Maintenance Characteristics of Multifunctional Industrial Farms on the Water in the Context of the Formation of the Advanced Development Territories in the Far Eastern Federal District

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Abstract. The purpose of the article is to identify the maintenance characteristics of the innovative multifunctional farms located on the water. The leading research approach is based on multivariate analysis of the formation stages of architectural objects for industrial purposes, from the development of the conceptual design to the subsequent construction and demolition. First of all, the analysis and allocation of the ADT sites with local resources for the placement of floating objects that perform as farms for the cultivation of fish, shellfish, algae; development and accumulation of energy resources; collection and desalination of water is carried out. Next, the formation features of multifunctional objects at different stages of operation are distinguished and compared. The materials of the article can be used in further theoretical studies and practical developments on architectural objects on the water.

1. Introduction
The current program of the creation of the Advanced Development Territories in the far East of the Russian Federation is aimed at cultivating private entrepreneurship, attracting personnel to the region in order to produce resources and improve the overall quality of life. The new economic zones created in the Far East have a number of special administrative preferences, including a reduced tax on mineral extraction, income, property and land; a preferential right for connection to infrastructure facilities; reduced rental rates; the absence of quotas for the involvement of foreign specialists; free customs zone; simplified control procedures to reduce the time for the implementation of construction, etc. [1].

Recent changes in the state legislative act on the managing of ADTs indicate a clear political interest in the development of adjacent water areas in order to provide additional business opportunities. In this regard, innovative architectural objects on the water open up prospects for positive environmental management, growth and development of the local economy.
2. Relevance of the issue
The number of international architectural firms are engaged in the design of multifunctional production facilities on the water. The formation of additional floating spaces is aimed at improving the quality of the urban environment through the creation of public leisure zones and farming industries that use the resources of local water bodies.

Created as part of the EXPO in Milan in 2015, the project “Jellyfish Barge” by Studiomobile is a floating urban greenhouse using hydroponic method of growing crops. Floating farms could be interconnected by modules, or they could stand autonomously on the river ways, providing nearest residential areas with locally grown food [2-3].

In 2018 in Copenhagen architects M. Blecher and Fokstrot studio constructed a prototype of a floating artificial island “Ø1” for recreation, public events and swimming. With the private initiative of the Danish arts fund nine "Copenhagen islands” will be designed to accommodate floating gardens, mussel farm, sauna, playgrounds for diving, leisure swimmers and kayakers [4].

The floating urban farm project was implemented in 2019 in Rotterdam to shorten the distance between growing and supplying products to commercial establishments. Transportation of products to the cities requires large investments, not to mention the traffic, which creates an additional load on the environment. The floating farm also involves the usage of solar panels and water desalination system [5].

Futuristic farm skyscrapers were designed by JAPA architects for the growing population of the planet. Focusing on the experience of floating fish farms in Singapore, the architects designed vertical hydroponic greenhouses to be located in the city port. The buildings will not disturb the existing architectural landscape and will contribute to the development of local industries, reducing the number of imported products [6].

Despite the variety of practical achievements in the field of design of multifunctional farms on the water, the principles of their formation at different stages of maintenance are insufficiently studied in architectural science.

3. Purpose of the research
The purpose of this article is to identify the features of operation of multifunctional farms of innovative type located on the water. This will require solving a number of research tasks:

- Analysis of potentially suitable ADT sites for accommodation of floating structures;
- Identification of the leading principles of spatial organization of floating objects and defining the stages of their maintenance;
- Analysis of the principles of operation of multifunctional architectural farms on the water and determination of the critical ones at a certain stage of the life cycle of the object.

4. Theoretical part

4.1. Placement of the floating objects on the ADT sites
Twenty ADTs are currently organized in the far Eastern Federal district, eight of which have water resources and represent the potential for the organization of floating structures. The list of these areas includes the following ADTs: Chukotka, Bolshoy Kamen’, Kangalassy, Kamchatka, the Kuril Islands, Nadezhdinskaya, Neftekhimicheskiy, Nikolaevsk. For each of the territories within the framework of the business development program a list of preferable economic activities with a special legal regime was compiled. These activities include crops production, animal husbandry, fishing and fish farming, water treatment and distribution, wastewater treatment, services for elimination of the consequences of environmental pollution, scientific research [7].

ADT Chukotka is the largest in the list (26.3 million hectares) and is located on the coast of the Bering Sea. There are organized several enterprises for the production of fresh-frozen fish, water treatment facilities, year-round hydroponic greenhouses, facilities for the extraction of minerals and precious metals (coal, metal ore, gold, silver). At present, on the ADT Bolshoi Kamen’ (8.1 thousand
hectares) overlooking the Ussuri Bay, a number of shipbuilding companies, pollock and other fish processing plants and recyclables have been implemented. ADT Kangalassi (36.5 thousand ha), located on the banks of the river Lena, has the resources to host fisheries and perennial greenhouses. ADT Kamchatka (13.2 million hectares) occupies an elongated area by the coast, which houses enterprises for the extraction of natural resources, fish farms and a tourist cluster.

ADT Kuril Islands occupies two relatively small areas (23.32 hectares) on Shikotan, where the fish processing complex is currently located. ADT Nadezhdinskaya (9.6 thousand hectares) based on the shore of the Amur Bay has transport and logistics enterprises, industrial waste processing plants, and fish farming facilities. ADT Neftekhimicheskiy (40.2 thousand hectares) has an access to the Bay of Peter the Great and is currently specializing in the production of motor fuels and other petrochemical products. ADT Nikolaevsk has accesses both to the Sea of Okhotsk and the lakes of Orel and Chlya and is the center of the fishing industry.

![Schemes of potential location of water bodies at the borders of ADTs](image)

**Figure 1.** Schemes of potential location of water bodies at the borders of ADTs (a – Chukotka, b – Bolshoy Kamen’, c – Kangalassy, d – Kamchatka, e – the Kuril Islands, f – Nadezhdinskaya, g – Neftekhimicheskiy, h – Nikolaevsk)

The dots in the diagram (fig.1) indicate the potential areas for multifunctional production farms placement. Each of the considered ADT has a number of industries that could be located both on the land and on the water. The adoption of the Federal Law dated July 26, 2019 N 254-FZ, providing the possibility of including surface water bodies in the ADTs, is aimed at improving the business environment [8]. ADT residents will be able to use water areas for the construction of recreational, hydraulic, industrial and other multifunctional structures.

4.2. *The leading principles of the spatial organization of multifunctional architectural objects on the water*

Based on the analysis of the international design experience and requirements for modern structures on the water, six principles for the formation of floating multi-functional objects were identified [9-11]. Among them are: the ability to transform rapidly, regulated mobility, a closed cycle of production and disposal, modularity, protection from the influence of extreme factors, compliance with the surrounding context.
Figure 2. The scheme of principles of spatial organization of multifunctional architectural objects on the water.

The principle of *rapid transformability* is necessary in the context of the long-term functioning of the structure and ensures continuous use of the interior at any time of the year. In the design of the prefabricated floating school “MFS” by architect K. Adeyemi, the principle of rapid transformability allows the usage of a school class space during the holidays as a warehouse for fishermen and the local population [12].

The principle of *regulated mobility* is responsible for the fixation and stabilization of an architectural object in a space characterized by instability and exposure to natural factors. In the “Amphibious house” project of Baca Architects, a specially prepared concrete tank and fixing rails running along the sides of a residential building keep the structure from being demolished by the river Thames during the floods [13].
The principle of a closed *inner production and disposal cycle* is an important condition for minimizing the anthropogenic impact on the biological environment of water bodies in which floating architectural objects are located. In the futuristic skyscraper “Dragonfly” by V. Callebaut, equipped with autonomous production farms, garbage removal is provided by phyto-cleaning, composting and conversion into energy resources that are used for operation [14-15].

The principle of *modularity* allows creation the above-water architectural structures of various scales from small city parks to floating cities. The modular park “Diller Island” in New York and the “Recycled park” in Rotterdam transform the urban environment, creating new recreational spaces [16]. Bjarke Ingels Group’s student dormitory, designed for the port of Copenhagen, was constructed from container modules, which solved the problem of expanding the campus in a short time [17].

The principle of *security in an extreme environment* is an essential condition for implementing a long-term survival strategy. Aviation technologies were used in the “Survival Capsule” project, carried out by NASA engineers in 2011, to create a scaled shelter during the environmental disaster [18]. This principle was also used in the construction of a floating capsule hotel in 2018 in Japan by Huis Ten Bosch for placement in an entertainment park [19].

The principle of *contextual correspondence* involves the usage of local materials, techniques and means of architectural expressiveness, ensuring the symbiosis of a new object with the existing environment. Within the project of a transformable houseboat for Vietnam, made by H&P Architects, locally grown bamboo used as a material for the outer shell, has a strong resemblance to the ethnic architecture [20].

The provided diagram (fig.2) shows the relationship between these principles and the stages of operation of architectural objects on the water, including the conceptual search, construction, operation, restoration and demolition.

5. **Practical relevance**
The solution of the problem stated in the article has strategic importance for the development and adaptation of the water areas of the ADTs in the Far East. The placement of multifunctional floating objects will positively affect the economy and the general quality of life in the region. This study will contribute to fundamental and practical developments in the field of structures in the aquatic environment.

6. **Conclusion**
Based on the research in this review, the following scientific results are obtained, formulated in these provisions:

1. There are currently eight zones located in the Far East that are potentially suitable for floating objects in water areas.
2. In the context of the predicted implementation of structures on water, the principles of *rapid transformability* and *regulated mobility* are relevant for three stages: operation, restoration and demolition.
3. The principle of a closed *inner production and disposal cycle* takes effect at the stage of conceptual search, operation and demolition.
4. The principle of *modularity* applies at all stages except the initial one.
5. *Security in the extreme environment* is a necessary principle at the operational stage.
6. Issues of *contextual* relevance are extremely important at the concept and restoration stage.

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