

**КАРТОГРАФИЧЕСКОЕ И ГЕОИНФОРМАЦИОННОЕ
ОБЕСПЕЧЕНИЕ ИССЛЕДОВАНИЙ ВОДНЫХ ОБЪЕКТОВ
И ПРИБРЕЖНЫХ ТЕРРИТОРИЙ**

**CARTOGRAPHIC AND GIS SUPPORT FOR STUDIES
OF WATER BODIES AND COASTAL TERRITORIES**

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**ASSESSMENT OF ECOSYSTEM SERVICES OF WATER RESOURCES
OF PORT WATER AREAS BY THE AMOUNT OF WATER RENT**

ABSTRACT

Ecosystem services of the marine environment can be considered as ecological, economic and social components of sustainable development, but at present, they are not fully evaluated. In this regard, the article sets the task of identifying and valuing ecosystem services in port waters. As a result of the study, the attribution of the benefits created by the port waters to the ecosystem services of the marine environment is justified, their division into two categories is carried out – into providing and supporting services, a methodology for their cost estimation is proposed. It is proposed to calculate ecosystem services by the amount of port water rent, which is understood as the residual income in port activities after deducting from it all costs and profit margins on fixed assets of port infrastructure. According to this methodology, calculations of the total cost of ecosystem services of port water areas for Russia as a whole and specific values of the cost of ecosystem services per 1 km² of port water area for all seaports of the country were carried out. Supporting services are proposed to be assessed by the rent of assimilation potential formed when compensatory measures are not carried out for environmental damage caused by port activity. According to the results of calculations, it was revealed that the total port rent is approximately 33–38 billion rubles. At the same time, payments for the use of water resources in the waters of seaports entering the budget system amount to an insignificant part of this value – 0.17 %, which indicates the inefficiency of the current payment system. To correct the situation, an algorithm for

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calculating fees for ecosystem services in port waters with the inclusion of an environmental component is proposed, the maximum share of port water rent (10 %) is justified, without disturbing the balance between the state and private structures. The significance of the work carried out is to substantiate a new category of ecosystem services of the marine environment, ecosystem services of port waters, and to show the possibility of using their valuation for management purposes, including through the formation of additional budget revenues.

KEYWORDS: ecosystem services, assessment, port water areas, port water rent

INTRODUCTION

Currently, there is a global reorganization of the world economy, largely due to the transition to the sixth technological order according to the theory of academician S. Y. Glazyev [Glazyev, 2015]. At this stage, natural resources are included in the national wealth of countries through their accounting in the system of macroeconomic statistical accounting and the composition of the capital of economic entities, if natural resources are tangible assets, such as land plots, or legally registered intangible assets, for example, in the form of rights to use something. According to International Valuation Standards, non-monetary assets are non-monetary assets that have no physical substance, but create certain interests and provide economic benefits to the owner¹. Ecosystem services, which are understood as various benefits created by ecosystems, are mostly intangible assets of the public sector that do not belong to a specific owner or owner. That is, there are no rights to them, and the benefits, the identification of which, and even more so, are reflected in the balance sheet of enterprises, are problematic and are mostly not carried out. A distinctive feature of the future sixth technological order is the attribution of ecosystem services generated by natural ecosystems to natural capital for the purposes of their management. For such attribution, their monetization is required, that is, evaluation in value or monetary form. However, this is not always possible due to a number of reasons, the main of which are: 1) the absence of internationally standardized methodological support for the valuation of ecosystem services, and 2) the absence of a market for ecosystem services, and as a consequence of market prices for them, which leads to the need to model cost estimates. These provisions fully relate to ecosystem services of water resources of port water areas, which are currently not identified and not considered in scientific research.

In relation to port water areas, the problem of missing classification of ecosystem services created by them for the purposes of valuation is added. If a general classification of ecosystem services has been created and used what is detailed in numerous studies [Bobilev, Goryacheva, 2019], including, for evaluation purposes [Ojea et al., 2012] and decision-making [Fisher et al., 2007], in respect of port equator initiative that allow to systematize and assess the benefits opar-towo activities, is still lacking, although there are some attempts to solve this problem taken. Thus, in the “General Classification of Ecosystem Services” developed for the European Union, it is recommended to develop an additional classification for abiotic ecosystem products [Haines-Young, Potschin, 2013]. At the same time, some researchers believe that no final classification is possible, since it does not allow covering all the benefits for a person, and classification systems should correspond to current management policies and tasks. In turn, the lack of a cost assessment of ecosystem services in port waters hinders the justification and application of economic mechanisms for regulating economic activity on the territory of ports in order to reasonably establish payments for water resources to reduce natural pollution and preserve the aquatic environment and ecosystems of coastal waters.

¹ International Valuation Standards 2011. Moscow: Russian Society of Appraisers, 2013. 188 p. (in Russian).

If, in methodological terms, in general terms, the issue of valuation of ecosystem services has been resolved [Assessment..., 2005, P. 133–154], then with respect to marine ecosystems, methods of their assessment are in the process of formation. Such methods are developed within the framework of the “blue” economy and are used for the management of marine and coastal territories. Now in the European Union, increasing attention is being paid to the impact of the ocean economy on the European landscape for planning sustainable blue growth, managing ocean and coastal ecosystems, as well as combating the effects of climate change. It is recognized that when making decisions on ocean management and activity planning, it is necessary to better take into account the value or cost of marine ecosystem services, since such assessments help to find compromise solutions between competing economic development and reducing the negative impact on marine ecosystems. In “Valuing marine ecosystem services” [2019], applied methods for assessing ecosystem services of the marine environment and approaches for their integration into the management and decision-making systems in the European maritime policy are covered in some detail. Also, these methods are considered in a 2015 study [Martin-Ortega *et al.*, 2015], which provides a detailed history of the development of methods for the valuation of ecosystem services of aquatic ecosystems in general. In this paper, an attempt is made to adapt the general classification of ecosystem services to ecosystem services of the marine environment. For this purpose, the concept of indicators of ecosystem services is introduced to reflect the content of the service when making decisions in management activities. However, it is stated that there are still no practical guidelines for the selection of indicators related to ecosystem services [van Oudenhoven *et al.*, 2012]. This observation is also characteristic of the marine environment, which makes it difficult and even impossible to fully measure the services of marine ecosystems. The task of fully accounting for the services of coastal areas, which, in our opinion, include port waters, has not been solved.

Problem statement. Most of the research on marine ecosystems takes into account such services as the provision of marine food (bioresources), recreation, climate regulation, biodiversity conservation and a number of others [Mangos *et al.*, 2010]. However, the port waters and the ecosystem services they create do not appear anywhere in them.

At the same time, port waters are of great importance for the economy of almost all countries with access to the seas and oceans. Thus, the total length of the coastline of the Russian seas is more than 60 000 km¹. The total number of seaports in Russia, according to The Register of Seaports of the Russian Federation is equal to 67. Their capacity is estimated at 1003.6 million tons of cargo per year.

However, the revenue streams generated by ecosystem services of water resources used by ports to date are not estimated in monetary terms in any way. The current situation with real economic estimates of these benefits does not allow creating effective models of port management from the standpoint of the state and society. The provision of port activities in scientific and applied aspects is nowhere considered as an ecosystem service. In the world, marine ecosystems are taken into account when making management decisions only when designing seaports [de Boer *et al.*, 2019]. Methods of their valuation for establishing payments are not offered either in foreign or domestic practice.

Thus, it can be concluded that the assessment of ecosystem services of marine water resources is actually still not fully measurable due to the absence of assessments of ecosystem services of port waters. There are no generally accepted methods and standards in this area. The main reason is the social significance and availability of economic benefits generated by water resources in port waters.

¹ State report “On the state and use of water resources of the Russian Federation in 2017”. NIA-Priroda, 2018. P. 83. Web resource: <http://fcpvhk.ru/wp-content/uploads/2019/03/Gosdoklad-po-vode-2017.pdf> (accessed 04.11.2020) (in Russian).

The purpose of the study. In this regard, the main purpose of this study was the cost assessment of ecosystem services of port waters, conducted on the example of Russian seaports, and the calculation of payments for them. To achieve this goal, the classification of ecosystem services of port water areas was carried out, a methodology for their cost estimation based on the allocation of water rents from the total revenues of ports was developed and justified.

MATERIALS AND METHODS

The calculated part of the study was performed using official Rosstat data, Register of seaports of the Russian Federation¹ and the Program Excel. The research methods are based on the methodology of ecosystem services assessment, rent assessment of the value of natural resources, the methodology of cost assessment of ecosystem services of port waters developed by the authors.

The first stage of the development of the methodology for the assessment of ecosystem services in port waters is the justification of a classification acceptable for the purposes of their valuation. The second stage is the calculation of the port water rent and the justification of the amount payments for ecosystem services in port waters.

Classification of ecosystem services in port waters. According to the most cited document containing the definition of ecosystem services “Ecosystem Assessment at the turn of the Millennium” [Ecosystem..., 2005; Millennium..., 2005 (a, b)] ecosystem services are defined as “the benefits that people receive from ecosystems”. There, these benefits are classified according to the functions performed by ecosystems, namely, they are divided into four categories: supporting, providing, regulating and cultural services.

Port waters generate significant flows of benefits for the economy and people that are not directly tracked by the market and market prices. That is, the port waters perform supporting functions, enabling ships to enter ports and carry out various operations in them for transshipment of goods and transportation of people for domestic, business and recreational purposes.

The benefits of these operations are of a rental nature and can be assessed as a sufficient income generated by the actual water space in the form of the port’s water area. The water area of the port is understood as the water surface of the port within the established boundaries, which provides for maneuvering and parking of ships in its part². Let’s conditionally call this income a port water rent. Since all these types of port operations, especially cargo transshipment, are associated with environmental pollution by emissions of pollutants into the atmosphere and their discharges into the aquatic environment, the ecosystems of port waters and the space above them partially assimilate these pollutants, creating a rent of assimilation potential [Gusev, 1997]. This function can be classified as supporting.

Thus, ecosystem services of port water areas can be divided into two groups:

1) providing or creating benefits in the form of economic rent from port activities – port water rent, and

2) supporting in the form of assimilation of pollutants created by port activities – rent of assimilation potential.

The latter can be estimated by the rent of assimilation potential.

Neither one nor the other rent at the level of the state and society is tracked and remains in the form of additional, unmeasured and, accordingly, tax-free income for port operators, which

¹ Register of Seaports of the Russian Federation. Web resource: http://www.morflot.ru/deyatelnost/napravleniya_deyatelnosti/portyi_rf.html (accessed 04.11.2020) (in Russian).

² Hydraulic engineering. Basic concepts, terms and definitions. FROM 34.21.308-2005. Web resource: <https://files.stroyinf.ru/Data1/48/48313/#i301633> (accessed 11.04.2020) (in Russian).

does not create incentives to reduce pollution and more equitable formation of sources of state income.

Methodology and methodology for calculating port water rent. For the purposes of calculations, the classification of ports according to their belonging to the main sea basins of Russia is applied: Azov–Black Sea Basin, Baltic Basin, Caspian Basin, Far Eastern Basin, Arctic Basin.

Further, in each of each marine basin, the main ports are identified and an assessment of the specific economic port rent is carried out for them to compare with other basins and make management decisions.

The methodology of the study consists in applying the theory of natural rent to assess ecosystem services in port waters, interpreted as the remainder of income attributable to a natural resource, after deducting from it the income attributable to materialized capital in the form of fixed assets. To carry out cost estimates, the study uses the methodology developed by the authors for calculating the rent created by the port water area (assessment of providing services) submitted in the official statistical database. In order to include the estimates obtained in the process of managing port waters and regulating economic activity in ports, the methodology for calculating payments for water resources of port waters is substantiated.

The methodology for calculating the port water rent is based on the application of a rent-based approach to the port industry, taking into account the economic opportunities for the withdrawal of water rent generated in seaports.

The port water rent is formed mainly during the transshipment of goods delivered by water transport. For to establish its volume in the industry related to the transshipment of goods delivered by water transport (the activities of stevedores or economic entities and port facilities), Rosstat statistics from the database of the Unified Interdepartmental Information and Statistical System (EMISS) for 2016–2018 were analyzed for the following types of activities:

- loading and unloading of cargo and baggage of passengers, regardless of the type of transport used for transportation;
- loading and unloading of dangerous goods by rail;
- stevedoring activity;
- loading and unloading of freight railcars;
- container handling;
- activities of terminal facilities, such as ports and piers (except loading and unloading operations);
- operation of gateways;
- navigation support, pilotage of vessels and wiring of vessels to the berth;
- activities for unloading ships by lighter and salvage of ships.

The analysis showed that the available information is sufficient to calculate the cost of ecosystem services in Russian port waters. To determine the volume of industry rents, data from profit and loss reports of enterprises, the specified types of activities aggregated by Rosstat were used, including within the framework of a quarterly statistical survey of enterprises in the form P-3.

In accordance with the established ideas about the calculation of economic and resource (natural) rents in Russian and international practice, including the practice of national accounting, according to the 2008 SNA standards [System..., 2012] and SEEA-2012 [System..., 2014], the resource rent is defined as “excess cost” (surplus value), received by the user or in General produced by the industry. It is defined as the residual income remaining with the user after deducting from the income from the sale of goods and services all costs and income rates for the fixed assets and working capital employed by the user (or in the industry of production). The resource rent is calculated by deducting targeted subsidies from standard *gross profit* indicators, adding targeted taxes and deducting expenses for the use of produced assets in the form of depreciation of fixed assets.

Since, according to the rules of Russian accounting, the cost of production includes depreciation of fixed assets used for core operating activities, in Russian practice, the sales profit indicator used has already been cleared of consumption (depreciation) of fixed capital.

Within the framework of the port economy, the resource of the industry, laying the basis for obtaining industry rents, are the port water areas, and the main capital is the port loading and unloading and berthing infrastructure.

Thus, the industry rent at current prices (prices of the analyzed period) can be estimated by the remainder method using the formula:

$$R_{it} = PS_{it} - (VB_{it-1} \times K), \quad (1)$$

where:

R_{it} – rent in industry i , received in year t ; in current prices of year t ;

PS_{it} – profit from sales (as the closest measure to gross profit in Russian accounting) in the year t in the industry i in the current prices of the year t ;

K – rate of return on capital/produced assets (accrual on the impact of fixed assets); the dimensionless quantity (specified in fractions of a unit); K is also the rental threshold of profitability, which, according to the recommendations of the Framework document SEEA-2012, you can use the average for the period nominal profitability in industries or the average rate on ruble denominated in government bonds on the money market (for example, 5 years); in the current Russian practice, you should use the indices K in the range of 10 % (a 5 % real return, plus 5 % – OE waiting annual inflation).

VB_{it-1} – the residual (balance sheet) value of fixed assets in year t in the industry under consideration i , or – for more dynamic industries – the average annual balance sheet values).

The calculation of the total port rent of Russia is given in the table below.

Table 1. Cost estimate of the total port water rent in Russia as a whole in 2017, billion rubles

	Profit from sales of the organization*	Fixed assets at residual value	Rate of return on capital, unit shares	Income capital	Port water rent
1	2	3	4	5 gr.5 = = gr.3×gr.4	6 gr.6 = = gr.2–gr.3×gr.4
All ports, including	41,7	74,57	0,1	7,46	34,24
Sea ports	40,3	72,27	0,1	7,23	33,07
River ports	1,40	2,30	0,1	0,23	1,17
Rent withdrawn from seaports to offshore					5,00*
Port water rent of seaports' water areas					38,07

*Expert assessment.

Source: calculated by the authors based on the analysis of Rosstat data and the dynamics of interest rates set by the Central Bank of Russia and leading banks of Russia.

In 2017, the total port rent was approximately 38.07 billion rubles.

Calculation of port water rent by seaports. To assess the value of ecosystem services of specific port waters, its specific value per one tonnage unit of vessels serviced in ports is determined (*Grosstonnage*, abbreviated *GT*):

$$WR_{GT} = R/V_{GT}, \quad (2)$$

where:

WR_{GT} – specific port water rent, RUB/*GT*;

R – the total port water rent received per year in the seaports of Russia, thousand rubles;

V_{GT} is the gross capacity of all vessels serviced in the port for the year, *GT*.

$WR_{GT} = 38\,070\,000$ thousand rubles/ 1621958 thousand *GT* = 23 rubles/ *GT*.

For the valuation of ecosystem services of specific port water areas in the calculation of km^2 , the formula is used:

$$WR_{ES} = (V_A \times WR_{GT})/S_A, \quad (3)$$

where:

WR_{ES} – valuation of ecosystem services of the assessed port water area, thousand rubles/ km^2 ;

V_A – annual tonnage, serviced in port vessels, *GT*;

WR_{GT} – specific port water rent, $WR_{GT} = 23$ rubles/ *GT*;

S_A is the area of the estimated port water area, km^2 .

The results of the assessment of ecosystem services in the port waters of the main sea basins of Russia are shown in the figures below.

The maximum port rent in the Azov-Black Sea basin is formed in the ports of Yeisk, Caucasus, Azov and Rostov-on-Don (Fig. 1).

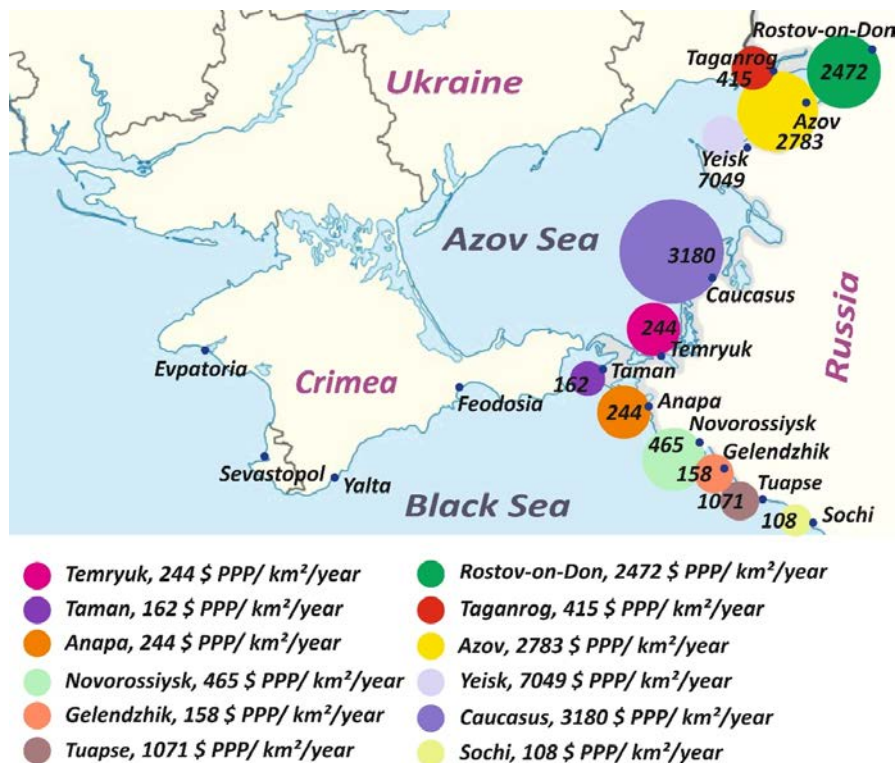


Fig. 1. Valuation of ecosystem services in the port water areas of the seas of Russia by the amount of port water rent: Azov–Black Sea basin

Source: author's estimates.

In the Baltic Basin, the maximum economic rent is formed in ports: Vysotsk, Kaliningrad, Primorsk and Ust-Luga (Fig. 2).

In the Caspian basin, the specific economic rent is an order of magnitude lower than in the Azov-Black Sea and Baltic basins, which is explained by the smaller number of cargo transshipment (Fig. 3).

In the Far Eastern basin, the maximum economic rent is generated in the ports of Nevelsk and Holmes. It is about 2 times higher than in the Caspian basin, but less than in the Azov-Black Sea and Baltic basins (Fig. 4).

In figures 1–5, the estimates obtained are represented by specific indicators of water port rent (per 1 km²), which allows us to see the cost differentiation of separate water areas.

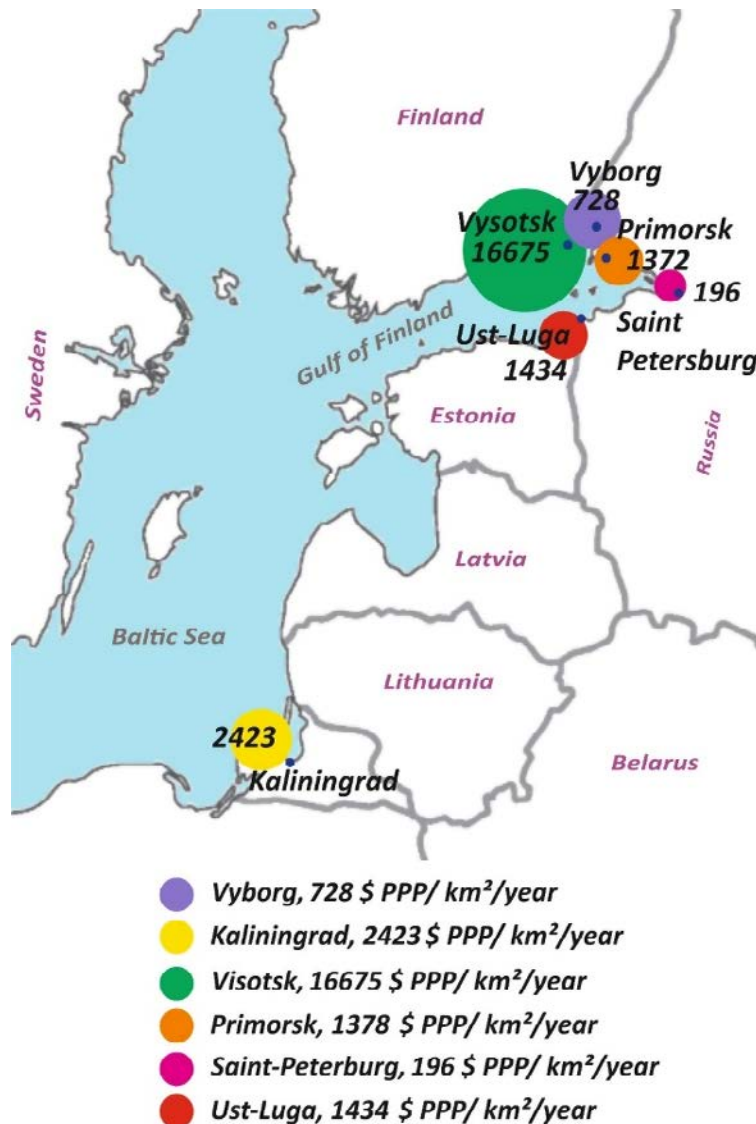


Fig. 2. Valuation of ecosystem services in the port water areas of the seas of Russia by the amount of port water rent: Baltic Basin

Source: author's estimates.



Fig. 3. Valuation of ecosystem services in the port water areas of the seas of Russia by the amount of port water rent: Caspian basin
Source: author's estimates.

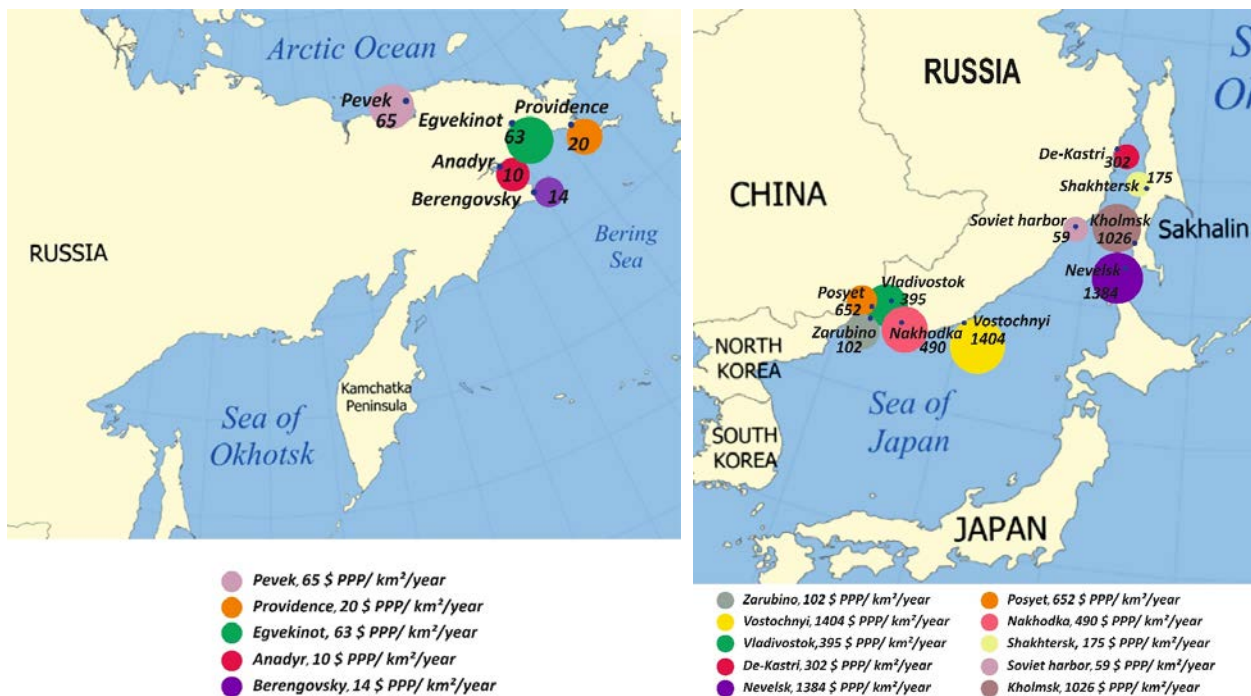


Fig. 4. Valuation of ecosystem services in the port water areas of the seas of Russia by the amount of port water rent: Far Eastern basin
Source: author's estimates.

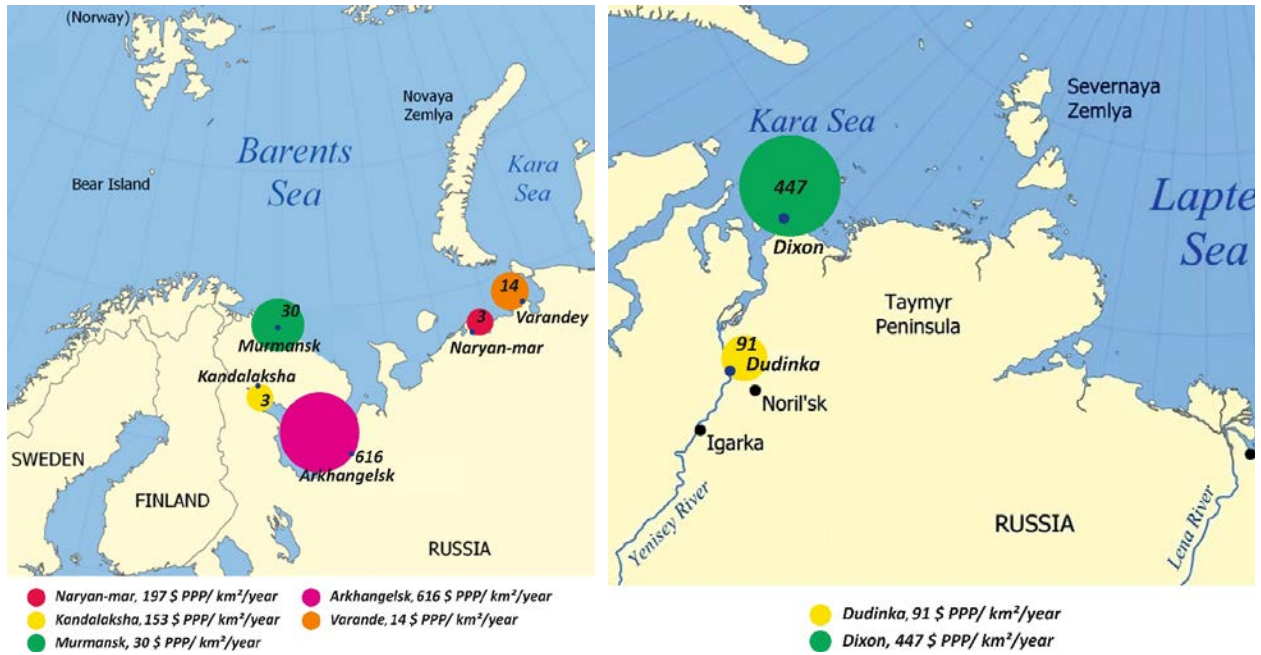


Fig. 5. Valuation of ecosystem services in the port water areas of the seas of Russia by the amount of port water rent: Arctic basin

Source: author's estimates.

Calculation of payments for the use of port waters. The obtained figures of the valuation of the port water rent allow us to reasonably establish the amount of payment for the use of port waters:

$$PP = BS \times V_{GT}, \quad (4)$$

where:

PP – annual payment of the port, thousand rubles;

BS – base rate of payment, rub /GT;

V_{GT} is the gross capacity of vessels that were provided with parking in the port according to the reports of FSUE “Rosmorport”, GT.

The base rate (BS) is defined as:

$$BS = 10 \% \times WR_{GT}, \quad (5)$$

where:

10 % is the share of the port water rent, which is supposed to be withdrawn to the state income;

WR_{GT} – specific port water rent; $WR_{GT} = 23$ rubles/GT.

RESULTS AND DISCUSSION

According to calculations, the offshore port facilities of the Russian Federation generate more than 33 billion rubles of port rent annually, which is on average about 20 rubles of rent per ton of various types of cargo transshipped through the seaports of the Russian Federation. The water rent of seaports makes up the majority of the total water rent of river and sea ports – about 97 %. This value can be calculated on the basis of official statistical data, without resorting to modeling methods of contingent estimates, which allows you to make informed management decisions

to optimize the operation of ports and assess the potential revenues that the state can receive from unaccounted rent flows without harming the economic activity of economic entities.

The estimate of 33 billion rubles of rent in the total seaport economy of the country is quite conservative, since many stevedores (economic entities on the territory of ports) often withdraw their profits by writing off their costs to offshore jurisdictions. For example, only one of the largest terminals of the Novorossiysk port in 2015 brought more than 1 billion rubles a year to offshore in this way. According to calculations, this port accounts for about 12–13 % of the gross capacity of all ships that have been provided with parking in Russian ports. Hence, it can be concluded that the rent withdrawn to offshore and from the ports of Russia and not amenable to official measurement can correspond to this figure and amount to at least 5 billion rubles per year, that is, the amount of port rent is much larger and can be estimated at 38 billion rubles per year. With the development of seaports caused by changes in traffic flows (for example, redirection of traffic flows to the port of Ust-Luga), this value may increase significantly.

At the same time, official revenues to the budget from payments for water use for all types of port water areas – both marine, river and lake, amount to only 66 million rubles¹. This is a negligible amount of the identified port water rent in the Russian port industry – 0.17 %.

The analysis of statistical data demonstrates the absence of rent directly from the basic infrastructure participants of port farms that have a state affiliation (Rosmorport, seaports administrations).

This means that they must resort to mechanisms of indirect withdrawal of rent from stevedores, for example, through rent from leased port property, in order to have an economic basis and financial opportunity to make payments for the use of port waters to the state and ensure the normal functioning of ports, taking into account the recent tightening of environmental restrictions and requirements.

There are other sources of revenue to the budget. But they are difficult to quantify in money due to the complexity of the legal formalization of the relationships of economic entities, as well as their return from the budget to port administrations.

When switching to a system of payments for the use of port waters on a rental basis, in order to maintain the balance of interests of the state and business and not reduce competition for port activities, it is proposed to withdraw no more than 10 % of the annual port water rent to the budget. This amount may amount to about 3.3–3.8 billion rubles annually.

The acceptability of this value is confirmed by calculations of the water rent received by the state from economically used water assets of fresh waters of Russia. So, at present, about 10 % of the rent created by water resources is withdrawn to the state income in the form of payments for water use. This value does not cause criticism from business entities, which indicates its acceptability for business. The calculation of this value is given in [Filchenkova *et al.*, 2019].

On the other hand, 10 % can be justified by the need to take into account the environmental factor, which is currently not evaluated in any way, in order to compensate for the damage to the environment caused by seaports and ships entering them to public interests on a national scale. Since the existing system of payments for negative impact on the environment, fines and compensation for environmental damage, operating in Russia is rather archaic, does not take into account changes, including global ones that have occurred in international relations and are mainly related to public interests in the field of ecology (environmental quality, global climate change, sustainable development goals, waste, etc.), this leads to the emergence of “ecological” rent or rent

¹ State report “On the state and use of water resources of the Russian Federation in 2017”. NIA-Priroda. 2018. P. 198. Web resource: <http://fcvvhk.ru/wp-content/uploads/2019/03/Gosdoklad-po-vode-2017.pdf> (accessed 04.11.2020) (in Russian).

of assimilative potential of water resources for entities operating in ports. Its value can be estimated in the amount of uncompensated social costs or environmental damage caused. This value will be a cost estimate of the supporting ecosystem services of the port waters.

CONCLUSIONS

Legal relations in the system of collection of mutual settlements are not fully settled. And there is a cross-system, when funds are first collected to the budget, and then returned.

Most of the port water rent is not assessed and is taken into account in the current system of payments for water resources of ports.

In addition, as a result of the applied and officially permissible tax optimization systems, a significant part of the rent, according to expert estimates, is withdrawn from the domestic taxation systems to various offshore jurisdictions and cannot be calculated.

You can change the situation by introducing reasonable payments for the use of port waters, calculated on a rental basis.

To do this, it is advisable to regularly conduct a cost assessment of ecosystem services in port waters, including port water rent and assimilation potential rent, which allows justifying payments for environmental pollution in ports.

However, at present, it is not legally possible to directly impute stevedores using the port infrastructure to pay part of the port water rent to the state, since they lease it from state unitary enterprises.

The same applies to ships entering seaports and paying various fees and charges. An increase in the latter will lead to a decrease in the competitiveness of ports and a decrease in cargo traffic, which may be reoriented to other ports for financial reasons.

Taking into account the current situation, we can propose the following mechanism for obtaining part of the port water rent to the state revenue.

For stevedores and other commercial structures engaged in port activities, it is advisable not to introduce separate payments for water use, including a rental component, but to shift this to the market mechanisms of their relationship with landlords.

To take into account the economic situation, establish floating rates of fees calculated on the basis of two statistically determined indicators – port water rent and tonnage of ships serviced in ports.

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