Architectural Facilities in the Water Environment as a Perspective Direction of the Far Eastern Region Development

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Abstract: The article is devoted to the adaptation of the water environment to the life of society, which is relevant in the context of adapting to the rapidly changing environmental, social and political conditions of life in the 21st century. The purpose of the article is to identify promising areas of development in the design of multifunctional architectural complexes in the water environment for the Far Eastern region. The leading approach to the study of this problem is based on a systematic analysis of the territorial, ecological and socio-political characteristics of the region, which can serve as an impetus to the formation of architectural spaces in the aquatic environment. Based on the revealed features, the expedient functional designation of structures in the water environment is predicted: space for life, scientific research, education, business or industry. The materials of the article and the examples of the implementation of floating objects from world practice can be useful for theoretical forecasting and practical implementation of architectural structures on the water that open new prospects for the development of architecture and construction in the Far Eastern region.

1. Introduction
Technological achievements of the society in the 21st century make it possible to adapt the water environment as a potential human habitat. The design of floating architectural structures opens up promising opportunities for the construction of innovative multifunctional building complexes that have unique environmental characteristics and form anthropogenic spaces for life, scientific research, education, entrepreneurship and industry. Architectural structures in the aquatic environment represent the potential for the development of those industries and areas of scientific activity that cannot be realized in the context of traditional architectural structures - from industrial development of deep-water resources to the study of unexplored species of marine fauna. In conditions of a worldwide reduction in the area of fertile land, floating structures can provide additional territories for the development of agriculture.

2. Relevance of the issue
Designing of architectural structures in the water environment is a direction of a current interest for a number of international researchers. Several large-scale urban-planning projects of artificial islands in the UAE, Japan, the Netherlands, the People’s Republic of China, and North Korea have been
implemented recently. Underwater marine research laboratories and tourist hotels have been already constructed in the United States, Maldives, Sweden and Zanzibar [1].

The modern Dutch architects K. Oltuis and D. Keuning are engaged in the design of residential complexes on the water and the development of innovative materials and methods of construction of floating foundations [2]. Futurist architects V. Callebaut and J. Rougerie are designing revolutionary projects of floating constructions aimed to solve a number of significant environmental problems - mobile cities that purify the environment and form a stable habitat.

Researchers at the Seasteading Institute in San Francisco J. Quirk and P. Friedman are forecasting the future of structures on the water and designing modular floating islands in French Polynesia [3]. Among the projects of the annual international architectural contest "eVoLo Skyscraper Competition", dedicated to the design of skyscrapers of the future, autonomous floating megastructures, embodying the vision of futuristic architecture, are increasingly encountered.

3. Purpose of the research
In order to determine how architectural objects in the water environment will contribute to improving the economic, ecological and socio-demographic indicators of the Far Eastern region, it is necessary to analyze the geographical characteristics, the current ecological conditions and the economic, political and socio-demographic situation. On the basis of the analysis, it is necessary to single out the areas of realization of structures in the aquatic environment, which it is advisable to implement in the context of the development of the territory of the Far Eastern region, and to give examples from the world’s design experience.

4. Theoretical part: characteristic features of the Far Eastern region
4.1 Geographical features
The Far Eastern region has significant reserves of water resources: Okhotsk, Chukchi, Bering, Japan, Siberian and Laptev seas, the Pacific Ocean, Lena and Amur rivers are located on its territory. In the Far East, the largest deposits of oil, natural gas, ore, diamonds and gold are concentrated. On the shelf of the Okhotsk, Bering, and Siberian seas, oil and natural gas are extracted. The second largest coal basin in the world, large reserves of black ore and non-ferrous metals are in the Republic of Sakha, Yakutia. Gold is mined in the Amur and Magadan regions. These characteristics make the region the most attractive for the development of extractive industries and the construction of multifunctional enterprises for the development of geological resources [4].

Simultaneously with the presence of the richest deposits, the geological characteristics of the Far Eastern region are characterized by increased seismic activity. In the territory of the Kurile-Kamchatka seismic zone geodynamic processes have been observed in recent decades, which can provoke earthquakes and tsunamis [5].

The territory of the Far East is rich in unique balneological resources. In Khabarovsk, Primorskiy, Kamchatka and the Sakhalin region there are deposits of mineral waters and therapeutic muds [6].

4.2 Ecological conditions
In connection with intensive industrial development, the ecology of the Far Eastern region is under threat. As a result of industrial development and intensive agricultural use, the quality of fertile land is declining and the areas of forest reserves are being reduced. Currently, more than 42% of the region's agricultural lands are waterlogged, 20% are marshes, 8% are subject to erosion [7]. In December 2017, within the framework of the "Days of the Far East in Moscow" project, the most important issues were raised to improve the ecological situation in the region: the inadequacy of measures to restore forest tracts, the low efficiency of treatment facilities and the shortage of infrastructure for waste processing [8].

4.3 Economic and political situation
Since 2015, the strategy of territorial development of the Far East includes the creation of territories of priority development that provide preferential conditions for the formation of industrial companies and entrepreneurship in order to attract local and international investment. In 2016, as a result of the Second Economic Forum, investment contracts were concluded for a total of 1.85 trillion rubles, aimed at the development of industrial automated production facilities using the region's forest, fish and agricultural resources [9]. Thanks to the geographical location of the Far Eastern Federal District, the neighboring countries of the Asia-Pacific Region are interested in the joint creation of enterprises on a mutually beneficial basis.

4.4 Socio-demographic conditions
In the period from 1991 to 2017, the population of the Far Eastern Federal District decreased by 23.2% as a result of the migration outflow to the Central, North-Eastern and Southern Federal Districts of Russia. After the collapse of the Soviet Union, there has been a gradual decrease in the population of the district, from 8.2 million in 1991 to 6.2 by 2017 [10]. To change the socio-economic disparity between individual federal districts in a short time is a difficult task, despite considerable investment in the development of leading industries. To return the population to the region, it is necessary to create a more comfortable living environment, which has unique characteristics and greater appeal in comparison with other regions of Russia.

5. Practical part. Architecture proposals
5.1 Mobile industrial facilities on the water
Architectural objects on the water can perform the functions of industrial structures and produce hard-to-reach deep-water resources. With the help of floating oil-producing platforms (SPAR, EVA-4000) natural deposits are being developed all over the world. In the above-water part there are technical and service rooms, and there are ballast weights supporting the construction afloat located under water. Massive structures are capable of withstanding prolonged storm loads in the open ocean.

The futuristic vision of floating architecture, reflected in the "Ocean Spiral" project of the Japanese company "Shimizu", is expressed in the connection of a residential function with an industrial facilities within an underwater hyper-structure. The object is a 500-m diameter sphere connected to a spiral that drops down to a distance of up to 4,000 m in order to develop the deep sea shelf resources of the seabed. Through the oscillations of the spring and the extracted resources, the autonomous existence of the underwater megastructure will be maintained [11].

5.2 Resumption of resources
Floating structures can serve as filters for water and air, recycling waste products. The project of the underwater structure "Seawer", presented within the framework of the contest "eVoLo Skyscraper Competition", serves as a floating filter that cleans the ocean of plastic waste [12]. The "X-Sea TY" project of the X-TU architectural bureau is a floating island that purifies air from carbon dioxide using algae energy (figure 1). The buildings are made of porous concrete with facades lined with photosynthetic materials. Floating islands can be located next to particularly polluted areas, gradually improving the state of the environment [13].

Architectural facilities that use the energy of hydrogen and biofuels can be located on flooded or waterlogged lands that make up more than half of the agricultural territories of the Far Eastern region. The "Hydro-net" project by "IwamotoScott Architects" is an infrastructure that uses the energy of water, condensate, and wind to support the movement of vehicles and the supply of electricity to residential buildings [14] (figure 2). The project of the eco-city of Dongtan in China, designed by the "Arup" group, also implied the creation of a transport network operating on biofuel and excluding the technological strain on the environment [15].
Floating structures may also provide additional autonomous territories for the placement of agricultural infrastructure facilities. The competition project "Arctic Harvester" by the architect M. Chabani is an autonomous floating hydroponic farm using water and mineral fiber for accelerated growing of crops and harvesting several times a year [16]. The project "Dragonfly" by the architect V. Callebaut is a floating skyscraper combining the functions of living quarters and vertical farms for the production of livestock and crops. Due to the variety of cultivated crops, soils do not lose fertility, and the process of reproduction of raw materials acquires a closed cycle [17].

5.3 Scientific research

Architectural objects in the aquatic environment can serve as mobile platforms for conducting oceanographic research that contributes to scientific discoveries in the field of medicine, technology, and the search for natural resources. The "SeaOrbiter" by architect J. Rougerie is a relatively small 18-person autonomous floating research station designed to observe marine fauna [18]. The project "City of Meriens" embodies the idea of a mobile scientific university for 12-15 thousand people engaged in marine research (figure 3). The structure extends 120 m deep and includes classes, laboratories, sports zones, fish and hydroponic farms [19].

5.4 Innovative space for life

Floating megastructures are a unique space for life, organized in accordance with the principles of sustainable development. Modern designs of structures in the aquatic environment, such as "Noah's Ark" by K. Schopfer (figure 4), the "HO2" + S. Sarkum scraper, A. Remizov's "Ark" form the concept of a completely autonomous, self-sufficient and balanced system that can withstand climate change and ecological catastrophes.

The project of the habitable hyper-structure "X-Seed 4000" by the Japanese company "Taisei Construction Corporation" was intended for placement on the territory of the seismically active ocean shelf. The pyramidal structure on massive pillars was designed to accommodate up to 1 million people...
[20]. Due to the internal organization of the hyper-structures, the amount of time a person needs to commute to work or home, provide himself with food and meet other needs is reduced.

6. Conclusion
Architectural structures in the water environment are able to provide unique opportunities for the development of the economy, industry, scientific activity and the formation of a sustainable habitat in the Far Eastern region. Mobile facilities in the water environment allow the development of deep-sea resources, the placement of agricultural farms and treatment facilities, research laboratories and universities of oceanology. Autonomous hyper-arks can create new conditions for life, save time resources, provide safe habitats in the event of environmental disasters and earthquakes. Adaptation of water spaces for the construction of multifunctional facilities is capable of improving the quality of life in the Far Eastern region, which is part of the state strategy for creating territories of priority development.

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