Lake Sevan

Experience and Lessons Learned Brief

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1. Description of Lake Sevan

Lake Sevan (Figure 1) is situated in the northern part of the Armenian Volcanic Highland, in Gegharkhounik Marz (province), 60 km to the north from the capital of Armenia, Yerevan (Figure 2). Lake Sevan is the greatest lake of the Caucasus Region and one of the greatest freshwater high-mountain lakes of Eurasia. The basin of Lake Sevan makes up one sixth of the total territory of Armenia. A peculiarity of Lake Sevan includes that the small ratio between the catchment and surface area of the lake is only 3:1, compared to other major lakes (10:1 on average).

Lake Sevan has a unique combination of great size, high mountain location, and comparatively "soft water" (mineralization = 700 mg/L). All other neighboring great lakes—the Caspian Sea (Azerbaijan, Islamic Rep. of Iran, Kazakhstan, Russian Federation, Turkmenistan), Lake Van (Turkey), and Lake Orumiyeh (Islamic Rep. of Iran)— are saline. Among high mountain lakes, Lake Titicaca (in the Andes; Bolivia and Peru) is far ahead by size (8,300 km^2), high altitude (3,812 m) and water quality.

The lake is the greatest inland water body of Transcaucasus Region and one of the greatest freshwater high mountain lakes of Eurasia. Before the increased artificial outflow which began in 1933 during the Soviet period, the surface of Lake Sevan was at an altitude of 1916.20 m asl with a surface area of 1,416 km^2 and volume of 58.5 km^3. The water-level decreases, from this artificial outflow process, influenced an array of hydrological and ecological conditions at the lakeshore and in the lake. The most important of these are: the draining of the wetlands, worsening of the water quality, changed species succession, and biodiversity loss. Lake Sevan is the most important source of fresh water and freshwater fish in the Transcaucasus Region. The importance of Lake Sevan in the economy of Armenia can scarcely be exaggerated: it is the main source of irrigation water and provides low cost electricity, fish, recreation, and tourism.

Lake Sevan and the wetlands of the basin are significant breeding, resting, foraging and wintering area for migratory waterfowl. The boundary of the Lake Sevan Ramsar site includes the watershed (catchment) around the external protective zone of Sevan National Park, identified in Figure 3.

Figure 1. The Lake Sevan Basin.

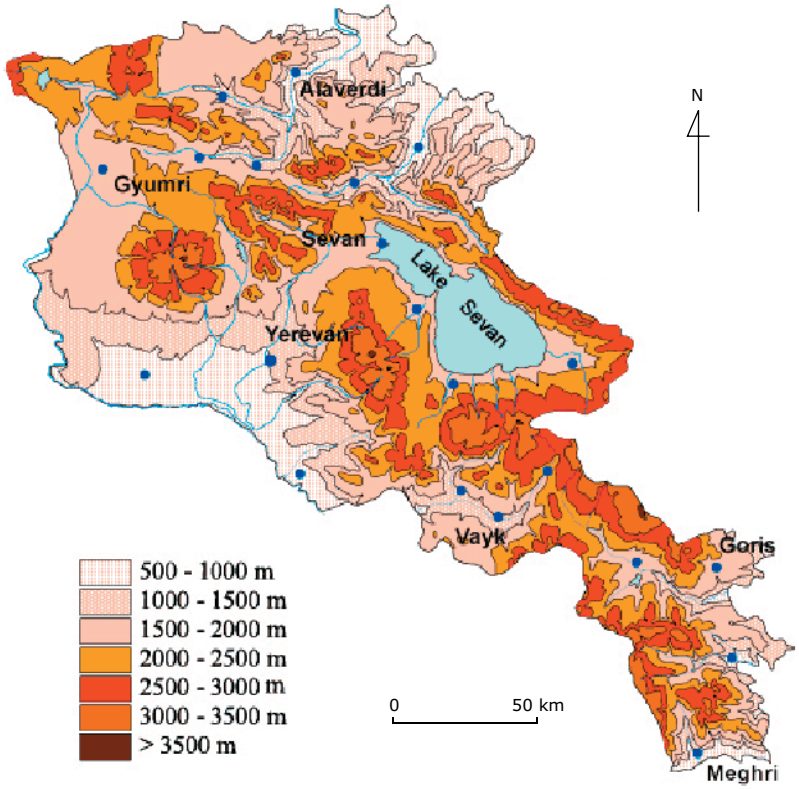

Figure 2. Physical Map of Armenia (Source: Environmental Research and Management Center, American University of Armenia).

It is difficult to overestimate the role of Lake Sevan and its basin for Armenia. The main economic activities in the basin are agriculture and fisheries. Approximately 20% of the livestock in the country is raised in the basin. About 90% of fish catch and 80% of crayfish catch of Armenia is from Lake Sevan. As a result of economic crisis following the collapse of the Soviet Union, industrial production has practically ceased. Development of intensive agriculture and industry, service facilities for tourism and recreation are desirable development goals; however, they need to ensure that ecological damage is minimal.

2. The Lake Sevan Environment

2.1 Physical Environment

2.1.1 Climate

The high-mountain location of the Lake Sevan basin influences the climate, which is cooler than other areas in Armenia. On the shore of the lake, mean temperature ranges from minus 6°C in January to 16°C in July, with average annual temperature of 5°C. There

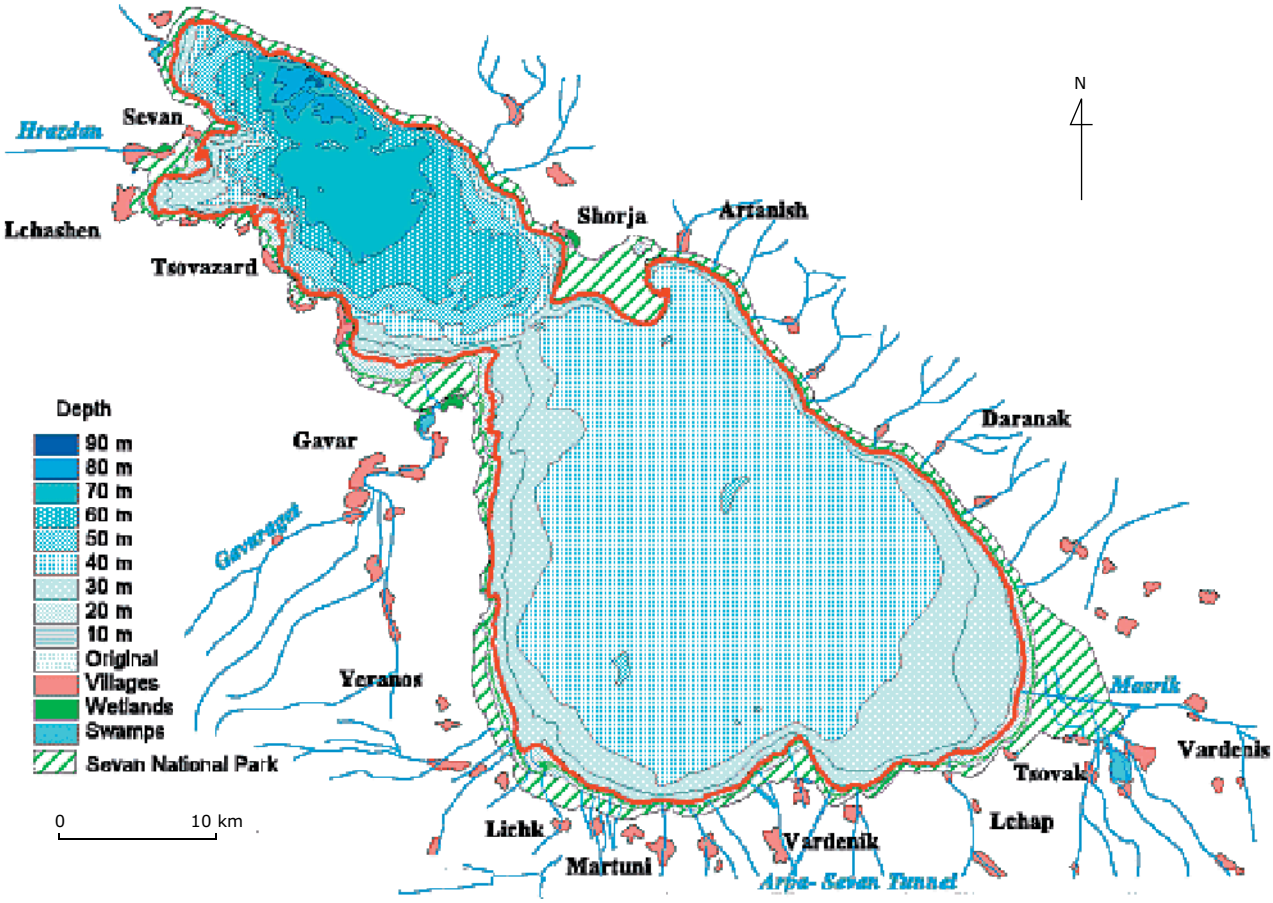

Figure 3. Map of Sevan National Park (Source: Environmental Research and Management Center, American University of Armenia).

are about 240 days with mean daily temperature over zero. The growing season is about 190 days. The annual number of sunny hours varies from 2,600 to 2,800, depending on location. Direct solar radiation is 48 x 10^6 Joules/m^2/yr; total solar radiation is 65 x 10^6 Joules/m^2/yr. Annual precipitation ranges from 340 to 720 mm, of which 17% of falls in the winter, 37% in the spring, 26% in the summer and 20% in the autumn. The weather is usually windy, with an average wind speed of more than 4 m/s, stronger during the winter (6 m/s) and weaker in spring and autumn (3 m/s).

2.1.2 Hydrology

Twenty-eight rivers and streams flow into Lake Sevan, and the River Hrazdan flows out of the lake. The outflow of water from the lake has been artificially regulated since 1933 for hydropower and irrigation. The hydrological balances for the different periods of water management strategy are given in the Table 1; the long-term water level changes are shown in Figure 4.

2.1.3 Geology, Geomorphology and Soils

The site is young on a geological scale. Morphologically, Lake Sevan consists of the deeper Minor Sevan and comparatively shallow Major Sevan (see Figure 3 for bathymetry). The age of Major Sevan is about one million years. The age of Minor Sevan is not more than 100,000 years. The bedrock is formed from tufa, clinker, porphyrite and limestone.

The Sevana, Vardenis and Geghama Mountain ridges, with elevations of up to 3,598 m, surround Lake Sevan from the northeast, south and southwest respectively. On the northern part, the watershed is 2-3 km from the lake and the slopes are steep. On the other parts, the boundary of the watershed is 30-40 km away and the slopes are gentler. The Geghama ridges, on the southwestern edge of the basin, have numerous signs of volcanic activity.

The soil of Sevan ridges is brown carbonate with 30-50% stoniness. The natural soil of the remainder of the basin is chernozem (black soil) with pH 5.8-6.2. On the southwestern shore of Minor Sevan, stony deposits predominate, on the western and southern shore of Major Sevan stoniness is 10-30%, and less than 10% in other parts of the basin.

2.2 Biological Resources

The Lake Sevan basin is located at the junctions of Transcaucasus and Middle East Regions and has elements of

Table 1. Lake Sevan Water Balance in Different Periods (million m^3/yr).

Components of balance	1927-1933	1949-1962	1970-1979	1984-1990	1992-1997	1998-2003
Surface inflow	811	669	774	990	1,144	986
Precipitation	509	475	479	486	466	498
Underground inflow	31	48	56	81	65	76
Summary income	**1,351**	**1,192**	**1,309**	**1,557**	**1,675**	**1,560**
Surface outflow	42	1,383	430	329	831	167
Evaporation	1,136	1,041	1,039	1,102	1,081	1,262
Underground outflow	84	26	9	9	15	20
Summary expenditure	**1,262**	**2,450**	**1,478**	**1,440**	**1,927**	**1,431**
Discrepancy	**+89**	**-1,258**	**-169**	**+117**	**-252**	**+129**

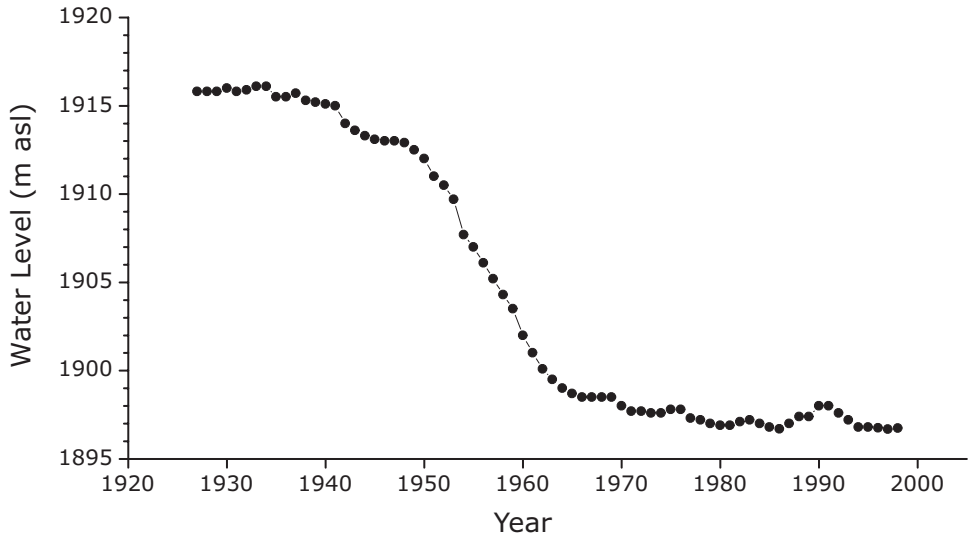

Figure 4. Water Level Changes in Lake Sevan from 1927-1998.

different natural zones: semi-arid steppe, alpine meadows, and broad-leaved forests. A unique feature of the Lake Sevan basin is the relatively high rate of endemism of flora and fauna. The biological diversity of plants is extremely high: approximately 1,600 species of vascular plants have been registered in the basin. Of these 48 species are in the Red Data Book of Armenia and six species are endemic. Vertebrate fauna consists of 276 species; of them, 48 species are in the Red Data Book of Armenia with three endemic for the region. Fauna of aquatic invertebrates include 150 species of different systematic groups.

2.2.1 Flora

The flora of the basin is typical to the highlands of the Transcaucasus Region which has a great diversity of plants. Along the shoreline of the lake is situated the greatest artificial woodland of the country which gives a number of interesting examples of natural and human affected ecological successions. Aquatic associations (plankton, benthos, ichthyofauna) are qualitatively poor with only a few dominant species, which has simplified studies on ecological relationships (food web, etc.).

About 1,600 species of vascular plants (50% of Armenia's flora) have been registered in the lake basin. Of them, 48 species are in the Red Data Book of Armenia. Six species are endemic: *Acantholimon gabrieljanae*, *Alyssum hajastanum*, *Astragalus shushaensis*, *Isotis arnoldiana*, *Isotis sevangensis*, and *Ribes achurjani*.

The dominant vegetation communities of the Sevan basin are mountain steppe, sub-alpine and alpine vegetation with different species of *Astragalus* and *Acantholimon*. The most characteristic arboreal plants of Sevana Mountains are junipers (*Juniperus policarpos*, *J. oblonga*). There are remains of natural oak forests in the central part of the Sevana Mountains. In the Vardenis and Geghama Mountains, sweetbrier (*Rosa canina*) and other species *Rosa sp*. are common everywhere.

After the water level decreased, the dried areas of the former lake bottom have been forested by alien species of plants. Artificial forests composed of pine (*Pinus caucasica*), poplar (*Populus canadensis*, *Populus simoni*), acacia (*Caragana brevespina*, *Caragana trutex*), and willow (*Salix viminalis*). In some area the sallow thorn (*Hippopae ramnoides*) forms almost impassable bush.

On Lake Sevan, emergent vegetation exists only in limited calm areas. Pondweeds (*Potamogeton spp.*) are abundant to depths of 2-5 m. Stonewort (*Chara spp.*) thickets cover the littoral zone to depths of 4-8 m. There is luxuriant development of aquatic vegetation in shallow coves, bogs and ponds.

2.2.2 Fauna

In the Lake Sevan basin there are six species of fishes (two in the Red Data Book of Armenia, two endemic). All native fish species, ishkhan (*Salmo ischchan*), Sevan barbel (*Barbus goktschaikus*), Sevan koghak (*Varicorhinus capoeta sevangi*) are in decline. Of them, the famous endemic ishkhan (*Salmo ischchan*) ("Prince" in Armenian) is now at the edge of extinction. Table 2 shows the changes in fish catches over time.

There are also four species of amphibians, none of them considered to be endangered. Amphibians are abundant everywhere that there are small ponds, pools and puddles.

There are 18 species of reptiles, two of which are in the Red Data Book of Armenia. The herpetofauna is more abundant on the northeastern shore of the lake and only grass snakes (*Natrix natrix* and *N. tesselata*) are common everywhere.

Two-hundred ten species of birds (36 are in the Red Data Book of Armenia, one is endemic, and 83 are included in the Agreement on the Conservation of African-Eurasian Migratory Waterbirds of the Convention on the Conservation of Migratory Species of Wild Animals). The artificial water-level decrease influenced the numbers of breeding waterfowl. From approximately 60 breeders formerly, only about 25 species are registered as breeding during recent years. The Eurasian coot (*Fulica atra*), mallard (*Anas platyrhynchos*) and endemic Armenian gull (*Larus armenicus*) are abundant at present. Numbers of individuals during the year are estimated to be 6,000 Eurasian coot, 5,000 mallard and 16,000 Armenian gull.

The lake is an important stop for migratory birds, especially in October-December, before the lake becomes covered with ice. Such rare birds as great egret (*Casmerodius albus*), glossy ibis (*Plegadis falcinellus*), mute swan (*Cygnus olor*), whooper swan (*C. cygnus*), demoiselle crane (*Grus vigro*) are documented here regularly during the migrations. Lake Sevan is important both as a resting and a wintering site for migratory waterfowl. Half a century ago, the area was known as the greatest inland breeding area for waterfowl between the Black and the Caspian Seas. Because of the water-level decrease and draining of most of wetlands, Lake Sevan's role as breeding area is now much reduced.

There are 36 species of mammals, eight of which are in the Red Data Book of Armenia. The most typical mammals are European hare (*Lepus europaenus*), red fox (*Vulpes vulpes*), wolf (*Canis lupus*), weasel (*Mates foina*) and most of the rodents.

Investigations on invertebrates have so far included only aquatic fauna: 14 plankton and 136 benthic species of different systematic groups. Plankton and benthos associations showed a close dependence on the trophic status of the lake.

Since the 1990s, an export-oriented commercial fishery (including the European Union) has developed with the recently-acclimatized long-hand crayfish (*Astacus leptodactylus*) abroad.

3. The Human Dimension

The first settlements in the Lake Sevan basin date back 7,000 years. In the past, the area was used for fishing and grazing. Although several permanent settlements occurred here from the 7th century, most of the modern population came here only 150 years ago, mainly from Persia (Islamic Rep. of Iran) and Turkey. Historical, architectural and archaeological relics located in the Lake Sevan basin include: an early Christian shrine and funerary steles of 9-15th century in Noradus; churches and a monastery of the 9th century on Sevan Island (now a peninsula); the ruins of a citadel dating to the 6th century B.C.; and cliff drawings of hunting scenes from the early Stone Age.

Lake Sevan has always been a popular place for holidaymakers. Beautiful landscapes, cool water, fresh air and close proximity to the capital of Yerevan attracts tens of thousands of people every weekend during hot summer days. Archaeological, historical and architectural relics from the early Stone Age until the late Middle Ages located near the lake are of great importance for all Armenians, both those living in the country and abroad. A theological seminary of the Armenian Apostolic Church was recently established on the Sevan Peninsula.

3.1 Socio-economic Values

Lake Sevan and its basin provide both inanimate and animate products, both dead and living, such as peat, plants and animal products. These products include sand, water, peat, fuelwood, hay, herbs and potherbs, mushrooms, berries, crops, fish, game birds, cattle, opportunities for recreation, tourism, bird watching, education, research and aesthetic appreciation. All of these products have direct use values because they have market price.

As of 1 January 2002, the Lake Sevan water volume was estimated as 32,921 km^3. This water is quite suitable for cattle watering and irrigation, and with minor purification, it is also suitable for drinking. Lake Sevan is the main source of water for thermoelectric power generation, manufacturing, and other industrial uses.

A number of mineral springs are situated in the Lake Sevan basin, of which those of greatest commercial importance are at Sevan and Lichk. Mineral waters are of great importance for the economy of the country and make up a significant portion of exports. The largest sand and gravel deposits of aquatic origin are situated mainly on the eastern shore of Lake Sevan.

Table 2. Recorded Fish Catches in Lake Sevan (in metric tons).

Years	Ishkhan	White fish	Koghak	Sevan barbel	Crucian carp	Total
1926-1930	5,113	25	3,109	62	0	8,310
1931-1935	5,740	14	3,438	147	0	9,339
1936-1940	5,779	22	5,262	180	0	11,243
1941-1945	3,459	18	5,349	89	0	8,915
1946-1950	3,050	94	5,361	86	0	8,591
1951-1955	4,018	419	5,583	204	0	10,225
1956-1960	3,000	1,128	5,096	179	0	9,403
1961-1965	2,636	2,550	4,333	67	0	9,585
1966-1970	1,758	5,414	2,712	50	0	9,935
1971-1975	734	7,615	1,547	20	0	9,915
1976-1980	100	9,640	2,763	0	0	12,503
1981	8	11,341	2,668	0	0	14,017
1982	10	9,963	2,714	0	0	12,687
1983	8	10,345	2,678	0	0	13,029
1984	0	16,069	2,096	0	0	18,186
1985	0	13,879	2,565	0	4	16,448
1986	0	14,034	2,447	0	14	16,495
1987	0	16,271	2,399	0	87	18,756
1988	0	17,640	1,592	0	27	19,260
1989	0	18,955	1,911	0	225	21,091
1990	0	19,839	1,104	0	516	21,458
1991	0	17,980	663	0	682	19,325
1992-2003	?	?	?	?	?	?

The total volume of commercial peat in the Lake Sevan Basin is around 30 million m^3. The main commercial excavation is near the village of Torfavan. The annual amount of extracted peat is estimated at around 50,000 tons. Peat is used in agriculture (50%; as fertilizer, substrate in horticulture, bedding material), as fuel (45%) and in therapeutic bathing (5%; mud-baths).

In the past reeds were harvested for such everyday necessities as thatching and structural building, in combination with the clay. Present uses of reeds are crafts, bedding material (litter) and fuel. Flexible willow branches are utilized for fish-traps and basket binding. Willow wood and other smaller-sized trees and bushes are used for fuel.

A number of plants are collected for hay, food (*Butomus*, *Nymphaea*, *Nasturtium*, *Rumex*, *Falcaria*, *Asparagus*), medicine (*Althaea officinalis, Bidens tripartida, Gnaphalium uliginosum, Glycyrrhiza glabra, Menyanthes trifoliate, Mentha longifolia, Nuphar luteum, Ononis arvensis, Polygonum hydropiper, Plantago major, Tussilago farfara, Valeriana sp.*), and bouquets. Some mushrooms are used for food, for example *Coptinus comatus*, *Cortinarius sp*.

Lake Sevan is especially significant for its fishery. Among fish species of commercial importance are whitefish, ishkhan, crucian carp and koghak. The marsh frog has increasing value for export. Waterfowl is traditionally a subject of commercial (in the past) and sports hunting. Of game birds the most important are puddle ducks (mallard and teal above all), coot and snipes. A number of mammals are also hunted for fur and meat.

Some benthic invertebrates, such as *Oligochaeta*, *Amphipoda*, larvae of *Chironomidae* (*Diptera*), and to a lesser extent *Ephemeroptera* and *Trichoptera* are collected for sale as food for aquarium fish.

Surrounding the lake are such types of wetlands as mires, bogs, marshes, and floodplains which provide space for grazing.

Lake Sevan and its basin have a number of areas of special beauty, including the Artanish Peninsula, Sevan Peninsula, Gull Islets, Lake Lichk, Noradus Fishponds, and Gridzor Rocks. These are all presently or potentially valuable for development of recreation, tourism, and bird watching.

3.2 Land Use

The main landscape of the Lake Sevan basin consists of mountain steppes, meadows, pastures, and crops surrounded by naked rocks on the heights over 3,000 m. Remnants of natural oak and juniper forests occur in the Sevana Mountains at the altitudes of 1,900-2,200 m. The landscape of Sevan National Park has a comparatively monotonous character, consisting of the artificial forest belt with a mosaic of recreational buildings. A near-natural landscape remains only on the Artanish Peninsula.

There are 92 settlements in Lake Sevan basin, five of which have populations over 10,000. Villages and towns are generally distributed around the former shoreline of the lake. As of 1999, around 277,600 people inhabit the province of Gegharkounik Marz.

Agriculture and fishing are the traditional economic activities in the Lake Sevan basin. The main crops are wheat, barley and potato; other agricultural plantings include hard and soft forage. Extensive cattle raising is traditional form of activity. Land not in crops is used for grazing and haying.

Industry is less developed. The main industrial centers are the towns of Gavar and Sevan, where cable, instrument, and knitwork factories exist. Since the early 1990s, industry is in a continuing crisis due to the loss of markets as the result of the collapse of the Soviet Union. Most factories have closed or are operating at minimal levels.

Each summer, Lake Sevan attracts several hundred thousand visitors due to its historical, archaeological and architectural monuments ranging from the Stone Age to the late Middle Ages. The shoreline of Lake Sevan is the most popular and traditional place for recreation and picnics. Before the breakup of the Soviet Union in 1991 and the establishment of the Republic of Armenia the following year, workers from all over the Soviet Union came to Lake Sevan for rest and recreation, but this important industry ended abruptly, leaving behind a substantial number of large hotels that are now mostly empty. The local administration is very interested in reviving the tourism industry.

Several illegal activities, such as poaching and unauthorized logging reflect negatively on the present management of the Lake Sevan.

3.3 Public Administration

The administration of Gegharkounik Marz Province is the responsible authority for management of area. The administration is situated in the town of Gavar. Sevan National Park, which lies within its territory, has three types of land zones: reserved, recreational and economic. Management duties are not yet clearly assigned between different governmental entities: ministries, central, provincial and local administrations.

3.4 Environmental Legislation of Armenia

The relevant legal framework of Armenia includes provisions in the Constitution of the Republic of Armenia (1995). According to Article 8, any utilization of private property should not cause damage to the environment. According to Article 10, the state is responsible for protection of the environment and the reproduction of biological resources. A series of codes, which deal with particular activities, and the array of environmental laws are summarized in Appendix 1. In addition, some periodic decrees by the government have relevance. The remainder

of this section describes the international treaties to which Armenia is a signatory. Most of these have been signed since independence.

3.5 International Environmental Treaties Relating to Lake Sevan

Armenia is party to seven international treaties that impact Lake Sevan and is under consideration for membership for three other treaties, as follows:

- **Convention on Biological Diversity** (UNCBD, Rio de Janeiro, 1992). Armenia is a Contracting Party since 1993. The Lake Sevan Basin supports 46% of flora and fauna diversity in Armenia.

- **United Nations Framework Convention on Climate Change** (UNFCCC, Rio de Janeiro, 1992). Armenia is a Contracting Party since 1993. In Lake Sevan basin is situated the largest deposit of peat in Armenia, Torfavan.

- **Convention concerning the Protection of the World Cultural and Natural Heritage** (World Heritage Convention, Paris, 1972). Armenia is a Contracting Party since 1993. Lake Sevan is the most important cultural and natural heritages sites of Armenia although not yet designated worldwide.

- **United Nations Convention to Combat Desertification** (UNCCD, Paris, 1994). Armenia is a Contracting Party since 1997. Most of the territory of Lake Sevan basin is subject to severe, strong and medium desertification.

- **Aarhus Convention on Access to Information, Public Participation in Decision-making and Access to Justice in Environmental Matters** (Aarhus, 1998). Armenia is a Contracting Party since 2000.

- **Convention on the Conservation of European Wildlife and Natural Habitats** (Berne, 1979). Armenia is a Contracting Party since 2003.

- **Convention on International Trade in Endangered Species of Wild Fauna and Flora** (CITES, Washington, 1973). Membership is under consideration.

- **Convention on the Conservation of Migratory Species of Wild Animals** (CMS, Bonn, 1980). Membership is under consideration. Lake Sevan is the largest internal water body between Black Sea and Caspian Sea and support tens of thousands of waterfowl during seasonal migration.

- **UNECE Water Convention on the Protection and Use of Transboundary Watercourses and International Lakes** (Helsinki, 1992). Membership position is not considered yet. Lake Sevan is part of Kura-Arax River basin shared with Armenia, Azerbaijan, Georgia, Iran and Turkey.

- **The Convention on Wetlands of International Importance, especially as Waterfowl Habitat** (Ramsar, 1971). Armenia is a Contracting Party since 1993.

Table 3. International Reports of the Ministry of Nature Protection with Wetland Measures.

Reports to International Treaties	Measures Projected (P) and Implemented (I) in the Wetlands
First National Communications of the Republic of Armenia under the UNFCCC (Final National Report, 1998)	Recognition of the role of Lake Sevan in climate mitigation and greenhouse gas effect reduction without special measures proposed
Armenia National Environmental Action Program (Main Report, 1999)	P. Development of integrated water resources master plan I. Undertake pilot project for restoration of Lake Gilli (successful)
Biodiversity of Armenia (Final National Report, 1999)	Special attention is given to conservation of wetland biodiversity and wetland landscapes, in particular in Lake Sevan Basin, without special measures particularly related to the wetlands
Biodiversity Strategy and Action Plan of Armenia (Main Report, 1999)	P. Provide technical assistance and equipment to Sevan National Park P. Establish new protected areas I. Conserve and rehabilitate key wetland ecosystems, including ecosystem of Lake Sevan (unsuccessful) P. Develop individual action plan for conservation endangered fish ishkhan I. Promote sustainable fisheries (extremely unsuccessful) I. Wetland management training (successful)
Lake Sevan Action Program (Main Report, 1999)	I. Undertake pilot project for restoration of Lake Gilli (successful) I. Rehabilitate ishkhan hatcheries (extremely unsuccessful) I. Develop crayfish fishery (relatively successful) I. Collect environmental data (relatively successful)
Natural Resources Management and Poverty Reduction Project (ongoing)	Gegharqouniq Marz is one of two case areas of project implementation. In particular, management plan for Sevan National Park should be prepared and implemented.

3.6 Reports on Government Programs and Action Plans

Reports on some programs and action plans carried out by the Ministry of Nature Protection, along with measures proposed for Lake Sevan, are listed in Table 3 with a brief description of the status of measures projected and implemented. It is evident that the measures are inadequate to meet the current management needs of Lake Sevan. Section 5 provides a longer discussion of various responses.

4. Threats to Sustainable Use of the Lake

4.1 Water Withdrawal

The so-called "Sevan Problem" arose in the 19th century. Primarily, the challenge has been how to use the water resources of the lake. Lake Sevan has been recognized as a key potential water resource for Armenia. The high location of the lake compared to the fertile, but arid Ararat Valley, and limited energy resources in the country attracted engineers to find methods to explore how to use the water of the lake intensively. Taking into account the water balance of Lake Sevan, where evaporation (800 mm/yr) largely exceeds direct precipitation (360 mm/yr), an Armenian engineer named Suqias Manasserian, in his book entitled "The Evaporating Billions and the Stagnation of Russian Capital" (1910), proposed to use water resources intensively for irrigation and hydropower generation. By dropping the original water level by 50 m, his plan was to reduce evaporation almost six times by completely drying Major Sevan and leaving a shrunken Minor Sevan of about 240 km^2 compared to 1,416 km^2 for the original lake.

Manasserian's proposal became as a major Soviet project under the direction of the central authorities of the Soviet Union. Implementation started in 1933 when the bed of Hrazdan River was excavated and a tunnel was bored some 40 m under the lake. The tunnel was inaugurated in 1949 as a major achievement of socialism, and the lake level started to drop at a rate exceeding 1 m/yr. The water was used for irrigation, and a cascade of six hydropower stations began to produce electricity.

Very soon the problem of how to use water resources was reversed into how to use wisely all natural resources, and the water in particular. By the 1950s it had become evident that the ecological and economic consequences of extensive exploitation of the water of Lake Sevan were too undesirable to continue in the same way.

Overall, human activities have had negative effects such as water level decrease, deterioration of a water quality, destruction of natural habitats and loss of biodiversity. Water loss is the most important threat. Artificial increase of the outflow from Lake Sevan resulted in the drop of the lake level of 19.88 m (from 1916.20 to 1896.32 m asl as of 1 January 2002; refer to Figure 4), decrease of the volume from 58.5 to 32.9 km^3 (44%), and reduction of the surface area from 1,416 to 1,236 km^2 (13%).

The water balance disturbance to Lake Sevan happens because of the use of water from the lake for hydropower (long term) and irrigation (short term or seasonal). The consequence of long-term water balance disturbance is deterioration of the ecological character of Lake Sevan at all levels. An example of short-term water imbalance is the River Vardenik, which is completely drained in drought summers because of flow diversion for irrigation. The river is of vital importance for population of the koghak fish (*Varicorhinus capoeta sevangi*).

4.2 Factors Affecting Sustainable Use

4.2.1 Internal Natural Factors

The most important internal natural factors that should always be considered are the physical and chemical composition of the water, transparency, oxygen and temperature regime, qualitative and quantitative development of plankton and benthos, and fish stocks.

4.2.2 Internal Human-induced Factors

It is evident the trophic status of the lake largely depends on human impact on water balance and pollution. The water volume has been artificially reduced from 58.4 km^3 in 1933 to 33.0 km^3 in 2002. Pollution inflicted from sewage, industry, agriculture has been sharply increased since 1960s; however, the pollution load decreased since the end of the Soviet Union due to the process of economic restructuring including a decline in agricultural activities. Despite this, the changes of trophic level of the lake remain sometimes unpredictable.

4.2.3 External Natural Factors

Weather events, particularly droughts, cause serious impact especially during the breeding period of fish and waterfowl. For example, desiccation of rivers and wetlands negatively impacts the spawning and nesting conditions of fish and waterfowl.

4.2.4 External Human-Induced Factors

The ecosystem of the Lake Sevan basin is comparatively well separated from external human induced factors due to bordering ridges, which are 1.5 km higher than the lake. Since 1981 up to 200 million m^3/yr year of water from the Arpa River has been diverted into Lake Sevan through a tunnel constructed under the Vardenis Ridge (Figure 1). The impact of "alien" water on Lake Sevan has had no apparent pronounced effect on overall water quality in the lake.

4.2.5 Factors Arising from Legislation and Traditions

Inadequacies of existing legislation in Armenia are obstacles to good management of the lake, and Sevan National Park in particular. Many traditional activities, such as reed harvesting, edible and pharmacological plant collecting, and buffalo breeding have been forgotten. The return of traditional rights to the local inhabitants, after the 75-year-long Communist experiment, should be carried out in combination with

measures to protect nature. One of the first important steps in this direction occurred in 1996, bringing into the force a licensed traditional fishery. However, the current licensing system is far from perfect because of bureaucratic obstacles and high margins of payments for use of natural resources.

4.3 Major Threats (Impact Assessment Analysis)

High vulnerability of mountain aquatic ecosystems creates difficulties for sustainable use and requires constant attention to complex protective measures. All major threats to Lake Sevan are human induced. At the heart of conflicts is the underestimation of economic and especially site specific social and ecological values and features. The conflicts themselves come from diverse views on the values by various stakeholders in the decision-making process. Numerous interviews with stakeholders show that depending on position of a given person and his/her relation to the lake, his/her approach to the values could differ and even contradict public opinion. This could be because of differences in understanding, judgments, preferences, priorities, precedence and positions.

4.3.1 Soil Deterioration

Exposure of soils to drying during the water-level drop has led to soil salinization. These lands are situated mainly along the southern shoreline.

4.3.2 Soil Erosion

Soil erosion on riverbanks is a natural process which is pronounced by human activities. It occurs mainly on the undercurrent of some tributaries of Lake Sevan situated on the soft sandy soils of the lake former lake bottom: River Dzknaget, River Gavaraget, River Tsakqar, River Lichk and River Masrik. During the last 60 years these rivers have formed 5-13 m deep U-shape valleys. Soil erosion augments significantly the sedimentation rate in Lake Sevan. Soil erosion is frequently aggravated by deforestation.

4.3.3 Sedimentation

Sedimentation is another natural process which becomes serious when intensified by human activities. Especially high sedimentation rates occur at the mouths of the Gavaraget and Lichk rivers.

4.3.4 Mudflows

Seasonal and regular rivers and creeks of the northeastern part of the Lake Sevan basin—River Pambak, River Dara, Creek Babajan, Creek Jil, Creek Gyuney, Creek Shishkaya—run the highest degree of danger of mudflows. Mudflow occurrence on these rivers is once in three years and sometimes even more often.

4.3.5 Waterlogging

Only 100 ha are water logged in the Lake Sevan basin, but the problem is serious because the waterlogging takes place directly in the villages Lichk and Artsvaqar.

4.3.6 Pollution

Surface water in Armenia, and especially in the Lake Sevan basin, generally seems to be of remarkably high quality, as compared to international standards. Groundwater resources are very well protected from pollution. Spring water usually is of good quality and can be used for drinking without further treatment. However, without proper attention the situation could change easily.

The discharge of industrial pollutants, domestic sewerage and agricultural run-off into the lake increases the organic loading. Decomposition of organic matter decreases the oxygen concentrations of the water body. In the 1970s, oxygen saturation in the bottom area of the lake during the stratification period was close to zero. The deterioration of oxygen conditions may seriously contaminate the water, endangering plants and animals.

Poorly controlled and managed disposal of soild waste is a significant environmental problem in the urban areas adjoining Lake Sevan, especially Sevan, Gavar, and Martuni.

4.3.7 Over-exploitation

Extensive use of water resources associated with increased pollution of Lake Sevan has had an effect on the overall ecosystem of the lake, from physical conditions to primary production and fish communities. Livestock overgrazing in Lake Lichk brought degradation of vegetation and serious deterioration of the waterfowl habitats. Uncontrolled fishing in Lake Sevan brought a serious decline of fish stocks. As a result of over-exploitation, two out of four subspecies of ishkhan (*Salmo ischchan*) have become extinct.

4.3.8 Habitat Disturbance

Access by people and cattle in the key habitat areas has adversely impacted the waterfowl. Waterfowl are especially sensitive to disturbance during their breeding period. This is illustrated by comparing two adjacent colonies of Armenian gull on the islet and on the peninsula in Lake Sevan. The first one is fully isolated from the mainland while the second is easily accessible to vacationers and cattle. In 2000, 84% of the hatches on the islet were successful, but only 8% were successful on the peninsula.

4.3.9 Deforestation

Deforestation is comparatively new threat that originated in the late 1980s and early 1990s during the blockade of Armenia by Turkey and Azerbaijan and the great energy crisis that the blockade caused. Deforestation of riverbanks increased soil erosion processes, as is clearly evident in the River Lichk area.

4.3.10 Invasive Species

Invasive plant and animal species are well known for their destructive impacts. Sea-buckthorn (*Hippophae rhamnoides*) occupies sandy soils around Lake Sevan sometimes making almost impassible stands. Introduction of crucian carp (*Carassius auratus*) in Lake Sevan in the 1970s reduced the number of the quantity of endemic koghak (*Varicorhinus*

capoeta sevangi). The fry of crusian carp and koghak are food competitors. There is also the constant risk of new introductions as happened recently with the muskrat in Lake Arpi. Appearance of muskrat in Lake Sevan could have unpredictable consequences.

4.3.11 Health Problems

Presently the epidemiological and epizootic situation on the entire territory of Armenia is not the best due to economic factors. In this regard it is necessary to conduct methodologically correct, full prophylactic measures. Biological methods of controlling the numbers of disease carriers and water purification, as well as health and sanitation education, should be given priority.

During contact with static and unpurified water an increase in the incidence of transmissible diseases can be expected. This already happened in a number of settlements around the foul canals of degraded drainage system on River Gavaraget downstream from the town of Gavar. Here a few events of cholera and dysentery were registered between 1991 and 2000. Other wetlands seem secured against human diseases.

4.4 Environmental Threats

4.4.1 Naturalness

The natural development of the area is strictly dependent on human activities, most particularly on the water balance policy. The former lake bottom, presently exposed, can be considered as a semi-natural system, which in the reserve zone of Sevan National Park will become a guided natural system, with waterfowl habitat especially targeted for Lake Lichk, Lake Gilly, Artanish Cove, and the Gull Islets. Terrestrial succession processes in have not been investigated yet.

4.4.2 Eutrophication

Increase of nitrogen inflow has been the main reason for eutrophication of the lake and, as a consequence, increases have been seen in primary production (Figure 5). Zooplankton productivity is shown in Figure 6. Changes in zoobenthos biomass and species composion are presented in Table 4.

4.4.3 Illegal Fishing, Woodcutting and Grazing

Interestingly, in Table 2 on fish catches, correct data are absent for 1992-2003 due to the great discrepancy between the legal and illegal fishery. Total fish harvest estimates for these years are between 50 and 300 metric tons. Poaching has affected not only on the number but also the population structure of the fishes. For example, the average weight of the white fish in the spring of 1997 was 222 g while 20 years earlier the average weight was 904 g. The collapse of communism and the economic transition has brought a new kind of illegal activity since the end of the 1980s: woodcutting for fuel, which together with cattle grazing and tourists promoted denudation of the artificial forest belt around the shoreline.

5. Responses to Threats

5.1 Water Augmentation

An epoch-making project started in 1964 to divert the Arpa River through a 49-km long tunnel under the watershed boundary, to Lake Sevan. Since 1981 the tunnel brings up to 200 million m^3 of water per year into Lake Sevan. Another 165 million m^3 of water per year from the Vorotan River to the Arpa River and then to Lake Sevan will be transferred through a second 22 km long tunnel. The construction of this second tunnel, the Vorotan-Arpa tunnel, was fully completed in April 2004.

In 1980 the Council of Ministers of the Armenian SSR decided to increase the water level of Lake Sevan by 6 m over the course of 25 years. The decision was based on a scientific prognosis made by the scientists of the Sevan Hydrobiological Station. According to their prognosis, a water level increase of at least 6-8 m was needed to restore environmental conditions to their near-natural state. Within five years it became clear that this ambiguous goal had failed.

However, the World Bank-funded Lake Sevan Action Program discussed two options based on cost-benefit analysis: a 3-meter water level increase over the course of 15-34 years and a 6-meter increase over 31-85 years. It should be mentioned

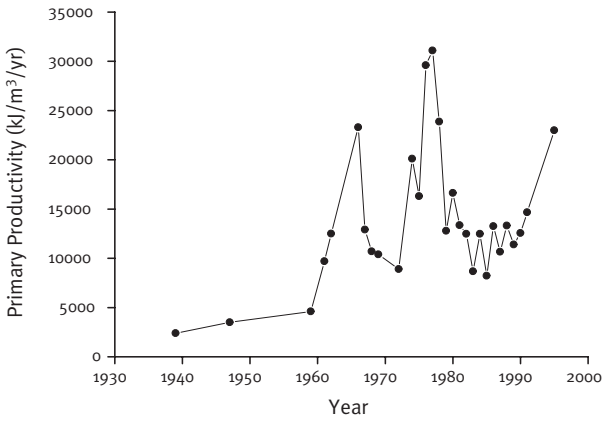

Figure 5. Primary Productivity in Lake Sevan.

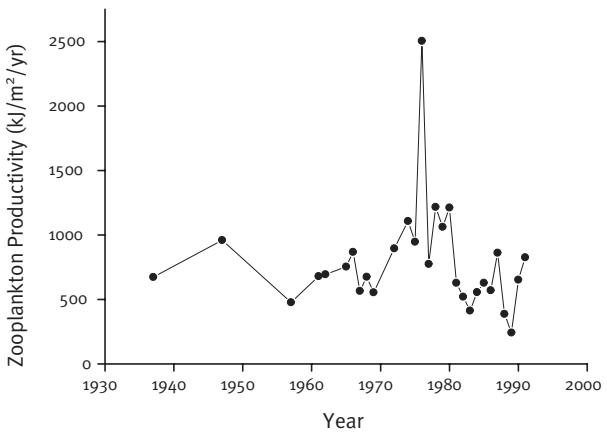

Figure 6. Production of Zooplankton in Lake Sevan.

that there is no scientific evidence that a 3-meter water level increase, proposed by the World Bank, would bring any substantial improvement of environmental conditions in Lake Sevan.

5.2 Lake Sevan Action Program

The Lake Sevan Action Program considers an implementation program of four phases, which are summarized in Table 5. The total cost of the core program is US$30 million. It also estimated that more than US$15 million would be required for completion of construction of the Vorotan-Arpa tunnel. In addition, it was estimated that more than US$100 million would be needed for a longer-term priority action including the construction of the Eghvard Reservoir for accumulation of Lake Sevan water for irrigation purposes. From this amount only funds for Vorotan-Arpa tunnel have been secured.

Government orders have been approved for breeding and reproduction of the endangered endemic fish species ishkhan and koghak, with a total budget of US$17,000 and plans to increase this budget to US$35,000 in 2007. State funds for management of the Sevan National Park are enough only for salaries of the staff and to address top-priority problems.

5.3 Sevan National Park

There was no explicit management for nature conservation in the Lake Sevan basin before 1978. Sevan National Park was established on 14 March 1978 by joint decree No. 128 of the Communist Party and the Council of Ministers of the Armenian SSR. Sevan National Park is a state institution protecting an area of 150,100 ha, which includes both the lake itself and 24,800 ha of surrounding land. The area was designated as a Ramsar site on 6 July 1993.

Lake Sevan itself is recognized as a national treasure and is a state property. The land between the lake and surrounding circular road is under the protection of Sevan National Park. Most of the land territory (94%) of the Sevan National Park is under the responsibility of the Park administration which is located in the town of Sevan. The remaining land in the territory is agricultural (4%) or devoted to hotels, motels and camping (2%). Until 1991, Sevan National Park was under the

Table 4. Average Annual Biomass (g/m²) of Different Systematic Groups of Zoobenthos of Lake Sevan.

Year	Oligochaeta	Leeches	Gasteropods	Bivalve	Gammaridae	Ephemeroptera	Trchoptera	Chironomidae	Whole zoobenthos
1928	1.64	0.41	0.03	0.12	0.62	0.01	0.05	0.38	3.26
1938	2.05	0.51	0.12	0.31	0.56	0.01	0.03	0.46	4.05
1948	1.98	0.30	0.06	0.20	0.69	0.01	0.02	0.66	3.92
1955	4.13	0.33	0.13	0.25	0.67	0.01	0.02	1.16	6.60
1961	2.04	0.35	0.46	1.23	0.78	0.03	0.04	1.71	6.64
1966	2.63	0.50	0.45	1.09	0.60	0.06	0.03	3.10	8.46
1971	3.19	0.30	0.48	1.44	0.78	0.06	0.01	7.20	13.46
1976	7.04	0.28	0.35	0.85	0.45	0.04	0.00	21.90	30.91
1978	12.57	0.19	0.41	1.11	0.24	0.01	0.00	22.42	36.95
1979	12.05	0.21	0.36	1.11	0.19	0.01	0.00	18.80	32.73
1980	10.54	0.15	0.29	1.02	0.10	0.01	0.00	10.68	22.79
1981	9.77	0.09	0.26	0.82	0.10	0.01	0.00	6.20	17.25
1982	9.57	0.04	0.33	0.74	0.08	0.01	0.00	5.14	15.91
1983	10.53	0.03	0.31	0.72	0.04	0.00	0.00	5.50	17.13
1984	11.84	0.03	0.35	0.71	0.04	0.00	0.01	5.60	18.58
1985	10.57	0.03	0.29	0.48	0.07	0.00	0.01	7.66	19.11
1986	9.14	0.03	0.15	0.26	0.09	0.00	0.01	4.29	13.97
1987	8.38	0.02	0.08	0.18	0.04	0.00	0.00	2.53	11.23
1988	8.96	0.01	0.10	0.20	0.01	0.00	0.00	2.80	12.08
1989	7.43	0.01	0.05	0.10	0.03	0.00	0.00	2.21	9.83
1990	7.51	0.01	0.07	0.14	0.09	0.00	0.00	2.07	9.89
1991	7.54	0.01	0.08	0.13	0.06	0.00	0.00	3.03	10.85

auspices of the Ministry of Water Economy. It is currently part of the Ministry of Environmental Protection.

Within the Sevan National Park, land use is determined by zones. The core zone of the park includes the lake, and the park also incorporates a number of smaller reserves and reservations. There are three main zoning areas: the core (reserve) zone, a recreation zone and a zone for economic use. The reserve zones are Noradus (416 ha), Lichk (645 ha), Karchaghbyur (210 ha) and Artanish (2,243 ha). The boundaries between the recreation and economic zones have not yet been established or mapped.

No activities except for research are allowed in the reserved zone. Restricted human activities are allowed on the recreation and economic zones, by consent of the Sevan National Park administration. The Park is managed as a research center, which monitors the ecosystem and undertakes various conservation measures. Since 1996, the Park also regulates the licensed commercial fishery on Lake Sevan.

All of the other parts of the lake basin (339,000 ha) form an external protective zone of the Sevan National Park. About one hundred settlements with a total population of 275,000 inhabitants are situated here. The ownership of the land is under the control of various are state, regional and local administrations, communities, and private farmers and businessmen.

5.4 Education and Public Awareness

Protection of Lake Sevan requires the cooperation of all government institutions responsible for management and exploitation of the nature resources and local communities within Sevan National Park. Unfortunately, there is often no agreement among the ministries or even different units of a single ministry on the management of Lake Sevan. Although the administration of the Sevan National Park makes efforts to involve the local population actively in nature conservation, there are still more problems than benefits. A permanent exhibition showing examples of the flora and fauna of the basin of the lake and the history of the site is situated in the town of Sevan. The replenishment of the exhibition and its existence depends on the enthusiastic work of a few devoted people. A number of publications about the lake are available in different languages. However, the most recent popular scientific publication is a booklet on the Sevan National Park that was issued in 1989.

5.5 Research and Study

Research and study are the only human activities which can be permitted by the Sevan National Park authorities in the preserve zones. Lake Sevan is one of most extensively investigated large lakes of the world although it is poorly known in the West due to the language barrier. The most important studies have been carried out in the field of hydrology and hydrobiology. Many aspects of the biology have a history of long-term monitoring. The inventory of many systematic groups of animals and plants

Table 5. Phases of the Lake Sevan Action Program.

Phase	Cost (in US$)
PHASE I: US$2,000,000	
Establishment of Lake Sevan Commission	900,000
Policy Measures and Instruments and Legal Reforms	400,000
Integrated Management Policy and Planning Activities	700,000
PHASE II: 4,200,000	
Environmental Awareness	500,000
Improving Water Quality	3,600,000
Biodiversity and the National Park	100,000
PHASE III: 6,800,000	
Increasing Water Quantity	1,500,000
Improving Water Quality	750,000
Biodiversity and the National Park	900,000
Fisheries	1,150,000
Applied Research	2,500,000
PHASE IV: 17,000,000	
Increasing Water Quantity (Vorotan, Eghvard)	*(115,000,000)*
Improving Water Quality	16,600,000
Biodiversity and the National Park	400,000
TOTAL (without Vorotan Tunnel and Eghvard Reservoir)	30,000,000

is already completed; however, there are still many issues to be studied, particularly the restoration of waterfowl habitat and recreation management.

6. Lessons Learned

6.1 Environmental Legislation of Armenia

A number of issues need to be clarified under existing legislation, particularly the rights and responsibilities of public and private sectors, and the role and participation of local communities and non-governmental organizations in management of protected and other areas, and open water, especially Lake Sevan. Plans for conservation regimes and opportunities for sustainable use are not defined clearly. The current system of protected areas is restrictive and might benefit from a broader range of types being recognized.

A range of environmental laws exists in Armenia. However, many of these laws are not effective enough and cannot be enforced properly at present. Some of the laws are now outdated and need revision to be brought into line with the current socio-economic and political situation, and land privatization in particular. Until now only a few specific regulatory acts have been adopted under these laws.

An issue in Armenian environmental legislation is that many of the laws do not correspond to international standards, particularly, to commitments taken upon accession to the Ramsar Convention and the Biodiversity Convention. In particular, the Law on Especially Protected Natural Areas does not correspond to the IUCN categories for protected areas (2000).

6.2 Approach to Investments

The application of economic instruments for investments in environmental issues has been through the legal reforms actively developed since independence. However, it is obvious that there is no possibility for substantial investments in Lake Sevan from internal sources, whether state or private, in the foreseeable future. The main efforts should be directed on international funding organizations and the Armenian Diaspora. In parallel the Government should serve as the guarantor of investments.

6.3 Capacity Building Efforts

Management duties are not yet clearly assigned between different governmental entities: ministries, central, provincial and local administrations, and Sevan National Park. In practice this means parallelism and even duplication of responsibilities, unreasonable bureaucratic obstacles and, as a result, gaps in daily management issues with far-reaching implications.

One positive accomplishment is that the objectives of Phase I of Lake Sevan Action Program are partly achieved: the Commission on Lake Sevan has been established; and the laws "about Lake Sevan" and "about Approval of Annual and Complex Measures on Conservation, Restoration, Reproduction, and Use of the Ecosystem of Lake Sevan" have been passed by the National Assembly. Much more should be done to achieve the objectives of the Lake Sevan Action Program and the main obstacle is the restricted access to funds to undertake activities outlined in the Action Plan.

6.4 Citizen and Stakeholder Participation in the Design and Implementation of Programs

Lake Sevan is the focus of attention of all citizens of Armenia and the Armenian Diaspora. People cannot imagine Armenia without Lake Sevan. The following entities are acting as primary stakeholders for management of the Lake Sevan: Government of Armenia, local communities, administration of Gegharquniq Marz, Sevan National Park, NGOs, research and educational institutions, farmers, fishermen, and vacationers.

Public participation includes activities such as public hearings and participation of representatives of stakeholders with environmental impact expertise, in designing and implementation projects and programs, and in different commissions acting for public authorities. The initiative in actions requiring cooperation with state authorities belongs to state authorities themselves that are in charge of public participation and who are responsible to provide all relevant information. All too often this creates a situation where public participation is considered simply as a formal obligation rather than as a process that adds value.

6.5 Sustainability of the Lake Management Institutions

Many institutions are engaged in different aspects of Lake Sevan's management: elected and appointed administrative authorities, scientific-research institutes, conservancy organizations, consumers, etc. Among them, Sevan National Park, under the Government of the Republic of Armenia and direct governance of the Ministry of Nature Protection, should take a leading role and overall responsibility for coordination of Lake Sevan management. Regrettably, this is far from the present reality for the following reasons: absence of legal grounds; weak human resources; weak material resources; poor scientific and technical equipment; lack of support of local inhabitants; and lack of self-dependence in operative decision-making.

6.6 Linkage of the Lake Management Program to the Broader National and Regional Water Resources Management Reforms

Lake Sevan's management program is closely linked with ongoing the Natural Resources Management and Poverty Reduction Project, where Gegharqouniq Marz is one of two case areas of project implementation. The management plan for Sevan National Park should be prepared and implemented within the framework of the project.

In the Biodiversity Strategy and Action Plan of Armenia, Lake Sevan is mentioned in Strategic Component A: In Situ Conservation, it is recommended to provide technical assistance and equipment for Sevan National Park that would (a) provide resource material for library at the Sevan National Park; (b) conserve and rehabilitate key wetland ecosystems including Lake Sevan; and (c) develop and implement individual action plans for conservation of key endangered species including ishkhan. In Strategic Component C: Sustainable Use, it is recommended to (a) review and revise, if necessary, existing regulations regarding commercial fisheries in Lake Sevan; (b) assess impacts of recreational activities in the Lake Sevan basin on biodiversity; and (c) develop criteria and regulations for recreational use in the Lake Sevan watershed. In Strategic Component G: Research, it is recommended to (a) record and monitor changes in biodiversity in Lake Sevan and (b) record and monitor changes in biodiversity in Lake Gilli.

The following activities outlined above are being implemented: (a) provide technical assistance and equipment for Sevan National Park, (b) develop and implement individual action plans for conservation of key endangered species including ishkhan and (c) review and revise, if necessary, existing regulations regarding commercial fisheries in Lake Sevan.

6.7 Indicators and Monitoring and Evaluation Mechanisms of Environmental Quality and Economic Status

A number of indicators might be suggested, against which improvements or deterioration of environmental quality and economic status can be assessed: water quality; water quantity; levels of pollution, including phosphate and nitrate; primary production rate (phytoplankton and macrophytes); secondary production rate (zooplankton and benthos); commercial fish stocks; condition of habitats, and wetland in particular; number of threatened species; number of endemic ishkhan; and socio-economic factors.

Monitoring and evaluation mechanisms should consider a standard framework for assessment and feedback that includes: extent that planned activities achieved their goals; extent that overall objectives been achieved through these activities; initial information available; other information that has become available; lessons that have been learned; existing gaps; and correlation of initially planned activities.

6.8 The Relevance and Quality of Scientific Research Being Undertaken

Scientific research on environmental conditions of Lake Sevan and its catchment is a critical prerequisite for decision-makers for actions to prevent and/or mitigate negative factors. Lake Sevan has been the focus of continual scientific observations since the establishment of Sevan Hydrobiological Station in 1923. Since then, the staff of this institution were always among the most advanced investigators of internal waters in the Soviet Union. Other institutions that have been involved are the Institute of Geology, Institute of Botany, Institute of Zoology, and Yerevan State University. Valuable data on quantitative and qualitative changes of a large number of environmental indices of Lake Sevan have been accumulated and analyzed. In particular, the long-term correlation between primary production (phytoplankton and macrophytes), secondary production (zooplankton and zoobenthos) and fisheries has been found.

Regrettably, most studies were suspended in 1992 because of lack of funds. For the 2004 Government budget, US$7,000 was provided for the estimation of commercial fish stocks and fishery limits in Lake Sevan. Modern scientific research towards environmental issues requires a comprehensive approach, advanced methods and technical supplies, scientific prediction of renewable biological resources and possible negative phenomena, and of course, significant capital investment. At this stage the major problems in Lake Sevan's management are left to chance or the complete absence of scientifically established data.

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Appendix. Environmental Legislation of Armenia.

Codes

The Criminal Code (1961) regulates criminal liabilities for tort, particularly violations of utilization of natural resources and protection of environment.

The Tort Code (1985) regulates administrative responsibilities for crime, particularly crime concerned with natural resources and environment.

The Forest Code (1994) regulates public relations in the fields of forest management, reproduction, protection and utilization.

The Land Code (1991/2001) regulates public relations in the fields of land management, fertility, increase of efficiency of land use, and different aspects of environment protection.

The Civil Code (1998) particularly regulates public and legal aspects of the use of natural resources and environmental protection.

The Ore Code (2002) defines ore as part of the earth's crust under the soil layer and in the absence of soil layer on surface, below the bottom of the stagnant and flowing water bodies. Treasures of the soil include underground fresh and mineral water, sediments of the stagnant and flowing water bodies.

The Water Code (2002/1992) aims at protection of national water resources, satisfaction of public needs in water supply through effective management of exploitable water and protection of natural water bodies. The Code defines the principles of management, use and protection of water resources and aquatic systems, and regulates issuing of permits for utilization of water resources. According to the Code, water resources are surface and underground water, including brooks, rivers, springs, wetlands, lakes, ponds and fishponds, glaciers, water-bearing layer, other water bodies, and short-term water resources. All water resources in Armenia are state property. The new Water Code aims to take into account the socio-economic and political changes of the last decade, particularly with regard to land privatization and the establishment of private sector.

Laws

The Law on Principles of Environmental Protection (1991) regulates the principles of national environmental policy and aims to protect the environment. It regulates the use of natural resources: ore, water, air, flora, and fauna.

The Law on Especially Protected Natural Areas (1991) regulates formation, organization, conservation and utilization of especially protected natural areas. According to this law the following types of especially protected natural areas in Armenia are state (strict) reserves, national parks, state (game) reserves, natural monuments.

The Law on Protection the Atmosphere and Air Quality (1994). The subject of the law is maintenance of atmosphere and air quality, reduction and prevention of chemical, physical, biological and other negative influence.

The Law on Environmental Impact Expertise (1995) regulates expertise of impact of proposed actions or proposed projects, general layouts or comprehensive schemes on the environment.

The Law on Payments for Nature Protection and Use of Natural Resources (1998) defines the concept of payments for nature protection and use of natural resources, circle of payers, types of payments; and regulates procedure of payments and stock-taking, and amenability for breaking of this Law.

The Law on Flora (1999) determines scientifically grounded protection, conservation, utilization and regeneration of plant resources. The Law aims to regulate public relations in the sphere of conservation and use of plant resources.

The Law on Fauna (2000) determines scientifically grounded protection, conservation, utilization and regeneration of animal resources. The Law aims to regulate public relations in the sphere of conservation and use of animal resources.

The Law about Lake Sevan (2001) regulates public relations in conservation, restoration, reproduction, natural development and utilization of ecosystems of Lake Sevan, as well as its catchment and economic zone.

The Law about Approval of Annual and Complex Measures on Conservation, Restoration, Reproduction, and Use of the Ecosystem of Lake Sevan (2001) approves annual and complex measures on conservation, restoration, reproduction, and use of water, plant and animal resources of Lake Sevan and its basin, including quotas.

The Law on Examination of the Ore for the Purposes of Excavation of Minerals (2002) regulates the policy of granting concessions in the field exploitation of minerals.

The Law about Local Government (2002) determines responsibilities of institutions of local governing, particularly responsibilities for management of territories of communal ownership.

Related Selected Government Decrees

Government Decree No. 125 of 14 March 1978 on establishment of Sevan National Park.

Government Decree No. 23 of 26 January 1996 on approval of the "Regulations of commercial fishery in Lake Sevan Park".

Government Decree No. 864 of 30 November 1998 on margins of payments for use of natural resources.

Government Decree No. 927-N of 30 May 2002 on reorganization of Sevan National Park into a "state non-commercial organization" and approving the "Regulations of Sevan National Park".

Government Decree No. 1380-N of 22 August 2002 on approval of the "Regulations of issuing licenses and signing treaties on use of animal resources for agricultural and industrial purposes".