

Clean Water of Russia: Problems and Solutions

Oleg Primin

Moscow State University of Civil Engineering, Yaroslavskoye shosse, 26, Moscow, Russia, 129337

Tepper2007@yandex.ru

Abstract. The article reveals the problems of water supply world-wide in general and in Russia and Moscow in particular. It reveals the current state of the water supply system in Russia, pointing out that its significant part needs replacement in order to prevent possible hazardous consequences. The article also describes main issues of “Clean water” state and municipal programs aimed at protection of water bodies and implementation of new technologies for water purification and wastewater treatment.

1. Introduction

At present the population of the world uses 54 percent of the entire available surface run-off. Taking into account the rates of the global economy growth, the index of the population growth of our planet (85 million people per year) and some other factors, it is expected that by the year 2025 this index will reach some 70 percent. According to the UNO information, more than 18 countries experience water shortage (the level of 1 000 m³ per capita per year or even less), when it is practically impossible to meet the water requirements of national economies and to satisfy the municipal needs of citizens. According to forecasts, the number of such countries will amount to 33 by the year 2025. [1]

The following regions are at a marginally low level of water supply: Middle East, North China, Mexico, North Africa, South-East Asia and a number of post-Soviet countries. The Russian Federation has a unique potential of water resources. From the point of view of water resources availability Russia ranks second in the world after Brazil. Russian renewable water resources (the volume of annual river flow on the territory of Russia) amount to 10 percent of the world river flow. The main weak point of Russian water resources is their extremely uneven distribution over the territory of the country. The greatest part of Russian water resources (90 percent) is concentrated in the basins of the Arctic Ocean and the Pacific Ocean, where less than 15 percent of Russian population live. The greatest shortage of water resources exists in the European part of the country – the basins of the Black Sea and the Caspian Sea – less than 10 percent of the river flow fall on these territories.

Countrywide, the total water intake for domestic needs is relatively low – some 3 per cent of the average annual river flow. Nevertheless, in the basin of the Volga River it amounts to 33 percent of the total Russian water intake and in a number of river basins this index exceeds the ecologically permissible volume of water abstraction [2].

Shorter average life-span of the Russian population compared to advanced industrial countries, to a large extent results from the consumption of low-quality water. Nowadays according to expert data, about 40 percent of surface water sources and 17 percent of groundwater sources of drinking water supply do not meet the requirements established by the standards. Over 6 thousand areas of



groundwater pollution are found on the Russian territory, and most of them are located in the European part of Russia. [2]

2. The condition of Russian water supply systems

The problem of providing the required reliability and environmental safety of Russian urban water supply systems has considerably aggravated as a result of the following factors: transfer to market economy, reforming the housing and utility complex under the conditions of considerably deteriorated and aged engineering life-support systems of Russian cities and settlements, lack of sufficient material and financial resources for the renovation of these systems.

In present-day Russia over 18 000 000 thousand m³ of water is supplied to the network, nevertheless, 30.5 million people or 22 percent of Russian population are not provided with the services of centralized water supply. 12 percent of Russian towns and 68 percent of rural settlements have no centralized water supply systems. On an average, the water losses in water supply systems amount to 18.5 percent of the total volume of the water supplied to networks. In the Russian Federation in general, the percentage of inefficient non-productive water losses amounts to 25 percent of the total volume of water intake. One of the reasons for high water losses is the deterioration of networks. One third of Russian water supply networks need replacement. In the year 2015 only 1.6 percent of the total length of networks was replaced. [2, 4]

The poor condition of water supply systems and wastewater disposal and treatment systems is a result of the insufficient financing of the industry.

In the present-day Russia, the problem of providing the population with drinking water of required quality and in sufficient quantity is most topical. The reason is not only some technical problems of outdated equipment and general technological backwardness, but first, the legislative, organizational and economic problems. The condition of water-bearing service lines gives rise to concern. From the point of view of the length of underground pipelines, Russia takes the second place in the world, while from the angle of pipe deterioration it takes one of the first places. About 70 percent of Russian pipes are made of steel.

According to the information of the Russian Ministry of Civil Engineering, the overwhelming majority of the existing pipes of Russian water supply and wastewater disposal systems (over 60 percent) are physically depreciated and need reconstruction. In a number of Russian cities and other settlements, water leakages and unaccounted water consumption during the water transportation by water supply systems amount to 60 percent of the water supplied to the network. [5]

Among the most important problems of the Russian water industry are the following:

1. Unsatisfactory condition of utility and drinking water supply systems, low quality of water supplied to the population because of surface water and groundwater pollution, insufficient application and frequently, lack of up-to-date methods for drinking water treatment and unsatisfactory condition of water supply networks.
2. Growing shortage of water resources in a number of basins.
3. Lack of up-to-date Russian technological and research bases, shortage of technical approaches, lack of technical conditions for the production of modern Russian equipment and materials, the volume of which would be sufficient for the needs of water companies.
4. Growing material and environmental detriments resulting from the failures in water supply and wastewater disposal systems.
5. Deteriorating technical condition of the facilities and equipment belonging to water companies, first of all in small Russian towns and settlements, where one half of Russian citizens dwell.
6. Low-efficient governmental control of the water industry, considerably reduced financing of research and design activities.
7. Low investment attractiveness of water companies, of the water sector and of the development of public and private partnership.
8. Lack of any well-defined system of government obligations for the provision of the population with clean water (requirements for the quality of water as a foodstuff).

9. Low professional level of the graduates of the relevant faculties of Russian universities, their isolation from the European and world educational and scientific achievements.

3. “Clean water” programs of Russia and Moscow

It should be mentioned that the problem of providing safe drinking water supply systems in Russia is not unnoticed by the scientific community and governmental authorities. In the last year, for the first time in Russian history, the problem of clean water was tackled at the highest level. Under the aegis of the United Russia party, the Institute of Macro-Economy of the Russian Academy of Sciences has developed a party program entitled “The Clean Water of Russia” governmental program. [5]

The main goals of the Program are as follows:

- Development of the government regulation system for water supply and wastewater disposal systems
- Establishment of conditions for the invitation of long-term private investments for the water sector through the improvement of the Russian Federation legislation in the field of public and private partnership and environmental legislation
- Modernization of water supply and wastewater disposal systems
- Safe water use
- Protection of water sources against human impact.

Nevertheless, it should be mentioned that the main disadvantage of the “Clean Water” governmental program is the fact that it does not contain any scientifically substantiated strategy for the innovative development of the Russian water sector, including any variants for the application of Russian water resources. Despite numerous declarations of politicians that Russian water resources are a strategic resource that may be considered an article of commerce that may be sold to other countries, the Clean Water Program does not mention anything of the kind. The Russian Federation has 14 neighboring countries. The total number of trans-border water bodies exceeds one thousand; 70 large and medium rivers are trans-border.

Must Russia become a water exporter or would it be expedient to develop Russian wet industries? The answer may be given by a long-term water strategy of Russia that should take into account our national interests and global water problems.

The program entitled “The Clean Water of Moscow” is an example of solving the problems of supplying the population of Russian capital with clean drinking water. This program was developed by MosvodokanalNIIproject Institute and approved by the Government of Moscow. [6] The necessity to develop a program for Moscow was long-felt. In the recent years this need became most apparent. The industrial growth resulted in new types of pollution. The territory of the sanitary protection belt is being quickly built-over. As a result, the human impact on water sources and the deterioration of facilities increased, while considerably reduced water consumption gave rise to new problems in the field of providing the sanitary quality of water in the network.

The main goal of “The Clean Water of Moscow” municipal special-purpose program is to solve one of the most urgent tasks of the social and economic development of the city of Moscow – to provide guaranteed drinking water supply to the citizens of the Moscow megalopolis at a reasonable price, to establish ecologically safe aquatic environment and on this basis, to improve the level of human health and to increase the duration of human life-time.

The program specifies the following complex of interconnected measures in the following directions:

- Human health and safe drinking water
- The introduction of up-to-date innovative technologies in the field of the water sector of the Russian capital
- Protection of water resources against human impact
- Construction (reconstruction) and modernization of water treatment and wastewater treatment plants, pipelines and the equipment of municipal water supply and wastewater disposal networks, pumping stations and regulating facilities
- Water saving and expedient water use

- Development of Russian technological inventions and their application for the enterprises of the water sector of Moscow
- Improvement of the regulatory and legislative framework
- Establishment of favorable business environment and attraction of extra-budgetary investments
- Improving the professional training level of the working staff of the water sector
- Establishing efficient informational and analytical background referring to the condition and development of the water sector
- Involving the population and other water consumers in the process of efficient and rational use of water resources.

4. The water supply system of Moscow: ways for modernization

At present the centralized water supply system receives water from the surface water sources of the Moskva-River – the Vazuza River system and from the Volga River system located on the territory of the Moscow Region, the Smolensk Region and the Tver Region. [4]

In Moscow the treatment of drinking-quality water is performed by five water treatment plants that use the water from the Moskva-River and the Volga River water sources. The actual total water treatment capacity of the plants is 6.7 million m³ per day; at present their reserve capacity amounts to 38.5 percent. The deteriorating condition of the water sources and the increasing risk of their man-induced pollution under the conditions of constantly tightening drinking water quality standards stipulate the necessity to introduce up-to-date efficient technologies.

In this connection, the main part of the Program deals with the introduction of up-to-date innovative technologies in the water sector and the substantiation of the modernization and reconstruction of the water supply system of Moscow. The main documents regulating the quality of potable water are the Sanitary Regulations and Standards – SanPiN 2.1.4.1074-01. [3] These standards are developed and adopted in accordance with the recommendations of the World Health Organization. Comparative analysis reveals that the most stringent drinking water quality standards have been adopted in Switzerland. It should be mentioned that the quality of deep water from the Baikal Lake is not inferior to the Swiss standards, while from the point of view of certain indices it even exceeds these standards.

Our studies revealed that traditional water treatment methods (coagulation, subsequent clarification and disinfection with chemical reagents) make it possible to remove suspended and colloidal particles; nevertheless, this technology is insufficiently effective in case of human pollution of water sources. Under these circumstances, it is possible to improve the barrier function and the reliability of treatment facilities only through the changes in the structure of treatment facilities and via supplementing the existing technology with other methods. [4]

The most efficient water treatment technologies, applied for the water supply system of Moscow that make it possible to obtain drinking water that meets the requirements established by the existing standards, are ozonation, activated carbon sorption and membrane filtration using ultra-filtration modules.

Powdered or granular activated carbon is used as sorbent. The application of ozonation and sorption method combined with classical drinking water treatment technology makes it possible to improve considerably the level of organic pollution removal, to reduce the concentration of water disinfection by-products and to improve the aesthetic characteristics of water. The quality of drinking water treated through the application of new technologies, is better than the quality obtained through the application of traditional technology. The absence of chlorophorm, high organoleptic properties of water, including its odor (regardless the quality of the Moskva-River water), insignificant turbidity level and insignificant aluminium and organic matter concentrations make the difference most apparent.

Today the capital of Russia consumes about 3 million m³ of water per day, while 10 years ago the water consumption amounted to about 6 million m³ of water per day. That is why the Program

manifests the necessity of careful and expedient water use through the application of the following methods:

- Monitoring of large water consumers in the city of Moscow from the angle of estimating the condition of in-house sanitary engineering systems of the buildings
- Improving the methods of water consumption monitoring and accounting
- Complete transfer to the system when the population pays to the managing authority for the actual water consumption based on the readings of water meters
- Introduction of automatic system for water consumption metering
- Introduction of innovative technologies for water leakage detection
- Carrying out activities aimed at network pressure normalization and monitoring
- Reducing inefficient water consumption by the enterprises located in the city of Moscow.

It is planned to reduce the water consumption to 190 liters per capita per day by the year 2016 and to 160 liters per capita per day by the year 2020.

5. Water loss reduction: challenges

“The Clean Water of Moscow” program pays special attention to the necessity of improving the safety of the system for water supply and distribution (SWSD). Drinking water is transported by the radial-circular pipe system, which length exceeds 11 thousand kilometers. The water supply network is among the most vulnerable elements of the water supply system of Moscow. The service life of about 5.3 thousand kilometers of pipes has ended. The basic material of pipe structure is steel resulting in a considerable corrosive damages. That is why the reduction of unaccounted water consumption and water losses is very important for the water supply of Russian cities including Moscow. [4]

At present, the water consumption is growing all over the world, while the available water resources are diminishing. Under the conditions of growing shortage, many countries include the strategy of water resources management in their sustainable development plans.

Water losses in water supply systems are a constant problem and a source of concern for operation engineers, even in the countries of a well developed infrastructure and a good practice of network operation. [1, 7]

The following reasons for eliminating the water losses should be mentioned here:

- Shortage of existing and potential water resources
- The hazard of a secondary pollution of drinking water if the pressure at the point of leakage is reduced
- Financial and economic aspects
- Necessity to use new water sources and consequently, extra treatment capacities of facilities and additional capital investments

Apart from these reasons, it is necessary to indicate the detriments resulting from water leakages from networks. These detriments result in under-flooding, corrosion, subsidence of facilities, earth drifts and water pollution. Material factor is also important. Nowadays everything is getting more and more expensive. Municipal services are no exception. Getting bills for water company services, consumers usually ask a very notorious question: why so expensive? Is not it surprising that water tariffs are growing, while water consumption is dropping? Nevertheless, potable water is far from being cheap. And if the consumers pay, they have a legitimate right to know, what they pay for and if the price is economically justified.

Largely the volume of water losses depend on the condition of pipes, on their safety, deterioration and the materials they are made of.

In various cities of the world, the volumes of water losses in water supply systems are sufficiently different depending on the following factors: the level of these systems' equipment with water meters, the materials the pipes are made of and their service life, the availability of instruments for pipe diagnostics, etc. Only for the most efficiently operated water supply systems in Europe and North America, the volume of water losses amounts to 4 – 6 percent, while the average relevant value for developed countries is about 15 percent. [1, 7]

In a number of Russian cities and settlements, the level of water losses and unaccounted water consumption during water transportation may amount to 60 percent of the water supplied to the network. For most efficiently operated water companies (especially, for private ones) the level of water losses above 15 percent is unacceptable, but under the existing Russian conditions, it is rather difficult to attain such an index.

As to the capital of Russia – the city of Moscow – in the last two years the level of water supply in Moscow Water Supply System amounts to some 10 – 12 percent of the total water supply. In fact, this is a good achievement, taking into account that the water supply network in Moscow is aging and deteriorating, while the level of its reconstruction and replacement is insufficient.

The strategy of water loss reduction is based on the implementation of four basic principles for real water loss regulation:

1. Promptness and quality of repair
2. Active leakage management
3. Network modernization and reconstruction
4. Pressure management

The implementation of the strategy for water loss reduction should take into account that for every water system there is the level of points below which any further investments in cost reduction are uneconomical. In other words, the cost of saved water is less than the cost of further leakage reduction. This is a so-called economy level of leakages.

“The Clean Water of Moscow” program determines the basic ways for improving the reliability and safety of water-bearing pipelines and correspondingly, the reduction of all types of water losses. [6]:

- Application of reliable and durable types of pipes and fittings that would efficiently prevent internal and external corrosion, such as pipes made of high-duty spheroidal-graphite cast-iron
- Introduction of scientifically substantiated strategy for network rehabilitation and renovation
- Increasing the volume of pipeline re-laying and reconstruction, the trenchless technologies being preferable
- Application of pipeline technical diagnostics aimed at the assessment and prediction of pipe technical condition
- Efficient protection of pipelines against external and internal corrosion
- Application of automated systems and information technologies for the control and monitoring of network operation
- Network pressure stabilization and monitoring
- Development of new (and updating of existing) regulatory and methodological documents and operating regulations that take into account the existing requirements for the reliability and ecological safety of pipelines.

6. Conclusions

1. Water in all competitive types of its application, has its economic value and must be recognized as an economic benefit. In the past the economic value of water resources was not recognized. This fact resulted in a wasteful and environmentally hazardous usage of these resources, while the expedient management of water resources as an economic benefit as well as water use rationalization are important means for efficient and appropriate usage of water resources, their conservation and protection.

2. Today there are some political and economic decisions aimed at reduction of water losses, improvement of water resources management and reduction of demand for water resources.

3. In general, the negative trends in the field of water resources and possible restrictions on their use are natural calamities, growth of population, resource-consuming industrial and agricultural production and pollution of natural bodies of water, coastal territories and groundwater with waste materials. According to the estimations of WHO, the incidence rate of water-born diseases is the highest. Many people in various countries are subject to risk because they consume water containing

harmful substances. In this connection WHO has recognized that reducing the pollution level of aquatic eco-systems and elimination of their sources are the main strategic goal of human health protection in general.

4. The interconnection “water – human health” must become one of the top-priority aspects of environmental protection activity. A very important role in this chain belongs to potable water, drinking water supply and public water supply. The indisputability of water factor impact on human health is proved by the Russian practice of centralized water supply development, which history exceeds one century.

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