements, and require the development of detailed legislation. Existing air protection laws are still based on the Soviet principles and approaches. According to these laws, source specific ambient-based standards are applied for stationary sources. There is no differentiated approach for existing and new facilities. For mobile sources, emission standards cut from Soviet models are employed. There is no differentiated approach for old and new models. Only CO and soot content in exhaust gases are regulated. There are no standards for NOx and HC emissions. Additionally, there are no regulations covering the vaporized (fugitive) emissions. Similarly, Soviet ambient air quality standards are used in the region. These are only health-based standards and do not take into consideration protection of ecosystems and amenities. Although some of the Caucasus countries, Georgia for example, attempted to adopt EU standards there are no finances and implementation mechanisms to undertake appropriate measures. The standards need not only change in quantitative values, but also change in the whole data collection, processing and analysis systems, which is a resource and time consuming process.

Even if the legislation were perfect, poor enforcement system would preclude compliance of existing laws and regulations. At present, the countries lack finances to develop modern compliance assurance monitoring and control systems. Environmental law enforcement officers are untrained and poorly equipped with measuring devices and there is no legal basis for the frequency and quality of inspections and emission measurements. Administrative penalties imposed on violators, including permit conditions, are symbolic, encouraging illegal activities. On a whole, the Caucasus countries lack legislation and practical experience related to environmental damage, liability and compensation issues, and public court suits.

Emission taxes currently employed in the region do not perform well. Although there is insufficient empirical evidence, it is doubtful that charges have any effect on environmental behaviour. First, charge rates are set at low levels, not taking into consideration marginal abatement costs of industries. Second, real charge rates are low due to the growing inflation and there is no frequent tax adjustment. The criteria for calculating base charge rate is unclear and somehow arbitrary. Although relative human health effects are used for the calculation of base charge rate, it is still unclear how closely they are related to marginal damages. Pollution charge system is very complex itself, covering hundreds of pollutants that are infeasible to monitor. Real revenues fall short of estimates due to the lax enforcement and monitoring. Economic difficulties that the industries undergo today contribute greatly to the low level of revenues from pollution charges. Many marginal enterprises are not capable of paying charges. Frequently, charge deductions and even exemptions are made for prioritised enterprises. The revenue generation is a major driver for regulators. Receipts from charge/taxes are not earmarked and there is no transparency on how much is spent on environmental purposes. However, the inertia of the political system and non-existence of a functional market are core reasons for the low performances of existing tax programs. "Predatory" rent-extracting systems are everywhere in the region. Although privatised, the same ministries, local authorities, and plant managers hold the firms. All of them are linked with each other by bureaucratic connections and mutual services. In practice, existing laws are not enforceable equally for all the parties. High authorities as well as prioritised sectors remain untouchable.

A current problem related to ambient air quality monitoring is the drastic decline in data collection due to shortage of financial resources and technical equipment. In general, existing monitoring networks do not meet international requirements in terms of number and location of sites, data collection, storage, processing and reporting methods, etc. In addition, the current economic situation requires the change in monitoring network design as well as gradual network automatisation, in order to reflect the current status of ambient air and the major pressures as well as conduct daily resource management and make short to medium-term forecasts. At present, the traffic related pollution is a major concern and will continue to exist as such in the future. Hence, particular attention should be paid to ground level ozone, CO, VOCs, NOx and PM10/2.5 measurements. In addition, considerable attention should be paid to ambient lead measurements, since leaded gasoline consists of significant share in total gasoline pool. Modelling capabilities have to be strengthened as well, since modelling, though imprecise, is one of the cost-effective ways for ambient air quality monitoring. Hence, it can be used as complement for real measurements.

During the period from 1972 to 1991, the USSR became signatory and party to the 1979 European Convention on Long-range Transboundary Air Pollution and some of its protocols, 1985 Vienna Convention for the Protection of Ozone Layer and 1987 Montreal Protocol on the Substances that Deplete Ozone Layer. Soviet experts participated also in the development of the UN Convention on Climate Change. After independence, the Russian Federation automatically became an inheritor of the Soviet legacy. The South Caucasus countries started participating in international treaties and agreements individually. They became parties to the Vienna Convention and Montreal Protocol. At present, Georgia is ahead from other South Caucasus countries in terms of participation in Montreal Protocol. She has already acceded to London (1990), Copenhagen (1992) and Montreal (1997) Amendments. South Caucasus Countries and the Russian Federation became also parties to the UNFCCC. Later, Armenia and Georgia have signed the Kyoto protocols. Georgia, Armenia and Russia are also the parties to EC Convention on Long-range Transboundary Air Pollution and actively participate in negotiations and development of relevant protocols. The countries also participate in the London Charter on Transport and Environment and Program of Joint Action (POJA) processes. Georgia together with some of the NIS countries participates in EU approximation processes funded by European Union. With financial assistance of different international institutions and donors, UNDP, UNEP, WB, GEF, Multilateral Fund, EU-TACIS, etc. various national activities have been implemented under the above treaties and agreements. Country programs and first National Communications under UNFCCC have been prepared in all these countries and National Climate Centres have been established in some of them. Ozone Country Programs and action plans have been prepared or are currently under preparation. Ozone Units have been established in some of these countries and several technical assistance and investment projects have been implemented.

Whereas the cooperation at the global level is high, there is practically no cooperation at the regional level to address transboundary air pollution issues. Although, in the past some of the ambient monitoring stations within the region were measuring regional background pollution levels, at present, there is practically no information on trans-boundary movements of pollutants.

## 2.8 Wastes and Hazardous Chemicals

Traditionally, there was no state system of integrated waste management in the FSU including the Caucasus region. No specific management agency existed. Separate sector-specific institutions and organisations were responsible for waste disposal generated under their auspices. There was no specific law regulating wastes. Only sanitary-hygienic rules and technical requirements existed. Whereas the system of state inventory and regular reporting was established for air and water discharges in the late 1970s, there was no such system for wastes. Therefore, there are practically no historical data on them. Limited data are scattered among different organisations. Whereas in 1986 an effort to introduce the state system of inventory and statistical reporting for industrial wastes was made by the Soviet central government, the system was never introduced widely.

Consequently, wastes were frequently disposed without due consideration of environmental issues. Legal landfills were not planned in an environmentally friendly manner either. Frequently, municipal wastes were disposed together with industrial and hazardous wastes from hospitals, military camps, etc. An even more uncontrolled situation exists at present.

## 2.8.1 Municipal Wastes

Population growth and urbanization have resulted in increased generation of municipal wastes over the last 30 years in all the regions of the FSU, including the Caucasus, although this trend slowed somewhat following the collapse of the Soviet Union. In Armenia, for example, per capita solid municipal waste generation amounted to about 370-430 kg annually in 1985-90, while the figure was about 247-285 kg in 1997 (UN-ECE/MNP of Armenia, 2000). The figures are similar to those in all transition countries. At present, annual municipal waste generation has been increasing with slight upturn of economy. As the studies in selected cities show, the largest share of solid domestic waste is due to the household wastes and the rest is harmless industrial waste. The studies for selected cities of Armenia show that the content of food residues has decreased by 9 per cent and that of soil, silt and debris increased by 12% since 1990. The percent share of paper and polymeric materials has been increasing as well. The study for the city of Tbilisi has showed increased plastic component in municipal waste (WB, 1996).

Historically, solid waste was taken to a landfill and covered with soil. Some was burnt and/or processed. There used to be some recovery of organic wastes. In separate cases food wastes were collected separately and used as animal foodstuff. Usually, legal landfills were built without special planning and due consideration of environmental issues.

At present, existing municipal waste landfills are overloaded, improperly operated and maintained and do not meet minimum health and environmental requirements. Illegal waste dumping is common as well. There is a very limited practice of waste separation and recycling. Only glass bottles are recycled in some urban areas. Wastes are disposed by private sector without any state control. Consequently, industrial wastes and even hazardous wastes are dumped into the municipal waste disposal sites. In rural areas, garbage is directly dumped on riverbanks, hence threatening surface and ground waters.

### Solid waste composition for the cities Yerevan and Hrazdan

| Constituents | Hrazdan | Yerevan | |
|---|---|---|---|
| | | *Before 1990* | *After 1990* |
| *Paper, corrugated paper* | 11.85 | 11.6 | 18.0 |
| *Food residues* | 32.67 | 40.9 | 30.0 |
| *Wood, leaves* | 5.95 | 6.7 | 2.0 |
| *Textile* | 2.72 | 2.8 | 2.0 |
| *Resinous substances, leather* | 1.74 | 2.0 | 1.0 |
| *Polymeric substances* | 2.41 | 2.0 | 2.0 |
| *Bones* | 1.69 | 1.8 | 1.5 |
| *Ferric metals* | 1.77 | 1.9 | 0.2 |
| *Non-ferrous metals* | 1.31 | 1.2 | 0.1 |
| *Glass* | 5.49 | 5.4 | 4.0 |
| *Rocks, glass* | 16.20 | 7.6 | 11.2 |
| *Soil, silt, etc.* | 16.20 | 16.1 | 28.0 |

*Source: UNEP/MNP of Armenia, 2000*

The absence of controlled landfills for environmentally sound municipal waste disposal or its proper incineration creates the following problems for the population and the environment:

- Risks of soil and groundwater contamination with heavy metals and other hazardous sub stances in the vicinity of landfills, especially where industrial and municipal wastes are dumped together;
- Evaporation of substances containing heavy metals and toxic organic pollutants from uncontrolled municipal waste landfills as well as release of toxics from open-land waste burning;
- Hygienic-epidemiological risks related to rodents (cholera, tularaemia, hepatic and other diseases).

In the past, municipalities and local authorities were better-operated due to the state financing. Modern sustainable waste management requires high level of institutional strength (legal procedures for planning, designing, operation and closing of landfills, establishment/operation of fee collection system, modern technical equipment, compliance to environmental standards, public awareness and participation, etc.). The most important constraint to the development of proper waste management systems is economic hardship, low environmental awareness and weak democracies in countries (especially poor delineation of duties and powers between central and local authorities).

### 2.8.2 Industrial Wastes

During the Soviet period, different industries, e.g., gas and oil, ferrous, non-ferrous, chemical, machinery, food, cement, light industries, etc. developed in the Caucasus region generated high volumes of industrial wastes annually, including hazardous wastes, containing heavy metals, solvents, oil products, etc. Soils around industrial zones, oil and gas drilling fields, quarries, and power plants were contaminated with toxic substances. In 1988, for example, in the city of Alaverdi in Armenia, where non-ferrous industries were developed, soil lead content was 11 to 29 times the existing soil quality standard and copper content was 16 times the background concentrations. Soils around steel manufacturing plants in Rustavi (Georgia) and Sumgayit (Azerbaijan) were contaminated with benz(a)pyrene, lead, copper, zinc, mercury, molybdenum, etc. and background concentrations were exceeded more than 10 times there. In the city of Zestaphoni, where a ferrous-alloys plant was located, high concentrations of manganese were found. In Yerevan and Sumgayit fluorine concentrations around aluminium plants were 6-10 times background levels (State Committee of the USSR on Nature Protection, 1989). High concentrations of PCBs, used as semiconductors in transformers and condensers, were found in soils around power and electrical machinery plants. PCB contamination, for example, was observed around condenser manufacturing plants in Baku and Ganja (State Committee of the Azerbaijan Republic on Nature Protection, 1993).

Traditionally, some industrial wastes were either utilized or rendered harmless. A small percent was directly dumped into solid waste landfills. The majority of hazardous wastes were buried into specially arranged polygons. Some of the industrial wastes, though in small quantities, were re-used by enterprises. For example, the Nairit plant in Armenia re-used rubber waste to make glue (TACIS/MNP of Armenia, 1998).

During the Soviet era, there was no specific law regulating wastes, including industrial wastes. Only specific regulations existed for waste disposal, utilization, transportation, rendering harmless and burial. In addition, technical and construction requirements were applied for landfills/toxic waste disposal sites.

In general, Soviet industry was a resource intensive and highly polluting sector. No tools, either regulatory or market-based, were employed to prevent pollution at source and promote cleaner technologies. The inventory system for industrial wastes, including toxic wastes, was not in force, whereas such systems, though not perfect, existed for air and water discharges. More or less full data exist for 1990, when the comprehensive inventory of industrial wastes was conducted throughout the Soviet Union.

The drastic decline in industrial activities that followed the disintegration of the Soviet Union resulted in a decline in industrial waste generation in the early 1990s. In Armenia, for example, non-hazardous industrial waste generation fell from 35.2 million tons/yr in 1985-90 to 251,000 tons/yr in 1995-96 (UNEP/MNP of Armenia, 2000). In parallel, the hazardous waste generation rate fell. Currently, a slight growth in industrial output can be observed. However, existing facilities still work at about 15-20% of their capacities. In general, the structure of industry shifted from heavy and chemical industry to oil and gas operations, mining, cement manufacturing, food processing, etc., which are more adapted to local markets and locally available raw materials. This itself might affect the industrial waste composition. At present, oil industries, mineral resources extraction and processing industries and power plants are major generators of industrial wastes containing oil residues, heavy metals and PCBs, etc. The problem of disposal, rendering harmless and utilization of industrial wastes is very acute in the region. In Sumgayit, for example, about 200,000 tons of mercury sludge, with 0.1-0.3% of mercury content has been accumulated since 1980s around the chlorine-alkali production plant. These wastes are inadequately stored, contaminating ground waters and Caspian Sea bed sediments through seepage (State Committee on Ecology and Control of Natural Resources Utilization, Azerbaijan, 1998). Since 1998 about 125 million toxic wastes containing arsenic have accumulated in the Tyrnyauz molybdenum and wolfram quarry and processing plant in Kabardino-Balkaria

(Ministry of Environment and Nature Resources Protection, Russian Federation, 1998). In Stavropol kray, about 4.4 million tons of toxic wastes were registered in 1995, of which one million tons were of highest toxicity (Ministry of Environment and Nature Resources Protection, Russian Federation, 1996). In Georgia, about 1.3 million tons of toxic wastes are accumulated at present (WHO/MoH of Georgia, draft, 2001).

Overall, the rate of utilization or rendering harmless of hazardous wastes is not high in the region. However, it varies for different parts of the Caucasus. In Stavropol kray, for example, the total amount of hazardous wastes generated in 2000 amounted to 226.6 thousand tons from which over 60.7% were utilized or rendered harmless, while in Krasnodar kray, of a total of 196.6 thousand tons, only 26% were treated (State Committee of the Russian Federation for Statistics, Russian Federation, 2001).

At present, toxic wastes are mostly accumulated within territories of industrial facilities or nearby territories or dumped into municipal waste landfills or illegal dumpsites. Known hazardous waste disposal sites are overloaded and not adequately isolated from the environment. There are no finances or mechanisms to arrange new sites.

Present status in the field of waste management system, including industrial wastes, is caused by the lack of appropriate national legislations and institutions. Licensing systems for industrial wastes are not put into force. Waste classification systems are either non-existent or imperfect, not going in line with EU (yellow and corrected red lists, etc), UN and OECD, etc. classification systems. There is virtually no system of toxic waste and contaminated site inventory. Because of that, information on industrial wastes is practically absent. Finally, there are no policies promoting prevention/minimization of toxic wastes at sources. Such principles and standards as IPPC and BAT, etc. although stated in framework environmental protection laws of some of the South Caucasus countries, are not yet implemented. Nor do the problem of liability for the past pollution is reflected in national legislations.

The problem of transboundary movement and disposal of hazardous wastes has become critical since the disintegration of the Soviet Union. Non-existence of sound law enforcement and monitoring systems as well as high corruption poses the threat that the Caucasus countries could become "havens" for international waste trading. In addition, existence of uncontrolled territories with practically no law and order promotes illegal trading and smuggling. Although, all South Caucasus countries and the Russian Federation are parties to Basel Convention on Transboundary Movements of Hazardous Wastes and their Disposal, they lack national capacities as well as finances to fulfil the commitments taken under the above treaty. There is a need to develop state-of-the-art waste management/custom legislation, build institutional capacities and raise public awareness. In this regard, international assistance is needed in order to promote regional co-operation in waste management and achieve environmental safety.

### 2.8.3 Radioactive Wastes

The issue of radioactive wastes in the Caucasus region is basically related to the nuclear power plant operated by Armenia, military camps, and oil drilling and processing operations in Azerbaijan and some parts of the North Caucasus. Different research and medical insti-

- In Azerbaijan, radionucleides of naturally occurring radium, thorium and potassium were found in oil drill fields. At some places, soils are so polluted that they need to be buried as radioactive wastes. "oil lakes" and flood fields, created while pumping bore-waters back into oil-bearing layers, aggravate the situa tion. Some old oil drill fields currently are used as settlements hence the population is exposed to radon noble gas damaging to the lungs. A similar situation exists for chemical plants and oil refineries. Ground waters with high radium-226, thorium-228 and potassium-40 content were used in a Baku iodine plant as a raw material. As a result, part of plant territory and equipment were polluted by radionucleides. Especially urgent is the problem of activated charcoal decontamination, accumulated in the plant territory;
- In Georgia in 1996, three people were injured, two fatally, when they opened the container with radioactive medical wastes. These containers were sent to Russia for disposal, but they were returned to Georgia due to the failure transportation routes. The issue was completely neglected.
- In 1997, nine soldiers were injured in training centre near Tbilisi from Cs-137 and Co-60 radiation sources, left by Soviet military troops.
- In winter 2002, three people received high doses of radiation in Western Georgia, after they dismantled 2 radioactive sources of strontium-90. These and other sev eral sources were brought to Georgia in 1980s for the construction of large-scale hydro dam and were designed to be used as power generators for radio com munications. As the hydro dam project was never implemented, these sources have been left without any control. Recently, local inhabitants have found the con tainers with these radioactive sources and decided to use them for domestic needs. Hence, they opened these sources and imposed high threat to their and other people's lives. After the injured inhabitants were hospitalised, the case gained wide public disclosure. With joint efforts of the Ministries of Environment and Internal Affairs and State Security Service of Georgia and the experts of International Nuclear Agency the dismantled sources were rendered harmless.

*Sources: State Committee of the Azerbaijan Republic on Nature Protection, 1993; TACIS/MoE of Georgia, 1998; Courier, Rustavi-2 night TV show, 04.02.02* tutions are also the sources for radioactive wastes. There are practically no data on these types of wastes and the issue needs to be further studied. Even if there is some information, it is frequently classified and not available for different users. Public awareness about radioactive wastes is also very low within the entire region. As a result, casualties in the population are not rare. In particular, a high threat is from former Soviet military bases, where significant amounts of radioactive wastes are accumulated. There are no comprehensive inventories of radioactive sources and wastes. Nor do storage facilities exist for them. Although, the Caucasus countries have designated authorities, they have little capacity to handle the issues.

### 2.8.4 Hazardous Chemicals and Obsolete Pesticides

During the Soviet period, fertilizers and agrochemicals were intensively used in the Caucasus region, since the region's economy was largely agriculture-based. Although total use has declined dramatically since the break up of the Soviet Union, there are some indications that the use has been slightly going up, at least for Georgia. There, about 60-70% of chemicals in use are illegally imported (MoE, expert interviews, 2000; GRID-Tbilisi, 2002). For other parts of the Caucasus, there is no information available.

There are still high volumes of obsolete and banned pesticides stored in warehouses for more than 15 years throughout the region. Many of these warehouses are completely outdate and do not meet existing technical and sanitary requirements, imposing high threat to surface and ground waters and nearby soils. Large quantities of pesticides are directly exposed to open air. Due to the lack of finances, source inventories and the measures for rendering obsolete pesticides harmless, proper storage, incineration, etc. is not undertaken by responsible authorities. Existing state inventory systems for hazardous chemicals, if they exist, malfunction and data on chemicals import-exports, production, and storage and consumption patterns are very scarce. Public awareness around hazardous chemicals is extremely low. Local farmers lack knowledge on the safe application of agrochemicals and hence, injuries are common among this group.

Thus, the current situation can be described in a following way:

- Centralised import of pesticides was stopped in the beginning of the 1990s due to economic difficulties;
- Illegal import and distribution of pesticides and wastes is growing as a result of inade quate legislation, law enforcement and weak management capacity of authorities;
- Management of chemicals is not co-ordinated among different authorities (MoE, MoA, MoH, etc.) at both central and local levels and no appropriate information for decision-making process is available;
- There is lack of training for new farmers in safe handling of chemicals;
- No regional co-ordination policies and activi ties exist for the integrated management of chemicals and hazardous wastes.

There are recent positive developments in the Caucasus to overcome problems indicated above: Convention on the Prior Informed Consent Procedure for Certain Hazardous Chemicals and Pesticides in International Trade (Rotterdam, 1998) is signed by Armenia, and Stockholm Convention on Persistent Organic Pollutants by Armenia, Georgia and the Russian Federation. In this regard, initial steps to enable implementation of the provisions of these multilateral treaties are undergoing. However, growing poverty and general (environmental) security issues have first priority in the new democracies of the Caucasus countries. Accordingly, if no specific international assistance is made in the short-term towards this direction, the issue of chemicals and waste management will remain critical, since the countries lack financial and technical capacities to handle it.

In order to prevent or mitigate the issue, it is necessary that the governments further develop their waste management legislations, policies, and build-up their capacities. Waste inventory systems have to be established. Sound market-based tools have to be introduced for field financing. Policies promoting cleaner technologies have to be implemented. All the countries have to strengthen their capacities towards controlling illegal trades and import-exports of wastes through building co-ordinated policies.

One of the specific examples of urgent co-ordinated actions needed in the region is: inventory, monitoring and environmentally safe disposal of PCB-containing wastes and products. In this regard, GEF enabling activities to assist countries to fulfil their obligations under the Stockholm Convention need new additional inputs through bi- or multi-lateral assistance mechanisms.

## 2.9 Natural disasters

Natural disasters, frequently of catastrophic character, are widespread phenomena in the Caucasus. Fortunately, not all the natural processes are observed in the Caucasus and some have relatively small intensity. The Caucasus is not an active volcanic zone, there are no tropical storms and hurricanes, and cyclones and floods are of much smaller size than those in tropics or areas with extensive lowland topography. Nevertheless, there are other environmental disasters: landslides, avalanches, mudflows, as well as some unfavourable hydro-meteorological processes that are very real for the Caucasus. Though meteorological processes (frost, drought, sand storms, winds storms, hailstorms, ice storms, etc.) do not lead to human deaths, they may cause very serious economic losses.

During the Soviet era, different institutions studied environmental disasters. Some data were also collected. Data collection, however, was irregular and no unified system existed for this.  Preventive measures against natural phenomena, such as reforestation, slope terracing, etc. were also conducted. There was no precise methodology for calculating damage incurred from natural disasters.

Natural disasters have become rather intensive recently. No single strategy to fight against environmental disasters has been yet developed, either in the region or in an individual country. Nor does any organization with the capacity to make forecasts and manage disasters exist in the region.  Nevertheless, some positive steps are being taken towards the strengthening managerial capacity in the field. For example, UNDP has financed some activities at national and regional levels for establishing early disaster warning and management systems and strengthening regional capacity for joint management of environmental disasters in the South Caucasus.

### 2.9.1 Landslides

Intensive landslides characterize mountainous territories of the Caucasus. The majority of landslides occur in the middle-mountain zone. Their intensification is due to excessive humidity, earthquakes, and different economic activities.

Landslides cause many changes in the environment. Specifically, they destroy topsoil and vegetation as well as settlements. For example, a landslide completely destroyed the village Marmarashen (Armenia, the bank of the river Azurn), and as a result the local population was forced to leave the place. There are numerous similar examples in different regions of the Caucasus.

Landslides intensify in case of unsustainable water use practices, water loss from reservoirs, and destruction of water distribution systems. For example, in Yerevan and its surrounding villages, favourable conditions for landslides have formed due to improperly built and maintained irrigation, water supply and sewage systems and high water losses.

Recently, a trend of increase in the amount of landslides has been observed. In Georgia alone, the amount of landslides has exceeded 50,000. The area of regions damaged by landslides has also increased. In Georgia 3.5 million hectares are within the area of landslide and mudflow processes (Tatashidze and et al., 1996). In Armenia, the regions affected by landslides occupy 500 km2 (2% of the total area of the republic). Landslides are especially prevalent in the south-eastern part of the Caucasus, Lenkoran (Azerbaijan), and foothills of the West and Central Caucasus and Meskheti and Trialeti ranges (Georgia) (The Map of Zoning...,1985).

- Intensification of landslides in Ajara in 1989 was connected with exten sive snow (snow depth exceeded 3m) and an unusually warm spring. April average temperature exceeded 4-50 C. All this was followed by intensive snow melting, saturation of rocks by water and numerous landslides, especially in the river Tsablana gorge.
- In September 1999, because of heavy rains, many landslides occurred in Dagestan near the towns of Buynansk and Gunib. The landslide damaged the 75-km length transport road, water supply and sewage sys tems, and over 2,000 buildings, etc.;
- In 1997 in Karachaevo-Cherkessia, in the district of Ust-Jeguta, over 12,000 $m^3$ landslide body was formed, which damaged transport com munications and the Stavropol irrigation canal.

*Source: Beruchashvili, 1995; GRID-Moscow, 2001*

### 2.9.2 Mudflows

Mudflows are characteristic of the mountainous regions of the Caucasus, resulting in serious economic loss. The negative impact of mudflows on the environment is multiple. Specifically, they bring about the formation of erosive slopes, pollute rivers with mud and pebbles and destroy agriculture lands, industrial enterprises and transport communications, including oil and gas pipelines, which impose a particular threat to the environment. Mudflows are most intensive on the southern slope of the Greater Caucasus within Azerbaijan. It was considered one of the most active regions of the former USSR, and the largest mudflow danger areas in the Caucasus (Geomorphology of Azerbaijan, Baku, 1959). In average, annual economic loss from mudflows in Azerbaijan amounts to $US 15 million and over hundred settlements with total population of 700 thousand people are under mudflow danger (Dangerous Natural Phenomena ..., 2002). Mudflows have frequently damaged settlements, such as Shecki, Ordubad (Azerbaijan), Yerevan, Kapan, Alaverdi (Armenia), Tbilisi, Kvareli, Telavi (Georgia), Tyrnyauz (Kabardino-Balkaria). In total, mudflows damaged about 200 settlements in Armenia, and several hundred ones in Georgia (UNDP, Armenia, 1999; Tatashidze et al. 1996).

Strong mudflows formed in the Caucasus bring down hundreds, sometimes millions of cubic meters of friable mass, forming enormous alluvial cones (Caucasus, Moscow, 1966). The region's relief, geological structure and specific climatic features, namely, steep slopes, fragile rocks, long droughts followed by downpours, etc. form favourable conditions for mudflows in many places. Mudflows have accelerated erosion processes, which have intensified over the last twenty years because of intensive woodcutting, overgrazing and unsustainable land use practices. In some places, tailings from mining operations accumulated on the slopes and riverbanks (which happens rather often) form additional factors for intensification of mudflows. In some places, one of the major reasons for the declining forest areas are thought to be erosion processes caused by mudflows.

Before the mid-1980s, over 20% of mudflows (1,130 flows) in the territory of the FSU occurred in the Caucasus. Of these, 936 (from 1978-1,030 flows) were registered in the South Caucasus, and 194 the North Caucasus (Dangerous Hydro-meteorological Phenomena in the Caucasus, Leningrad, 1984).

In order to prevent the destructive influence of mudflows special constructions against mudflows are built in Caucasus. Along the South Caucasus railway line, there are mudflow-gassings, built in the 19th century. Many constructions were built to protect against mudflow in the Soviet period. Nevertheless, there are still no perfectly regulated mudflow basins unlike in some countries of West Europe where thousands of such systems operate.

- A catastrophic mudflow was formed in the Terek Gorge at the village Larsi (the North Caucasus). It came from Devdarak glacier (from Mkinvartsveri, Georgia). It brought a huge boulder (29X15X13 m), known as "Yermolov's Stone," which is considered as one of the biggest glacier boulder in Eastern Europe. In the river Terek basin, strong mudflows occur frequently. They often damage the Georgian Military Road, one of the most important Trans-Caucasian motorways.
- Mudflows are common in the Duruji River gorge (left tributary of the river Alazani, Georgia), posing danger to the town Kvareli. In 1899 a mudflow of catastrophic character brought down 224-ton boulder ("Duruji boulder") with the size of 5,8x4.2x4m. In 1997, a mudflow damaged the town Kvareli, where stone, road metal and mud covered town streets, damaged melioration systems and arable lands.
- Mudflow on the river Sadon (Ardon basin, North Ossetia) in 1958 was one of the strongest in the Caucasus.
- Extremely high intensity of mudflows was reported in 1989, for both the North and South Caucasus, especially in North Ossetia, Kabardino-Balkaria, Dagestan, Georgia and Azerbaijan. This was related to heavy rains and intensive snow melting in March-May.
- In 1977 due to high temperatures and extensive precipitation, mudflows were intensified in the North Caucasus, involving almost all altitude zones. In particular, mudflows were intensive in the basin of the river Bezengsky-Cherek.

*Sources: Tsomaia, 1985; Dangerous Hydrometeorological…, 1983*

### 2.9.3 Flooding

Water hydrology of the Caucasus is largely affected by two factors: atmospheric precipitation and snow melting. Usually, annual precipitation increases together with elevation until 2,000 m above sea level and decreases from west to east. Rivers that flow in areas with high precipitation and are fed by snow melting are characterized with high flow. Many rivers in originate in high mountain zones of the Greater Caucasus, where eternal snow and glaciers are located. High flood periods, lasting about 6 months, are characteristic of these rivers. In spring and summer periods, when intensive snow melting starts, water level increases considerably. Usually, one peak discharge occurs on these rivers, whereas on the rivers that start in foothills of the Caucasus there are two of them: in spring when snow melts and in fall after downpours. Floods are spontaneous only in some years, when the most intensive snow melting occurs and water covers adjacent plane territories, incurring great damage to agriculture.

The following rivers form the largest flood areas: Kuban, Terek, Kura, Araks and Rioni. Along their shores there are concrete dikes and levies to prevent material loss caused by floods. Many reservoirs regulate water, such as the Mingechevir on the river Kura, Krasnodar on the river Kuban, Chirkei, Chiri- Yurti on the river Sulak, Lajanuri, Gumati, Vartsikhe on the river Rioni, Jvari on the river Enguir, Akhurian, Arpichil, Araks hydro knot on the river Araks, etc

During the past 30 years major floods occurred in Western Georgia in April 1978, May 1982, and January 1987; in Baksan gorge in the North Caucasus in July 1975 and in Krasnodar Kray in the North Caucasus in February 1998. All these floods had serious social-economic and environmental impacts. Specifically, they inundated settlements including the large towns Kutaisi, Zestaphoni, Krasnodar, Tikhoretsk etc. They also damaged large areas of agricultural lands and infrastructure: roads, bridges, water supply and sewage systems, etc. For instance, as a result of a 1998 flood, about 329,000 ha of agricultural land was damaged in Krasnodar Kray (Dangerous Hydrometeorological…, 1983; Ministry of Environment and Nature Resources Protection, the Russian Federation, 1994; GRID-Moscow, 2001). The flood, occurred in West Georgia in 1987 inundated nearly 200 km sq. area, significantly damaged 3.2 thousand and completely destroyed more than 2.6 thousand buildings. Total economic loss amounted to $US 300 million (Dangerous Natural Phenomena ..., 2002).

### 2.9.4 Avalanches

Avalanches are one of the most common natural disasters in the Caucasus. They impose danger to populated areas, industrial enterprises, and means of communication. In winter, traffic is often blocked between the North and South Caucasus.

Avalanches are particularly typical in highlands, although the lowest border of high-risk territories descends far below. The risk zone comes down the lowest in the West Caucasus (to 50-100 m on southern slopes, 550 m - on North Caucasus), while in the East Caucasus it is found at elevations of 1,400-1,500 meters and higher. The whole territory located above these hypsometric levels of the Greater and Lesser Caucasus represents an avalanche-prone area (Dangerous Hydrometeorological…,1983). However, the frequency of avalanches varies at different altitudes. The zone of the Caucasian highlands with alpine relief is featured by the highest danger of avalanche (the main ridge of the Caucasus and Skalistyi (rocky) ridge), where the ratio of avalanche danger is 75-80%. Avalanches are observed here during the whole year, but represent danger for only for mountaineers. Northern and Southern slopes of the Caucasus, individual ridges of Lesser Caucasus (Bazum, Pambak, Zangezur, and Murovdag) are also located in avalanche risk prone areas (50-75%).

The avalanche danger period lasts six to eight months, posing a significant danger to populated areas, mountain pass roads etc.

The remaining territory of the Caucasus is at relatively small risk. Here avalanches happen rarely, although because of populated areas and industrial facilities they cause great damage to the economy. In heavy snowy winters, avalanches may even be catastrophic here. In lowlands and foothills, avalanches also cause great economic damage. They are sporadic and occur once every five years or less.

The greatest number of avalanches occurs at heights of 1,000-4,000 m above sea level. They are particularly frequent from January to March, occurring in all areas of the zone of avalanche danger. Avalanches are particularly frequent in the regions not rich in forests. Avalanches destroy mountainous forests too.

There is no comprehensive monitoring of avalanches in the Caucasus, although information about them has been collected since 1804. Special research began in the 1930s. Avalanches occurring near populated areas and roads of strategic importance are studied better. Only three meteorological stations: Mamisoni pass, Kazbegi, and Sulaki located at high altitudes provide information on them. Therefore, the available data do not show a comprehensive picture.

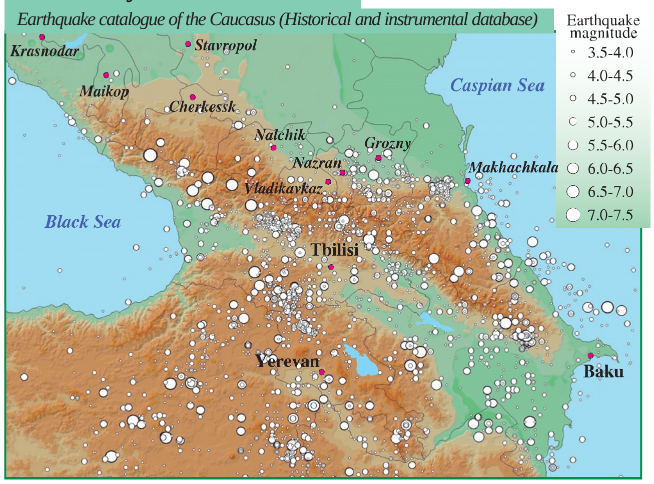
- Following a very snow winter avalanches on both slopes of the Central Caucasus took place in 1976. They were especially powerful in the gorges of Nenskra and Nakra rivers (Enguri basin, Georgia) where 546 hectares of forest were destroyed.
- The winter of 1986-1987 was marked with many avalanches in West Georgia, caused by abundant precipitation that formed high snow cover. That winter was unusually warm. A powerful anticyclone, formed in Eastern Europe, provoked the movement of several warm Mediterranean cyclones to the Western Trans-Caucasus, causing heavy showers in the Colchian lowland and heavy snow in mountain areas. As a result, in Upper Svaneti several avalanches took place leading to human deaths and huge economic losses. Intensive snow melting resulted in serious floods of the Rioni, Tskhenistkali, Khobi and other rivers. Since soils accumulated huge amount of moisture, landslides occurred in spring. Finally, a number of large mudflows occurred in the summer. Overall, damage by these processes in Georgia alone amounted to about $US 300 million. Many people died, hundreds of buildings destroyed, transport communications damaged, 20,000 people evacuated.

*Sources: Land Snow Cover and Glaciers in Caucasus. 1983. Beruchashvili, 1996; Beruchashvili, 1995*

## 2.9.5 Earthquakes

The Caucasus is located in one of the most active Alpine-Himalayan collision belt. Over the past two thousand years, there have been many earthquakes in the Caucasus. Some have been catastrophic, resulted in thousands of deaths, infrastructure destruction and environmental degradation. Sometimes damage caused by earthquakes may be more linked to landslides generated after them than to the actual earthquake.

### Seismicity of the Caucasus



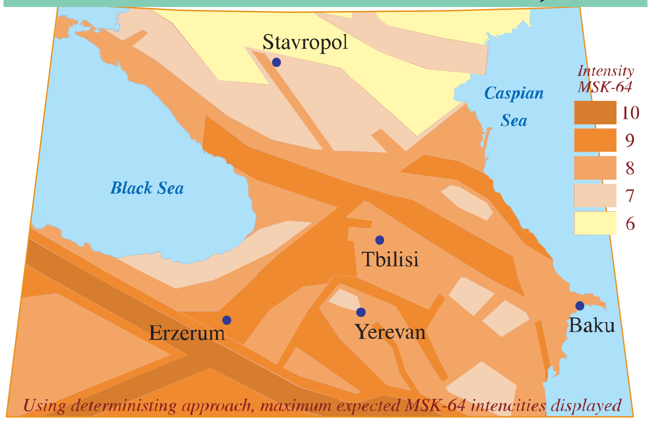

*Source: Institute of Geophysics of Georgia*

The landslides and rockslides resulting from earthquakes have formed lakes in several places. Lake Abrau (near Novorossiisk) was formed two to three thousand years ago, Big and Small Ritsa-250-300 years ago, Gey-Gel (Armenia) in 1139, Amtkeli (West Georgia) in 1891 etc.

Since 1800, over 2,000 significant earthquakes have been recorded in the Caucasus, 1,200 in the last half of the 20th century. While they differed in intensity, their capacity was generally less than 8MSK. Compared with the most active seismic regions of the world, (Japan, California) the Caucasus seems calm. However, over the past decades several powerful earthquakes of 6-6.5M have shook the region (Spitak, 1988; Sachkhere, 1991; Barisakho 1992; Eastern Turkey 1976, 1983 and 1992; North Iran, 1990 and 1997). Among these earthquakes, the most disastrous was the Spitak 9MSK earthquake of 1988, which killed 25,000 people. The earthquake damaged 21 cities, 342 villages, and left 520,000 people homeless (Ministry of Environmental and Nature Resources Protection, Russian Federation, 1994; Institute of Geophysics of Georgia). After this earthquake, some of the regions of the Caucasus were declared 9MSK earthquake zones.

The location of epicentres close to the earth surface (the average epicentre depth is about 20-30 km and less) is one of the specific features of the earthquakes in the Caucasus. Therefore, weaker earthquakes may cause disastrous

**Seismic hazard of the Caucasus test area, 1997**




*Source: Institut of Geophisics of Georgia*

effects there. Moreover, many of buildings of the Soviet period are not built to withstand earthquakes of high magnitude.

The Great Caucasus and Javakheti-Armenian highlands are at the highest level of seismic risk. Most important seismic centres are located along the large tectonic breaks. The Javakheti-Armenian highlands is the most active tectonic area in the Caucasus, characterised by the highest frequency of earthquakes.

## 2.9.6 Wild Fires

Wild fires have some impact on the Caucasus economy and environment. However, they are not as critical as other natural disasters in the region.

Fires negatively affect forest formation, reduce forest quality and productivity, and destroy such functions of forests as water protection, recreation, etc. Fires are caused by both natural factors (lightening, peat self-firing, etc) and human activities. The greatest share falls to the latter.

Clearcutting causes the highest risk for wild fires. Pine forests and dying damaged trees, as well as areas of arid and dry juniper forests are most vulnerable. Clearcutting is very rare in Caucasus, however. Caucasian forests are very diverse, for example in beech forests one can find younger trees next to 200 year-old trees. In Colchic polidominant multi-layer wet forests, the structure is even more complex. That is why there are very few fire risks to old forest ecosystems in the Caucasus. Dry juniper forests remain only in nature reserves (Vashlovani reserve in Georgia, for example) and are fully protected from fire risk. Wild fires frequently occur because of burning of agriculture fields.

Areas with pine forests are growing very intensively at the expense of former agricultural lands. In Racha (Georgia) for instance, forested areas have increased by 5-10% over the past few decades. As mentioned, the danger of fire in pine forests is extremely high, although the wet climate in these districts mitigates this risk. In the Caucasus, wild forest fires are rare (compared with Savannas in Africa). In highlands, this is due to the wet climate, in steppes - mainly to irrigation.

The 1970-80s saw a decreasing number of wild fires, which can be explained by better technical equipment of fire fighters. That is why in the past, forest fires were not considered an important environmental problem for the region. However, in recent years wild fires have been increasing in both the number of fires and the areas damaged by them. One assumes that current trend will continue.

How to preserve the relatively safe situation in terms of wild fires is a critical issue at present. The only solutions are putting restrictions on clearcutting and visiting virgin forest groves as well as establishing an early-warning system for monitoring forests in the Caucasus.

## 2.9.7 Drought

In terms of humidity, the Caucasus is a region of great contrasts. Its western part and highland zones are more humid and the North Caucasus plains and the Javakheti-Armenian highlands are more arid. Evaporation in the entire region exceeds the flow by 140mm, indicating a spreading of arid landscapes in the major part of the territory. Annual amount of atmospheric precipitation exceeds 1,000mm only on the Greater and Lesser Caucasus and Colchida. In the rest of the territories, it is less than above value and in many places amounts to 300-450mm. That is why in light of global warming the problem of xerophyzation (desertification) is very acute in the region. It is more acute in the lowlands and foothills of the North Caucasus, especially in Eastern part as well as in Eastern parts of the South Caucasus: Iori-Ajinauri plateau, Kvemo Kartli plain, Akhaltsikhe depression, Javakheti-Armenian highlands, Kura-Araks lowland, etc.

Droughts are more characteristic of the eastern part of the Caucasus. The lowest amounts of atmospheric precipitation fall in the Terek-Kuma and Kura-Araks lowlands and Ararat Valley.

Lately, a drop in the amount of precipitation is observed, negatively affecting agricultural output. In addition, strong arid winds bring great damage too. For example, 1998-99 autumn and winter droughts in Armenia affected more than 75% of winter wheat crops and up to 50% of orchards (MNP, Armenia, 2001). Similarly, in 1998 in Karachaevo-Cherkessia, droughts damaged more than 50% of cereals. Damage also was incurred to the agricultures of Krasnodar and Stavropol krays, Adigeya, Ingushetia. 1998 and 2000 summers were also extremely dry for Azerbaijan and Georgia, incurring significant economic losses to these countries.

In general, droughts are one of the major factors for desertification. In the Caucasus, desertification process became more intensive in recent years and thus semi-desert and desert elements are met even in places not characterised by such elements, e.g. riparian forests. In East Georgia, for example, over 3,000 ha of total land area is under the process of desertification, caused by droughts and over-grazing (MoE of Georgia/UNDP, 2001-2002)

In the future, global warming will cause the Caucasian landscapes to be more "sensitive" to atmospheric precipitation and less to air temperature. Desertification process will considerably affect arid and semi-arid landscapes in plains and foothills of the East Caucasus as well as sub-alpine and alpine landscapes of high mountains (Beruchashvili, 1995).