

The Volga River Is Russia's Lifeline and in Need of Maintenance, Mitigation and Restoration

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Abstract

The Volga River flows entirely through Russia and the watershed includes three of the country's ten largest cities. The river is the longest in Europe and western Russia's principal waterway. The Volga River basin is home to approximately half of Russia's population and occupies almost two-fifth of European Russia. It covers much of the Volga region and stretches 3530 kilometers from its source in the Valdai Hills to the Caspian Sea, the world's largest inland water body. Its economic, cultural, and historic importance makes it one of the world's greatest rivers. The Volga basin makes up 8 percent of the Russian territory. Stalingrad, located on the banks of the Volga River, has been described as the site of the greatest defeat in the history of the German Army. It is often identified as the turning point on the Eastern Front of WWII, in the war against Germany, and in the entire WWII. The meeting point of the Eurasian Civilization was historically the Volga River. The river has some of the world's largest reservoirs and is a major source of livelihood for millions of people. Many factories and cities empty their waste including sewage, industrial waste, fertilizers, and pesticides into the Volga River. Pollutants tend to settle in the reservoirs and contain several meters of heavily contaminated muck. The primary objectives are to assess lessons learned, manage, and restore the Volga River system lifeline in Russia.

Keywords

Volga River, Caspian Sea, Soviet Union, Russia, Germany, WWII, Stalingrad, Volgograd

1. Introduction

In the 2nd century A.D., the Greeks discovered that the Volga River flowed into

the Caspian Sea (**Figure 1**). The Geographer Ptolemy described the Volga around 150 A.D. Since Viking times, the Volga has been an important trade route [1]. The Vikings used the Volga to trade goods with Persia [2], Constantinople, northern Russia, and Scandinavia. Prior to the steamboats, large gangs of serfs pulled barges up the Volga River with ropes [3]. Many important cities, including Tver¹, Yaroslavl², Kostroma³, Nizhniy Novgorod¹, Kazan³, Ulyanovsk², Samara³, Saratov³, Volgograd⁴, and Astrakhan³ (**Figure 2**) and (**Figure 3**) are on the Volga River and are home to a huge variety of ethnic groups, including Tatars, Chuvash³, Mari, Mordva, Kyrgyz, and Germans.

Europe's largest river by discharge and drainage basin is the Volga River (**Figure 4**). Its drainage basin stretches 1.36 million square kilometers and is located mostly in Russia. Geographically, the Volga basin is international: the territory of neighboring Kazakhstan is drained by headwaters of several left tributaries of the Volga River, as well as a small part of its delta, including the Kigach branch. In addition, the flow of several rivers in Western Kazakhstan is fed from the Volga through a system of irrigation and watering canals. The drainage basin is the world's 15th largest, covering most of European Russia [4]. The drainage basin is divided into five geographic zones: taiga, temperate broadleaf forests, forest steppes, temperate steppes, and desert steppes (or semi-deserts).

The Volga basin makes up 8 percent of the Russian territory (**Figure 5**). The Volga River carves (**Figure 6**) and (**Figure 7**) its way through European Russia, supporting more than 25 percent of the country's agriculture (**Figure 8**) and (**Figure 9**) and industry (**Figure 10**). Some 40 percent of the country's population (**Figure 11**) and (**Figure 12**) and (**Figure 13**) is concentrated within the river's basin [1]. The Volga discharges about 250 cubic kilometers per year at the average rate of 8060 cubic meters of water per second. The maximum discharge rate is 48,500 cubic meters of water per second [3]. Volga's important tributaries include the Kama, Sura, Oka, and Vetluga. The Volga River delta (**Figure 14**) comprises about 500 small rivers stretching 160 kilometers and making it Europe's largest delta [4]. The primary objectives are to assess lessons learned, manage, mitigate, and restore the Volga River system lifeline in Russia.

2. Description of Natural Resources

2.1. Volga Delta

In the 20th century, the Volga Delta grew significantly because of the lowering of the Caspian Sea. It is now the largest delta in Europe (**Figure 4**). Today the Volga Delta is 160 km wide with an area of 27,224 km². The delta is known for its shallow waters and as a fish (**Figure 15**) migration pathway. There are impassable jungle-like ducts and thicket reeds which are home to many fish species including pike (**Figure 15**), carp, trench, saber fish, perch, and other fish.

¹From 1932 to 1990 the city was named as Gor'kiy.

²Named as Simbirsk in 1648 - 1780 and Simbirsk until 1924.

³Named from 1935 to 1991 as Kuybyshev.

⁴Historical names of the city were Stalingrad (1925 to 1961) and Tsaritsyn (1589 to 1925).



Figure 1. Volga River map. Photo Credit: Watershed delineation: Heberger, Matthew. 2022. <https://mghydro.com/>



Figure 2. Statue on hill in Volgograd on the Volga River. Photo Credit: <https://russiatrek.org/>

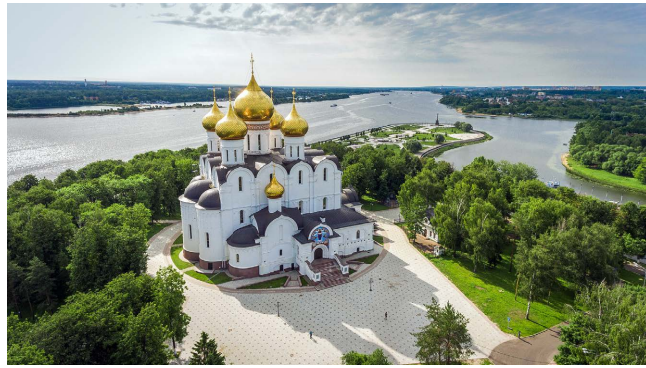


Figure 3. The Golden Ring “capital” in Yaroslavl’. Photo Credit: <https://russiatrek.org/>

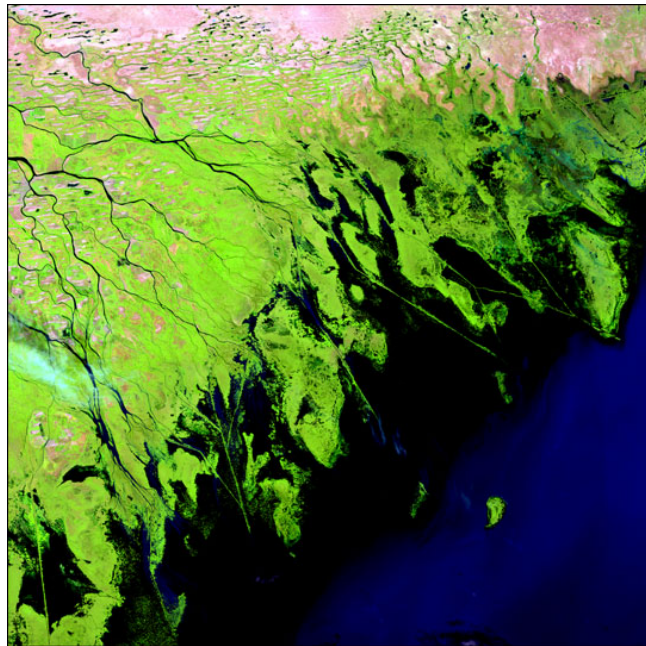


Figure 4. Landsat 7’s enhanced image of the Volga Delta. (1999) Enhanced Thematic Mapper plus sensor on August 29, 1999. NASA Earth Observatory.

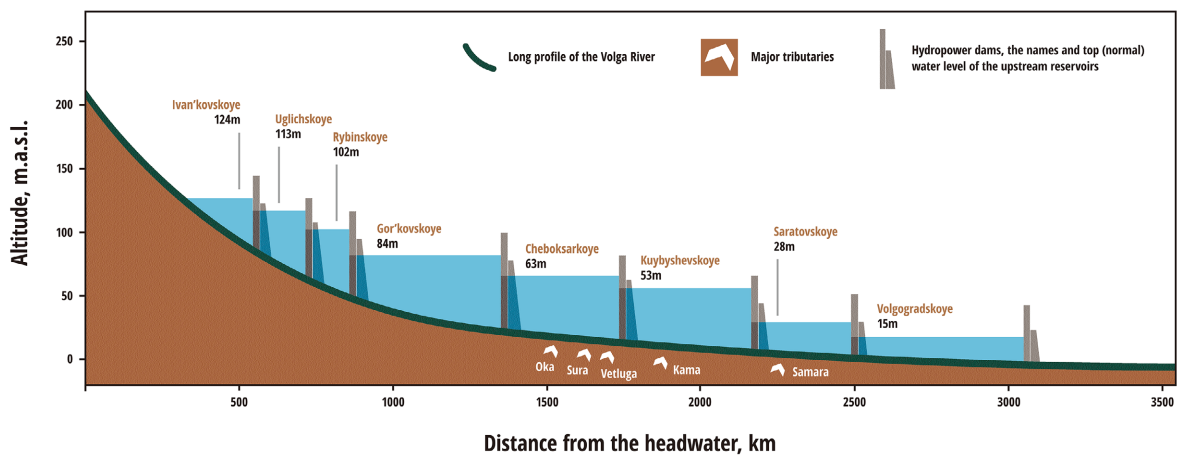


Figure 5. Dam profiles on the Volga River. Data on the top level of reservoirs are taken from RusHydro Group’s official web-site at <https://eng.rushydro.ru/>. Diagram created by Sergey Chernyanskii and Cruz Dragosavac.



Figure 6. Shoreline stream bank erosion along the Volga River. Photo Credit: Encyclopedia Britannica.



Figure 7. Volga River sand bars and islands: Photo Credit: Russian Nature.



Figure 8. Horticulture Green house in Volga River watershed. Photo Credit: <https://utextensionnr.tennessee.edu>



Figure 9. Channel erosion in Volga watershed. Photo Credit: Reddit.



Figure 10. Air pollution and chimney stacks. Photo Credit: <https://fineartamerica.com/>



Figure 11. Picture of a church and bridge in a Rybinsk, Russia along the Volga River. Photo Credit: World Atlas.



Figure 12. Volga River with church and castle. Photo Credit: Encyclopedia Britannica.



Figure 13. Russian wooden village on tributary. Photo Credit: Sergei Rzevsky.

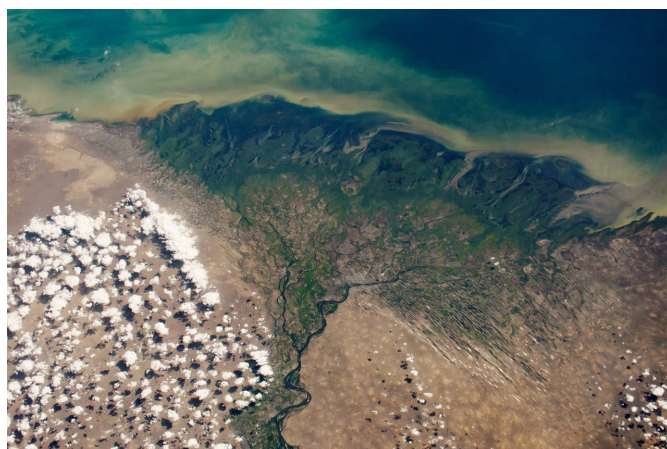


Figure 14. Volga Delta, Caspian Sea, Sediment outwash, Volga River. Photo Credit: NASA, Earth Observatory. Photograph ISSo48-E-63048 was taken on August 21, 2016 with Nikon D4 digital camera using a 78 millimeter lens by the ISS Crew Earth Observations Facility and the Earth Science and Remote Sensing Unit, Johnson Space Center.



Figure 15. Russian Nature (2012) Dead Pike fish. Photo Credit: Russian Nature.

South of Astrakhan on the Caspian Sea is where the Volga River branches into 800 smaller streams and flows through large marshes (Figure 4). The marshes filter out the pollutants before they reach the Caspian Sea. The Volga Delta is home to ducks, swans, white-tail eagles, and many other bird species. It is home to approximately 30 other animals including the wild boar, muskrats, beavers, and foxes. In the summer the marshes become colorful. The Volga River Delta is a species-rich habitat home to 127 fish species, 260 species of birds, 430 species of flora, 850 species of aquatic invertebrates, and a large number of insect species. Many migratory birds, including the great white egrets and Dalmatian pelicans, breed in the Volga Delta's wetlands [4]. Fish species in the river include Volga lampreys, whitefish, herrings, and several types of sturgeons.

Up to 60% of the total Volga River discharge comes from snow melt (Figure 16). Precipitation levels in the Volga basin gradually drop from north to south. The northern reaches of the watershed experience warm, humid summers and cold, snow-covered winters. The lower part of the river basin has dry, hot summers, and cold winters. Underground sources accounting for 30% of the discharge and rainfall only accounts for the other 10% of the total discharge. Historically, the Volga's regime was characterized by annual fluctuations and spring floods. Construction of reservoirs (Figure 17) along the river changed the flow pattern and sequence. The water level ranged from 7 to 11 meters on the Upper Volga, 12 to 14 meters on the Middle Volga, and 3 to 15 meters on the Lower Volga [4] (see Figure 5 for more detail). At the river's mouth the average annual discharge is about 8000 cubic meters per second. The river's average discharge also varies by location, with 1100 cubic meters per second at Yaroslavl, Tver recording 180 cubic meters per second, and 7715 cubic meters per second at Samara.



Figure 16. Frozen river with ice and sediments. Photo Credit: World Atlas.



Figure 17. Rybinsk hydroelectric dam. Photo Credit: Megaconstruccion.es.

The Volga River hosts some of the world's largest dams and reservoirs, creating a chain of artificial water bodies. The reservoirs include hydropower stations and navigation locks. The uppermost reservoir at Dubna (**Figure 18**) (*Ivan'kovskoye*, see **Figure 5**) was completed in 1937 and covers approximately 326 square kilometers. The following downstream Uglichskoye reservoir covers about 250 square kilometers, while the next Rybinsk Reservoir (**Figure 17**) stretches 4532 square kilometers. Other reservoirs are located at Cheboksary, Nizhniy Novgorod, Samara, Balakovo, and Volgograd. The Volga has eight hydroelectric power stations and the Kama, its main tributary, has three power stations.

Rostislav Frolov, a professor at the Academy of River Transportation in the



Figure 18. Ivan'kovskoye Reservoir. Photo Credit: megaconstrucciones.



Figure 19. Building wall on hill above Volga River. Photo Credit: Moscow Times.

city of Nizhny Novgorod [1], stated “*The Volga River is now much more than just a river. It also includes a complex web of lakes, smaller rivers and man-made canals stretching from the far north to the country’s southern reaches. Thanks to canals, the Volga is now the main link in a huge system which has allowed Russia to be connected to the White Sea far to the north, the Baltic Sea, the Black Sea, the Sea of Azov, and the Caspian Sea*” [1].

2.2. Cultural History

During the 16th century, forces of the grand princes of Moscow traveled south from the city, conquering the long reach of the Volga, creating Russia. Eleven of

Russia's 20 largest cities (**Figure 19**) had their beginnings as Volga fortresses [1]. The river played a key role through Russia's early imperial history and the rise of the Romanov czars. The bloody civil war, following the 1917 revolution, was finally decided on the Volga. During World War II, over 1 million Russians died defending the Volga River.

The Volga ices up (**Figure 20**) and river transport shuts down in the winter. Until the ice forms, speedboats and sailboats travel the waters. Fishermen in modest boats fish along the low-lying forested shore. What's not visible lately is commercial traffic—even in what should be the busy season [1]. In the 1990s, cargo transport was way down and cruise ships (**Figure 21**) and (**Figure 22**) owned the river. In 1989, Russian inland river transport was 600 million tons, about equal to the United States. It's now down to 100 million tons according to government statistics. After the collapse of the Soviet Union, in the 1990s, ships were broken up for quick cash and metal. Efforts are being made to restore the fleet, but rebuilding is expensive and difficult.

2.3. Military History: Stalingrad Campaign, Turning Point of WWII

Ice on the Volga in the winter of 1941 prevented tugs and boats from supplying the Soviet defenders of Stalingrad. By the spring of 1942, the German Army (**Figure 23**) finally reached the Volga River banks (**Figure 24**) and captured Stalingrad, Soviet Union [5]. However, the fighting continued in the factory area (**Figure 25**) inside the northern part of Stalingrad as well as on the Mamayev Kurgan slopes (**Figure 26**) [6]. The German 6th Army lost 60,548 men, including 2221 missing, 12,782 killed, and 45,545 wounded [5], from 21 August to 20 November 1942.

Stalingrad, located on the banks of the Volga River, has been described as the site of German Army's greatest defeat in the history. It is often identified as the turning point on the Eastern Front of WWII, in the war against Germany, and in the entire WWII. By the end of 1942, Germany's Sixth Army had ceased to exist. The destruction of the entire German Army and the frustration of Germany's grand strategy made the battle a watershed moment and turning point. There was little doubt about Stalingrad's strategic implications and Stalingrad's symbolism to the rest of the world. Germany's defeat shattered its reputation for invincibility and dealt a devastating blow to German morale. In a speech on 9 November 1944, Hitler himself blamed Stalingrad for Germany's impending doom [7].

The news of the Stalingrad battle echoed around the world. People started to believe that Hitler's defeat was inevitable. The Soviet Union celebrated "Red Army Day" on 23 February 1943. In Great Britain, under orders from King George VI, a ceremonial Sword of Stalingrad was forged. It was presented to Stalin by Winston Churchill at the 1943 Tehran Conference after being publicly displayed in Britain. Soviet media wasted no time and spared no effort on capitalizing on the Stalingrad triumph which impressed a grateful global audience.



Figure 20. Frozen Neva River at St. Petersburg. Photo Credit: Encyclopedia Britannica.



Figure 21. Cruise ship on the Volga. Photo Credit: Russian Nature.

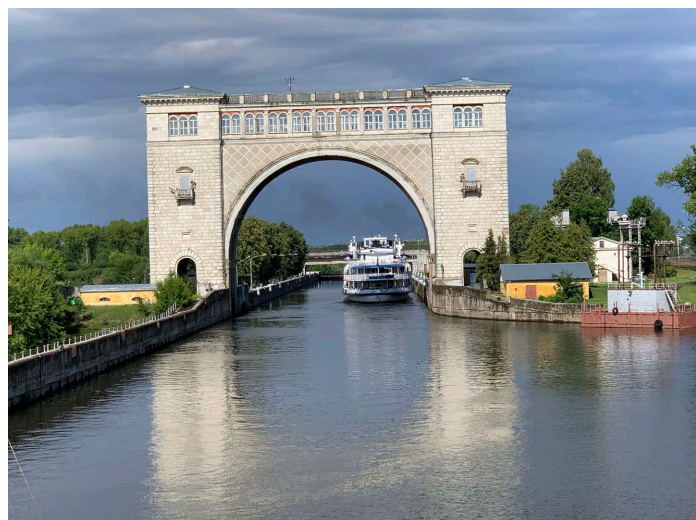


Figure 22. Cruise ship behind gateway arch on a tributary canal. Photo Credit: Russian Nature.



Figure 23. German soldiers in trenches at Stalingrad. Photo Credit: historypress.co.uk.



Figure 24. A German heavy mortar crew during the Battle of Stalingrad. September 1942. Photo Credit: New York Post.



Figure 25. Tractor factory battle on a bridge over the Volga River. Photo Credit: incredibleimages4u.



Figure 26. Soviet troops armed with light machine guns attack German positions in the Volga River valley during battle of Stalingrad. 26 November 1942. Photo Credit: New York Post.

The prestige of Stalin, the Soviet Union, their political position in the World and the worldwide Communist movement, was immensely enhanced by the Stalingrad defense [5].

In recognition of the determination of the Stalingrad defenders, the city was awarded the title “Hero City” in 1945. Even though the city itself was renamed Volgograd in 1961, numerous streets and other urban sites all over the world still bear its military glory title. A huge monument was erected in 1967 on Mamayev Kurgan, called “The Motherland Calls”, the hill overlooking the city where rusty metal splinters and bones can still be found. Every year hundreds of bodies of soldiers, who died in the Stalingrad battle are still being recovered on the banks of the Volga and reburied in the cemeteries at Rossoshka and Mamayev Kurgan [5].

2.4. Waterways

The navigation potential of the Volga River is currently supported by a cascade of reservoirs and associated hydraulic structures (dams, locks, navigation canals, etc.), but historically, the waterways⁵ (Figure 27) linking the Volga with other major river basins and seas were of no less importance. Nowadays all of them remain both transportation and water balance significance, also serving as unique modified freshwater habitats and monuments of hydraulic engineering development.

⁵In the context of this article, we use the term “canal” to refer to waterways consisting mainly of artificial channels and reservoirs, while the name ‘waterway’ refers more to a combination of canals with natural lakes, as well as straightened and deepened sections of natural riverbeds.

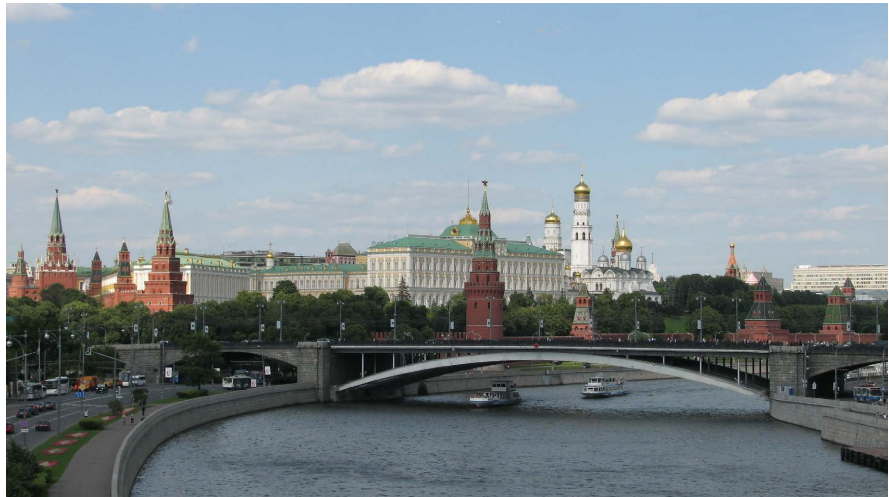


Figure 27. Moscow river and skyline pictures. Photo Credit: <https://pxhere.com/>

2.4.1. Volga-Baltic Waterway

The V.I. Lenin Volga-Baltic waterway has a total length of 1100 km. Constructed in the early 19th century and was rebuilt in the 1960s. It became part of the Unified Deep-Water System of European Russia [5]. The first link between the Volga and the Baltic opened in 1731. A second route opened in 1811. Called Mariinskiy at the time, the waterway was then improved in the 1850s and in the 1890s. The whole system was rebuilt between 1939 and 1964. The system has seven modern automatically controlled locks. A ship can draft up to 3.5 m and have a 5000-ton capacity. The importance of this water system is due in no small part to its connection to the North Dvina Waterway which allows navigation to the North Dvina and Sukhona rivers (Figure 28) with access to the White Sea.

2.4.2. Moscow Canal

The Volga's Ivan'kovskoye Reservoir is connected to the river of Moscow by the 137 km long Moscow Canal. The canal was commissioned by Stalin to bring drinking water to Moscow (Figure 28). It was built using GULAG prisoners. The canal took 4.5 years to build. The canal has 11 locks and passes through villages, forests, and farmlands north of Moscow. The Canal is of great significance to the national economy and Moscow's development. Moscow's water supply problem was solved by bringing in relatively clean water via the Canal.

Moscow desperately needed the Volga River and its water in the 20th century [1]. When Russia was a collection of principalities, it had been located on the much smaller Moscow River. Russia's isolation had been considered a strength. However, the world had changed. Soviet leader Josef Stalin using prison labor harnessed nature, in 1933, by constructing a canal to link Moscow to the Volga located 130 km to the north. Thousands died during the construction process.

Vladimir Debolsky of the Institute of Water Problems, Academy of Science in Moscow [1] stated “*Without this canal, the expanding Russian capital could not have prospered. The Moscow River, which often dried up, could not supply the*

capital's growing needs. Now, 90 percent of water for this city of 10 million comes from the Volga. Many died building this canal. I have no love for Stalin, but there was no other way to do it, given the conditions at that time.” [1]

As cruise ships move through the Uglich Reservoir, they pass a half-drowned bell tower (Figure 29), where villages were flooded. One of the main challenges in creating reservoirs in the Volga basin was the need to flood many settlements and resettle the villagers. Many Orthodox churches in these flooded areas are still a silent reminder of these tragic events (Figure 29). There are now eight reservoirs which are among the largest in the world. The dams check the Volga's flow south. Under Stalin, the river was also dammed to provide hydroelectric power. The Moscow-Volga Canal has provided the City of Moscow with waterway access to the White Sea in the north, the Baltic Sea near Scandinavia and both the Black and Caspian Seas in the South.



Figure 28. Volga River and Waterway map created by Mic Greenberg. Modified by Cruz Dragosavac.



Figure 29. Church tower in Uglichskoye Reservoir. Photo Credit: Reddit.

2.4.3. Volga-Don Canal

The V.I. Lenin Volga-Don Canal is a 101 km long sequence of artificial channels and reservoirs connecting the Volga River downstream the Volgograd Dam with the Sea of Azov and the Black Sea via the River of Don. The completion of the Volga-Don Canal in 1952 created a Russian inland waterway from the Black Sea to the Baltic. The Volga flows into the Caspian Sea (**Figure 28**) while the Don empties into the Sea of Azov near the city of Rostov-on-Don. For many years the Soviet Union and Russia invested in barges and canals rather than highways and trucks. The Volga-Don Canal was updated from 2010 to 2019, is currently undergoing a major reconstruction with the prospect of further expansion in coming decades. The ships and barges were impeded by bottlenecks at the canal locks making it difficult to deliver fresh vegetables to the north. The Volga-Don canal was closed during the winter.

2.5. The History of Industrial Development

The Volga region became an important area for the activities of the first large transnational companies. In particular, in the 19th century, The Nobel Brothers' Petroleum Production Company, or Branobel, the largest petroleum-industrial firm, built and operated for a long time a heating oil production facility in Saratov (a full-fledged petrochemical complex was commissioned on the same site in 1934, then badly damaged by WWII bombing, rebuilt and is still operating today), an industrial and storage complex in Tsaritsyn (also heavily damaged by bombing during the Battle of Stalingrad and subsequently replaced by the city's recreational facilities), a ship repair dock-yard in Astrakhan and many other facilities.

A flotilla of tankers transported crude oil and petroleum products (mostly kerosene and heating oil) along the Volga River from Baku through Astrakhan, Tsaritsyn, Saratov, Samara, Nizhny Novgorod, Yaroslavl, Rybinsk and then the cargo

was delivered by the Mariinskiy Waterway to St. Petersburg and on to Riga. Along the route of the ships there were production facilities, warehouses, berths and settlements for workers and employees—the so-called Nobel townships.

In Soviet times, the Volga-based transportation and energy cascade became one of the main axial lines of industrial development, further accelerated by the transfer of large and medium-sized enterprises from the western regions of the USSR during WWII. The main areas of industry in the Volga cities were oil and gas processing (further stimulated by the discovery of a large number of hydrocarbon fields in this region), as well as the chemical industry and a variety of machine building.

2.6. Pollution

Many factories and cities empty their waste into the Volga River (**Figure 30**). Pollution comes from sewage, industrial waste (**Figure 31**), fertilizers, and pesticides. Pollutants tend to settle in the lakes and contain several meters of heavily polluted muck. Gennady Rozenberg, a biologist at the Russian Academy of Sciences in the Volga city of Togliatti, stated *“the political and economic crises have brought some good news—at least for now. There’s much less industry now and pollution is therefore less. However, this improvement has nothing to do with environmental measures. Now that the government says it is going to double the GDP, we can expect a lot of new serious [pollution] problems [1].”*

The Volga River, a vital transportation artery, traverses several urban centers including Volgograd, a city of 1 million inhabitants (**Figure 30**). A fenced-off 28 hectares area called Beloye Morye (“White Sea”) lies just 200 meters from the Volga’s shore. Despite its name, the Khimprom factory site (**Figure 31**) is in fact a toxic dumping ground. The factory produced chemical weapons during the Soviet era and was shut down in 2019. Environmental expert and public activist Elena Vasilyeva told The Moscow Times [1] *“It’s an absolute mess over there. The cocktail of chemicals is unbelievable. The horror is that it’s located almost in the center of the city, with residential buildings nearby.”*

Beloye Morye is just one of thousands of abandoned Russian sites which include industrial facilities, oil wells, old mines, quarries, and illegal landfills. Apparently, the regional authorities only had the right to assess these sites. The new regulations, which took effect on October 1, 2023, made it their obligation. Some of these sites are remnants of the Soviet era and others have emerged in modern Russia. All the sites are putting the health of millions of Russians at risk and constitute a major challenge for authorities.

In the mid-20th century, Beloye Morye started accumulating sludge. It now holds between 1.5 million to 3.5 million tons of waste [1]. Authorities started dumping lime (**Figure 30**) and (**Figure 31**) on the ground in the 1970s, to neutralize this waste, which gave Beloye Morye its name. According to the latest official document obtained by The Moscow Times [1] *“The site leaks multiple substances into the environment in concentrations hundreds and thousands of times above safe levels, including mercury, phenol, and Benzo_a_pyrene”.*



Figure 30. Panorama of the city of Volgograd and large waste storage lagoons (unofficial name - Beloye Morye) of the Khimprom chemical plant. Photo Credit: Alexei Volkhonsky.



Figure 31. View of the Volgograd's "Beloye Morye": this chemical time bomb is currently under remediation. Photo Credit: Alexei Volkhonsky.

Vasilyeva [1] said *“Because the Volga’s banks are elevated in this area, the spring meltwaters and rainfall from the hills inevitably carry the dangerous chemicals into the river. If you stand above this Beloye Morye, you can see how these little white whirls rise above it and drift toward the nearby residential area. If this stuff washes away into the Volga, it will be a big problem for everyone.”* [1]

In 2021, Russia launched the General Cleanup Federal Project with a budget of 20 billion rubles (\$206 million) to identify abandoned environmental hazards and to determine the top priorities for reclamation based on their impact on public health [1]. The Natural Resources Ministry identified 3100 such sites. By 2024, the General Cleanup project aims to lift 213 sunken ships, reclaim 500 abandoned deep-hole wells, and eliminate environmental damage along Lake Baikal shores. Chistaya Strana (Clean Country), another federal project, plans to rehabilitate hundreds more toxic sites by 2024. In the Russian Arctic alone,

waste sites cover around 2500 hectares. Scattered across the tundra, are empty barrels which may be leaking oil products and remained following the decline of Soviet industry and military presence in the Arctic [1]. In addition, the final resting place for approximately 18,000 containers of radioactive waste and other nuclear legacy objects was the seabed of the western Arctic.

The Beye Morye site on the Volga has been an environmental time bomb for the last 70 years. In 2017, local officials were tasked to find a solution for the troubling sludge storage by then-Russian Prime Minister Dmitry Medvedev. Volgograd regional Governor Andrei Bocharov at the time [1] stated “*This is one of the main problems on the banks of the Volga. It would be detrimental to everyone—the Black Sea, the Caspian Sea, the Sea of Azov, and our friends in neighboring regions if, God forbid, something were to happen. That’s why we are addressing this issue.*”

In 2021, Beye Morye was included in the rejuvenation of the Volga Federal Project. The project goal was aimed at the ecological rehabilitation of the river basin where about one-third of Russia’s population resides. The plan for the toxic facility’s reclamation is currently undergoing public discussions in Volgograd [1]. Experts remain cautious in predicting whether new regulations and state plans will lead to significant ecological rehabilitation. There are also international doubts about staff capacities in the relevant ministries as well as the adequacy of the budget and spending priorities.

3. Conclusion

The Volga basin makes up 8 percent of the Russian territory. The Volga River flows through European Russia, supporting more than 25 percent of the country’s industry and agriculture. Some 40 percent of the country’s population is concentrated within the river’s basin. The meeting point of the Eurasian civilization was historically the Volga River. Stalingrad, located on the banks of the Volga River, has been described as the site of the greatest defeat in the history of the German Army. It is often identified as the turning point on the Eastern Front of WWII, in the war against Germany, and in the entire WWII. The Volga has some of the world’s largest reservoirs and is a major source of livelihood to millions of people. Many factories and cities empty their waste including sewage, industrial waste, fertilizers, and pesticides in the Volga River. Pollutants tend to settle in the lakes and contain several meters of heavily polluted muck. The Volga River system lifeline in Russia needs to be managed, mitigated, and restored.

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Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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