Sergey P. Gorshkov[1]*, Laurent Touchart[2], Olga I. Mochalova[3], Andrey Yu. Ozerskiy[4], Larissa S. Evseeva[1]
[1] Faculty of Geography, Lomonosov Moscow State University
* **Corresponding author**, e-mail: spgor-smir@yandex.ru
[2] The University of Orleans
[3] Environmental Initiatives Centre, Design Bureau, LLC
[4] Krasnoyarsk Mining and Geological Company

FROM PONDS TO MAN-MADE SEAS IN RUSSIA

ABSTRACT. Russia has more than 2200 reservoirs and large ponds. As time went by, ponds lost their importance in some aspects of human life, while newly created man-made seas impacted the nature and the people in two ways. The costs involved in designing, constructing, and operating the artificial seas, especially on the plains, have been too high to consider them as an undisputed achievement of the Soviet scientists transforming the nature. This paper discusses the problem of ponds and man-made seas in Russia.

KEY WORDS: mega projects, quantum leap, overflowing, giant reservoir, large industrial complex, environmental damage, drift wood, abrasion, landslide processes, intensification of karst, disintegration of family relationships.

INTRODUCTION

Construction of ponds was wide-spread in Russia before the 1917 revolution. At the turn of the 20th, city ponds were mostly used for recreational purposes. Water released from the ponds in rural areas of Nechernozemye provided power for mills and sawmills. This was the main function of local ponds, although they were also used in goose and duck breeding and for other purposes. Ponds became widespread in the arid areas primarily because of the need to supply the agricultural lands with water. Construction of ponds played a significant role in the economy and recreational infrastructure of the Tsarist Russia.

The post-revolutionary period after October 25, 1917, saw hard times for pond development, which was only natural under the existing totalitarian regime. The Civil War of 1917–1922, confiscation of food by the government, crop failures and famines in the early 1920s and 1930s, dekulakization and collectivization, and industrialization aimed at developing the military industry took place amid the repressive crackdown and GULAG camps. Under the circumstances, the authorities had to make some highly questionable decisions relating to land ownership and the public. Josef Stalin and his henchmen took extremely tough social and economic measures to make a quantum leap in the military and industrial development using coercion, punitive measures, and propaganda. Providing economy with electric power was one of the main problems facing the country at that time. Large hydroelectric power stations were regarded as a way of dealing with this issue. Man-made seas were created with this purpose in mind. This looked more like an obsession with gigantic projects. It was forced upon and imposed by Josef Stalin. In the 1930s, the country had about 60,000 water engines. By the 1950s, almost all water and wind engines were out of operation due to wear and tear, as well as massive overflows of reservoirs, which caused the agricultural lands to be flooded. Many ponds, though still remaining in the rural areas, gradually fell into disuse due to lack of proper care. Therefore, their recreational potential also diminished. Urban ponds were not managed in the best way either. Some of them were scrapped altogether.

In 1956, the cult of Stalin was exposed and shortly after that, the GULAG network was abandoned. More benevolent totalitarian regime meant fewer possibilities for exploiting convicts. However, technological power of the country, which won the World War II, grew significantly. With the help of the propaganda campaign, the construction of the tallest dam in the world or the creation of an enormous man-made sea was made to look almost like an achievement equal to the first human space flight of Yuri Gagarin. In this way Russia became the country with the largest man-made seas that flooded hundreds of settlements, several cities, huge areas of arable land, grasslands, steppe, woody, and even tundra pasture lands, as well as vast areas of marshes, forests, archaeological sites, ancient monuments, churches, bridges, and civil engineering structures.

The return to capitalism in the 1990s did not bring any improvement to the pond sector of the Russian Federation. Even in Moscow, the quality of water from ponds now is more likely to be poor than good. Most ponds have lost their natural capacity for self-purification, while the banks are not protected against washouts and sliding. However, the program of ponds reclamation recently got underway in Moscow, and it is being implemented, though partially. The tradition of conquering the nature did not change in terms of major rivers. It has become increasingly difficult to attract funds to finance mega projects in the water industry. However, there is no guarantee that fragmentation of the great Russian rivers and overflowing of man-made seas, which were disastrous for wildlife and damaging to the population, are a thing of the past. Meanwhile, the biosphere mechanism controlled by the fine-tuned interaction between the planetary biota and non-living matter is already very much disturbed by the unbridled exploration of the planet.

PONDS

There were far more ponds in the past. To give you an example, Moscow ponds were used for breeding fish. They provided water for fighting fires. People used them for washing clothes and even for bathing. During the last few centuries, the city authorities shut down about 700 ponds. Now, many of them can only be found in historical records or on the pages of works of fiction. The present-day Moscow's Yaroslavsky Railway Station is located at the site of the ancient Red Pond, which was also called the Great Pond. That was one of the oldest ponds in Moscow, which was referred to as the Great in the Annals since 1423. Later, a royal village called Krasnoselskoye was founded not far from the pond, so from that time on the pond became known as Krasnoselsky. Its area was 23 hectares. However, it has being shrinking gradually. In the 19th century, the Krasnoselsky Pond was used for sewage disposal and in 1910 it was shut down.

In the 17th century, the Zhivotinny Dvor slaughterhouse was located next to Chistoprudny Boulevard. Wastewater was discharged into the pond called Pogany (Rotten) for that reason. During the reign of Peter the Great, Prince Alexander Menshikov bought this land plot. The building on the corner of the street at the Myasnitsky Gate had belonged to him since 1699. The Prince built a church deep in the courtyard, which was nicknamed Menshikov Tower, cleaned the pond and ordered to stop polluting it. Since then, the pond is referred to as Chistye Prudy (Clean Ponds) (Fig. 1).

Nowadays, Moscow has some 76 ponds (Fig. 2). They are mainly used for recreation. Some ponds are reserved for swimming. Ponds are filled with surface-, subterranean-, and rainwater. The quality of water in Moscow's ponds is often rather low. Most of the ponds have lost their natural capacity for self-purification and the banks are not protected against washouts and sliding. Activities aimed at keeping the ponds within the sanitary standards include: pumping of polluted water, collecting litter, dredging, covering the bottom with gravel and sand, protecting from sewage waters, landscaping the banks, filling with fresh water, reclaiming

Fig. 1. Chistye Prudy in Moscow

the adjacent terrain, introducing aquatic organisms, installing feeders for birds, and a number of other activities [Moscow Ponds ..., 2007].

Both in the Tsarist Russia and during the Soviet era before the collectivization, which led to the compulsory formation of collective farms, watermills and sawmills running on water from the ponds were commonly used in the agricultural sector. The Nechernozemye region, since it was well-supplied with water resources, had the best potential for the creation of pond engines.

Ponds were in especially high demand in arid areas of Central and Southern European Russia since the 19th century due to the increased damage from severe droughts and crop failures. These disasters were especially devastating in 1890–1892. V.V. Dokuchayev offered to capture and accumulate moisture in agricultural soils: a) by compacting snow on the fields; b) by creating forest strips to accumulate snow and to prevent snow from being blown away by wind; and c) by accumulating water in the ponds during the thaw, after which this water is redirected to the lowland meadows and fields to temporarily flood them. Deployment of these and some other emergency measures in such arid regions as Voronezh, Kharkov, and Dnepropetrovsk proved to be efficient. Experimental fields showed improved microclimate and increased yields. About 60,000 water engines were still in operation in the country in the 1930s. By the 1950s, almost all water and wind engines were out of operation due to wear and tear, and because of massive overflows of reservoirs, which caused the rural lands to be flooded [Shipunov, 1988].

MAN-MADE SEAS

The idea to tap the power of the largest Russia's rivers has originated a long time ago. The project of the Zhiguli Hydropower Station (presently the Kuybyshevskaya

Hydropower Station) on the Volga was developed in 1913 by G.M. Krzhizhanovsky. The Bratsk Hydropower Station project on the Angara was presented to the governor-general of Irkutsk by A. Krutikov as early as in 1906. The political situation in Europe in 1920s–1930s forced Josef Stalin and his entourage to use tough social and economic measures in order to make a quantum leap in the field of military and industrial development using coercion,

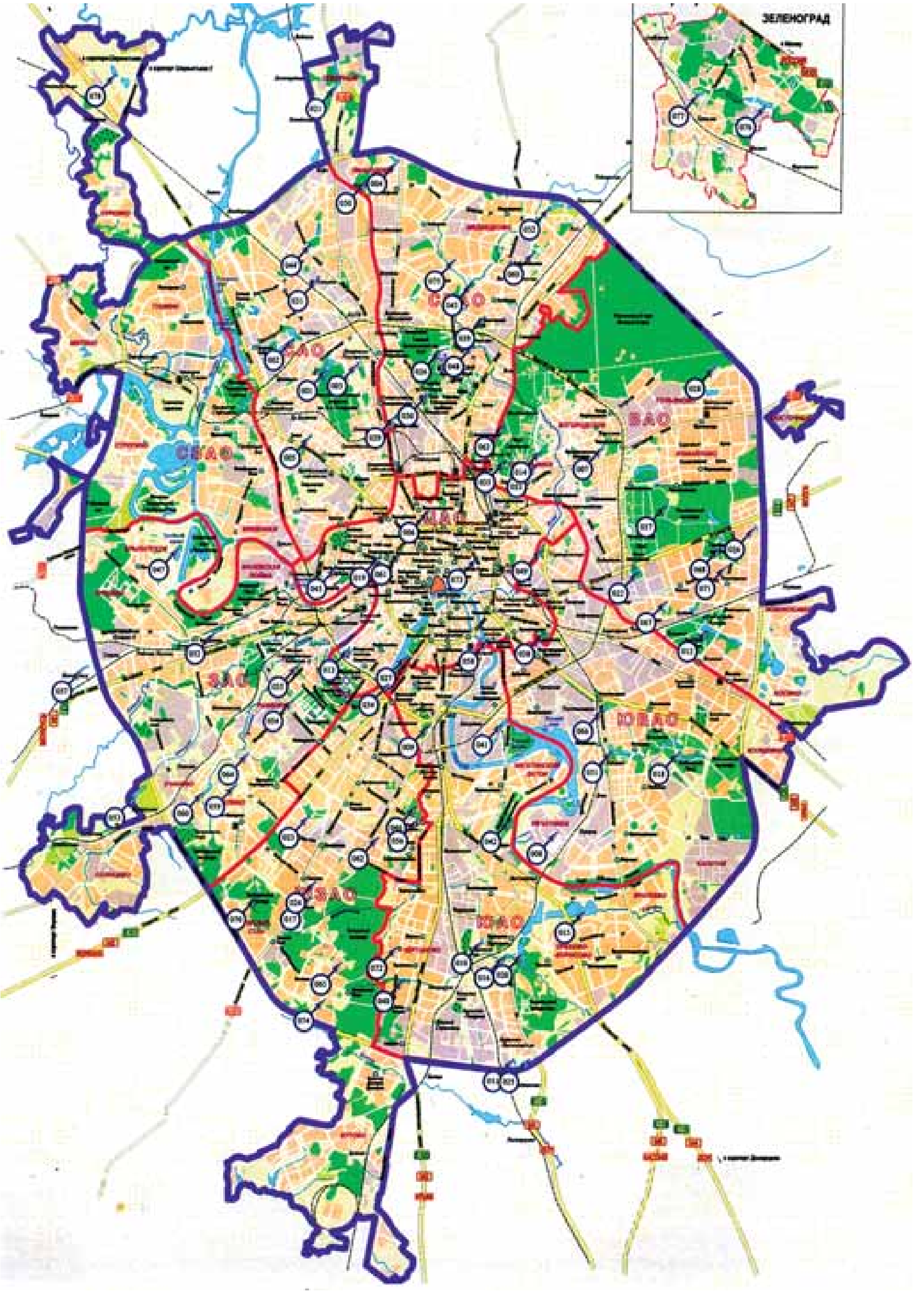


Fig. 2. Map of Moscow ponds [Moscow Ponds ..., 2007]

punitive measures, and propaganda. Providing industry with power supply was one of the top priorities. Large hydroelectric power plants (HPP) were regarded as a way of dealing with this issue. This signalled the advent of man-made seas in the country. The plan was to build the plants with maximal capacity. It is rumoured that Stalin personally adjusted the designs, and his corrections often meant that power stations capacities exceeded the limits established by common sense and science. At the same time, man-made seas were becoming even more boundless and were beating all of the world records [Cherkasova, 1989, p. 20].

The Volga River basin. The rise in power supply for industrial enterprises in the Central and Eastern parts of the European area of the USSR is largely associated with the construction of the Volga-Kama cascade of HPP. The priority was given to its construction firstly in the Volga upper reaches due to the need for electric power in the country's center, including Moscow.

The Ivankovskaya, Uglichskaya, and partly Rybinskaya HPP that were constructed before the World War II provided power supply to the military plants and other facilities in Moscow, Moscow region, and several neighbouring cities. Out of those three, the Rybinskaya HPP was the main power generating facility. The Rybinsk man-made sea of 4,6 thousand sq.km was the world's largest at that time.

Its construction proved to be a real tragedy for the people living in the Upper parts of the Volga River. This project ruined the lives of people who had been living in the area for centuries. For example, 130 thousand people were relocated from the Mologo-Sheksna interstream area and 20 thousand had to move out from the Upper Volga valley. People had to leave their old comfortable houses that they worked very hard to build and graves of their family members and loved ones. The Rybinsk Sea dam gates were shut down on April 13, 1941. Spring waters of the Volga, the Sheksna, and the Mologa rivers overflowed the banks, flooded the plain and the Mologo-Sheksna interstream area together with the city of Mologa. Almost 27,000 households went to the bottom of the Rybinsk reservoir, and over 4,000 households got into the flooded area. About 800 villages had gone under water, thousands of hectares of fertile land, the famous flood plain meadows, pastures, oak forests, 3,675 sq. km of woods, ancient monuments, and cultural sites had also gone. The Mologo-Scheksna area, once a land of plenty, was turned into a huge grave of water. When water level in the Rybinsk sea falls, one can sometimes see street pavements, house foundations, and a cemetery with gravestones. In commemoration of this disaster, the Mologa Region Museum was opened in Rybinsk [Danilov, 2003].

By some miracle, the Rybinskaya, Uglichskaya, and Ivankovskaya HPP were not destroyed by bombing in the autumn of 1941 [Burdin, 2010]. All three hydroelectric power stations were in the near-front zone. In the above-mentioned case, the Upper Volga gigantic dams became one of the factors which helped saving Moscow from the German troops. Moscow needed electric power, which was produced converting the energy of the Great Volga. The true cost of construction and miraculous preservation of these three HPP, which were vital for defending Moscow, was immeasurably high. In addition to the above-mentioned environmental and social damage and sufferings of local people, one should take into consideration that the power stations were constructed basically by the GULAG convicts, many of whom died of this grinding toil and awful living conditions.

Construction of hydroelectric power stations continued in the Volga basin after World War II. The largest of those, Kuybyshevskaya HPP, was constructed between 1950 and1959. In October 1958, N.S. Khrushchev participated in its commissioning (Fig. 3). The Kuybyshev sea area is 6,500 sq. km and it is the second largest water-storage basin in the world among the valley reservoirs. Its gross storage capacity is 58 cub. km and reservoir live storage is 34 cub. km. Backwater level near the dam is 29 m high. The HPP provides 27% of power generated by the Volga-Kama cascade.

Fig. 3. N.S. Khrushchev at the opening of the Zhigulevskaya HPP in October, 1958

Professor of the Kazan State University, V. Yakovlev, emphasized in 2005 that 50 years of existence of the Kuybyshev sea had resulted in more harm than good, as claimed by many scientists and experts. Water quality in the Volga River worsened with the construction of the reservoir and still continues to deteriorate. The banks of the mighty Russian river are being destroyed, fish is dying, buildings and structures are being flooded, and people are suffering. There are dozens of magnificent islands that were considered natural sanctuaries, churches, cemeteries, and entire villages and even cities, for example, Spassk that are now at the bottom of the giant reservoir. Was it correctly decided on the construction of the Kuybyshev water-

Fig. 4. Map of the Volga-Kama cascade of reservoirs

storage basin and the whole great Volga-Kama cascade? In the opinion of V. Yakovlev, this is not only an environmental issue. It refers to our history as well.

The entire area of the Volga-Kama cascade reservoirs is around 26,000 sq. km (Fig. 4). Dams, reservoirs, and the HPP are located on the rivers of the Volga basin, the Moskva-Volga Canal and on the Don River at the lower end of the Volga-Don ship canal. By the beginning of the 2010s, the total rated output power of the cascade exceeded 12,870 MW, and the annual average primary power output was 38,5 billion kWh, which is equivalent to almost 4% of the country's output and is the most valuable on-peak energy. It is also 22% of renewable energy of the country.

The Ob River basin. The activities there represent an obsession with gigantic projects aimed at taking immediately from nature as much as anyone, anywhere, and at any time could. The projects followed. A meeting of the governmental expert Commission of the State Planning Committee took place in Moscow in January, 1963. The meeting had to decide about the construction of the HPP in the lower reaches of the Ob River. The experts expressed a preference for the option of the Nizhne-Obskaya HPP with a dam of 42 m high, a reservoir area of 113,000 sq. km, and a volume of 1,600 cub. m, with the annual runoff of the Ob of 400 cub. km per year, producing 35 billion kWh of power per year, which is just as much as the power generated by the whole Volga-Kama cascade [Novosti Yugry ..., 2011]. N.S. Krushchev banned this construction at the request of the President of the Siberian Branch of the USSR Academy of Sciences M.A. Lavrentyev. The scientist appealed that the monstrous-sized man-made sea would flood the area, where geologists promise to discover soon the richest deposits of hydrocarbon crude, which in fact was done shortly after the project was banned.

The Ob was blocked off in Novosibirsk. The sea of Novosibirsk has an area of 1,082 sq. km, its gross storage capacity is 8,8 cub. km, its reservoir live storage is 4,4 cub. km, and the dam height is 28 m. The hydroelectric power station was built in 1953–1959.

The HPP capacity is 455 MW with the power output of 1,7 billion kWh per year. The water-storage basin flooded low and some elevated areas mostly covered with black earth. The floodland in the tailwater pool of the reservoir was made suitable for boat traffic and lost its forage value, as well as the Don River floodland in the tailwater pool of the Tsymlyansk reservoir. Signs of boat traffic in the floodland can be tracked within 300 km downstream below the dam. The Zaysanskaya HPP (banked-up lake) and the Kamenogorskaya HPP were constructed in the Irtysh River (left tributary of the Ob River).

The Yenisei River basin. Rich in hydropower and other diverse natural resources, the Siberia to the East of the Yenisei River interested hydraulic engineers more than other regions. Here, in addition to the Yenisei River, there is the Angara River which has always been the most attractive one for engineers for it has a relatively regular annual run-off due to the fact that the river flows from the Baikal Lake.

In 1920, A.A. Velner suggested constructing a HPP cascade in the middle reaches of the Angara River as a contribution to the GOELRO plan. Professor N.N. Kolosovsky associated the development of the Angara energy resources with the creation of a large industrial complex in the Middle Angara region. The idea was implemented in the post-war years.

In pursuit of a momentary super-efficiency, hydraulic engineers tried to have a stab at the integrity of the Baikal Lake in 1957. They thought it possible to spend part of the ancient lake water resources. They suggested making a 25-meter slot in the headwater rocks of the Angara by means of explosion. The Baikal Lake water level could have been lowered by 4 m. However, as you can see from the previous figures, it was also possible to drop the untouchable lake's water level by the larger amount of water. N.A. Grigorovich, working at the Moscow Gidroenergoproyekt, was the author of this project. The biologists managed to ban this dangerous project [Plyusnina, Dalzhinova 2008].

At present, the statistics on the Angara Cascade HPP (Fig. 5) is as follows:

The Irkutsk man-made sea: 31,965 sq. km with Baikal Lake (31,500 sq. km to the storage pond). The height of the Irkutsk dam is 44 m. The level of the Baikal Lake was raised by 1 m, sometimes it goes up by 1,4 m. The HPP was constructed between 1950 and 1958. Its capacity is 662 MW with the power output of 4,1 billion kWh per year.

The Bratsk man-made sea: Its area is 5,470 sq. km, the gross storage capacity is 169 cub. km, reservoir live storage is 35.4 cub. km, and drawdown level is 7 m. The construction occurred between 1954 and 1967. The dam height is 147 m. The HPP capacity is 4,515 Mw. It generates from 19,0 to 26,5 billion kWh of power per year.

The Ust-Ilimsk man-made sea: its area is 870 sq. km, the gross storage capacity is 59,4 cub. km, reservoir live storage is 2,8 cub. km, and drawdown level is 1,5 m. the construction of this HPP was done between 1963 and 1980. The dam is 105 m high. The HPP capacity is 3,840 MW, the average annual production is 21,7 billion kWh.

Fig. 5. Map of the Angara cascade of HPP (construction of the Boguchanskaya HPP is not completed)

Here are the losses that occurred due to the construction of the Angara cascade:

- 7,600 sq. km of land was flooded, including 2,300 sq. km of plough-lands and pastures, 5,000 sq. km of forests, and 300 sq. km of other lands, including residential areas with the cities of Balagansk and Old Bratsk, as well as more than 300 villages. The bridge over the Angara River went underwater together with 110 km of the railway track.

- Several hundred thousands hectares of forest and steppe-forest lands were transformed into urban and rural areas in order to accommodate 102,000 residents relocated from their previous places of residence, which were flooded due to the construction.

- Forests were cut during preparation of the reservoir beds; there were some attempts of burning the forest in humid weather; part of the cut wood and living forests (35 mln. cub. m) were submerged, the waters of the Bratsk and Ust-Ilimsk man-made seas were clogged by drift wood, and bottom waters of the water body were contaminated with hydrogen sulphide from wood decay. Eutrophication took place. Valuable fish species such as sterlet, sturgeon, cisco, grayling, taimen, and lenok disappeared.

- Over 5,300 ha of the reservoir coastland was destroyed and lost due to abrasion, landslide processes, land masses detachment, as well as to flooding, intensification of karst, and subsurface erosion. Over 500 houses and farms were either destroyed or relocated. Several thousands residents had to move. Over 3 mln. cub. m of wood went underwater.

– The biosphere lost almost 100 mln. tons of phytomass due to the flooding of 5,000 sq. km of taiga and 2,300 sq. km of steppe-forest. There was also environmental damage caused by out-migrants moved from the flooded area.

– The Angara cascade of reservoirs affects the climate and phenological phases of the adjacent areas, extending the cold period in spring and the warm period in autumn.

– The Angara River does not freeze in winter: polynyas stretch from the Irkutsk, Bratsk and Ust-Ilimsk HPP dams. The above-mentioned facts are the reason for high air humidity and fogs, accumulation of pollutants in urban air, deterioration of health of the Siberians, and transport operation issues [Gorshkov, 2001].

– Coastal abrasion of the choked Baikal Lake which stretches for 1,800 km with the water level raised by 1 m. The coastline moved back by 4–20 m. The Trans-Siberian railway subgrade was washed out in some places. Spawning conditions deteriorated on the coastal shelf and fish yield fell by 2,5 times.

Two man-made seas were created on the Yenisei River.

The Krasnoyarsk sea: its area is 2,000 sq. km, gross storage capacity is 73,3 cub. Km, reservoir live storage is 30,4 cub. km, and the dam is 124 m high. It was constructed between 1956 and 1972. The maximum level fluctuation rate is 19 m. The HPP capacity is 6,000 MW. The power output is 20,0 billion kWh per year.

Violent fluctuations of the water body level sometimes bring about earthquakes in the city of Krasnoyarsk. Low water temperature (around 12 °C degrees) in summer makes swimming in this sea impossible. Increased air humidity coming from the Yenisei, embraces the whole city throughout the year but especially in winter, causing fogs and smog. During warm winters, polynya in the tailwater pool of the reservoir stretches for 500 km downstream below the dam. Choked ice floodings are quite often in winter and spring during the seasonal flood. This is dangerous for the coastal residential areas. There are some other negative effects of the river fragmentation caused by the HPP dam [Gorshkov, Mochalova, et al., 2010].

The Sayano-Shushenskoye sea area is 633 sq. km, gross storage capacity is 31,3 cub. km, and reservoir live storage is 15,3 cub. km. The HPP dam height is 245 m. It was constructed between 1963 and 2000. The HPP provided 22,8 billion kWh per year in 2000 and only 12,0 kWh per year in 2010 after the accident that happened on August 17, 2009.

Social changes caused by the HPP man-made seas in Siberia, according to L.A. Bezrukov and S.P. Yelin, are as follows:

– The situation becomes very complicated when the would-be bed of a reservoir is being prepared for flooding due to the relocation of penal colonies, deforestation, and other preparatory activities. Areas populated by released convicts have increased crime rate, alcohol abuse, debauchery, and disorderly conduct.

– Relocation of people from the area to be flooded by a reservoir unwittingly activates the disintegration of family relationships.

– It is particularly hard for the elderly: old people hold on to their homes and gardens literally until the last moment. They feel themselves aliens at the new places being torn from their homes and the graves of the ancestors.

– Economic activities of the local residents are brought to an end or significantly limited if we consider farming combined with cattle-breeding, fishing and hunting, as well as homemade crafts [Gorshkov, 2001].

Looking ahead, we should note that the major concern is the giant Evenkiyskaya HPP on the Nizhnyaya Tunguska River, to the East of the Turukhansk village put forward in the 1980s. Taking into consideration the maximum dam height of 200 m, the flooded area would cover almost 10,000 sq. km and the water body would stretch for 1,200 km. According to a moderate option, the dam height would be 140 m. In both cases, flooding would cover the north taiga subzones of reindeer pastures. High valley slopes of the river and its tributaries would remain above water. Mostly they are covered with lifeless rock streams. Here, permafrost is underlain by cryopegs and that is the bed of a would-be reservoir. These are brines with mineralization of up to 300–400 g/l [Borisov, 1996]. There is a risk of their increasing penetration into the lake-sea. Signs of this can be seen even now. Therefore, water with salt content can be found in winter in the Nizhnyaya Tunguska River near the Tura village, the capital of the Evenk Autonomous Area. Its salinity level is 1,5 g/l. Estimates show that the Evenk sea will have water with significant salt content. With regard to unstable temperature conditions during winter, which have been typical of Central Siberia for the last 20 years, there can be icing-up of wires and even power-transmission towers. Industrial accidents are highly probable. A similar situation happened in Quebec in the late 1990s and early 2000s within the overhead lines connecting the HPP cascade on the La-Grande River to the cities located down to the south of the province. Consumers of the cascade were to buy electric power from the USA in wintertime. The Quebec cascade disaster was reported at the World Climate Conference that took place in Moscow in 2003. The HPP construction on the Nizhnyaya Tunguska River is not feasible, taking into consideration that oil and natural gas deposits are located in a close proximity to the Turukhansk village.

CONCLUSIONS

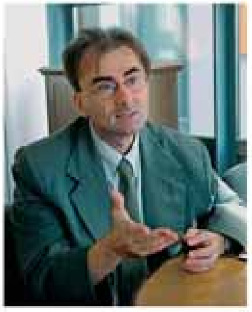
Construction of ponds was a prominent part of the economy and recreational development of Tsarist Russia. No changes to the better took place during the totalitarian regime era after the revolution of October 25, 1917. The civil war, confiscation of food by the government, crop failures and famines in the early 1920s and 1930s, dekulakization and collectivization, and industrialization aimed at developing the military industry took place against loss of life in World War II amid repressive crackdown and the GULAG camps. All the above-mentioned influenced negatively the governmental strategy aimed at interaction between man and the nature. Natural resources were used destructively by the ministries and authorities [Sidorenko, 1967]. An obsession with gigantic projects gained a foothold in the country. Decision-makers in the sphere of natural resources, both in the Russian Federation and the former USSR, in view of inertia of the past and other circumstances are not, in fact, ready to combine efforts to defend social, economic, and environmental human rights as it is the case in the developed countries. This, in particular, is the reason for their sluggish attitudes towards the remnants of the pond construction system in our country and preservation of plans for construction of environmentally hazardous large HPP reservoirs in the basin of the Amur River, on the Angara River, and what is totally unacceptable, of a giant dam and the sea for the Evenkiyskaya HPP on the Nizhnyaya Tunguska River.

Something other is required by time. Slightly less than one-half of the living matter remained on the Earth by the end of the 20th century due to the unbridled development of the terrestrial parts of the world [Watson, et al., 2000]. In the developed countries, and recently also in China and India, forests are being restored, environmental framework is being shaped, and different types of green economy are being introduced. That has a positive impact on the Earth's climate. Keeping to the strategy of man-made seas construction and fragmentation of major rivers with dams in Russia looks unacceptable compared to the contemporary international approach. The impact is hazardous to the human beings and nature not only at the regional level. It causes a multifaceted damage to the environment-shaping mechanism of the biosphere. It also has a negative impact on the natural links between the in-land river basins and the pericontinental ocean zone. Its condition is important primarily for the quality of the world waters and, consequently, for the functioning of the main heating mechanism of the Earth [Lisitsyn, 2004; Gorshkov, 2007]. It is necessary to raise this issue at the international level. Protection measures should be taken to preserve the system of in-land river basins and the pericontinental ocean zone. ■

REFERENCES

1. Borisov, V.N. (1996). Features of the climate and technogenesis impact on hydrosphere in the brine-bearing areas of cryolithic zone (case study of the North Siberian platform). In: Modern changes in the lithosphere under the influence of natural and anthropogenic factors. Ed. by V.I. Osipov. M., Nedra, pp. 93–113.
2. Burdin, E.A. (2010). Hydraulic engineering in Russia: from Volgostroy to the Great Volga (1930–1980). Ulyanovsk, the Ulyanovsk State Pedagogical University, 222 p.
3. Cherkasova, M. (1989). Hydro gigantohegemony: where are its roots? Znaniye-Sila Publishing House, No. 4, pp. 20–27.
4. Danilov, A.Yu. (2003). Mologa. Rybinsk Reservoir. History and contemporaneity. Rybinsk, Rybinskoye Podvorye Publishing House, 208 p.
5. Gorshkov, S.P. (2001). Conceptual basics of geoecology. 2-nd ed. Moscow, Zheldorizdat, 570 p.
6. Gorshkov, S.P. (2007). Doctrine of the biosphere. Introduction. M., Faculty of Geography, Lomonosov Moscow State University, 118 p.
7. Gorshkov, S.P., O.I. Mochalova, L.S. Evseeva (2010). Specific features of the temperature signal in Central Siberia during the second half of the XX century. In: Geographical education and science in Russia: past and present. St.-Petersburg, VVM, pp. 235–242.
8. Lisitsyn, A.P. (2004). Sediment and contaminant fluxes in the World Ocean and global monitoring methods. Stockholm, Rio, Johannesburg: crisis milestones. M., Nauka, pp. 133–193.
9. Moscow Ponds (past and present): technology and brief characteristics of ponds, technological features (2007) Ed. by S.V. Kryuchkov (authors V.P. Grinev, K.A. Gromov, V.N. Ivanchenko, etc.). M., Galereya, 176 p.
10. Novosti Ugry (News of Ugra), December 8, 2011.
11. Plyusnina, V.V., Dalzhinova, I.A. (2008). The Angara cascade. Environmental impact (2nd half of the 20th century). Ulan-Ude. Publishing House of the Buryat University, 144 p.
12. Shipunov, F.Ya. (1988). Look at your house. M., Sovremennik, 240 p.
13. Sidorenko, A.V. (1967). Man, Technology, Earth. M., Nedra.
14. Watson, R.T., Noble, I.R., Bolin, B., et al. (2000). Land use, land-use change, and forestry. Cambridge: Cambridge University Press, 377 p.

Sergey P. Gorshkov is Professor of the Lomonosov Moscow State University, Faculty of Geography, PhD in geological-mineralogical sciences, DSc in geography. In 1956 after graduating as geomorphologist he was engaged in field research in the Krasnoyarsky krai, Murmansk region, Tyva and Khakass republics. During recent 40 years Sergey Gorshkov has been taking up the problems related to the biosphere and mankind interaction on local, regional and global levels. He is author of more than 200 publications, including 8 monographs.



Laurent Touchart is Professor of University of Orleans, geographer, limnologist, the author of more than 100 publication, including 12 monographs. He is the author of several books on biogeography and climatic characteristics of Russia. He has a number of articles on climate change in the Eastern Siberia. He studies the thermal regime and water quality of the ponds in Limousin, France.

Olga I. Mochalova – PhD, Head of the department at the Environmental Initiatives Center, geographer, geoecologist. She studies the climate change in the Eastern Siberia, the transformation of the landscape structure due to the creation of reservoirs on the Angara River and Rhone, so as the linear construction of transport infrastructure in the Mzimta valley. She is the author (co-author) of about 30 publications.

Andrey Yu. Ozerskiy, PhD in geological-mineralogical sciences, Head of the Geoecological Department of the Krasnoyarsk Mining-Geological Joint Stock Company, awarded marks of the Russian Ministry of Natural Resources and Ecology "Excellent prospecting" and "Honorary Prospector". He is the author of over 150 publications on hydrogeology, geochemistry, ecology; co-author of monographs: "Kansko-Achinskiy Coal Basin" (1996), "Coal Base of Russia" (2003), author of the textbook "Fundamentals of Environmental Geochemistry" (2008).

Larissa S. Evseeva – PhD, Senior Researcher of the Department of Hydrology, Faculty of Geography, Lomonosov Moscow State University. She engages in hydrological runoff calculations, studies global environmental changes, the influence of reservoirs on natural complexes transformation in river valleys, the influence of ponds and wetland basins on the runoff formation. She is the author of more than 100 scientific works.