Revista Gestão & Tecnologia
e-ISSN: 2177-6652
revistagt@fpl.edu.br
http://revistagt.fpl.edu.br/

FORECAST OF DEVELOPMENT OF REGIONAL WATER SUPPLY AND SANITATION SYSTEMS CONSIDERING ENVIRONMENTAL, ECONOMIC, AND SOCIAL ASPECTS AS EXEMPLIFIED BY SAINT PETERSBURG

PREVISÃO DO DESENVOLVIMENTO DOS SISTEMAS REGIONAIS DE ABASTECIMENTO DE ÁGUA E SANEAMENTO, CONSIDERANDO ASPECTOS AMBIENTAIS, ECONÔMICOS E SOCIAIS EXEMPLO DE SÃO PETERSBURGO

PRONÓSTICO DEL DESARROLLO DE LOS SISTEMAS REGIONALES DE ABASTECIMIENTO DE AGUA Y SANEAMIENTO CONSIDERANDO LOS ASPECTOS AMBIENTALES, ECONÓMICOS Y SOCIALES, COMO SE EJEMPLA EN SAN PETERSBURGO

Anna Bezdudnaya
Saint Petersburg State University of Economics, Russian Federation
bezdudnaya.a.g@mail.ru
http://orcid.org/0000-0002-7605-5660

Marina Treyman
Saint Petersburg State University of Economics, Russian Federation
m.g.treyman@yandex.ru
http://orcid.org/0000-0002-7533-2777

Tatyana Ksenofontova
Emperor Alexander I St. Petersburg State Transport University
Russian Federation
http://orcid.org/0000-0002-3189-9990

Alexander Pogoreltsev
Saint Petersburg State University of Economics, Russian Federation
alexander.s.pogoreltsev@yandex.ru
http://orcid.org/0000-0001-8728-3979

Roman Smirnov
Saint Petersburg State University of Economics, Russian Federation
roman.val.smirnov@yandex.ru
http://orcid.org/000-0001- 7565-5544

Editor Científico: José Edson Lara
Organização Comitê Científico
Double Blind Review pelo SER/OJS
Recebido em 19.01.2022
Aprovado em 16.03.2022

ABSTRACT

The study examines the features of the theoretical and methodological basis of water resources management, defines the term, as well as the principles of resource-saving in urban water supply and sanitation systems. The object of the study is the water resources management of St. Petersburg, and, in particular, the performance of the resource-supplying water services company SUE "Vodokanal of St. Petersburg", whose operation is considered in detail in the context of the implementation of elements of sustainable development into its practice through environmental management systems. Besides, mission, vision, values, problematic aspects, initiatives, and challenges to further improvement from environmental, economic, and social positions are identified. Based on the conducted analysis and the company's directives, a forecast of the water resources use in St. Petersburg up to 2030 was made in general terms and the context of the city's water supply stations, taking into account the modernization of production and technical systems. Tools for regulating the environmental activities of water resources management enterprises were proposed, and correction coefficients were introduced for calculating fees by categories of polluting components. These measures will reduce the overall ecological footprint on water bodies in the region.

Keywords: Environmental Management Systems, Forecast of Water Resources Management, Negative Impact on the Environment

RESUMO

O estudo examina as características da base teórica e metodológica da gestão dos recursos hídricos, define o termo, bem como os princípios da economia de recursos nos sistemas urbanos de abastecimento de água e saneamento. O objeto de estudo é a gestão dos recursos hídricos de São Petersburgo e, em particular, a atuação da empresa fornecedora de recursos hídricos SUE "Vodokanal de São Petersburgo", cuja operação é considerada detalhadamente no contexto da implementação de elementos de desenvolvimento sustentável em sua prática por meio de sistemas de gestão ambiental. Além disso, são identificados a missão, a visão, os valores, os aspectos problemáticos, as iniciativas e os desafios para uma maior melhoria das posições ambientais, econômicas e sociais. Com base na análise realizada e nas diretrizes da empresa, foi feita uma previsão do uso dos recursos hídricos em São Petersburgo até 2030 em termos gerais e no contexto das estações de abastecimento de água da cidade, levando em consideração a modernização dos sistemas produtivos e técnicos. Foram propostos instrumentos de regulação das atividades ambientais das empresas gestoras de recursos hídricos e introduzidos coeficientes de correção para o cálculo das taxas por categorias de componentes poluentes. Essas medidas reduzirão a pegada ecológica geral nos corpos d'água da região.

Palavras-chave: Sistemas de Gestão Ambiental, Previsão da Gestão dos Recursos Hídricos, Impacto Negativo no Meio Ambiente

RESUMEN

El estudio examina las características de la base teórica y metodológica de la gestión de los recursos hídricos, define el término, así como los principios de ahorro de recursos en los sistemas urbanos de abastecimiento de agua y saneamiento. El objeto del estudio es la gestión de los recursos hídricos de San Petersburgo y, en particular, el desempeño de la empresa de

servicios de agua de suministro de recursos SUE "Vodokanal de San Petersburgo", cuyo funcionamiento se considera en detalle en el contexto de la implementación de elementos de desarrollo sostenible en su práctica a través de sistemas de gestión ambiental. Además, se identifican misión, visión, valores, problemáticas, iniciativas y desafíos para seguir mejorando desde posiciones ambientales, económicas y sociales. Con base en el análisis realizado y las directivas de la empresa, se realizó un pronóstico del uso de los recursos hídricos en San Petersburgo hasta 2030 en términos generales y el contexto de las estaciones de suministro de agua de la ciudad, teniendo en cuenta la modernización de los sistemas productivos y técnicos. Se propusieron herramientas para regular las actividades ambientales de las empresas de gestión de recursos hídricos y se introdujeron coeficientes de corrección para el cálculo de tarifas por categorías de componentes contaminantes. Estas medidas reducirán la huella ecológica general en los cuerpos de agua de la región.

Palabras clave: Sistemas De Gestión Ambiental, Previsión De La Gestión De Los Recursos Hídricos, Impacto Negativo En El Medio Ambiente

I. INTRODUCTION

Currently, in world practice, the issues of careful attitude to the environment are significant in terms of preserving the resource potential, but also in terms of assessing the detrimental effect of water supply and sanitation systems in urban areas. Studies have shown that the main complex of water resources management problems for regions both in Russia and abroad is reduced to the following trends: water losses in production and technical systems are quite significant, and at the moment there are no optimal ways to reduce them; the quality of drinking water does not meet international standards and has a significant impact on the health of the urban population and future generations; wastewater from water supply and sewerage enterprises does not always meet the standards of discharge into surface water bodies, which negatively affects the environmental situation in the regions. Thus, the generalization of the research problems is reduced to the issues of the lack of systematization of technologies in water resources management and the need to form competent strategies and forecasts for the development of water supply and sanitation systems in the future.

The purpose of the present study was to analyze regional water resources management based on the experience of the resource-saving enterprise SUE "Vodokanal of St. Petersburg", as well as to identify bottlenecks and operation features, and to propose a development forecast of the water resources management of production systems based on certain trends and taking into account environmental, economic, and socially significant factors.

The authors of the study consider and predict further development trends of water supply and sanitation systems and propose the necessary measures to increase the efficiency of using

the resource base and reduce the negative influence of the enterprise on the environment.

II. LITERATURE REVIEW

The term "water resources management" is widely used in the scientific literature (Garnov, Krasnobaeva, 2014; Pavlenko, Yukhimenko, 2014; Bulichenko, Verevkin, Glazkova, 2015; Managi, 2015). The authors of the present study systematized this term and gave their own definition, taking into account the works of domestic and foreign authors. Water resources management is the process of the fullest possible use of water resources to meet the needs of the population, production, and economic activities of enterprises in the region with the least threat to the ecological state of the studied region. Russian authors, in their works, often associate rational water resources management with the most complete and environmentally safe use of water resources as components of the technological process in the industry and do not pay enough attention to its social significance for the urban population (GOST R 57651, 2017; Pishchulov, 2016), which the authors of the present work consider not entirely accurate since the term of sustainable development implies a combination of all types of factorial influence, including social. Some works consider also the regional activities of water supply and sewerage enterprises in Russia and note the significant problems of the industry (Larionov, Larionov, Melnikov, 2014; Petryanina, Viktorova, Razzhivin, 2015; Sheina, Zilberova, Kasyanov, 2017): the lack of updatability of production equipment, functional management systems of enterprises, and standardization of processes; not all enterprises have implemented environmental management components and elements in their practical activities, and prioritize the focus on providing quality water supply and sanitation services to the urban population. All noted problems are mainly related to the reduction of financing and investment of enterprises' activities (Efimova, Ulanova, 2015; Kirilchuk, Rykunova, Sevryukova, 2016). To date, there are a significant number of domestic and foreign methodological developments aimed at modernizing both water supply systems (creating circulating water supply, using advanced materials when replacing pipelines, etc.) (Tyaglov, Kiseleva, Timchenko, 2017; Ugryumova, Kopchenov, Perevozova, 2016), and management processes (implementing environmental management and quality management tools, providing customer orientation, and creating environmental and economic indicators to assess the activities of resource-supplying enterprises, etc.) (Polishchuk, 2017).

Thus, there are currently no unified systematized solutions to the problems of water resources management in the regional aspect. To determine possible research areas, the authors analyzed statistical data on water resources management in Russian and foreign cities and proposed a scenario for the development of water resources management in St. Petersburg until 2030.

III. MATERIALS AND METHODS

Below is a comparative analysis of data on the most significant urban areas of the world, taking into account the population and area of territories, as well as quantitative indicators of the water supply and sewerage enterprises' performances (Table 1).

Table I.
Main performance characteristics of water supply and sewerage enterprises (Watertime Project of the European Commission, n.d.).

City	Population size, thousand	Urban area, km2	Per-capita daily water consumption, l	Water supply volume, m^3	Waste-water volume, m^3	Total profit, mln euros
Saint Petersburg	4,529	1,439	155	944.0	1,010	40
Berlin	3,390	892	117	214,0	215	62
Bucharest	2,354	228	250	475.0	568	18
Hamburg	1,739	755	113	112	145	76
Budapest	1,719	525	175	228.0	224.0	24
Stockholm	1,148	188	200	133.0	135	20
Helsinki	760	186	170	82.6	88.9	34
Leipzig	600	298	90	34.3	35	15
Vilnius	553	402	187	30	38.69	2
Gdansk	457	262	110	31	34.8	1.5
Tallinn	397	158	104	29.2	54.8	18

In terms of population size, St. Petersburg is a leading city (per-capita water consumption per day amounts to 155 liters/day). Nevertheless, this indicator turned out to be the highest in the cities, such as Bucharest (250 liters/day), Stockholm (200 liters/day), Vilnius (187 liters/day), and Helsinki (170 liters/day). At that, the lowest indicators were noted in the cities of Berlin (117 liters/day), Hamburg (113 liters/day), and Leipzig (90 liters/day). Such a spread of data directly depends on the stimulation of the population to

rational water consumption. Thus a low water consumption indicator is typical for German cities, where utility bills, tariffs, and tax deductions are quite high (the rating on the utility fee indicator is presented in Table 2). Besides, several legislative acts have been adopted in Germany that stimulate the population to save water resources. The basic laws are: "Law on Regulation of the Water Consumption Schedule" (WHG), "Resolution on Drinking Water" (TrinkwV), etc. (The water sector in Germany…, 2018). The foregoing is also confirmed by the comparison of income and expenditure curves of German cities (Fig. 1).

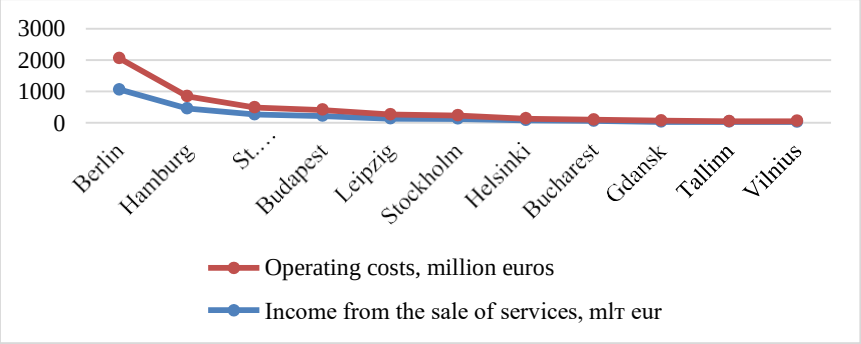

Fig 1: Comparison of income and operating expenses of water supply and sewerage organizations in the world

The highest incomes are typical for Berlin and Hamburg, while St. Petersburg holds 3rd place. It is also interesting to compare the expenses and incomes of organizations. Note that incomes exceed expenses, and this means that enterprises eventually have a positive financial result, but also the indicators of the cost part are quite high, which indicates investments in technology and capital investments in network repairs, as well as modernization of the equipment of production facilities.

The experience of Germany is interesting in terms of using the water management principles, which allow the state to keep enterprises and the population within strict limits in terms of water use.

The basic principles include compensation for damage at the expense of the culprit, preservation of the habitat, minimization of resource costs, reduction of pollution sources, reversibility, regionality, cooperation and participation, etc. The implementation of these principles extends responsibility for the actions not only of water supply and sewerage enterprises but also of individual water consumers, that is, the costs of violating the balance of water use are shared by all participants in the process (The water sector in Germany…, 2018).

Below is a rating of cities in the world according to certain operating parameters, compiled by the authors (Table 2).

Table II.
Ratings of water and sewage utilities by activity parameters (compiled by the authors according to (Watertime Project of the European Commission, n.d.)

N/a	City	Potable water productivity m^3/person	Rating	Acceptability of utility fees, %	Rating	Profitability, %	Rating
1	Saint Petersburg	**208.4**	**1**	**1.07**	**5**	**17.9**	**5**
2	Budapest	132.6	**2**	2.51	**9**	12.4	**6**
3	Stockholm	115.9	**3**	0.59	**1**	18.4	**3**
4	Helsinki	108.7	**4**	0.61	**2**	65.6	**2**
5	Tallinn	73.6	**5**	2.00	**8**	110.8	**1**
6	Gdansk	67.8	**6**	0.77	**4**	4.5	**10**
7	Hamburg	64.4	**7**	1.20	**6**	19.8	**4**
8	Berlin	63.1	**8**	1.37	**7**	6.2	**9**
9	Leipzig	57.2	**9**	0.75	**3**	12.1	**7**
10	Vilnius	54.2	**10**	4.53	**10**	9.4	**8**

The first place in terms of production capacity is occupied by St. Petersburg, then Budapest, and Stockholm. However, in terms of economic characteristics (profitability), Helsinki and Stockholm are in the lead, which mainly is due to the quality of services provided and competent environmental management, as well as support for effective water use by state authorities of the countries. Tallinn ranks 1st in terms of profitability, which is due to high utility bills, fines, and tax fees, but this is not reflected by other economic development tools.

The research object of the article is the water resources management of St. Petersburg as one of the most important cities in the North-Western region. Below is a comparative analysis of the performance indicators of some Russian enterprises.

Table III.
Main technical and economic parameters of water supply and sewerage enterprises in Russia (Federal State Statistics Service, n.d.)

City	Population size, thousand	Urban area, km^2	Coverage of the population by water supply, %	Coverage of the population by sewage systems, %	Water sales volumes, mln m^3 per year	Losses, %
Moscow	10,101	1,100	99.8	99.8	1,658, 204	8.6
Saint Petersburg	4,529	1,439	98.7	98.4	812,472	16.6
Novosibirsk	1,426	500	93.5	91.1	226,710	26.9
Nizhny Novgorod	1,311	411	96.7	95.5	209,747	26.3
Yekaterinburg	1,293	467	93.6	95.3	172,213	27.0
Omsk	1,134	572	86.8	86.7	158,736	27.5
Kazan	1,110	425	93.5	92.5	134,888	28.2
Chelyabinsk	1,078	500	92.9	95.5	134,234	30.6
Rostov on Don	1,070	349	89.6	89.0	118,733	19.1
Perm	1,000	799	94.8	94.0	153,218	21.3

According to the data presented in Table, the largest percentage of water losses are typical for the cities of Omsk, Kazan, Chelyabinsk, and Yekaterinburg, which is due to the low availability of new production and technical equipment for water supply facilities and the need to replace pipelines.

According to the data obtained, Moscow is indisputably the leader in terms of performance indicators since with significantly high sales and population, the percentage of water losses is consistently minimized, while in St. Petersburg, the percentage reaches an average of 16.6%. However, it is worth noting that there are certain problems, for example, sustained losses in the village of Strelna in 2019 reached 40%. This is due not only to production problems but also to the abundance of the private sector households which do not install water metering devices. This does not allow determining the actual indicators of water consumption. Besides, some facts of unauthorized use of water supply services were also revealed (water use without concluding contractual relations), etc. Nevertheless, water services company SUE "Vodokanal of St. Petersburg" is an advanced enterprise in its industry. First of all, positive trends in its operation are associated with the implementation of environmental management and quality management systems, which allowed significantly

restructuring of its performance. The company mission, vision, and values are presented below.

The company's mission is to provide affordable and high-quality services to the urban population, and allow providing the sustainable development of the metropolis and preserve the Baltic Sea.

The vision of further activities consists in striving the company to become one of the best world-class organizations in terms of the quality of services provided and attitude to the environment by reducing its adverse impact on ecology.

The vision of the enterprise forms its *values*, presented in Figure 2.

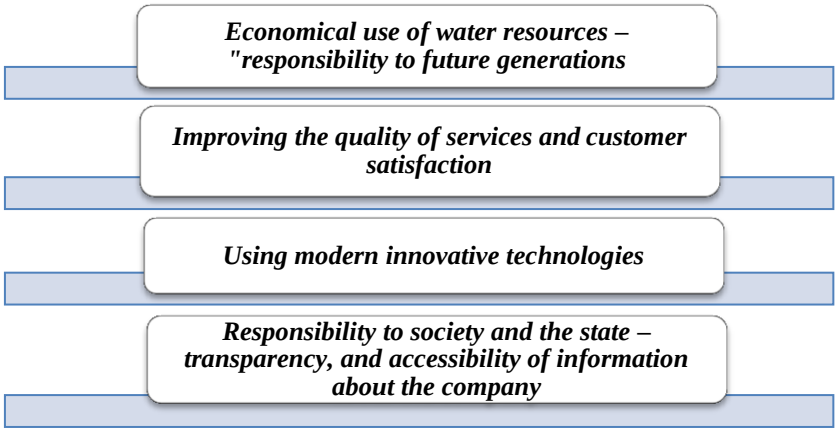

Fig 2: Values of the SUE "Vodokanal of Saint Petersburg"

Competent environmental management subsequently significantly influenced the definitions of production and technology initiatives and the definitions of the company's operation areas. Corresponding data are presented in Table 4.

Table IV.
The initiative activity of the SUE "Vodokanal of St. Petersburg" for the development of water supply and sanitation systems (internal corporate data)

Name of the event (water resources management section)	Description of the results	Effects of the actions taken
Reducing the percentage of water losses (water supply)	At the moment, this problem has not been fully solved, since significant amounts of reconstruction of the pipeline system and water supply stations are required, laid down in the "Master Plan for the development of water supply and sewerage until 2030".	The estimated cost of reconstruction measures is 2.7 bln rubles

Switching direct discharges – reducing the discharge of untreated wastewater (wastewater disposal)	Over the past year, 366 m3 of sewage water was discharged per day through 15 tail drains. These are drains in the Petrogradsky District with a total flow rate of 314 m3 per day, four drains in the Malaya Nevka River, one general drain in the Srednaya Nevka River, as well as 10 more drains in the Krasnogvardeysky, Krasnoselsky, Admiralteysky, and Primorsky districts	The fee for the discharge of insufficiently treated sewage water has increased by 8% in 2019
Increasing the quality of wastewater treatment (wastewater disposal)	Stable maintenance of wastewater treatment quality according to the requirements of Russian standards and HELCOM recommendations: according to the "total nitrogen" indicator – less than 8 mg/l; according to the "total phosphorus" indicator – less than 0.5 mg/l	Reduction of fines for exceeding the maximum permissible discharges into the Gulf of Finland by 5%
Implementing snow-melting (water disposal)	During the 2018-2019 season, 15,585.69 thousand m^3 of snow was processed through melting	Obtaining additional profit by the enterprise, increasing the total profit by 1.5%
Implementing environmental management systems at all stages of the company's activities (all sections of water resources management)	Implementing into practice the principles of resource-saving and energy efficiency, as well as lean production in terms of the consumption of raw materials and recourses, such as the "20 keys of Kobayashi" system, the application of ISO 14000 standards, the greening of production processes, developing systems of key performance indicators of the enterprise, determining environmental risks of the enterprise, etc.	On average, cost reduction due to the implementation of environmental management systems at the enterprise resulted in savings of 1.5 mln rubles in three years.

The issue of the payment structure for discharge into the surface water bodies of the city deserves special consideration (Fig. 3.)

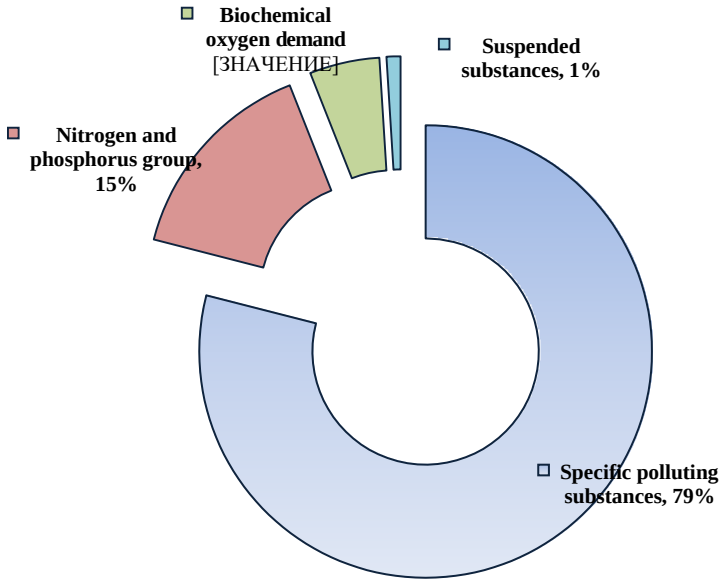

Fig 3: The payment structure for the discharge of pollutants into water bodies, 2019

In the presented diagram, the largest share in the payment structure is occupied by the segment corresponding to "Specific polluting substances", which includes discharges from the industrial complex of St. Petersburg. These are mainly heavy metals (copper, iron, nickel, etc.) as well as organic substances (benzene, toluene, high-molecular compounds, etc.). Thus, at the moment, the issues of effective purification of this group of substances are quite acute for SUE “Vodokanal of St. Petersburg” and yet have not been resolved, despite a significant reduction in the discharge of biogens.

For effective sustainable water resources management in the region, it is necessary to maintain a balance of the following factors (Fig. 4):

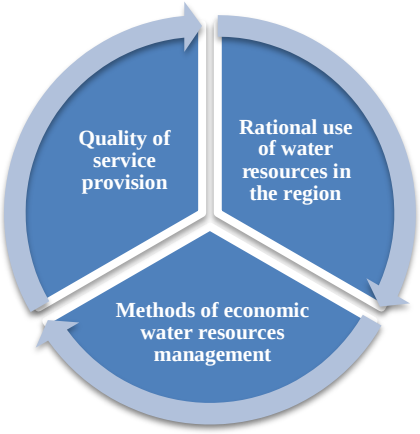

Fig 4: The main components of water resources management in the region

Even though SUE "Vodokanal of St. Petersburg" is engaged in direct improvement of its activities at this stage, there are several significant problems. To solve them in the future it is necessary to focus on qualitative and quantitative services indicators, which is possible when developing water resources management methods and tools, peculiar to the region (Fig. 4).

IV.RESULTS

A scenario for the regional development of water supply and sanitation systems for St. Petersburg, developed by the authors, includes two main aspects considered below.

A. Perspective balance of water supply in St. Petersburg

We have compiled a forecast of water supply development trends in the city until 2030, presented in Table 5.

Table V

Water demand in St. Petersburg and adjacent territories of the Leningrad Region

Indicator	Value
Specific household and drinking consumption of cold water, l/day per person	100
Total maximum daily water supply to St. Petersburg: liters/day	1,717
Besides, the maximum daily water supply to the Leningrad Region: liters/day	211
Total: liters/day	1,928

The forecast is based on statistical data from previous periods, as well as on "St. Petersburgwater supply and sanitation scheme for the period up to 2025, taking into account the prospects up to 2030", and the investment program for the enterprise development. The forecast was made for a projected population size of 6,353 thousand people. Note the tendency to reduce the specific water consumption from 155 to 100 liters/day due to the installation of metering devices, elimination of losses, the development of a culture of domestic water use, and the strict conclusion of contracts with SUE “Vodokanal of St. Petersburg”.

According to these documents, the city's water supply will be provided by eight water supply stations with water treatment units. The projected prospective capacity of water supply stations is 2,287 thousand cubic meters per day. The perspective balance of water use in the context of stations is shown in Fig. 5.

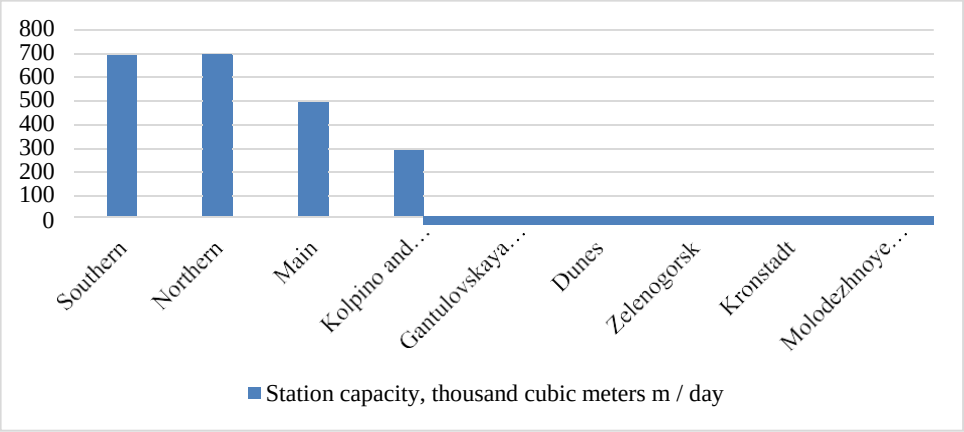

Fig 5: Balance of water resources management by 2030 in the context of water supply stations

According to the data obtained, the main objects of water resources management with the greatest load will are the Southern and Northern water supply stations. In the past five years, reconstruction and replacement of equipment have been carried out at the Southern and Main water supply stations, therefore in the future, it is planned to focus on the modernization of the Northern Water Supply Station (Table 6).

Table VI.
Main measures for the construction, reconstruction, and modernization of water supply facilities according to the Scheme of water supply and sanitation of St. Petersburg

No.	Measure	The estimated cost of works, bln rubles
1	Reconstruction of the Main water supply station including the construction of a new water treatment unit for 500 thousand cubic meters/day.	11.1
2	Reconstruction of the Northern water supply station with a capacity of 700 thousand cubic meters/day (the first lift, the raw water supply system from the water intake complex to water treatment facilities, water treatment facilities, the construction of an additional stage of water treatment, and construction clean water tanks).	10
3	Reconstruction of the Southern water supply station including the installation of a water treatment unit with a capacity of 350 thousand cubic meters/day (first lift, raw water supply system for water treatment facilities, and water treatment facilities).	5.7
4	Modernization of the Volkovskaya water supply station with the transfer to a pumping station.	0.9
Total by structures:		27.7

Thus, the planned measures will increase the production capacity and load on the Northern water supply station and will require a total amount of investments equal to 27.7 bln rubles.

Reduction of discharge of specific pollutants

To reduce discharges by these indicators, first of all, it is necessary to work with the industrial sector, since these types of pollutants are generated directly in the technological process of enterprises. Therefore, it is necessary to reduce their discharge by adjusting the technology and installing local treatment facilities to capture them.

Modernization of wastewater treatment systems will not give results, since biological treatment applied at stations does not clean wastewater from specific contaminants. SUE Vodokanal of St. Petersburg needs to develop a set of measures to control the most environmentally hazardous industrial facilities, as one of the options for the most serious reduction of the adverse impact, as well as to divide enterprises into groups depending on their hazard to the environment, and establish additional increasing coefficients for the discharge of pollutants, which should significantly increase the fee for such discharges. Their possible options are given in Table 7.

Table VII
List of increasing coefficients for environmentally hazardous enterprises of the city

Category	Category description	Payment increase coefficient*
1st category (most hazardous)	Enterprises that discharge organic compounds and heavy metals belonging to hazard class 1-2	1.35
2nd category (moderately hazardous)	Enterprises that discharge heavy metals in small quantities or metals belonging to hazard class 3, and not discharging organic compounds	1.2
3rd category (low-hazard)	Enterprises that discharge metals with hazard class 4	1.05
4th category (non-hazardous)	Enterprises that do not discharge heavy metals and organic compounds	1

* – coefficients are derived based on the degree of impact on the population's health and the norms of wastewater discharge into a surface water body.

Thus, the negative impact of water supply and sanitation systems can be minimized by production, technological, construction, as well as management measures.

V. DISCUSSION

In the course of the study, a scenario for developing water resources management for St. Petersburg was proposed based on theoretical and statistical materials, as well as the most essential bottlenecks were identified. This concerns, first of all, the Northern part of the city, characterized by a high percentage of losses in certain areas of water supply, the need to further reduce the indicator reflecting the specific water consumption, as well as the need to develop measures to reduce the adverse impact of hazardous components of pollutants on the natural environment. These issues are consistent with the theoretical developments of other authors. The projected development scenario is based on statistical data and initiatives of the enterprise, as well as on its directives, such as a strategic development plan, an investment program of activities, a scheme for the development of water supply and sanitation systems, as well as a theoretical generalization of a set of problems. The presented developments are original and reflect emerging trends, are significant from a scientific and practical standpoint, as they allow identifying opportunities for self-improvement of the enterprise and offering tools to influence water consumers (in terms of reducing water consumption and dumping hazardous pollutants). In the future, it is possible to conduct a more complete detailed study of the factors for forecasting activities with the refinement of the forecast at the level of regional

enterprises and organizations that affect the overall water resources management and the redistribution of loads across water supply zones.

VI. CONCLUSIONS

Sustainable development of water supply and sanitation systems is possible based on pre-predicted volumes of water resources consumption and indicators of specific water consumption of the population. According to the research results, the total volume of water consumption on the balance sheet for St. Petersburg and the Leningrad Region will be *1,928 thousand liters/day*, which is significantly lower than today's figure – *2,392 thousand liters/day*. It is also proposed to change the load on the water supply zones taking into account changes in the production capacities of the stations, which will free up about 30% of the currently operating production sites of the enterprise.

From an ecological perspective, the measures, proposed by the authors, will reduce the load on the facility and increase its environmental safety, as well as reduce the adverse impact on the technosphere. From an economic standpoint, these measures will reduce the costs of maintaining additional sites, as well as reduce fines and environmental fees, and reduce damage. From a social point of view, the proposed measures will reduce the incidence of the population. Further research may be associated with the redevelopment of wastewater treatment systems employing other types and methods of treatment, that is, the possibility of replacing biological treatment with more mobile and efficient methods, as well as ways to further increase the degree of reliability of water supply.

REFERENCES

Bulichenko, Yu.N., Verevkin, M.V., Glazkova, E.A. (2015). Gulf of Finland. Harmony water area. St. Petersburg: Nevsky Perspective.

Efimova, N.B., Ulanova, I.A. (2015). Methodological foundations of environmental management implementation under current conditions. Volgograd: Volgograd State University.

Federal State Statistics Service. (n.d.). Available at: http://www.gks.ru

Garnov, A.P., Krasnobaeva, O.V. (2014). Aspects of environmental responsibility of economic entities of the Russian Federation. Moscow: INFRA-M.

GOST R 57651. (2017). Environmental management. Quantitative environmental information. Guidelines and examples. Quantitative data on the environment. Guidelines and practical examples. Moscow: Standartinform, 2017.

Kirilchuk, I.O., Rykunova, V.L., Sevryukova, L.V. (2016). Economic stimulation of environmental protection. Kursk: Southwest State University.

Larionov, V.G., Larionov, G.V., Melnikov, O.N. (2014). Environmental management: Nature management and ecology of industrial cities. Moscow: Biblio-Globus.

Managi, Sh. (2015). The economics of green growth: New indicators for sustainable societies. London: Routledge.

Pavlenko, V.A., Yukhimenko, Yu.M. (2014). Management of ecologization of the territory. The hypothesis of the interaction of social mediums with the environment. Novosibirsk: SGGA.

Petryanina, L.N., Viktorova, O.L., Razzhivin, V.M. (2015). Urbanism and ecology of urban territories. Penza: PGUAS Publishing House.

Pishchulov, V.M. (2016). Methodology of forming models of human interaction with the environment. Moscow: INFRA-M.

Polishchuk, O.N. (2017). Management of the socio-ecological situation of the region. Belgorod: Publishing House of the Belgorod University of Cooperation, Economics, and Law.

Sheina, S.G., Zilberova, I.Yu., Kasyanov, V.F. (2017). Sustainable development of territories, cities and enterprises. Rostov-on-Don: DSTU.

The water sector in Germany: Methods and experience – the Federal office of environmental protection for the benefit of humans and the environment. (2018). Berlin: Publishing House of the Federal Ministry for the Environment, and Nature Conservation.

Tyaglov, S.G., Kiseleva, N.N., Timchenko, V.A. (2017). Modern aspects of the green economy development in the Russian Federation. Rostov-on-Don: Assistance - XXI century, 2017.

Ugryumova, N.V., Kopchenov, A.A., Perevozova, O.V. (2016). Sustainable development of Russia in the context of global changes. Chelyabinsk: Chelyabinsk Press House.

Watertime Project of the European Commission. (n.d.). European Commission. Available at: www.watertime.org