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Sustainable aquaculture and water management
SYLLABUS

Study subject No: **1.4.**

Responsible Unit: Vytautas Magnus University, Department of Water engineering, Faculty of Engineering (VMU)

Credits and distribution of academic hours*:

	Credits ECTS	Contact hours		Independent study hours	Total hours
		Lectures	Practical works or seminars		
VMU	6	27	27	126	180
JAMK	2	9	9	42	60
Total	**8**	**36**	**36**	**168**	**240**

** 1 ECTS = 30 hours (9 contact hours and 21 independent hours);*
1 academic hour = 40 minutes;
Theoretical lectures not less than 50% of contact hours.

Course developers:
Vytautas Magnus University, Lithuania (VMU)**, Algirdas Radzevicius, Prof. Dr.**
JAMK University of Applied Sciences (JAMK), **Tuija Manerus, B.Sc.**

Notes: General study course for the master programme Bioeconomy.

Prior knowledge: biology, hydraulics, water and environmental engineering.

Annotation:
The course provides students with knowledge of the status of water resources (quantity and quality) available for the development of aquaculture in different landscapes, global and regional food fish resources, a conceptually understanding of the development of sustainable aquaculture. During the course students will know the fisheries and aquaculture schemes, used in breeding, fish productivity enhancement, rearing and feeding technologies, water supply, water and wastewater treatment methods and the design and construction principles of the fisheries and aquaculture facilities. Students also get acquainted with aquaculture wastewater treatment methods, requirements for discharging treated wastewater into natural water bodies or the environment. The course also provides students with knowledge of domestic water management and dry sanitation technologies especially in the rural households. After completing the course students will know sustainable water management and sanitation as a part of the circular economy and their importance in nutrient and water cycles, modern fisheries and aquaculture technologies and systems, improving food security and poverty reduction.

The aim: Providing students with basic knowledge of modern fish breeding, nutrition and rearing technologies used in the design, management and operation of aquaculture farms, and wastewater purification processes and technologies from aquaculture and fish treatment. Improving students´ skills on the sustainability of water use and

sanitation including dry toilets and increasing students´ understanding of the impact of nutrient load of anthropogenic origin to the water bodies used for food fish production and the environment.

Description of the organization and tasks of students' independent work: The student must do independent work about fish farming in closed aquaculture systems, to select the main parameters of the system and to present the work in practice. The student has to complete and submit independent work about his/her use of water, study of domestic water and wastewater treatment and use of dry toilets in Uzbekistan.

Learning outcomes (knowledge, skills and competences)

Learning outcomes	Assessment methods	Levels of achievement		
		Satisfactory	Average	High
KNOWLEDGE				
Students will be able to: demonstrate comprehensive knowledge on water resources for food fish production, problems of global fish stocks and opportunities for the development of aquaculture, will understand the most promising fish species suitable for farming in closed and open aquaculture systems.	Discussions in classes	Knowledge of the most important problems of fish resources, nature protection, available water resources and opportunities for the development of aquaculture, but it is difficult to understand their complex interplay.	Understanding of the interplay between the conservation of global fish stocks and the development of aquaculture.	Understanding of the interrelationships between global fish stocks, climate change, nature conservation, food fish production and aquaculture.
Demonstrate detailed knowledge of the basic determination of hydro-physical and hydro-chemical parameters in fishery waterbodies and aquaculture systems and their control methods.	Case study, laboratory work, test	Knowledge of the parameters to be set, methods of their determination and control. 40-69% of the questions were answered correctly.	Knowledge and understanding of the parameters in waterbodies and aquaculture systems and an ability to identify and analyse interaction of the most important elements and compounds. 70-89 % of the questions are answered correctly.	Comprehensive knowledge and understanding of the parameters in waterbodies and aquaculture systems and an ability to identify and analyse interaction of the most important elements. 90 % of the questions are answered correctly.
Demonstrate the knowledge and understanding of the self-purification processes: ammonification, nitrification, denitrification, chemical degradation and bioaccumulation that take place in waterbodies, fishponds, closed aquaculture systems, will be able to manage these processes.	Case study, laboratory work, test	Knowledge of the basic principles of ammonization, nitrification, denitrification processes, but not enough knowledge and skills to control these processes.	Knowledge and understanding of ammonization, nitrification, denitrification processes and sufficient knowledge of how to manage these processes.	Comprehensive knowledge and understanding of ammonization, nitrification, denitrification processes and their management.
Students will be able to:	Discussions in classes	Basic knowledge of interplay	Knowledge of interplay and	Comprehensive knowledge and

demonstrate comprehensive knowledge and understanding of sustainable use of water, and basis of water management as a part of circular economy. Students have understanding of the impact of nutrient load of anthropogenic origin to the water bodies and the environment.		between use of water and formation of wastewater and nutrient load from the human origin to the water bodies and the environment.	consequences between use of water and formation of wastewater and nutrient load from the human origin to the water bodies and the environment.	understanding of interplay between use of water and water management and their sustainability, impact of nutrient load from human origin to the water bodies and the environment and nutrient and water cycles.
Demonstrate knowledge of the parameters water quality from households, aquaculture farms and fish treatment facilities, water and wastewater treatment technologies.	Discussions in classes, independent work	Basic knowledge of domestic water quality and water and wastewater treatment systems.	Knowledge of the parameters of domestic water quality, domestic water and wastewater treatment systems, operating principles and wastewater purification processes.	Comprehensive knowledge of domestic water quality, domestic water and wastewater treatment systems, operating principles and wastewater purification processes.
Demonstrate knowledge of the dry toilets and alternative toilets, operating principles, maintenance, nutrient cycles and composting.	Discussions in classes, independent work	Knowledge of different types of dry toilets and alternative toilets, basis of operating principles and composting.	Knowledge of different types of dry toilets and alternative toilets and their operating principles, maintenance and composting.	Comprehensive knowledge of different types of dry toilets and alternative toilets, operating principles, maintenance, nutrient cycles and composting.
SKILLS				
Professional skills				
Design and select the technological equipment for mechanical, biological and chemical treatment, disinfection and oxygenation of water in recirculating aquaculture system	Discussions in classes, independent work	Knowledge of the key principles of mechanical, biological treatment, disinfection processes. The author does not explain some of his decisions.	Knowledge and understanding of mechanical, biological treatment, disinfection processes. The author explains his decisions.	Comprehensive knowledge and understanding of mechanical, biological treatment processes. Ability to critically assess taken decisions.
Assess the use of fresh/clean water and domestic water and wastewater management and their sustainability.	Discussions in classes, independent work	Ability to assess sustainability of use of water and domestic water and wastewater treatment methods.	Ability to assess sustainability of use of water and domestic wastewater treatment methods and their impacts on the water bodies.	Comprehensive knowledge and understanding of sustainable use of water and domestic wastewater treatment methods

			Knowledge and understanding how to diminish nutrient load from the human origin to the water bodies and the environment.	and processes as well as to diminish nutrient load from the human origin to the water bodies and the environment. Ability to critically assess taken decisions.
Design and select suitable dry toilets to different situations and know their operational principles, composting and treatment of end product available to the nutrient cycles.	Discussions in classes	Knowledge of the key principles to design and select suitable dry toilet in particular circumstances and basis of their operational principles.	Knowledge and understanding to design and select suitable dry toilets in particular circumstances, their operational principles, composting and treatment of end product available to nutrient cycles.	Comprehensive knowledge and understanding to design and select suitable dry toilets in particular circumstances, their operational principles, composting and treatment of end product available to nutrient cycles.
Soft skills				
Come up with creative solutions and reasonably discuss the design, construction and environmental issues of aquaculture systems.	Discussions in classes, independent work	Ability to solve only practical issues of selection and calculation of equipment for aquaculture systems.	Ability to explain the advantages and disadvantages of the technological solutions found in aquaculture systems, when the decisions made may be questionable.	Ability to explain the advantages and disadvantages of the found technological solutions of aquaculture systems, when the decisions made are based on analysis and regularities.
Come up with creative solutions and reasonably discuss of domestic water, wastewater treatment and dry toilets as a part of the circular economy and diminish nutrient load from the human origin to the water bodies and the environment.	Discussions in classes, independent work	Ability to discuss and solve the practical issues.	Ability to explain the advantages and disadvantages of use of water, domestic water and wastewater treatment, dry toilets and nutrient cycles.	Ability to explain the advantages and disadvantages of the technological solutions found in use of water, domestic water and wastewater treatment, dry toilets and nutrient cycles.
COMPETENCE				
Define, describe and analyse the technological processes that take place in recirculating aquaculture systems using production quality, minimum cost oriented methods.	Discussions in classes, independent work	Knowledge is insufficient and based only on the final product, other components influencing the technological	The knowledge is based on the analysis of many components that affect the technological parameters of the aquaculture system.	The knowledge shall be based on an analysis of all the components affecting the technological

		parameters have not been evaluated.		parameters of the aquaculture system.

Requirements for awarding credit points: The student has to pass two tests, as well as complete and submit practical assignments performed during practicals and excursions to complete an independent assignment and present it in practicals.

Knowledge assessment and prerequisites for taking a test or examination
The final mark in the course is based on cumulative score: (10%), Activity during practicals/ seminar classes (30%), individual independent work and a presentation (60%). 10% are equal to one point on a 10-point marking scale.

** 10 percent are equal to one point on a 10-point marking scale (or 10 percent are equal to 0.5 point on a 5-point marking scale).*

Topic	Type of assessment	Percentage	Assessment deadline
Activity during lectures	Individual activity	10	During the entire semester
Activity in practicals/seminar classes	Practical assignments during classes and at home	30	During the entire semester
Independent work about fish farming in closed aquaculture systems, his/her use of water, study of domestic water and wastewater treatment and use of dry toilets in Uzbekistan.	Individual independent work	60	Within the specified time for presentations
Total		100	

The course contents

1. Lectures

1. Global ocean fish stocks: major commercial fish species in the seas and inland waters and in aquaculture. Promising aquaculture species for artificial rearing in open and closed aquaculture systems. Importance of fishing and aquaculture for the economy, general trends and directions.
2. Hydro-chemical parameters of water to be observed in fish farming systems, limit values for water pollution. Methods for determination of water hydro-chemical parameters, their control and management.
3. Fish breeding and rearing technologies: hatcheries, juvenile and commercial fish farming systems. Aquaculture as a tool for the sustainable use, protection and recovery of fish stocks.
4. Closed recirculating aquaculture farming systems: their classification, technological schemes, equipment, their components.
5. Processes occurring in closed recirculating aquaculture systems. Ammonification, nitrification, denitrification: reactions, kinetics, effects of environmental factors.
6. Aquaculture wastewater treatment technologies: mechanical and biological water treatment, degassing, disinfection, oxygen saturation. Recirculating water treatment and its reuse.
7. Design and construction of aquaculture facilities. Calculations of productivity of aquaculture farming systems, amount of feed, water treatment, disinfection equipment, composition of farming basins and technological equipment.

8. Pollution of aquaculture effluents, environmental requirements for the discharge of aquaculture effluents into open water bodies. Management of aquaculture sewage sludge.
9. Sustainable use of water. UN global goals for sustainable development. Use of water in households.
10. Water management. Process from water resources to discharge of (cleaned). Load value of a person. Water management in rural areas /towns and cities. Water protection against the wastewater pollution in Finland.
11. Domestic water.EU drinking water directive. WHO water quality criteria. Domestic water management in cities and rural areas. Domestic water treatment process. Wells.
12. Domestic wastewater. Domestic wastewater treatment technologies.
13. Introduction to dry toilets. Benefits. Challenges. Types of dry toilets. Classification according to the operating mode. Models of dry toilets with details.
14. Alternative toilets, ventilation, bulking material and maintenance of dry toilets.
15. Composting, urine and leachate their use as fertilizer. Indoor dry composting toilet and sustainable sanitation project in Ghana.

2. Practicals

1. Investigation of hydro-chemical parameters of recirculating water.
2. Fish breeding and rearing technologies.
3. Investigation of a closed circulating aquaculture system.
4. Excursion to the fish farm.
5. Water treatment technologies: mechanical and biological water treatment.
6. Processes occurring in closed recirculating aquaculture systems: ammonification, nitrification, denitrification.
7. Design and construction of aquaculture facilities.
8. Excursion to fish breeding station.
9. Teamwork, peer assessment and presentations of individual assignment about use of water.
10. Teamwork, peer assessment and presentations of individual assignment about study of domestic water and wastewater management.
11. Investigation of use of dry toilets in Uzbekistan.
12. Teamwork, peer assessment and presentations of individual assignment about study of dry toilets in Uzbekistan.

List of sources of training, methodological and scientific literature and information

Compulsory reading (books, scientific articles, online sources etc.):

1. Timmons M. B., Ebeling J. M. Recirculating Aquaculture. Third edition, 2013, 788 p.
2. Bregnballe J. Guide to Recirculation Aquaculture, 2015, 94 p. http://www.fao.org/3/a-i4626o.pdf
3. Камилов Б.Г. Юлдашов М.А. Аквакультура. Ташкент, ТГАУ, 2020.
4. Freshwater Aquaculture. William McLarney. Echo Point Books & Media, 2013, 594 p.
5. Салихов Т.В., Камилов Б.Г., Атаджанов А.К. Рыбы Узбекистана. Ташкент, ChinorENK, 2021.-152с.
6. Global dry toilet association of Finland website https://huussi.net/en/frontpage/
7. Water Europe website https://watereurope.eu/publications/
8. Sustainable sanitation alliance SuSanA website https://www.susana.org/en/
9. Guide for the maintenance of dry toilets in Russian https://huussi.net/wp-content/uploads/2013/06/Guide-in-Russian.pdf
10. Planning and construction of a dry toilet in Russian https://huussi.net/wp-content/uploads/2013/06/Huussi_esite_rus_talvi09.pdf

Further reading:

1. B. B. Jana, Dr. R. N. Mandal, Dr. P. Jayasankar Wastewater Management Through Aquaculture https://link.springer.com/book/10.1007%2F978-981-10-7248-2
2. Tapio Katko and Bo Højris, IWA Publishing 2017. Finnish Water Services: Experiences in Global Perspective

Periodicals and other sources:

1. Clivus multrum dry toilet website https://ecoflo.com.au/clivus-multrum/installing-a-clivus-multrum
2. Biolan dry toilets website https://www.biolan.com/ecological-living/dry-toilets.html
3. Pikkuvihreä dry toilets website https://pikkuvihrea.fi/en/product-category/dry-toilets/
4. Ekolet dry toilet website https://ekolet.com/
5. Cinderella incineration dry toilet website https://www.cinderellaeco.com/fi-en/articles/121/what-is-an-incineration-toilet
6. Cinderella incineration dry toilet video https://www.youtube.com/watch?v=5eMDMC4_Zqo
7. Incinolet incinerating dry toilet https://www.youtube.com/watch?v=4rdkGUFzvfc

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