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TILIGUL ESTUARY: AN OBJECT OF A RESEARCH PLATFORM FOR MASTERS OF AQUATIC BIORESOURCES AND AQUACULTURE IN SOUTHERN UKRAINE

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The article is devoted to the analysis of scientific research on the assessment of the current ecological state of the Tiligul Estuary as an important water body in southern Ukraine. Given the complex ecological situation associated with natural and anthropogenic factors that have led to increased salinity, hypoxia, reduced bioproductivity, and decreased freshwater inflow to the estuary, the choice of this object for research is relevant and timely.

The purpose of the study is to summarize the ecological state of the Tiligul Estuary as a unique object in southern Ukraine and to determine its potential as a base for research work by students majoring in H5 «Aquatic Bioresources and Aquaculture».

The object of research is the Tiligul Estuary as a promising site for conducting scientific research in the field of aquatic biological resources and aquaculture.

The subject of the study is the ecological, hydrological, bioproductive, and educational-scientific aspects of using the Tiligul Estuary as a natural environment for developing the professional competencies of master's students and the fisheries potential of southern Ukraine.

The following methods were used during the study: analysis of scientific literature, synthesis, generalization and systematization, modeling.

The role of higher education institutions in southern Ukraine in training a "new generation" of specialists capable of integrating modern scientific approaches, aquaculture technologies, and environmental management to ensure the rational use and restoration of the estuary has been determined. The study proposes a model that combines the practical and theoretical components of the educational process, based on the principles of communication, interdisciplinarity, and cooperation, and indicates their role in the development of research competencies of future masters.

The creation of a research base on the basis of the Tiligul Estuary will contribute to the implementation of sustainable development programs, increase fish productivity, and preserve biodiversity, which will further positively affect the food security.

Key words: sustainable development, aquatic bioresources, scientific potential, master's research, aquaculture, ecological status.

Statement of the problem. The current stage of development of Ukraine's fishery sector is characterized by the impact of environmental risks caused by a combination of anthropogenic and natural factors, and therefore the study of the current state of coastal estuaries, in particular the Tiligul Estuary, is of particular relevance. The Tiligul Estuary is a unique water body in southern Ukraine that performs important tasks, including supporting fisheries potential, regulating the hydrological regime, and contributing to biodiversity conservation. However, in recent years, there has been a deterioration in its ecological condition, including a decrease in freshwater flow, increased salinity, more hypoxia and water pollution, which leads to a decrease in the number of valuable species of aquatic life and gradual degradation of the water area.

Given these environmental issues, the Tiligul Estuary has significant potential for its use for educational and scientific purposes, in particular as a platform for training applicants for the second (master's) level of higher education in the specialty H5 "Aquatic Bioresources and Aquaculture". In this context, the urgent task is to develop scientifically sound approaches to its conservation and restoration, integrate research practices into the educational process, and create conditions for the sustainable use of the estuary's natural resources for fisheries purposes.

Analysis of research and publications. The southern region of Ukraine has a fairly strong resource potential in the agricultural sector, which has been negatively affected by factors of various kinds in recent years. Given the dynamism of changes and the comprehensive pressure on aquatic ecosystems, one of the pressing issues facing the scientific and educational community and the production sector is the formation of an effective strategy for the post-war recovery of our country to ensure food security [2,10]. For the successful European integration of Ukrainian education and science through research, it is important for higher education institutions (HEIs) to provide graduates with competencies aimed at achieving the global sustainable development goals by 2030, proclaimed by the United Nations General Assembly resolution (September 25, 2015, No. 70/1, as defined by the Decree of the President of Ukraine of September 30, 2019, No. 722) [1,3,12].

In the regional context, educational programs for the training of specialists in aquatic bioresources and aquaculture, ecology, and water management for the South of Ukraine are unique in the context of the resource potential of fisheries, water, and land management.

In modern conditions, under the negative influence of military operations and climate transformations, the concept of a "modern specialist" who is able to quickly adapt to new challenges of realities is an urgent issue for our country, which is faced by specialists, scientists and practitioners, and involves not only their professional competencies and skills, but also the formation of personal

qualities [3,15]. Therefore, awareness of the importance of the role of higher education institutions in this process should be the basis for taking this approach into account in strategic development programs and the mission of higher education institutions. Given that the specialty of aquatic bioresources and aquaculture is "live", dynamic, with contact with living organisms (aquatic bionts), practical skills with an in-depth study of the "subtleties" of the specialty are necessary [3]. Therefore, it is imperative to develop and optimize an integrated set of technical measures and consolidate them, taking into account current and modern problems with an emphasis on hydraulic, water-saving and ecological-agrotechnical techniques [4,5,11].

Using the example of one of the water bodies in the South of Ukraine as a research project, this article considers, summarizes and supplements the relevance, issues and research vectors.

Formulation of the objectives of the article (task statement). The aim of the research is to summarize the ecological state of the Tiligul Estuary as a unique object in southern Ukraine, to determine its potential as a basis for research work of higher education students majoring in H5 «Aquatic Bioresources and Aquaculture».

In accordance with the aim, the following tasks were set:

– to analyze the current ecological state of the Tiligul Estuary and factors affecting its water-biological balance;

– to assess the bioproductive and fishery potential of the estuary in the context of climate and anthropogenic changes;

– to justify the feasibility of using the estuary as a research platform for training masters of the specialty H5 «Aquatic Bioresources and Aquaculture»;

– to propose directions for optimizing its rational use and ecological restoration.

Materials and methods of the research. The information basis of the research was the scientific works of domestic and foreign scholars.

The following methods were used in the course of the study: analysis of scientific literature, synthesis, generalization and systematization, and modeling.

Research results and discussion. First of all, it is worth emphasizing the leading role of the successful combination of practical and theoretical training of higher education students in dynamic and humanitarian specialties (aquatic bioresources and aquaculture are no exception). A practice-oriented approach to the implementation of educational programs in this area significantly enhances the professional characteristics of graduates. Figure 1 shows an example of such a model in a concise form with an emphasis on these aspects.

Undoubtedly, in the training of higher education students for master researchers in the fisheries industry, professional *(hard skills)*, social skills *(soft skills)* and lifelong learning skills significantly complement each other *(lifelong*

learning) [3]. However, in this paper, we will consider the practical component on the example of choosing the research object in the South of Ukraine for research work – the Tiligul Estuary.

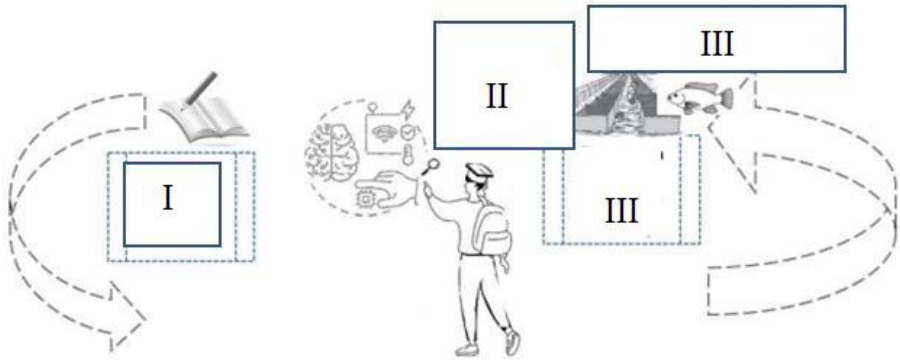

Figure 1. **Visualization of the model of acquiring practical competencies in combination with theoretical knowledge for higher education students: I – HEI, higher education institution; II – higher education student; III – object of study and practical basis (e.g., dual form of education)**

– The rationale for choosing this topic for a master's researcher in the educational program of the specialty Aquatic Bioresources and Aquaculture can be the consequences of anthropogenic pressure and transformations of climatic processes, under which the Tiligul estuary is in a critical ecological state. Major environmental problems require an integrated approach to addressing global issues. Experts identify the following as marker problems:

– a significant amount of pollutants entering the water area as a result of economic activity;

– an increase in the level of development of the territory and household use;

– the presence of hypoxia in the bottom layers and in certain areas of the estuary, which leads to the death of aquatic life;

– an increase in water salinity due to a decrease in the inflow of fresh water into the estuary as a result of the shallowing of the Tiligul River.

In the context of organizational and economic cases of solving these problems, the authors propose to target measures to support the development of the natural and economic component with the search for international investment and taking into account the needs of stakeholders in the South of Ukraine [13]. The concept of three components is practiced: communication (1), coordination (2) and cooperation (3). The dominant vector is the restoration and sustainable development of the Tiligul Estuary.

Among the topics for masters researchers of the educational program Aquatic Bioresources and Aquaculture, experimental studies on ensuring a balance between bioproductive capabilities and fish production characteristics (including the introduction of fish species that can reproduce in the ecological conditions of water areas [6,7,8,14]) are promising.

The issues and assessment of the current state of the estuary are of national importance for our country. The authors note that a significant decrease in surface runoff, which is directly related to the decrease in water levels in the Balaychuk, Tiligul, and Tserega rivers, is associated with the transformation of climatic parameters and anthropogenic impact. It should be noted that the decrease in freshwater inflow to the Tiligul estuary has significantly affected the overall ecological condition, in particular, the bioproductive capacity. Scientific research by leading scientists demonstrates the results of a decrease in the species diversity of aquatic life [14].

The artificial canal contributes to the «natural» purification of the estuary's polluted waters by replacing them with sea water, and also ensures water exchange between different, dispersed areas of the estuary. This ensures that the estuary is supplied with water during dry periods and prevents its complete shallowing. In addition, the canal has a positive impact on the estuary from a fisheries perspective, as during the feeding season, a significant number of marine fish enter its waters from the sea, which increases and renews the fish fauna naturally [9].

The presented data reveal the importance of developing comprehensive scientific and practical recommendations with a vector of water protection and water conservation measures aimed directly at the objects of the national economy near the estuary to ensure sustainable use of its waters and reduce the risks of water pollution. Given that there are a large number of unfavorable environmental processes in the estuary, and its condition is regarded as "critical" in most scientific papers, it is advisable to use comprehensive measures aimed at stabilizing the general condition of the reservoir and ensuring the rational use of the aquatic ecosystem potential. In the formation of research topics for applicants for the second (master's) level of higher education in the specialty 207 (H5) «Aquatic Bioresources and Aquaculture», this direction is relevant, has practical significance and corresponds to the vectors of strategic programs for the development and restoration of the industry. Further scientific research should be aimed at developing and implementing measures to protect and restore the ecosystem of the Tiligul Estuary, taking into account its uniqueness. In this way, such results will complement existing knowledge and contribute to the conservation of biodiversity and ensure the fishery potential of the Southern region of Ukraine.

The current ecological state of the Tiligul Estuary requires coordinated management, conservation and development of water resources, and rational use of its potential. Thus, as one of the most important natural objects, the Tiligul Estuary plays a key role in preserving unique biodiversity and has valuable natural resources. To ensure the sustainable development of Ukraine as a strong European country, it is important to choose the dominant directions and to provide comprehensive support at the state level. Only under these conditions can an effective synthesis of academic and applied science be achieved through successful partnerships. Raising the level of scientific research, expanding opportunities to attract international resources: all these aspects are important in supporting the sustainable development of Ukraine's southern region.

Conclusions. The study made it possible to summarize scientific data on the current ecological state of the Tiligul Estuary, identify the key factors affecting its bioproductivity, and outline the areas of use of this water body as a basis for the training of masters of specialty H5 "Aquatic Bioresources and Aquaculture". The findings confirm that the estuary is under environmental stress caused by a combination of anthropogenic pressure, reduced freshwater flow, and changing climatic parameters, which has led to increased salinity, hypoxia, and reduced species diversity of aquatic organisms. At the same time, the ecosystem of the Tiligul Estuary retains the potential for recovery, provided that water protection and reclamation measures are implemented, water exchange is optimized, and environmental quality is monitored.

The scientific and pedagogical importance of the Tiligul Estuary lies in its suitability for integrated ecological, hydrobiological and fisheries research. Its use as a research platform creates opportunities for the formation of practical competencies, development of research skills and implementation of the principles of sustainable environmental management for master's degree students. It has been established that the formation of a system for monitoring the state of the estuary, attracting international partnerships and government support can ensure the stabilization of the ecological balance and increase fish productivity. Prospects for further research are to develop a model for restoring the hydroecological regime of the Tiligul estuary and to determine effective mechanisms for its sustainable use in the aquaculture system of the southern region of Ukraine.

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ТИЛІГУЛЬСЬКИЙ ЛИМАН: ОБ'ЄКТ НАУКОВО-ДОСЛІДНОЇ ПЛАТФОРМИ ДЛЯ МАГІСТРІВ СПЕЦІАЛЬНОСТІ ВОДНІ БІОРЕСУРСИ ТА АКВАКУЛЬТУРА ПІВДНЯ УКРАЇНИ

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Статтю присвячено аналізу науково-дослідної роботи щодо оцінки екологічного поточного стану Тилігульського лиману як важливого водного об'єкта півдня України. Визначено потенціал лиману як навчально-дослідної платформи для підготовки здобувачів магістерського рівня вищої освіти спеціальності Н5 «Водні біоресурси та аквакультура». З огляду на складний екологічний стан, пов'язаний з природними та антропогенними чинниками, які призвели до підвищення солоності, гіпоксії, зниження біопродуктивності та зменшення об'ємів надходження прісної води до лиману, вибір даного об'єкта для дослідження є актуальним та своєчасним.

Метою дослідження є узагальнення екологічого стану Тилігульського лиману як унікального об'єкта півдня України, визначення його потенціалу як бази для науково-дослідної роботи здобувачів вищої освіти спеціальності Н5 «Водні біоресурси та аквакультура».

Об'єкт дослідження – Тилігульський лиман як перспективний об'єкт для проведення науково-дослідних робіт у галузі водних біоресурсів і аквакультури.

Предмет дослідження – екологічні, гідрологічні, біопродукційні та освітньо-наукові аспекти використання Тилігульського лиману як природного середовища для формування професійних компетентностей магістрів і розвитку рибогосподарського потенціалу південного регіону України.

Під час проведення дослідження було використано наступні методи: аналізу наукової літератури, синтезу, узагальнення та систематизації, моделювання.

Визначено роль закладів вищої освіти півдня України у підготовці фахівців «нового покоління», які здатні інтегрувати сучасні наукові підходи, технології аквакультури та екологічний менеджмент задля забезпечення раціонального використання лиману та його відновлення. У дослідження запропоновано модель, що поєднує практичну та теоретичну складові освітнього процесу, які базуються на принципах комунікації, міждисциплінарності і кооперації та зазначено їх роль у розвитку науково-дослідних компетентностей майбутніх магістрів.

Створення на базі Тилігульського лиману науково-дослідної бази сприятиме забезпеченню реалізації програм сталого розвитку, підвищенню рибопродук-

тивності та збереженню біорізноманіття, що у подальшому позитивно вплине і на продовольчу безпеку регіону. Результати дослідження можуть бути використані для формування стратегії регіонального розвитку, розробки наукових проєктів та освітніх кейсів магістерського рівня, які будуть спрямовані на забезпечення рибогосподарського та водогосподарського потенціалу України.

Ключові слова: сталий розвиток, водні біоресурси, науковий потенціал, магістерські дослідження, аквакультура, екологічний стан.

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