Energy resources of the world ocean ecosystem: study and problems

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Abstract. The paper discusses the traditional components of the nature of the World ocean. Their participation in the formation of living matter in the conditions of hydrospheric, atmospheric, and lithospheric changes in the ocean. It is pointed out that it is necessary to further study the energy properties of the ecosystem, as Vernadsky V.I. repeatedly wrote in his works. The most important results of modern studies of the ocean should include the development of oceanic doctrine of Russia for the period until 2020, the formation of Marine College under the Government of the Russian Federation (2004) and the written concept of scientific research of the nature of the world’s oceans as a whole by the Russian Academy of Sciences.

1. Introduction

In due time academician Vernadsky V.I. drew attention to the need to know the energy properties of the ecosystem. He saw this as the key to deciphering the laws of functioning of external spheres.

According to V.I. Vernadsky, “not only in climatology and meteorology, but also in geochemistry and mineralogy, the phenomena of change – chemical processes – are not related to the energy of deep layers of the Earth’s crust or the Earth, but are caused by the energy of the Sun, the cosmic energy passed to Earth from the outside. The source of change is the planet’s high living surface film. The space energy accumulator, its distributor in mineralogical and geochemical processes is the living substance concentrated in it. Obviously, the more and more precisely we will know its energy properties, the clearer the whole process of chemical changes of the Earth’s crust will be for the study” [1, 2].

Whatever the phenomena of life, the energy released by organisms – mostly or entirely – is the radiation energy of the sun. Through organisms, it regulates the chemical developments of the Earth’s crust.

The detailed study of living matter only began from the late 19th century and throughout the 20th century. During the same period, researchers began to study not only land, but also the ocean. Then there appeared ships equipped with complex “scientific instruments, bathyscaphes, scientific research was carried out and the works of outstanding biogeographers-oceanologists Zenkevich L.A., Bogorov V.G., Vinogradov M.E.; geographers Dobrovolsky A.D., Bogdanov D.V., Markov K.K., Leontiev O.K., Kaplin P.A., Lebedev V.L. and others were published [1].
2. Materials and methods
The studies on the assessment of the state of the ecosystem in the world’s oceans were carried out on the basis of many years of studies of biogeographers-oceanologists, remote sensing data, results of the assessment of the modern state, environmental variability and biological productivity of natural systems, principles and methods of reducing anthropogenic load on sea ecosystems of the Russian Federation using modern methods of processing and visualization of data, mathematical models [3].

3. Results and discussion
The scientific works served the basis for geographical and later environmental views on the study of the ecosystem of the land, the ocean and their parts.

One scientific postulate is put forward in one of the works of such ocean researchers as Lebedev V.L. and Aizatulin T.A. Thereunder, any law and any science in general is a model of reality. It allows forecasting the behavior of real objects in a certain range of conditions. It also emphasizes that when we begin to study the problem, neither the size nor its complexity are known, and only by reaching certain stages of knowledge can we understand what needs to be achieved in the next stages. This is one of the main methodological provisions. Later, the scientists begun to study the most complex nature of the World Ocean using such methodological provisions. It should be emphasized that the above-mentioned studies began in the 1980s.

Important results of the world ocean study include the development of the Oceanic Doctrine of the Russian Federation for the period up to 2020. The Concept of the Research Fleet of the Russian Academy of Sciences was written and the Concept of the Research Fleet of the Russian Academy of Sciences and the Maritime Board were created under the Government of the Russian Federation (2004). The Russian Federation is surrounded by oceans on three sides: Pacific, Atlantic and Arctic. In this regard, the research carried out by Russian oceanologists supports national interests in further development of the surrounding seas, but also the oceans as a whole. Today, natural resources and the ocean ecosystem are being studied. Oceanologists developed the fundamental bases for the integrated assessment of the modern state of the ecosystems of the Russia’s seas [4–6].

These initiatives are linked to the conditions of increasing anthropogenic impact and climate change. The fundamental bases of georisk assessment and ecological safety in the development of oil and gas fields in the seas of Russia were studied. Such developments were used in the implementation of a number of major projects. There are ongoing projects for the construction of the Blue Stream gas pipeline (Black Sea).

In this construction, engineering and environmental survey projects are implemented in the area of large oil fields of the Russian Sector of the Northern Part and the Caspian Sea Center. The integrated ecosystem approach is based on ship and satellite observations.

The waters of the World Ocean are being judged thus making it possible to assess the significance of its areas and the negative intensity of its use. Life in the deepest depressions of the World Ocean was studied at a pressure of more than 600-800 atm and in hot hydrothermal springs in the clouds of hydrogen sulphide and heavy metals – a prototype of the atmosphere of our planet during life formation. The consequences of environmental disasters of nuclear submarines are assessed and forecasts of environmental changes are made in the places of accidents [1, 4–8].

And yet over the recent decades (30 years) the oceanological science of the Russian Federation has lagged behind the developed countries in many directions. There is lack of modern scientific equipment on the research vessels of the Russian Academy of Sciences and difficulty in the construction of new specialized vessels (while there is considerable development in western countries). This situation poses major problems for science in this direction. The Russian Federation is losing scientific priorities and the possibility to influence the geopolitics both within and outside the economic zones [4].

The importance of the circumambient oceans is enormous. It is important to support scientific directions, their study in hydrochemical, hydrophysical, biological and other branches of science. Substantial efforts should be directed to integrated expeditionary research of some seas. This will
result in the establishment of system oceanographic databases for each sea with a view to applying scientific results to forecast further geo-ecological situation.

There is a need for scientific justification and practical development of a system to monitor the characteristics of the oceanological environment with the assessment of climate change and human intervention, ecosystem change [5–9].

Among the most important and promising tasks is the “integrated research and monitoring” of the seas of the Russian Federation in order to assess their resource and biological potential. Hence, it is important to ensure applied and fundamental study of certain oceans and seas. This is the task of the Russian Navy and research on the future extraction of natural biological resources in the open ocean. The impact of the ocean on the Earth’s ecosystem as a whole should be further assessed [3, 4].

Despite the above-mentioned difficulties, the oceanologists of the Russian Federation are emphasizing new directions in the study of the World Ocean. These includes comprehensive studies of the current state of the marine environment and biota of strategically important marine areas of the Russian Federation.

Their purpose is to assess the current state, natural variability of natural systems and their biological productivity. There is continuing development of principles and methods aimed at reducing anthropogenic stress on the ecosystems of the seas of the Russian Federation; development of systems of databases of modern oceanographic data for internal and peripheral seas of Russia with the prospect of creating forecast estimates of the state of their regime.

Comprehensive scientific and technical support for projects on the seas of the Russian Federation is being developed and implemented. Their purpose is to ensure environmental safety and preserve the environment. New rationally adapted system criteria for assessing the effects of technogenic activity on water areas are being developed. There is a need to forecast marine ecosystems under anthropogenic stress, including satellite methods to monitor marine ecosystems. The study is related to control of physical and biological parameters of the medium [7, 8].

Scientific and practical bases of assessment of the main natural and technogenic georisk are being developed. They are connected with catastrophic phenomena, with extraction and transportation of hydrocarbon raw materials in water areas. These include waves, sea level fluctuations, ice situation, seismicity, landslide hazards, submarine volcanism, tsunami, gaseous cavities. This requires innovation, extrabudgetary financing, use of public-private partnership in the implementation of infrastructure projects with the involvement of Russian companies [4, 7].

Scientific research should focus on a number of areas where one of the most important is the study of the dynamics of ocean ecosystems with a view to assessing the impact of ocean processes on the ecosystem of the planet in general. It is necessary to study the mechanisms of biological productivity of the World Ocean.

The purpose of the study is to assess biological resources and identify areas promising for their production outside the economic zone of Russia. This direction requires specialized marine experiments for vertical versifications of satellite meters and the creation of a system of regional algorithms [5].

There is also the need for comprehensive geophysical study of the transition zones from the shelf to the foot of the mainland slope – areas of the most probable accumulation and concentration of biological resources; failure of their production. It is necessary to continue the study of hydrothermal processes in the reef zones of the World Ocean, including processes of modern ore formation [4, 7–10].

Russia is interested in its participation in basic international programs devoted to the large-scale problems of the World Ocean. For this purpose, there is a need to strengthen the collection of information, primarily from satellite instruments. These include altimeters, radiometers, thermographs and other complex ocean study systems. Obtaining information from satellites is a real opportunity to present the terrain of the ocean surface, the concentration of chlorophyll, etc. [4, 8].

Modern ocean research facilities include buoy stations of various modifications, autonomous unmanned and manned underwater vehicles. There are works with remote sensing information from space by specialized research vessels. For a long time, the results have been transmitted to the satellite
from stationary and drifting buoys. Many international organizations are studying the ocean area, including GARP, WOKE, CLIVER.

The next stage of transmission is the centers of collection of data on temperature, current rate, water column, its biological resources and its physical and chemical state. As a result, we may refer to the variability of the World Ocean’s ecosystems.

According to Vernadsky V.I., the chemical composition of the living substance is rather ingenious. It is dominated by light atoms. These are 13 light chemical elements: H, C, N, O, Na, Mg, Al, Si, P, S, Cl, K, C and one heavy – Fe [1, 3, 6].

During the scientific creativity of Vernadsky V.I., biomass estimates were inaccurate and based on the idea of the prevalence of the ocean living matter over continental matter by weight. Hence, he formulated a wrong provision.

The fluctuations of planetary biomass are significant, even during the geologically very short, quaternary period, when during the glacial epochs the forestry of continents, and therefore the mass of the living matter as a whole, decreased dramatically [11]. But during the existence of mankind, it seems that it is possible until the 20th century to consider constant the sum of biomass of an animal substance. Potential phytomass of land, i.e. excluding its anthropogenic reduction, is calculated by N.I. Bazilevich as 2400 billion tons in terms of dry organic matter or 1080 billion tons in carbon equivalent [12].

Data on living matter biomass in the ocean are borrowed from different authors (Table 1).

| Land         | Ocean       |
|--------------|-------------|
| Phytomass    | Phytoplankton| Phytobenthos   | Zooplankton | Zoobenthos | Nekton |
| Zoomass      | Phytoplankton| Phytobenthos   | Zooplankton | Zoobenthos | Nekton |
| 2402         | 2.0         | 1.54           | 25.03       | 1.5        | 0.04   |
|              | 21.5        | 3.3            | 0.23        |            |        |

For conditions of undisturbed biosphere N.I. Bazilevich also calculated net primary products (net production). Every year 180 billion tons of organic matter (dry weight) could be created on land [12].

Recent definitions using satellite data showed that in terms of carbon the primary ocean production reaches 70 billion tons or 103 billion tons. For modern conditions the net primary production on land reaches 45 billion tons in carbon [11].

Despite the intense and, in some cases, excessive use of the biological resources of the ocean, they are still of great economic importance. The main stationary indicator of living matter stocks is the biomass of major groups of organisms; in terms of the use of biological resources the main dynamic indicator is production – productivity of a certain group of organisms. Phytoplankton is the most important producer of organic matter in the World Ocean. The biomass of phytoplankton accounts for about 90% of the total phytomass of the World Ocean.

The estimate of the total stock of the bottom fauna on the shelf, in bathyal and abyssal according to the calculations of modern data, is the average concentration of bottom organisms on the shelf in the range of depths making 0–200 m and is 1.5 times lower than was calculated earlier in 1960, as well as the total biomass of zoobenthos at these depths. The biomass of zoobenthos on the mainland slope exceeds that calculated in the 1960s of the last century. Probably, a large amount of organics entering the regions of the mainland slope to developing life here – average concentrations of zoobenthos in the range of 200–3000 m were 1.5 times higher than the previous values. The average concentration for the depths of more than 3000 m today is an order of magnitude higher than the previous indicator, and the total biomass in the same zone exceeds the data of the last century by 11 times. Such growth may be determined by modern accounting of data for local zones [6, 10].

4. Conclusion

Environmental processes in the ocean are caused by the biological properties of its waters. In the general cycle of matter and energy, the metabolism of living beings plays a major role. Lithosphere,
atmosphere, hydrosphere repeatedly “pass” through the body of living organisms, which absorb minerals, water, gases and once again return them in processed form to oceanic nature.

Marine organisms are able to stabilize the ocean’s chemical system. It is important to analyze the flows and cycles of substance and energy, structure causal relationships between the elements of geoecosystems. It also requires the study of stocks over time.

Characteristic manifestations of the ecological process in time, its speed, dynamics, rhythm are necessary since the current state of the ocean waters is under anthropogenic influence.

The importance of the nature of the washing oceans is enormous. It is important to support scientific directions, their study in hydrochemical, hydrophysical, biological and other branches of science. Substantial efforts should be directed to integrated expeditionary research of certain seas.

There is a need for scientific justification and practical development of a system to monitor the characteristics of the oceanological environment, assess the climate change and human intervention, and ecosystem change.

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