Additional information

Physical features of the site

Geology and Geomorphology

The site is young in geological scale and is of high seismic activity.
The bedrocks are formed from tufa (volcanic stone), clinker, porphyrite and limestone.
Mountain ridges up to 3597 m height surround Lake Sevan. On the northern part the watershed is close to the lake (2-3 km), the slopes are steep. On other parts the watershed is up to 30-40 km away and slopes more gently towards the lake.
While it remained undisturbed, the lake located 1916.2 m a. s. l., had 99 m maximum depth, 1416 km2 surface area and 58.5 km3total volume.
To 2001 the water-level has dropped on 19.88 m, the lake surface has shrunk to 1236 km2 and the volume to 33.1 km3. 2001 was the year of the minimum level mark.
As of 1st January 2011 the water-level has increased on 3.45 m, the lake surface was 1271 km2 and the volume was 33.9 km3.
Underwater ridge stretched between Ardanish and Noratus capes and divides the lake into two morphologically different parts. The lake consists of the deeper Minor Sevan (average depth 42 m, surface 333 km2, volume 13.0 km3) and the comparatively shallow Major Sevan (average depth 27 m, surface 938 km2, volume 20.9 km3).
The relief of the former littoral zone of Lake Sevan (from the current surface of the lake until 1916 m a. s. l.) is mainly wavy or flat. The shores mainly have a moderate decline, in some places steep, with 3-8 meters height.

Origin.

The lake is of tectonic origin. The age of Major Sevan estimates ca. 1,000,000 years, while the age of Major Sevan less than 100,000 years.

Hydrology

Lake Sevan Ramsar site represents a complete hydrological system: the lake with its watershed, tributaries and outflow.
The ratio between the lake surface (1271 km2) and watershed (3620 km2) is ca. 1/3, which is 2-2.5 times less than for most major lakes. 28 rivers feed Lake Sevan, of which 4 flow into Minor Sevan, and 24 into Major Sevan. Total sum of surfaces of the river basins (catchment area) comprises 2930 km2 (81% of the total area of the lake's watershed), the area of inter-basins covers some 696 km2 (19% of the total area of the lake watershed).
Five rivers are originated from the Geghama mountain range. Of which River Gavaraget flows to Minor Sevan, and the other rivers to Major Sevan. The total flow from the Geghama mountain range comprises 27.7% of the total river flow to Lake Sevan.
Nine rivers are originated from the Vardenis mountain range and flow to Major Sevan. The total flow from the Vardenis mountain range comprises 61.9% of the total river flow to Lake Sevan.
Eleven rivers are originated from the Sevan mountain range and flow to Major Sevan. The total flow of the rivers of the Sevan mountain range comprising 4.6 % of the total river flow to Lake Sevan.
Two rivers originate from the Areguni mountain range and only one flows from the Pambak mountain range, which flows to Small Sevan. The total flow of the rivers from the Areguni-Pambak mountain range comprises 5.8 % of the total river flow to Lake Sevan.
The average flow of the rivers is 26.8 m3 sec-1 (without Arpa-Sevan channel). The affluent season of the year for major rivers is April and June due to spring pouring. Water starts to abound on the first or the second ten days of April and mainly end up during the second half of June. Most of the rivers have very-well expressed two dry seasons: summer-autumn and winter.

The only outlet of Lake Sevan is the river Hrazdan, the natural course of which used to be 110 million m3 before drop of the Lake level. Currently this river has become a net of channels and water-pipes, through which water withdrawn from Lake Sevan is taken for irrigation purposes.
The hydrological balances for different periods of water management strategy are given in the **Table 1**.

Table 1. Water balance of Lake Sevan, average for different periods, 106 m3 year-1

Components of Balance	1927-1933	1949-1962	1970-1979	1984-1990	1992-1997	2002-2009
Surface Inflow	770	669	774	776	892	735
The transfer from River Arpa	0	0	0	214	252	219
Precipitations	550	475	479	486	466	593
Underground Inflow	0	48	56	81	65	94
Summary income	**1320**	**1192**	**1309**	**1557**	**1675**	**1641**
Surface Outflow	50	1383	430	329	831	158
Evaporation	1210	1041	1039	1102	1081	1045
Underground Outflow	60	26	9	9	15	14
Summary outcome	**1320**	**2450**	**1478**	**1440**	**1927**	**1217**
Discrepancy	**0**	**-1258**	**-169**	**+117**	**-252**	**+424**

Under the natural conditions the lake was covered by ice every 15-20 years. The ice-cover has occurred almost every year during the 1970-1980's. Usually the ice-cover period is from the end of January to the beginning of April. However, the lake was fully covered by ice for the last time in 2002.
The water temperature in July-August is over 18°C and up to 22-24°C in shallow parts.

Soils

The natural soil is "chernozem" (black loam). In some parts the soil contents sand, clay or peat.
Mountainous-steppe dry "chernozem" soils cover the relict juniper-oak woodlands of Sevan national park, eastern side of Sevan peninsula, the central and eastern rocky and hilly areas of Ardanish peninsula, and mountainous-and-meadows "chernozem" soil cover the areas above 2400 m.
The land area released from waters of Lake Sevan covers the major part of Sevan national park territory. They are sandy, light soils, with too little humus composition. The main developed soil types are: humid-meadow-sandy, ill-developed sand-and-clay and saprolite steppe soils. Ill-developed sand-and-clay soils cover a considerable area. Soil formation is in progress on the former lake bed.
River-valley-slope soils have been formed in the river valleys and their steep slopes.

Climate

The main factors of climate formation of Lake Sevan are solar radiation and atmospheric circulation. The number of solar hours per year varies between 2600 and 2800.
Mean temperatures range from -6°C in January to +16 °C in July with average annual temperature fluctuating between +5 and 6°C. The maximum temperature is observed in July-August (+29 oC) and the minimum one in January-February (–36oC on the most western side of the lake watershed and -25 oC on the north-eastern side of the lake).
The number of days in the mountains above 0oC is only 200, compared to 240-260 at lake level.
Atmospheric precipitations of Lake Sevan basin are dependent on the elevation and increase from 400 mm (in the littoral zone of the lake) to 900 mm (within the tops of surrounding mountains). On the shoreline of the lake annual precipitation ranges from 340 to 720 mm: of which 17% falls in the winter, 37% in the spring, 26% in the summer and 20% in the autumn.
The humidity varies on daily and seasonal basis. The average humidity is in winter 70-85% and in summer 65-75%.
The weather is usually windy, average speed of the wind is more than 4 m sec-1. Winds are stronger in winter (6 m sec-1) and calmer in spring and autumn (3 m sec-1).
The snow blanket on the basin of Lake Sevan is formulated in mid November and the sustainable blanket at the beginning of December. Snowmelt starts at the beginning of March and continues till the end of April.

Physical features of the catchment area

Physical features of the catchment area coincide with described for the Ramsar site

Ecosystem Services

Social and cultural values:

The lake causes an interest of local inhabitants mostly because of fish resources.
The basin of the lake provides local inhabitants with eatable plants and mushrooms, fuel wood. There is an interest in productive agriculture, especially cattle breeding and recently tobacco growing. The industrial enterprises are declined.
Religious importance Lake Sevan Ramsar site consists in presence of many operating and not-operating churches of IX-XX centuries which are traditional pilgrimage areas. Theological Seminary of Armenian Apostolic Church is situated on Sevan Peninsula.
Archaeological, historical and architectural relics from the early Stone Age until the late Middle Age (the cliff drawings of hunting scenes of 7,000 B. C., the ruins of citadel of 600 B. C., early Christian shrine and funerary steles of 4th century, the monastery of 9th century, etc.) are important heritage for all Armenians living in the country and abroad.
Beautiful landscapes, cool water, fresh air and close location to the capital attract dozens of thousands people every weekend during hot summer. Lake Sevan and its basin are in the focus of Goverment to develop all-year-round tourism industry.

Factors (past, present or potential) adversely affecting the site's ecological character, including changes in land (including water) use and development projects

within the Ramsar site:

Water Withdrawal
The so-called *Sevan Problem* arose in the XIX century. High location of the Lake Sevan over the fertile but arid Ararat Valley attracted engineers to elaborate projects of using the water of the lake for irrigation.
Primarily, the challenge was how to use the water resources of the lake. Lake Sevan has been recognized as a key potential water resource. The high location of the lake compared to the fertile, but arid Ararat Valley, and lack of energy resources in the country attracted the engineers to find methods to explore the water of the lake intensively. Taking into account the water balance of Lake Sevan, where evaporation (800 mm year-1) largely exceeds direct precipitation (360 mm year-1), 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 km2 compared to 1,416 km2 for the original lake.

Manasserian's proposal became as a major Soviet project under the direction of the central authorities of the USSR. The project started implementation in 1933 when the bed of Hrazdan River was excavated and a tunnel was bored some 50 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 per year. The water was used for irrigation, and 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 1950's it had become evident that the ecological and economic consequences of extensive exploitation of the water of the lake were too undesirable to continue in the same way. Human activities have had such negative effects 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 by 2001 in the drop of the lake level of 20 m (from 1916 to 1896 m), decrease of the volume from 58.5 to 32.9 km3 (44%), and reduction of the surface area from 1,416 to 1,236 km2 (13%).

A project to increase the water level of the lake at least on 6 m is implemented in practice from 2001 (After adoption of the Law on Lake Sevan). As of 1 January 2011 compared to minimal conditions the water level increased on 3 m, surface on 35 km2 and the volume on 0.8 km3.

Internal Natural Factors
The most important internal natural factors of physical origin that should always be considered are the chemical composition of the water, water transparency, oxygen and temperature regimes.
Qualitative and quantitative development of phyto- and zooplankton, phyto- and zoobenthos, and fish stocks forms ecological food chain (Table 2).

Table 2. Changes in primary (phytoplankton and phytobenthos PP), secondary (zooplankton and zoobenthos; SP) and fish (FP) production in Lake Sevan (average for decade in Joule m-2)

	1920's	1930's	1940's	1950's	1960's	1970's	1980's	1990's	2000's
PP	2400	2400	4100	4600	12700	19000	11600	18800	15000
SP	620	690	620	520	740	1330	630	890	750
FP	34	43	43	45	46	53	81	60	25

Internal Human Induced Factors
The ecological conditions of Lake Sevan currently depend on human activities which influence mainly on hydrology and trophic status of the lake.
The following human induced activities negatively affect the ecological status of the lake: sewage, agricultural and industrial pollution, soil erosion, illegal fishing, unauthorized logging, overgrazing, water logging.
It is evident the trophic status of the lake largely depends on human impact on water balance and pollution, as well as on vegetation waterlogged due to recent water level increase.

External Natural Factors
Weather impact, particularly droughts, cause serious impact especially during breeding period of fish and waterfowl: drying up of rivers and wetlands negatively impacts the spawning and nesting conditions of fish and waterfowl.

External Human-Induced Factors
The ecosystem of 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 the water from Arpa River flows into Lake Sevan through a tunnel. The impact of "alien" water on Lake Sevan has had no apparent pronounced effect on overall water quality in the lake.

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.

in the surrounding area: not applicable