**CURRICULUM**

Main field of study: Environmental protection

Specialty: Aquatic Ecosystem Protection

Type and level of program: second-degree program

Enrolment status: full-time

Educational profile of the program: general academic

Duration: 3 semesters

1. **GENERAL REQUIREMENTS**
2. **Information technology in environmental protection**

*Educational objective:* Transfer knowledge of the capabilities of using information technology to support various spheres of activity in environmental protection. To acquire skills in handling specialised software in a range of different techniques, including statistical data, image analysis, mass and energy balances and life cycle analysis.

*Course content*

*Lectures:* Definition of information technologies. Information technologies and informative technologies. Coding systems of alphanumeric signs and numbers versus information technologies. Computer architecture: structure and principle of functioning. Boole’s algebra. Applied technologies with the use of digital logic systems. Mathematical algorithms versus computer algorithms. Programming process. Text editors and graphical software. Spreadsheets. Databases. Display presentation software. LAN/MAN/WAN network technologies.

*Classes:* Application of procedures for statistical analysis of the research results for M.Sc. diploma in environmental protection with the use of an EXCEL spreadsheet, and STATISTICA statistical package. Transformations, colour models in computer graphics with the use of COREL software. Balances of mass and energy with the use of SuperPro software. LCA with the use of GaBi software.

*Learning outcomes*

*Knowledge:* Student displays knowledge of the use of specific software to solve problems associated with statistical, graphics, mass and energy balance and life cycle analysis. Student shows knowledge of experimental designs and multi-aspect analysis with the use of different information technology tools.

*Skills:* Application of information technology in acquiring and processing information from the scope of environmental protection. Presentation of results with the use of information technology tools. Knowingly uses modern information technology in the field of data collection, calculation, interpretation and presentation of results.

*Social competence:* Student is aware of the need for further education and self-improvement in terms of the use of information technology in effective realization of work.

1. **Foreign Language**

*Educational objectives:* Students develop foreign language competency that enables them to understand, translate and use specialist vocabulary in a given field of study at the B2+ level according to the Common European Framework of Reference for Languages.

*Course content*

*Classes:* During the course, student learn vocabulary and grammar, including selected elements of specialist language, that will enable them to communicate in a foreign language; analysis of scientific texts, discussions, language exercises, translating texts, presenting various learning techniques, encouraging self-assessment, identification and formulation of linguistic rules, various methods of instruction (individual, in pairs, in groups), selection of exercises that are best adapted to the student’s ability and personality.

*Learning outcomes*

*Knowledge:* The student has the knowledge necessary to understand and formulate statements in a foreign language, containing specialist lexicon in the field of a given field of study, according to the table of requirements for the B2 + CEFR level and in proportion to the number of hours planned; has knowledge of the problems currently presented in foreign language directional literature.

*Skills:* The student has language skills that allow the use of specialist terminology, in the fields of science and scientific disciplines relevant to the studied field of study, speaking in a discussion or scientific debate, presenting his own arguments and opinions, asking questions, polemicising with the arguments of other interlocutors; can translate not very complex specialized texts.

Social skills: The student understands the importance of knowledge of a foreign language as one of the conference languages and an element allowing to take a better position in the conditions of growing competition on the labor market; is aware of the need to learn throughout life.

1. **Subject taught as part of the general academic module - humanities**

*Educational objectives*: Students are introduced to the humanities and the issues in this academic discipline. They are encouraged to formulate open questions and analyse diverse points of view. Students learn basic terminology and become familiar with the terminology, assumptions and consequences of the formulated theories and points of view.

*Course Content*: Students are encouraged to acquire additional knowledge, skills and social skills in the chosen general academic subject in the humanities.

1. **Economic Development**

*Educational objectives*: Students acquire rudimentary knowledge about sustainable and multi-functional development, determinants of economic growth and the growth of various sectors of the economy.

*Course content*

*Lectures*: Economic development as an academic discipline. Determinants of economic growth and development. Indicators of economic growth. Economic dualism in the contemporary world. Characteristic features of highly developed, developing and underdeveloped countries. Production factors and their role in economic growth. Sustainable and multi-functional development. Theories of economic growth. Factors and barriers to economic growth. Models of economic growth. Regional variations in development in Poland. Urbanization and industrialization. Development of agriculture in the world. Debt and public debt. Financing agricultural development. Poverty and social exclusion. Knowledge as a prerequisite for economic growth. The role of the state in social and economic development.

*Learning Outcomes*

*Knowledge*: The student has knowledge of economic development and management and has sufficient knowledge to analyse social and economic processes. The student has the necessary knowledge to undertake research.

*Skills*: The student is familiar with the determinants of economic growth and can access various sources of knowledge to analyse social and economic development.

*Social competence*: The student participates in discussions on social and economic development.

1. **Economic Policy**

*Educational objectives*: Students learn about the concepts and mechanisms of economic policy in various systems, particularly in open markets, to further their understanding of the key problems in economic management and rational and effective economic policies introduced by central governments, public institutions and international organizations to improve social welfare. Economic policies do not compete with market mechanisms, but are introduced as a complementary measure.

*Course content*

*Lectures:* Introduction to economic policy – functions, economic systems, determinants, goals and fields. Entities influenced by economic policy, social preferences. History of economic policy – doctrines, systems, trends. Market failure. Economic development policy – sustainable growth, development strategies. Introduction of economic planning and forecasting. Structural policy. Industrial policy. Food policy. Regional policy. Environmental protection policy. Science and innovation policy. Investment policy. Regulatory mechanisms – monetary policy, budgetary policy, labour market regulation, income and price regulation. Foreign policy. Social policy.

*Learning Outcomes*

*Knowledge:* The student is familiar with the main trends in economic theory relating to economic growth and regulatory mechanisms in economic policy. The student explains the role of the state in managing economic processes. The student is familiar with social and economic processes in the national economy.

*Skills:* The student is familiar with the main concepts and mechanisms of economic policy, social and economic phenomena and processes.

*Social competence:* The student adopts a rational and cautious approach in analyses of social and economic processes.

1. **CORE COURSE UNITS**
2. **Statistics and modelling in environmental protection**

*Educational objective:* Development of statistical knowledge. Acquisition of principles of natural phenomena modelling.

*Course content*

*Lectures:* A review of basic concepts in probability and statistics. Descriptive statistics and analysis of environmental data on the basis of random sample. Random variables and their distributions. Parameter estimation, confidence intervals, hypotheses and tests of significance. Deterministic and probabilistic models. Simple regression and correlation - Pearson and Spearmann's correlation coefficient. Mathematical model of ANOVA and assumptions of analysis. Experimental design and ANOVA model. Tests of significance in ANOVA and mean comparisons. Transformation of environmental data. Simple and multiple regression models. Modelling methods and multivariate testing. Non-parametric hypotheses – chi-square test.

*Classes:* Probability analysis and basic measures of combinatorics. Statistical analysis of environmental data samples. Random environmental variables. Estimations and testing. Regression analysis and simple correlation. ANOVA for Completely Randomized Design (CRD). ANOVA for Randomized Block Design (RBD). Multi-factor ANOVA. Interpreting interactions. Statistical conclusion validity. Testing differences between means. Multiple regression and multivariate analysis methods. The chi-square test.

*Learning outcomes*

*Knowledge:* The student presents in-depth knowledge in the field of statistics; understands the issue of mathematical modelling in environmental sciences; knows the methods of statistical analysis, is able to interpret the results to be used directly in practice.

*Skills:* The student comprehensively analyses problems affecting the environmental conditions through a proper configuration of the predictive environmental variables and output data in models as well as shows knowledge of the application and exploitation. He/she is able to match and modify typical applications appropriate to natural resources based on mathematical models; is able to perform statistical analyses within the adequate model with the support of IT tools

*Social competence:* The student is able to forecast effects of activities in the environment.

1. **COURSE UNITS RELATED TO THE FIELD OF STUDY**
2. **Soil biochemistry**

*Educational objective:* The aim of the course is to acquaint students with the basic biochemical processes occurring in soil and methods of determining the activity of selected soil enzymes

*Course content*

*Classes:* Preparation of the soil material to determine the enzyme activity. Determination of: dehydrogenase activity, catalase activity, the activity of acid phosphatase and alkaline phosphatase, the activity of β-glucosidase, arylsulfatase activity, urease activity, ammonifying activity and nitrification activity. Remediation of contaminated soils. Biochemical processes occurring on a waste landfill. Biochemical processes occurring during wastewater treatment. Bio-leaching as a method for the recovery of heavy metals from waste. Biochemical transformation of organic matter in the process of composting and for storage of natural fertilizers. Calculation of biochemical indicators of soil quality**.**

*Lectures:* Biochemical processes in the environment. Glycolysis and gluconeogenesis. Krebs cycle. Pentosephosphate pathway. Glyoxylic cycle. Energy balance of biochemical transformations. Characteristics of soil enzymes. Resolution of organic compounds in the soil. Synthesis of humic acids (humus). Proteolysis and ammonification in different environments. Nitrification and de-nitrification. Desulphurisation and oxidation of sulphur. Oxidation and reduction of other elements, present varying degrees of oxidation. Methane fermentation. Biochemical decomposition of mineral and organic impurities. The correlation between the biochemical activity and the quality of the soil.

*Learning outcomes*

*Knowledge:* Properly draws conclusions from the results of biochemical analyses of the soil. Distinguishes important enzymes participating in the metabolism of carbon, nitrogen, sulphur and phosphorus

*Skills:* Constructs a simple biochemical indicator of soil fertility. Analyses the activity of enzymes and biochemical processes

*Social competence:* Recognizes the importance of biochemical assays in estimating soil quality. Has the ability to work independently and in a biochemistry team.

1. **Physical chemistry**

*Educational objective:* Knowledge and understanding of basic phenomena and physico-chemical processes occurring in the biosphere. Acquisition of independent research ability for selected physicochemical parameters representing components or supplementing instrumental analysis of water and soil. Mastery of mathematical and statistical methods of measurement data and analysis of the causes of errors in the measurements. Shaping teamwork skills while maintaining safety rules.

*Course content*

*Classes:* Determination of: pKa for weak acid by the pH-metric titration method, the molar heat of neutralization of strong acid by a strong base, the Freundlich isotherm of adsorption, the isoelectric point for gelatine, the activity coefficient of copper sulphate, the dissociation constant pKa during conductometric titration of weak acid, the rate of chemical reaction and the Nernst distribution constant

*Lectures:* Surface phenomena, mechanisms of adsorption, adsorption isotherms, characteristics of selected sorbents, technological applications. Colloidal state, methods of obtainment of colloids, micelle structure, coagulation - theory and practice, electro-coagulation. Aggregates, agglomerates and flocs, electrokinetic phenomena, sedimentation. Introduction to chemical kinetics. Electrolytic conductance, conductometry; ion mobility, ionic strength. Introduction to electrochemistry. Electrochemical potential, electrodes and cells, electrochemical corrosion, analytical methods based on electrolysis.

*Learning outcomes*

*Knowledge:* The student has knowledge of the physical and chemical processes in the environment and the mechanisms of electrode potential generation. He/she knows the phenomena occurring at the interfaces and in colloidal systems in relation to the phenomena observed in water and soil. The student knows the methodology of measuring physicochemical parameters and can plan a series of measurements for statistical and mathematical data processing.

*Skills:* The student is able to analyse the measurement data obtained and interpret them using various literature data and is able to adapt and use the known methods of testing physical and chemical parameters in the study of environmental protection.

*Social competence:* The student demonstrates responsibility for risk assessment at the workplace and takes care to maintain order. The student has the ability to responsibly perform tasks for measuring research and can effectively work in a group, both at the stage of experimental research and the development of measurement data. He/she understands the need to constantly improve skills.

1. **Ecotoxicology**

*Educational objective:* Familiarising students with harmful substances in the environment, their effects and various methods of determining those contaminations

*Course content*

*Classes:* Occupational health and safety principles and regulations applicable to students participating in classes. Environmental toxicology – basic terms. Plants and animals as bioindicators of air, soil and water pollution. Determining the degree of water environment pollution with selected substances with the use of bioindicators. Evaluation of morphological and physiological changes in plants resulting from environmental pollution. Determination of the content of glucose and ascorbic acid in roots of plants growing on polluted ground. Toxicology and ecotoxicology of crop protection chemicals. Preparation of samples to determine the remains of the residue of active substances of chlorinated hydrocarbons in plant material. Safety data sheets for hazardous substances. Determining toxicity indicators.

*Lectures:* Ecotoxicology in contemporary science and its extent. Selected terms in toxicology. Review of major environmental contaminants. Hazardous substances in the environment: characteristics, evaluation of ecological and health risks and their effect on landscape elements. Distribution and biotransformations of xenobiotics in the natural environment. Natural defence mechanisms against xenobiotics. Long-term effects of toxic substances. Plants and animals as bioindicators of environmental contamination. Crop protection chemicals in individual elements of the environment and agricultural produce. Selected issues in food toxicology. Medicines in the natural environment. Routes of toxic substances and their effect on populations and ecosystems. Methods of detecting environmental pollution. Chemical safety. Legal regulations of ecotoxicology.

*Learning outcomes*

*Knowledge:* The student has in-depth knowledge concerning basic contaminants, their impact on the environment, effects on living organisms and consequences. The student can choose a method for rapid detection of pollution in the environment and distinguish methods and criteria for establishing chemical safety levels.

*Skills:* The student knows how to select and use chemical and biological methods and how to interpret results and to identify, detect and evaluate risks resulting from the presence of toxic compounds in the environment and make decisions. The student independently determines the effective concentration of selected toxic compounds in relation to various bioindicators.

*Social competence:* The student understands the need for learning and is able to cooperate and work in a group and is aware of the responsibility for the condition of the environment. The student is also aware of the need for oriented acquisition of additional knowledge.

1. **Land use planning**

*Educational objective:* Students are familiar with: the basic concepts of spatial planning, the legal basis of spatial planning in Poland, systematic planning studies, principles, content, procedure of preparing, reviewing, consultation and adoption of planning studies, the spatial effects, environmental and financial effects of Local Spatial Management Plan, the procedure of agricultural land and forest production, principles of assessment and valorisation of the area. Awareness of the role of citizens in the process of local development planning.

*Course content*

*Classes:* The range and content of study of conditions and directions of spatial management. The scope and content of Local Spatial Management Plan. Symbols used in the local zoning plan. The financial impact of the adoption of Local Spatial Management Plan (fee planning, betterment levies, for the exclusion of production). Planning decisions in the investment process. Graphic signs used in projects land development. Land development plan.

*Lectures:* The history of spatial planning. Basic concepts and definitions of the spatial economy. Systematic planning studies. Spatial planning at national and regional and local (contents, rules and procedure for the preparation, evaluation, consultation and approval). The effects of spatial, environmental and financial adoption of Local Spatial Management Plan. Repurposing and exclusion of agricultural and forestry production (procedure, fees, exemptions). Building and land development permits (types, content, rules for drawing up and issuing). Public participation in planning local development. Evaluation and valorisation of space planning.

*Learning outcomes*

*Knowledge:* The student has extensive knowledge of the condition and the complex factors that determine the functioning and development of rural areas, identifies and evaluates the natural and cultural landscapes.

*Skills:* Student incorporates an ability to find, understand, analyse and creatively use the necessary information from various sources and in various forms appropriate for the protection of the environment,

*Social competence:* The student understands the need for learning throughout life, can inspire and organize the process of learning for other people, can interact and work in a group, take on different roles and have knowledge of measures to minimize the risks and predict the effects of activities in the field of environmental protection and management.

1. **Enterprise in environmental protection**

*Educational objective:* The course illustrates that profit can be made while serving an environmental cause. This course explores environmental entrepreneurship compared to regular entrepreneurship. The student is anticipated to perceive and enhance market opportunities for entrepreneurs actively working in the environmental protection.

*Course content*

*Lectures* The concept of entrepreneurship, entrepreneurial attitudes and characteristics of an entrepreneur, types of businesses, the impact of the market mechanism, analysis of business environment, rules for the preparation of business plans, marketing management, the role of innovations, recognizing market needs in environmental protection, assessment of market potential, risk assessment

*Learning outcomes*

*Knowledge:* Thestudent knows the principles of creation and development of individual entrepreneurship forms; has extensive economical knowledge allowing him/her to start a business in environmental protection.

*Skills:* Student is able to plan his/her career, properly assess potential effects of undertaken activities towards solving problems related to environmental protection

*Social competence:* The student is able to think and work in an entrepreneurial way.

1. **Environmental policy**

*Educational objective:* Learning about the principles of environmental policy development at various levels and presenting information about both the instruments used to achieve the objectives of this policy and implementation problems

*Course content*

*Classes:* Assessment of selected environmental policy measures in terms of their efficiency and effectiveness. Analysis of environmental policy evolutions, with particular emphasis on the protection of biodiversity as well as management of natural resources. Selected issues of the environmental policy (local, regional, national, international) – problem-solving sessions

*Lectures:* The current state of the natural environment in Poland as a basis for the implementation of environmental policy. Environmental protection concepts. Environmental policy – basic assumptions, objectives, and principles. Evolution of the environmental policy. Environmental protection and sectoral policies. Environmental policy and environmental protection instruments in the European Union. The influence of the integration of Poland with the EU on the environmental policy. Economic consequences of the implementation of environmental policy. Environmental policy instruments. Financing and investments in environmental protection. Responsibility in environmental protection and the tasks of public administration in the field of environmental protection. Social aspects of environmental protection and environmental awareness.

*Learning outcomes*

*Knowledge:* The student indicates the links between the environmental policy and sectoral policies. Explains the processes of changes to the environmental policy and indicates priority measures. Identifies current problems of the environmental policy;

*Skills:* Student understands political as well as legal and economic determinants of environmental protection. Analyses the causes and effects of changes introduced to the environmental policy.

*Social competence:* The student is able to use knowledge of environmental issues in education and the development of environmental awareness of the public, as well as in resolution of conflicts at various levels in the area of environmental protection through negotiations. The student is also oriented towards pro-environmental measures and is able to identify priorities in environmental policy and is aware of the need for changes and the necessity for supplementary education in the field of environmental policy.

1. **Natural resources geography**

*Educational objective:* Education awareness of the importance of resources and environmental value for the inhabitants of the Earth and the willingness to work for their protection. Awareness of the variety of negative and positive uses of the human resource environment. Training in critical thinking skills, participating in dialogue, including the presentation of his own position and his defence in relation to the policy pursued towards the natural potential in different parts of the world.

*Course content*

*Classes:* Development (graphics and text) of selected components of the geographical environment, social and economic situation of the world: raw material mineral resources and mining (energy resources and metal); unconventional energy sources, location, importance; climate change and water resources, the location of regions as a result of threats of rising sea levels and the occurrence of extreme hydrology and meteorology; water resources of water: the water balance of the continents, the water of the world's oceans, access to drinking water; formations, vegetable cultivation of selected plants; distribution of soils in the world, the structure of land use; demographic situation: the status and distribution of the population.

*Lectures:* Classification of natural resources. Mineral resources. Mining. Energy in nature. Atmospheric pollution and climatic consequences. Water resources. Multifunctional water. Plant formations. Forest and its functions. Agricultural space. Forms of land use. Man and the environment. Population and demographic issues.

*Learning outcomes*

*Knowledge:* The student has a wide range of factual knowledge of current problems of modernity and can distinguish and identify natural environmental resources. The student can explain the relationship between the ecological, economic and social spheres.

*Skills:* The student knows the ways of obtaining and processing information necessary for the performance of individual subjects in the form of written papers, using teamwork to evaluate the accuracy, credibility and logical consistency between the management of the environment and the economy and anthropogenic influences.

*Social competence:* The student is competent in individual and team creativity and is aware of the responsibility for the state of the environment in the context of existential issues of the modern world.

1. **COURSE UNITS RELATED TO THE SPECIALTY AREA**
2. **Limnology**

*Educational objective:* The course of limnology covers all facets of fresh water aquatic habitats, and therefore, considers the physical, chemical and biological characteristics of freshwater ecosystems. The student should be able to account for structure and dynamics in biogeochemical cycles and organism communities; analyse and evaluate abiotic and biotic conditions in aquatic systems; carry out basic sampling and analyses in freshwater field/laboratory systems; plan and carry out experiment/field studies; present and evaluate experiment/field studies both orally and in writing.

*Course content*

*Classes:* The watershed of a lake as a source of water and contaminants. Bathymetry of a lake. Calculation of water resources of a lake. Water retention time and water balance of a lake. Trophic state and methods of its assessment. Recognition of the basic groups of aquatic organisms. Susceptibility of a lake to degradation.

*Lectures:* The course presents an ecosystem perspective on inland water, which comprises both physical, chemical and biological parts. Lake morphometry. The optical and thermal properties of water, dissolved gases, trace elements, nutrients, dissolved salts and organic substances. Sampling theory is also included, as well as sedimentology, paleolimnology and an orientation to aquatic environmental problems such as eutrophication and acidification. The hydrological cycle and lake watersheds. Abiotic elements of freshwater ecosystems. Physical factors affecting lakes - Light, Heat, Temperature. Water movement and oxygen distribution in lakes. Waves and Currents. Trophic gradients. Eutrophication: causes, consequences and trophic status. Major ions, conductivity and salinity of lake water. Water quality monitoring. Classification of lakes. Biodiversity of lakes. Functioning of the littoral zone in lakes. Primary and secondary production. The methods of monitoring, conservation, management and aquatic habitat restoration.

*Learning outcomes*

*Knowledge:* The student has wide knowledge of biology, chemistry mathematics and physics adequate to the course of study and understands the complexity of processes and phenomena in the environment. The student also has relevant knowledge of the functions of hydrobionts at various levels of complexity and technical engineering tasks and demonstrates an understanding of the potential applications of biology and has increased knowledge that enables understanding complex relations in the environment.

*Skills:* Individually and widely analyses problems influencing water quality and environmental state. The student knows how to apply special techniques and their optimisation related to the aquatic ecosystem assessment. He/she applies advanced techniques and methods adequate to limnology.

*Social competence:* properly identifies problems related to the threats of water ecosystems.

1. **Monitoring of aquatic ecosystems**

*Educational objective:* Understanding the scope of monitoring of aquatic ecosystems and water quality in relation with other components of the environment, especially with standards in Poland and European Union.

*Course content*

*Classes:* The rules of monitoring of surface water and groundwater based on the latest legislation. Criteria for the selection of surface water for monitoring in the framework of monitoring: diagnostic, operational, research and protected areas and criteria for the designation of points for measurement and control. The method of collecting representative samples of surface water and groundwater. Assessment of potential risks and indicators of water pollution in the country and in Warmia and Mazury. The choice of methods used in the analyses of water and the scope and frequency of research. Determination of selected quality indicators in surface waters. Analysis of the purity of surface water in Warmia and Mazury. Forecasting changes in the state of environment and the selection of preventive measures to counter the negative effects of the discharge of pollutants into aquatic ecosystems.

*Lectures*: Organization and review of the monitoring programs of water ecosystems in Poland since the start of its operations. The current structure of the State Environmental Monitoring and monitoring of aquatic ecosystems. Characteristics of tasks in the monitoring of aquatic ecosystems. Cooperation with the European Environment Agency and other international organizations occupied monitoring research. Quality and information systems in environmental monitoring. Dissemination of research of monitoring results.

*Learning outcomes*

*Knowledge:* The student knows the structure and programs of the monitoring of water ecosystems implemented in recent years, legislation, pollution indicators and methods used in the study of the aquatic environment and the trends of changes in water pollution and related other environmental elements.

*Skills:* The student gains the ability to interpret results of research and assess the state of main elements in the environmental water ecosystems and the degree of exceeding the limit values for pollutants contained in the legislation - national and European Union, as well as to predict changes in the state of environment that may occur in the future.

*Social competence:* The student understands the need for systematic expansion of the knowledge of the research of the environment state of aquatic ecosystems, especially in the context of its pollution and he is aware of the importance of monitoring tests in environmental protection and the validity of preventive and conservation actions to prevent the negative effects of emissions to the individual components of the environment, mainly water. The student demonstrates competence with knowledge of the scope and methods of research in the framework of monitoring.

1. **Hydrobiology and aquatic ecology**

*Educational objective:* Acquisition of knowledge about the mechanisms of aquatic ecosystems functioning in terms of their different types: lakes, ponds, reservoirs and water courses. Understanding the key factors shaping the biodiversity of species, the structure of the food web and the interactions between aquatic formations. Understanding the mechanisms of evolution and changes in the structure of aquatic ecosystems under the influence of natural and anthropogenic factors. Mastering the typical test methods used in hydrobiology and aquatic ecology.

*Course content*

*Classes:* Hydrobiological research methods – the main goals, sampling process in various types of freshwater habitats. Methods for assessment of water quality and trophic status based on biological indicators: saprobe system, evaluation of the ecological status of water bodies, trophic status indexes based on biomass and diversity of freshwater organisms. Assessment methods for biological production in the waters. The role of macrophytes in aquatic ecosystems, based on the assessment of the vegetation structure. Rules of phytosociological vegetation research and near-water habitats, organization of field work, preparing necessary documentation, processing of results. Preparation of hydromorphological assessment of rivers, evaluating watercourses as habitats for aquatic organisms. Mathematical models reflecting the functioning of aquatic ecosystems. Forecasting changes in water quality on the basis of succession and anthropogenic transformation of the structure of aquatic organisms.

*Lectures:* Lakes, rivers, ponds and reservoirs as a habitat for organisms. Biodiversity of aquatic ecosystems. Complexes of organisms inhabiting different types of waters: plankton, benthos, periphyton, nekton, neuston and pleuston. The relationship between habitat type and biocenosis in aquatic environments. The main physical and chemical factors affecting aquatic organisms. Circulation of matter and energy in aquatic ecosystems. Biological production, conditions and abundance of organisms. Food web. The relationships between the formations of organisms in the water. Various interactions between organisms in the water: competition for resources, predation, defence mechanisms, symbiosis, migration, invasive species. Processes linking reservoirs with their surrounding areas: transport of matter, estuary zones, ecotones. The functioning of aquatic ecosystems under the influence of anthropogenic pressure. The impact of pollution, hydrotechnical equipment and changes in the catchment on the biocenoses of stagnant and flowing water.

*Learning outcomes*

*Knowledge:* Comprehension and understanding the impact of processes occurring in surface waters with the participation of living organisms. Knowledge of aquatic environments ecology, groups of organisms occurring in them and the interactions and relationships with the widely interpreted environment. Knowledge of the diversity of aquatic ecosystems and the specifics of main types of surface waters.

*Skills:* Ability to analyse the structure of aquatic ecosystems and assess the relationships between the different components of the environment. Ability to recognize the degree of transformation and the natural state for different types of aquatic ecosystems, especially in shallow lakes and reservoirs, using conventional methods of assessment. Ability to plan and carry out research using tools and techniques appropriate for the type of surface water

*Social competence:* Awareness of the sensitivity of aquatic ecosystems to anthropogenic influences and understanding of the need to counteract such change. Understanding the need for water protection and its relationship with the protection of biodiversity and landscape, preparation to implement these principles and to educate people in the surrounding environment

1. **Microorganisms in Aquatic Ecosystems**

*Educational objective:* Familiarization with the occurrence and activity of microorganisms in aquatic environments and sewage as well as familiarity with the biological aspects of reduction of organic pollutants. Development of skills in the use of bacteriological evaluation criteria hygienic and sanitary surface water for drinking.

*Course content*

*Classes:* Sampling for microbiological analysis. Techniques for bacterial cultures on solid and liquid nutrient media. Determination of psychrophilic and mesophilic bacteria. Methods for determination of coliform bacteria. Isolation and culture of fungi on artificial media. Saprobic zones and indicator organisms occurring in them. Microscopic observation of water fungi from different zones saprobic. Risks resulting from the presence of pathogenic fungi. Microscopic observations and classification of algae that cause eutrophication. The microbiological analysis of wastewater from the dairy industry and breweries. The microbiological analysis of activated sludge. The microbiological analysis of the water supply. The microbiological analysis of water and waste water treated biologically. Application of the Microtox test to assess the quality of water and wastewater. The microbiological analysis of benthos.

*Lectures:* Water as a living environment for microorganisms. Arrangement of microorganisms in water reservoirs. The role of microorganisms in aquatic ecosystems. Pollution of surface water. Bacteria pathogens occurring in the water and sewage. Illness causing viruses occurring in the water and sewage. Self-purification of water surfaces. Self-purification of water. Bacteriological health analysis of water. Bacteriological criteria for evaluation water quality. Microorganisms occurring in the sewage. Biological of methods for sewage treatment. Participation of biopreparations in the process of treatment water and sewage. Protection and sanitary condition of surface waters in the light of legal acts.

*Learning outcomes*

*Knowledge:* The student can explain the definition and participation of micro-organisms in aquatic ecosystems and is able to characterize polluting surface waters and to present manners of the counteraction based on the activity of micro-organisms.

*Skills:* On the basis of the knowledge gained, the student can perform microbiological analysis of water and sewage and has skills in the choice of appropriate methods for the microbiological examination of water.

*Social competence:* The student understands the hazards arising from the presence of pathogenic microorganisms in the water. The student is aware of the importance of microorganisms in the process of self-purification of water and sewage treatment

1. **Climate vs. water resource management**

*Educational objective:* The aim of education is to demonstrate the relationship between the properties of the climate and the water balance in time and space. The changing climate will cause many consequences in this regard, which must be considered by the decision-makers responsible for water management.

*Course content*

*Classes:* Performing statistical analysis on the dynamics of rainfall by type and causes. Working with climate models allows predicting changes in the dynamics and structure of rainfall, depending on the scenarios of climate change with a focus on climate change issues.

*Lectures:* Meteorology and climatology, supported by the use of geographic information systems, remote sensing, mapping and statistical methods that permit the production, analyses and forecasts of atmospheric and hydrological processes. Water resources and their relationship with the climatic conditions, the dynamics of rivers in relation to the volatility of their power, the functioning of objects and hydraulic engineering in water management and forecasting their impact on river ecosystems, risk analysis and environmental hazards. A comprehensive explanation of the impact of processes, hydrological phenomena and weather on the environment and the various forms of human activity. Knowing weather allows decision-making in the field of water management in a community, district and region.

*Learning outcomes*

*Knowledge:* The student possesses communicative competence, convincing and professional approach to the key issues of climate and water management in the field of environment protection and development

*Skills:* The student will acquire the ability to analyse weather conditions in the context of the current and foreseeable weather systems

*Social competence:* The student will acquire a competence communicative, convincing and professional approach to the key issues of climate and water management in the field of environment protection and development.

1. **Aquatic Ecosystem Protection**

*Educational objective:* Understanding the mechanisms and effects of natural and anthropogenic transformation of surface water, the acquisition of the ability to assess the needs for renewal of surface water, mastering the methods of the risks and consequences of the degradation of surface water, knowledge of technical, planning and biological methods for protection of various water types.

*Course content*

*Classes:* Evaluation of the transformation and the level of risks for chosen surface water types – shallow lakes, small water reservoirs and rivers. Development policies of direct catchment area and the banks of the water bodies for their protection. Technical and biological development designing of rivers and reservoirs. Pro-environmental designing for improvement of the landscape and reduction of pollutant migration into groundwater. Processing the programs and the assumptions for threatened reservoirs and rivers protection. Assessment of costs, impacts and control needs for undertaken protective actions.

*Lectures:* The concept and criteria for evaluation of natural inland waters. Physical and chemical properties and ecological status of surface water under various severity of human pressure. Ecotones associated with waters in the environment. Ecological basis for natural surface water restoration. Technical activities conducted in the catchment areas for improving the ecological status of water bodies. Requirements and limitations of natural water conservation. Environmental and economic effects of different water conservation methods. The importance of vegetation in the protection and restoration of water bodies. The impact of conservation measures on water balance and hydrological conditions of the basin. The role of planning in water protection. Examples of objects subjected to various protective actions - their assumptions, implementation process and obtained effects.

*Learning outcomes*

*Knowledge:* Knowledge and understanding of the impact of the processes and factors that determine the status of natural surface water and of the functioning and effectiveness of different techniques to protect aquatic ecosystems and their requirements and restrictions. Knowledge concerning principles of planning and implementation of research using tools and techniques appropriate for the type of surface water

*Skills:* Ability to recognize the degree of transformation and the state of naturalness different types of aquatic ecosystems, using conventional methods of assessment and to prepare projects and blueprints concerning the protection of aquatic environments, taking into account the needs of the natural and economic constraints. Ability to forecast the effects of measures taken for water protection.

*Social competence:* Awareness of the importance to preserve and restore the best obtainable socio-economic status of natural waters under the given circumstances. Understanding of the need for protection of water and its relation to the evolution of biodiversity and landscape, the student is prepared to implement these principles and to educate the public in their environment

1. **Valorisation of wetland areas**

*Educational objective:* Acquisition of knowledge and practical experience in performing valorisation of wetlands. Acquisition of knowledge about various kinds of wetlands and their functions in rural landscape

*Course content*

*Classes:* Research project - valorisation of a chosen area based on data from nature inventory: abiotic conditions, relief, hydrography, soil cover, plant cover, including indicator species characteristic for various syntaxons of plant communities, plant species used for valorisation (keystone species, plant species under legal protection, endangered, rare). Proposals for protection of an investigated site, including elaboration of rules of active protection, elaboration of expert reports to establish legally protected areas.

*Lectures:* Characteristic features of wetlands. Classification of wetlands. Main kinds of wetlands. Functions of wetlands. Wetlands in land-use plans. Selected methods used in evaluation of environment. Unique versus typical wetland sites. Sources of information useful during performing survey, inventory and valorisation of nature. Legal regulations of nature protection. General inventory of nature for rural districts. Rules of conservation and protection of nature. Valorisation methods of areas valuable from nature protection point of view. Examples of protection plans for various sites and areas (nature reserves, landscape parks, ecological sites, nature monuments, etc.)

*Learning outcomes*

*Knowledge:* The student has mastered selected methods of collection information concerning environmental conditions and is able to process and evaluate information originating from various sources and own field observations in order to assess the quality of wetlands. The student is able to carry out a field survey of wetlands and is ready to evaluate the obtained results from a nature protection point of view.

*Skills:* The student is able to select appropriate methods of nature inventory depending on local conditions and knows how to conform forms of nature protection to the existing needs of society. The student is also able to gain the required information and is able to reconsider opinions.

*Social competence:* The student appreciates landscape diversity as well as biotic diversity and is careful about threats to nature and is able to undertake steps towards nature protection on a local scale in accordance with the laws in force.

1. **Master thesis**

*Educational objective:* Motivation to creative and innovative application of the knowledge within the area of interest (study course). Supervision of defining and solving specific problems according to the formulated hypothesis. Stimulation to use scientific infrastructure and other methods and tools for practical implementation of knowledge. Elaborating the outcomes in a coherent manner. Knows the scientific literature and has critical views on it. Gaining deeper knowledge in a range of issues related to the master's degree thesis topic. Writing a master’s thesis and preparation for the diploma exam. Indicating the need for taking responsibility for own students’ work as well as enhancing her/his competences.

*Course content*

*Classes*: Preparation, implementation and assessment of the master thesis work programme. The student is able to provide aims and arguments in favour of the hypothesis. She/he gets support in writing a master’s thesis and preparation for the diploma exam.

*Learning outcomes*

*Knowledge:* The student knows the methodology and rules of master thesis preparation; basic principles from the scope of a copyright law and protection of intellectual property and work safety regulations. She/he has knowledge concerning the most important problems in the field of environmental protection and development and is fluent in environmental protection terminology. The student knows and understands the methodology principles of research work and is familiar with statistical analyses to properly analyse the results and infer conclusions.

*Skills:* The student makes use of scientific literature from the scope of environmental development and protection and properly selects research methods and conducts self-planning, execution, analyses and assessment of the correctness of the performed task in the scope of environmental protection.

*Social competence:* The student understands the need for targeted education and self-improvement in the scope of environmental protection. Correctly identifies and solves dilemmas related to environmental protection.

1. **MSc laboratory**

*Educational objective:* Preparation of the student to perform a master's degree thesis.

*Course content*

*Classes* Support in the experimental part of the master's degree thesis execution.

*Learning outcomes*

*Knowledge:* The student knows and understands the principles of experimental design

*Skills:* The student shows practical abilities to perform experiments and is able to select or adjust proper methodologies to perform the experimental part of the thesis

*Social competence:* Understands the need for lifelong learning and constant enhancement of her/his competences and skills.

**V. SPECIALISATION**

1. **Special seminar for bachelor degree students I-III**

*Educational objective:* Preparation of the student to prepare a master's degree thesis and to **pass the final examination.** The aim of the education is preparation of a diploma student to the research and creative approach of solving water-related problems, including perception and verbalization of water pollution, ecosystem services and management, formulating scientific hypotheses, ability to logical and efficient selection of materials and methods, literature, applying statistics, logical presentation of research outcomes and effective discussion.

*Course content*

*Classes*: Individual and group work of diploma students: presentation of the selected issues based on the literature. Review of the literature related to the aquatic ecosystem specific issues. Compilation of the information on environmental problems of water ecosystems required for the issues for final exam*.* Methodology of research within the scope of environmental protection and management. Methodology of master thesis structure (chapters, subchapters, references etc.). Selection of the problem being a subject of M.Sc. thesis. Presentation of the range of methods applied. Writing and graphical skills. Interpretation and verification of the study outcomes, confrontation with the literature. Formulation of conclusions and inferences.

*Learning outcomes:*

*Knowledge:* The student has knowledge of scientific methodologies. She/he possesses knowledge concerning the most important problems in the field of water resource protection and development. Knows and understands the methodology principles of research work. She/he is familiar with statistical analyses of the results and properly formulates conclusions. The student knows the methodology and rules of master thesis preparation, the basic principles of copyright law and protection of intellectual property and work safety regulations.

*Skills:* The student is able to apply the methodological principles in his/her research work. She/he is familiar with statistical analyses to properly analyse the results and infer conclusions. The student skilfully complies and interprets the results of the research outcomes and compares them with the literature.

*Social competence:* The student is prepared for research work and understands the need for constant life-long learning. She/he has got the ability to plan, inspire, work in groups. She/he is able to use the achieved knowledge in teamwork following legal and ethical principles.

**VI. PRACTICAL TRAINING**

1. **M.Sc. Diploma placement**

*Educational objective:* Familiarising the student with principles of experimental design, planning and organisation as well as methods of data analyses during the writing of a M.Sc. thesis.

*Course content*

*Classes:* Familiarising the student with principles of experimental design, planning and organization; support in the preparation and performing the experiments; methods of research planning and organization. Stages of the research process (formulating of the scope of research; hypotheses (theoretical solutions); practical planning of empirical procedures; Workout of methodology and experimental plans; selection of the statistical technique.

*Learning outcomes:*

*Knowledge:* The student shows extensive knowledge related to the study course , which is used during the experimental part and in the phase of thesis writing. The student understands the necessity of the planning and organization phases of research, validation and verification of the data set; collecting and data processing.

*Skills:* The student conducts the study with the help of a supervisor; collects and selects the data considering copyright laws and protection of intellectual property and work safety regulations

*Social competence:* The student appreciates the need for research planning and its organization. The student has developed skills to work in a team.

**VII. OTHER REQUIREMENTS**

1. **Etiquette**

*Educational objectives*: Students are introduced to the ceremonial aspect of protocol procedures, rules of etiquette and respect for precedence.

*Course Conten*

*Lectures*: Introduction to rules of etiquette and processes of diplomatic protocol during formal functions. Cultural differences in rules of etiquette and diplomatic protocol. Table manners.

*Learning Outcomes*

*Knowledge:* The student is familiar with the basic principles governing interpersonal relations in private and professional life.

*Skills:* The student abides by rules of etiquette and courteousness in private and professional life.

*Social competence:* The student recognizes the importance of rules of etiquette in interpersonal relations.

# Safety and hygiene at work

*Educational objectives*: Students learn procedures for handling accidents and emergencies at university, the causes and circumstances of accidents involving university students, first aid procedures, potential risks to be avoided by university students.

*Course Content*

*Lectures*: Occupational health and safety regulations (Constitution of the Republic of Poland, Labour Code, Regulation of the Minister of Science and Higher Education of 5 July 2007 on occupational health and safety in universities). Identification and evaluation of life and health hazards in different fields of study (dangerous, harmful and unpleasant factors). Causes and circumstances of accidents involving university students. Procedures for handling accidents and emergencies at university (e.g. fire). First aid procedures and the first aid kit. The training addresses the specific needs of different study fields and identifies the potential threats in those environments.

*Learning Outcomes*

*Knowledge:* The student is familiar with the procedures for handling accidents and emergencies at university, the causes and circumstances of accidents involving university students and first aid procedures.

*Skills:* The student safely handles dangerous and harmful substances and materials and is familiar with occupational safety requirements and uses personal protection equipment, rescue equipment and gives first aid.

*Social competence:* The student exercises caution in handling dangerous and harmful substances and materials and observes and promotes the observance of occupational health and safety regulations by others. The student is also responsible for occupational health and safety in his/her environment and participates in emergency procedures.

1. **Ergonomics**

*Educational objectives:* Students are introduced to the interdisciplinary concept of ergonomics, the problems (including health problems) associated with ergonomic deficiencies in and outside the workplace and the benefits of ergonomic solutions.

*Course Content*

*Lectures:* Ergonomics – basic concepts and definitions. Ergonomics as an interdisciplinary science. The main trends in ergonomics: workplace ergonomics (physical and mental effort in the workplace, adapting the workstation to specific workers and tasks, the work environment), product ergonomics – ergonomic quality engineering, ergonomics for elderly and disabled persons. Ergonomics of standing and sitting work stations.

*Learning Outcomes*

*Knowledge*: The student is familiar with the basic concepts in ergonomics, in particular work station ergonomics.

*Skills:* The student identifies ergonomic problems and threats inside and outside the workplace.

*Social competence:* The student adopts an anthropocentric approach to working and living conditions and responds to threats resulting from ergonomic deficiencies. The student also identifies the needs of disabled persons in the realm of ergonomics.

1. **Patent Information**

*Educational objectives:* Students develop an understanding of the legal, normative and practical aspects of patenting and protecting inventions, industrial designs, utility models and know-how. They learn about the basic concepts, principles, goals and key regulations relating to Polish and European copyright laws.

*Course Content*

*Lectures*: Basic concepts and definitions relating to industrial property, patents, inventions, patent protection, industrial designs, utility models, trademarks, geographical indication, chip topography, protective laws, rights in registration. Copyright law and copyright protection. Related rights. Industrial property and the provisions of the Industrial Property Law. Industrial property protection system. Patents and inventions as objects of patent law. History of patents and patent policy. Subject matter of patents. Content and scope of a patent. Patent registration procedure. International access to patent information. Copyright law in the European Union. Copyright law in the Internet. Copyright transfer agreements. Systems for the protection of utility models and industrial designs.

*Learning Outcomes*

*Knowledge:* The student is familiar with industrial property concepts such as intellectual property, invention, patent, industrial design, utility model, geographical indication, chip topography and know-how and the patent policy and patent registration procedures in Poland and other countries.

*Skills:* The student identifies various types of industrial property, the applicable protection laws and protection periods.

*Social competence:* The student recognizes the significance of intellectual property protection. The student is familiar with the risks and penalties relating to illegal appropriation of intellectual property.

1. **Intellectual property protection**

*Educational objectives*: Students learn the basic principles, concepts and procedures relating to intellectual property protection.

*Course Content*

*Lectures*: Intellectual property concept. Subject matter of intellectual property. Owners of intellectual property. Intellectual property law – copyrights and related rights. Limitations of intellectual property. Compulsory and contractual licenses. Public copyright license. Copyright infringement (plagiarism and piracy). Detailed regulations of the copyright law – protection of computer programs and databases.

*Learning Outcomes:*

*Knowledge*: The student is familiar with the basic concepts relating to intellectual property protection.

*Skills:* The student identifies and applies limitations and exceptions to copyright in critical analyses and scientific work in the academic environment.

*Social competence:* The student observes copyright laws in the academic environment and private life (e.g. copyrighted work on the Internet).

**VII. ELECTIVES RELATED TO THE FIELD OF STUDY**

1. **Specialisation module I**
2. **Cost-benefit analysis for water ecosystem conservation**

*Educational objective:* The basic aim is to provide theoretical knowledge and provide practical tools for cost-benefit analysis of investment-protection ventures. Cost-benefit analysis should show whether a venture will lead to a welfare increase in the community affected by its consequences. A general socio-economic cost-benefit analysis should consider not only the financial costs and benefits expressed in cash flows, but also provide information about these aspects of the impact of the venture, which are not the subject of market transactions. These aspects are especially characteristic for public goods in the natural environmental.

*Course content*

*Classes:* Stages of cost-benefit analyses of investment projects, defining and determining goals, project identification, feasibility and alternatives, financial analysis, economic analysis, multi-criteria analysis, sensitivity risk analysis. Example of a project

*Lectures:* Theoretical and practical source of creation of cost-benefit analysis. Welfare economics. Economic rationality and efficiency and effectiveness. The main problems in the methodology of cost-benefit analysis in the context of natural environmental. Stages of cost-benefit analyses of natural environmental valuation. Methods of natural environmental valorisation and their application.

*Learning outcomes*

*Knowledge:* The student defines basic terms related to costs-benefits analysis. The student knows the possibilities and limitations of the costs-benefits analysis in the valuation of the natural environment and determines the indicators determining the specificity of environment-friendly investments.

*Skills:* The student knows the procedure for assessing the efficiency and rationality of ventures for the protection of aquatic ecosystems and knows how to evaluate economic efficiency based on the example of investment project in the field of water and wastewater management.

*Social competence:* The student is aware of the need to protect aquatic ecosystems and can communicate and express his/her opinions.

1. **Water ecosystems in land use management**

*Educational objective:* Acquiring skills in designing waterside areas. Presenting landscape values of selected types of aquatic ecosystems. Understanding the role of spatial planning in the protection of aquatic ecosystems.

*Course content*

*Classes* Discussion on the basic design principles of waterside areas development. Overview of good practices of waterside area development in selected countries.

*Lectures:* Aquatic ecosystems and wetlands – introduction. Spatial planning of waterside areas - case studies. Principles of waterside area development and environmental impact assessment of selected investments. The influence of selected elements of spatial development on aquatic ecosystems. Proposed reduction and prevention solutions of spatial development negative impact on the environment.

*Learning outcomes:*

*Knowledge:* Students are introduced to good practices in waterside area development and know the rules of waterside area development and the role of spatial planning in the protection of waterside areas.

*Skills:* Students acquire the ability to design waterside areas and are able to obtain and analyse the data necessary to design these areas.

*Social competence:* Students appreciate landscape variety related to the presence of a body of water. Students understand the need for protection of aquatic ecosystems.

1. **Agricultural water pollution**

*Educational objective:* Equip students with knowledge concerning of the types, sources and effects of water pollution resulting from farm production and reducing the negative impact of agriculture on water quality.

*Course content*

*Classes:* Determination of the organic nitrogen and ammonia concentration in water. Spectrophotometric determination of phosphate in water. Determination of Ca, Mg, Fe by flame atomic spectrophotometry and pH in water.

*Lectures:* Agricultural impact on water quality. The types and sources of pollution from agriculture. Point and non-point agricultural sources of water pollution. Efforts to reduce the negative impact of agriculture on the quality of water. Ammonia and organic nitrogen in water is an important parameter of their quality. Phosphorus content of the soil and drainage water quality as the criteria for identifying areas sensitive to pollution of waters with biogenic elements. Recent trends in water pollution from agricultural nutrients and pesticides. Use of regulatory policy instruments to control agricultural water pollution. Toward sustainable management of water quality in agriculture.

*Learning outcomes*

*Knowledge:* Student shows in-depth knowledge of the biosphere, chemical and physical processes taking place there; basic knowledge on technique and environmental management. She/he shows familiarity with advanced methods of environmental pollution assessment; has knowledge of methods of protection and restoration of aquatic ecosystems.

*Skills:* Students have the ability to carry out chemical analysis of water and are able to assess water quality based on the results of chemical analyses.

*Social competence:* Students show knowledge of risk limitation methods and forecasting the results of activities within the range of environmental protection and management.

1. **Molecular diagnostics of pathogenic microorganisms in the aquatic environment**

*Educational objective:* Students will be familiarized with modern diagnostic techniques (conventional methods, immunological techniques, molecular biology techniques including PCR and real-time PCR assays) used for the detection and identification of microorganisms in the aquatic environment. Students will learn how to perform diagnostic tests.

*Course content*

*Classes:* Methods of plant disease diagnosis (conventional methods, immunological techniques - ELISA, molecular biology techniques including PCR and real-time PCR assays, with particular emphasis on major fungal and bacterial pathogens). Diagnosis and identification of pathogens with the use of species-specific primers. Quantitative determination of microbial DNA and genes involved in toxin production.

*Lectures:* Methods (serological techniques, PCR) for the detection and identification of microorganisms in the aquatic environment. The concept of stress. Biotic and abiotic factors determining the development of pathogen populations in the aquatic environment. The effects of trace elements on plant cells in water bodies, microorganisms and aquatic habitats. The defence responses of cells in living organisms exposed to trace elements. Molecular defence mechanisms in living organisms in aquatic habitats exposed to fertilizers and pesticides.

*Learning outcomes*

*Knowledge:* Students will demonstrate an extensive knowledge of the functioning of living organisms (crop plants, fungi, bacteria, viruses, phytoplasmas and spiroplasmas) and their interactions at the molecular level and environmental threats. Students will be familiarized with molecular biology techniques and tools based on PCR data analysis, used for the detection and identification of pathogenic microorganisms.

*Skills:* Students will be able to analyse and evaluate research tasks involving DNA isolation and the application of PCR techniques, conventional and immunological methods for the detection and identification of various microorganisms.

*Social competence:* Students will be able to solve problems relating to the presence of undesirable microorganisms that are harmful to human and animal health.

1. **Wetlands protection and restoration**

*Educational objective:* The aim of this course is to present problems of wetland conservation and rational management of these areas

*Course content*

*Classes:* Determination of physical and water-physical properties of drained and natural wetlands. Principles of wetland conservation. Methods of active protection of wetlands. Project of conservation tasks and restoration design of chosen wetlands.

*Lectures:* Classification of wetlands. Development of wetlands. Fauna and flora of wetlands. Transformations of wetlands and subsidence of peatlands. Wetland use in Poland and in other parts of the world. The role of wetlands in water circulation and GHGs emissions. Maintenance of water conditions. Wetland conservation. Programs of wetland protection. Restoration of peatlands in Poland. Methods of restoration of wetlands.

*Learning outcomes*

*Knowledge:* The student possesses knowledge of the role of wetlands in the environment, threats to wetlands and responsible management of wetlands and possesses knowledge of the current problems of wetland protection

*Skills:* The student can plan restoration activities on wetlands and assess the state of wetlands and degree of degradation

*Social competence:* The student identifies the state of the wetland and plans restoration activities

1. **Grasslands in water protection**

*Educational objective:* Understanding the role of grasslands in water protection

*Course content*

*Classes:* Issues related to the natural meaning of the grasslands, the requirements of the water meadow plants, the flow of nutrients in sodden areas, grasslands in the accumulation of water resources in shear flood wave, the role of grasslands in water intakes and the protection of water bodies against pollution from agricultural sources. Discussion on the issues discussed.

*Lectures:* Grasslands in Poland and in the world. The diversity of grasslands. Natural importance of grasslands. Water requirements of plant grasslands. Types of grassland depending on the water conditions in their habitat. The flow of nutrients to sodden areas. Grasslands as water reservoirs. Alluvial meadows and flood protection. Grasslands in water intakes. Grasslands and eutrophication of water bodies.

*Learning outcomes*

*Knowledge:* She/he has knowledge of the role of grasslands in water protection.

*Skills:* She/he identifies the effect of the presence of grassland in the catchment on water quality.

*Social competence:* She/he is focused on the need to protect water resources

1. **Water resource management in protected areas**

*Educational objective:* To acquaint students with the possibilities of water management in protected areas, the use of solutions to prevent and counteract the adverse transformations ecologically valuable areas, the use of technical and biological solutions aimed at rational water management and protection of natural values.

*Course content*

*Classes:* Evaluation of the impact of human activities on selected protected areas. Legal procedures in the investment process in protected areas. Principles for implementing applications for administrative decisions. Execution of sampling water permit investments related to water management in the protected area.

*Lectures:* The basic obligations of operators engaged in investments in protected areas resulting from various directives and laws relating to the environmental aspects of water management. Possibilities of economic use of water in protected areas. Projects related to water management with a significant impact on natural areas. The impact of the various projects on the natural ecosystems (dams and barrages, small retention, flood dikes and polders, etc.). Investments related to ecosystem restoration of wetlands.

*Learning outcomes*

*Knowledge:* The student has a thorough knowledge of the functioning of ecosystems and human impact on the natural environment. He knows the basic obligations under the various directives and laws relating to the environmental aspects of water management. He knows the limitations related to water management in highly natural and legally protected areas.

*Skills:* He/she has the ability to take into account in the design of water management areas the ecologically valuable possibility of the occurrence environmental threats, degradation of water and vegetation and the introduction of methods of natural and technical restoration of water bodies. He/she has the ability to follow the national regulations relating to water management in protected areas

*Social competence:* He/she understands the need for development of water management in the region, taking into account human needs on a par with the protection requirements. Understands the need, priorities of environmental requirements before the economic activities related to water management in areas with high natural values.

1. **Laws and Regulations in Water Resource Protection**

*Educational objective:* To acquaint students with the Polish and European Union legislation in the field of water conservation.

*Course content*

*Classes:* Legal procedure in investments related to water management in relation to the Water Framework Directive. Guidelines for the preparation of the dossier in the investment process (request for a decision on the environmental conditions, application to establish location of a public investment, aquatic legal survey). Preparing the application for a decision on the environmental conditions.

*Lectures:* The organization of environment management system in the European Union, EU directives relating to the environmental aspects of water management. The national rules relating to water management, general assumptions of the existing legal solutions relating to water resources. Legislation in the field of environmental regulations affecting water protection. Integrated system for water quality management.

*Learning outcomes*

*Knowledge:* The student has a thorough knowledge of the organization system of environmental management in Poland and the European Union. He/She knows the basic obligations under the various directives and laws relating to the environmental aspects of water management and limitations related to water management in legally protected areas and those with high natural values.

*Skills:* The student has the ability to analyse the compatibility of the proposed investments in the Polish legislation and the European Union. He/She has the ability to use the design of the investment impact on the quantity and quality of water from the national legislation and EU directives and the ability to prepare legal documentation needed when preparing an investment for implementation.

*Social competence:* He/She can broaden their knowledge about new environmental problems and can find positive solutions to reconcile the requirements of water protection and the needs of infrastructure and understands the needs and priorities of environmental requirements as well as economic activities relating to water protection.

1. **The most valuable aquatic ecosystems**

*Educational objective:* Students will acquire knowledge on the primary forces responsible for the health and functioning of aquatic ecosystems and will also comprehend the importance of water in providing essential ecosystem services. Students will have the opportunity to apply this basic knowledge in ‘real-life’ conservation scenarios of the most precious water ecosystems, recognizing the role of humans in both the degradation and preservation of aquatic ecosystems, and how human actions can impact ecosystem services. Students will also improve their ability to think critically, learn independently, function in a team or group learning setting and obtain working knowledge of biological and ecological concepts required for aquatic ecosystem conservation.

*Course content*

*Classes:* Typology of freshwater and marine ecosystems. Examples of the most valuable water ecosystem characteristics, including conservation and successful management strategies, will be presented. Ecosystem services analysis.

*Lectures:* An overview of the structure and functioning of freshwater and marine aquatic ecosystems. Overview of a number of challenges facing the most threatened and valuable aquatic ecosystems. Analyses of approaches and strategies that can be used to solve these challenges. Examples and scenarios will be presented based both on regional and global perspective to aquatic conservation issues and how regional differences in problems and solutions exist. Emphasis will be placed on the importance of using science to generate successful management strategies.

*Learning outcomes*

*Knowledge:* The student understands complex environmental phenomena and processes.

*Skills:* The student shows an ability to search, understand, analyse and use the required data from different sources and in various forms adequate to the study course.

*Social competence:* The student acquires knowledge of activities focused on risk attenuation and predicting the effects for agriculture and environment.

1. **Mobile systems in environmental monitoring**

*Educational objective:* Learning the principles and methods used in environmental monitoring measurement systems.

*Course content*

*Classes:* Becoming acquainted with sample equipment used in environmental quality measurement systems, with particular focus on water quality. Types of data recorders working with the equipment. Examining the possibilities of controlling the equipment from the computer - uni- and bidirectional communication (analogue and digital connections). Calibration of the measuring equipment. Operation of mobile measuring systems using the example of a “MobiLab” mobile environmental monitoring laboratory.

*Lectures:* Importance of the use of mobile measurement systems in environmental monitoring. Definition and classification of measuring systems. Configuration and structures of measuring systems. Measuring system interfaces, computer buses. Remote transmission of measurement data. System calibration, gauging and adjustment. Trends in measurement technology development. Miniaturization of measurement systems.

*Learning outcomes*

*Knowledge:* The student knows the advantages, disadvantages, operating principles and use of advanced systems for measuring the quality of the environmental elements.

*Skills:* The student is able to use mobile measurement systems to evaluate the degree of environmental pollution.

*Social competence:* The student is able to identify the condition of the environment based on modern measurement methods.

1. **Marine ecosystems**

*Educational objective:* To acquaint the student with the physiography of seas and oceans, including the biota of marine ecosystems

*Course content*

*Classes:* The oceans of the world.. A trip to the Maritime Aquarium in Gdynia. The project "We are building a marine aquarium" (in theory, in practice)

*Lectures:* The structure of ecosystems. World Ocean. Geography seabed. Atlantic Ocean. Pacific Ocean. Indian Ocean and the Arctic Ocean. Movement of sea water. Ocean currents. Coral reef.

*Learning outcomes:*

*Knowledge:* Students have the necessary knowledge of the structure of marine ecosystems, geography of the world's ocean and the principles of mass and energy changes in sea waters

*Skills:* Students have the necessary skills and knowledge search ability in the analysis of marine biodiversity and geography resources.

*Social competence:* Students are aware of the responsibility for the state of the environment represented by the marine ecosystems, which are constantly subjected to anthropogenic pressure.

1. **Water ecosystems**

*Educational objective:* The course of "Water ecosystems" deals with the importance of water ecosystems for human life. Students should define and characterize the factors influencing fluvial landscapes based on the hydrological and geomorphological knowledge and characterize the functions of water ecosystems in the natural and cultural landscapes. Students should also possess the ability to assess water-related changes in the environment and understand the vitality of water features for nature protection, recreation and aesthetics. Students should understand the causes of aquatic ecosystem degradation and indicate methods of water ecosystem restoration.

*Course content*

*Classes:* Classification of water ecosystems. Hydrographic maps and other sources of hydrological data. Hydrographic catchment parameters. Hydrography and hierarchy of a river network. Characteristics of a chosen river system. Rules of location of man-made water bodies. Hydro-morphological assessment of a stream channel section (outdoor classes), including an assessment of the degree of naturalness of the stream channel. Hydrological measurements of surface and groundwater. Morphological characteristics of the bank zone of a reservoir or a river.

*Lectures:* The course covers all facets of fresh water aquatic habitats, and therefore, considers the physical, chemical and biological characteristics of freshwater ecosystems. The significance of water ecosystems in the landscape. Geomorphologic features formed by water. Fluvial landscapes. The role of groundwater in the landscape. Functions of lakes in the landscape. Types and role of the retention reservoirs. Artificial water bodies in urban areas. Waterfronts and ports. Boulevards. Methods of water ecosystem management for recreation and economical purposes. Water ecosystem threats and restoration – the most interesting investments worldwide.

*Learning outcomes*

*Knowledge:* The student has extensive knowledge of biology, chemistry, mathematics, physics and other sciences adopted to the studied area and understands complex phenomena and natural processes. She/he knows the role of water management in the sustainable use of biodiversity and its threats.

*Skills:* The student has the ability to research, understand, analyse and creatively use the required information for environmental protection from various sources. Independently and comprehensively analyses the problems influencing the quality of water, human health, state of the natural environment and water resources and is able to apply special techniques and optimise them to the requirements of the study course and profile.

She/he is able to communicate precisely with other entities in oral, written and graphic forms.

*Social competence:* The student has an ability to undertake activities aimed at risk limitation and prediction of the agricultural impact on water ecosystems. She/he is able to define the priority activities essential for the realization of the specific tasks.

1. **Specialisation module II**
2. **Biotechnological Processing of Organic Wastes**

*Educational objective:* Acquainting students with hazardous substances in the environment and biotests used to evaluate the natural environment contaminated with various compounds.

*Course content*

*Classes:* Occupational health and safety principles and regulations applicable to students participating in classes. Environmental toxicology – basic terms. Determination of the degree of water contamination with selected substances, using Algaltoxkit, Daphtoxkit and Lemna Tests. Determination of morphological and physiological changes in higher plants emerging as a result of pollution in the soil environment, using Phytotoxkit. The effect of substrate pollution on the chlorophyll content in selected plants. Rapidtoxkit – a test for determining herbicides in water. Determining chlorinated hydrocarbons in rapeseed oil. Detecting nitrates and nitrites in water and food. Determination of the presence of salicylates in bodily fluids.

*Lectures:* Toxicology in contemporary science and its extent. Toxic substances in the natural environment. Factors affecting the toxicity of xenobiotics. Toxicologial and ecotoxicological evaluation of crop protection chemicals. Characteristics of methods used in evaluation of environmental pollution. Biomonitoring of environmental pollution (types of biomonitoring, bioindication and bioindicators). Methods for conducting research with the use of biotests. A choice of biotests. Biotests in evaluation of the environmental condition. Biological fluids as a source of information of human exposure to environmental chemical factors. Legal regulations concerning biotests.

*Learning outcomes*

*Knowledge:* The student has in-depth knowledge concerning basic contaminants, their impact on the environment, their effects on living organisms and their consequences. The student can choose a method for rapid detection of pollution in the environment.

*Skills:* The student knows how to select and use chemical and biological methods and how to interpret results. The student knows how to identify, detect and evaluate risks resulting from the presence of toxic compounds in the environment and is able to make decisions. The student independently determines the effective concentration of selected toxic compounds in relation to various bioindicators.

*Social competence:* The student understands the need for learning and is able to cooperate and work in a group and is aware of the responsibility for the condition of the environment.

1. **Aquatic Ecosystems in the Landscape**

*Educational objective:* Presentation of the landscape values of selected types of aquatic ecosystems. Acquiring skills in designing educational paths in the vicinity of natural water reservoirs.

*Course content*

*Classes:* Discussion of the basic design principles of educational paths next to the bodies of water in relations to the issues of environmental protection. Overview of good practices of tourism development in the legally protected waterside areas in selected countries.

*Lectures:* Definitions, types and kinds of landscapes. Contemporary transformations of waterside landscapes in selected countries. Hydrogenic landscapes - spatial structure and its functioning. Aquatic ecosystems in the city, countryside and in the open landscape. Modern systems of water retention in the city – ecological subdivisions. Good practices in waterside area development - presentation of selected facilities. Possibilities of using selected aquatic ecosystems for the development of tourism and recreation.

*Learning outcomes*

*Knowledge:* The student is familiar with good practices in waterside areas development. He or she is able to evaluate the landscape values of selected objects.

*Skills:* The student has acquired the ability to design educational paths. He or she is able to obtain and analyse the data necessary to design paths.

*Social competence:* The student appreciates landscape variety related to the presence of a body of water. The student understands the need for protection of aquatic ecosystems.

1. **Using Horticultural Plants for Phytoremediation**

*Educational objective:* Learning about new solutions for the removal or detoxification of the soil and air pollution with heavy metals and xenobiotics by horticultural plants.

*Course content*

*Classes:* Hyper-accumulators in phytoremediation. Horticultural plants used for phytoextraction, phytodegradation, phytostabilisation, rhizofiltration and fhytovolatalisation. Horticultural plants for phytoremediation sites in urban and industrial areas contaminated with emergency spills of crude oil. The economic importance of phytoremediation

*Lectures:* Techniques of phytoremediation. Continuous and supported phytoextraction. Substances supporting the process of phytoextraction. Phytodegradation. Phytostabilization. Rhizofiltration.

*Learning outcomes*

*Knowledge:* The student demonstrates knowledge of basic methods, techniques, technologies, tools, materials and their practical applications to remove contaminants from the environment using plants.

*Skills:* Has the ability to solve practical tasks related to the potential use of horticultural plants in phytoremediation to improve the environment

*Social competence:* The student knows the importance of phytoremediation in environmental protection

1. **Water Resource Management in River Basins**

*Educational objective:* The aim of the course is to acquaint students with the possibilities and methods of development and protection of water resources in river basins by understanding forms of retention and water management projects using non-technical and technical means contributing to the increase of the quantity and improve of water quality by slowing the circulation and the associated circulation of chemical ingredients.

*Course content*

*Classes:* Planning of water resource management in river basins, study procedures, water and economic policies and processes for the authorization for the execution of small hydropower projects, development of water management and protection of hydrological extreme events. Recognition of river water for urban, industrial, agricultural purposes, construction and modernization of water systems for the collection of water to meet the water demands of the population and the economy.

*Lectures:* Water balance and its components. Water circulation means and the possibility of its regulation. The phenomenon of outflow origin drain and its effects. Possibilities and methods of water management in river basins. The local dimension of water management. The activities in the catchment area to increase the resources of soil water in the unsaturated zone and saturation. Small retention. The effects of circulating water in the environment. Measures to regulate water relations. The needs of technical infrastructure in terms of water management in small catchments, its functions, the effect of lack of infrastructure. The criteria for the distribution of drainage. Features of drainage. A review of the methods of regulating the relationship of air-water and carbon soil waterlogged by both technical as well as phytotechnical and agronomic measures.

*Learning outcomes*

*Knowledge:* The student has knowledge of the circulation of water in the catchment area and the possibility of its retention as well as knowledge of administrative and legal procedures for the execution of small hydropower projects. He has knowledge of the needs of the technical infrastructure in the field of water management in small catchments, its functions and the effects of lack of infrastructure.

*Skills:* Ability to design water management and protection against extreme hydrological phenomena. The ability to determine the proper application of the relevant measures governing the air-water relationship and overwatered soils by both technical as well as phyto-technical and agrotechnical treatments

*Social competence:* The student is aware of the responsibility of proper management of water resources in river basins and the risks resulting from the improper management of water in river basins.

1. **Hydrobiology and Baltic Sea Protection**

*Educational objective:* Students learn about the issues of the Baltic Sea with emphasis on its protection

*Course content*

*Classes:* Develop reports and presentations based on statistical issues such as: exploitation of the Baltic Sea, the economic use of the Baltic Sea Waters, International cooperation in the Baltic region, pollution of marine waters, including pollution agricultural origin.

*Lectures:* The concept of hydrobiology and ecology. Flora of the Baltic Sea. Fauna of the Baltic Sea. Geography of the Baltic Sea.

*Learning outcomes*

*Knowledge:* The student has knowledge in the field of natural and economic functions of the Baltic Sea, with particular reference to the risks arising from its exploitation.

*Skills:* The student is able to assess the problem of the devastation of the waters of the Baltic Sea, for example, in the context of international cooperation and pollution from agricultural sources.

*Social competence:* The student identifies problems of economic exploitation of the Baltic Sea basin and the environmental threats to the Baltic Sea flora and fauna

1. **Environmental Information Systems**

*Educational objective:* General theory of GIS, the creation of spatial databases, the basic operations on the spatial data and databases

*Course content*

*Classes:* Raster and vector data layers and their display. Geo-references of raster layers and spatial measurements. Creating vector layers and attribute tables. Analysis of raster and vector layers. Analysis attribute tables. Spatial processing (extract, dissolve, buffer, clip, merge, intersect, union).

*Lectures:* The theory of geographic information systems (GIS). Raster and vector data layers. Attributes and databases. Analysis of raster and vector layers. Database analysis. Generate, edit and process layers. Numerical methods of processing information from aerial photographs and satellite images. Coordinate systems. DEM. Design of GIS use.

*Learning outcomes*

*Knowledge:* Knows the theory of geographic information systems.

*Skills:* Can obtain information about the natural environment from various sources

*Social competence:* Understands the need to use modern tools for creating and analysing spatial databases

1. **Recreational use of water**

*Educational objective:* To acquaint students with the possibilities of using inland water reservoirs and flowing waters for recreation

*Course content*

*Classes:* Evaluation of the usefulness of natural and artificial reservoirs for recreation. Adjustment of natural and artificial water reservoirs to some forms of recreational use. Calculation of natural absorbency and capacity of the tourist area boundary. Amateur fishing. The role of the Polish Fishing Association in recreational use of water. Rules of the organization of sport fishing. Legal, fishing equipment, methods and techniques of fishing in standing waters and flowing. Special rules of fishery operations. Methods of analysis of recreational waters. Development of recreational selected coastal zone holding unused values of tourism and recreation

*Lectures:* Tourist and recreational use of surface water in Poland and in the world. Concepts related to the recreational use of water. Capacity, tourist absorption. Tourist use of waterways in Poland. Legal conditions for recreational water use. Technical infrastructure in the recreational use of waters. The requirements of water quality for recreational activities including swimming. Recreational value of natural and artificial reservoirs. Ecological marinas in Poland. Water security. Methods of assessing the impact of tourism activity on the state of biodiversity.

*Learning outcomes*

*Knowledge:* Students have the knowledge to carry out a preliminary assessment of natural environment for recreational use. Mastering the knowledge in the field of equipment and recreational facilities necessary for the operation of various forms of activity tourism and recreation. Students also have knowledge of the basic concepts of recreational fishing and can describe the effects of recreational use on the development of the natural environment and species protection.

*Skills:* Students can identify opportunities to improve the environmental value of water bodies by proposing the proper form of recreational use of the basin. Ability to use available sources of information in order to analyse the possible use of recreational waters. The students can identify and evaluate factors and events affecting the ecological status of water bodies.

*Social competence:* The students are aware of the role of recreation in the protection of water bodies and are able to assess the effects of human activities and are aware of the risks and understand the importance of principles used to protect and restore the aquatic environment.

1. **Ecological agriculture in water protection**

*Educational objective:* Acquisition of knowledge concerning the importance of ecological farming in water ecosystem protection. Acquisition of knowledge about contemporary requirements concerning farm infrastructure, including sites for keeping farm manure.

*Course content*

*Classes:* Percentage of crops cultivated in Poland and trends of change. Economic importance and site requirements of cultivated plants. Rules of tillage and crop cultivation applied in ecological farming. Selection of species and cultivars for cultivation in ecological farms. Principles of elaboration of crop rotations in ecological farming. Fertilization and fertilizers used in ecological farming. Balance of organic matter and balance of main nutrients (N, P, K) in various agricultural systems and their effects on adjacent water ecosystems. Crops nurturing in ecological farming. Time and techniques of crop harvesting used in ecological farming.

*Lectures:* Management systems used in agriculture. Distinctive features of conventional, integrated and ecological agriculture. Land use structure. Field arrangement within an ecological farm. Influence of infrastructure of surrounding areas and equipment availability as well as the kind and volume of production on protection of soil and water ecosystems. Importance of intercropping to soil and water protection. Legal regulations concerning ecological farming.

*Learning outcomes*

*Knowledge:* The student has advanced knowledge about the importance of environmental conditions and sustainable use of resources and knowledge of biodiversity at the farm level and factors that threaten the quality of the environment. The student is able to identify and assess natural and cultural values of the landscape.

*Skills:* He has the ability to communicate precisely with various subjects in verbal, written and graphic forms. He has the ability to select and modify typical activities, including agricultural technology in the field of environmental protection

*Social competence:* He understands the need for lifelong learning, can inspire and organize the learning process of others. Correctly identifies and resolves dilemmas related to the protection and shaping of environments.

1. **Invasive Species in the Aquatic Environment**

*Educational objective:* Understanding the threats to native species and biodiversity caused by invasive organisms. Understanding the fundamental distinguishing features of organisms considered potentially invasive and the characteristics of aquatic habitats potentially exposed to colonization by invasive species and the ability to estimate and limit threats.

*Course content*

*Classes:* Characteristics of alien invasive species origin, methods of propagation, the spread and the rate of migration (settlement). Features of habitats susceptible to colonization by invasive species. The processes of plant invasions (start and dynamics) - Models of invasion. Comparison of biology and ecology of native species from invasive species. Develop and analyse the collected data. Characteristics, biology, threat of some invasive species - presentations. Proposals for the use of alternative crops for invasive species in fishing cultures: ponds, lakes and rivers. Prevention activities and methods and programs for the eradication of invasive species. Developing recommendations to reduce the impact of invasive plant and animal species deliberately introduced to water and currently available for purchase.

*Lectures:* Biodiversity and processes of plant invasions. Definitions: invasive species, alien, quarantine, introduced, re-introduced genetically modified GMO - opportunities and threats. Invasive organisms, nomenclature and classification. History of research on biological invasions and directions for further research into biological invasions. Objectives, introduction and reintroduction of species. Threats from alien species to wildlife. The harmfulness of alien invasive organisms for forestry, agriculture, fishing and hunting. Preventing an invasion of an alien species (border controls, quarantine, inspection, monitoring and alerting). The latest regulations on limiting the introduction of alien species in Poland, Europe and the world. Dealing with the threat of invasive alien species in the environment.

*Learning outcomes*

*Knowledge:* The student is able to assess the risks to biodiversity and identify the effects of the appearance of alien species introduced deliberately or accidentally into the aquatic environment. The student can also analyse data collected in the field on the occurrence of invasive species occurring in aquatic ecosystems and in their vicinity and has knowledge of the need to reduce the occurrence of alien species intentionally introduced into ponds, lakes, rivers, forests, gardens, parks and replace them with native species.

*Skills:* The student is able to identify invasive alien species and observe their harmfulness and is able to propose alternative species for alien invasive cultures used in fishing.

*Social competence:* The student is focused on the development of recommendations to reduce the impact of invasive plant and animal species deliberately or accidentally introduced into ecosystems and is involved in collecting data on the incidence of invasive species in the field and consciously cares about the environment.

1. **Resources and protection of groundwater**

*Educational objective:* Familiarize students with: the hydrological basics of evaluation of resource exploitation of groundwater, with the current laws and procedures in place for assessing and documenting resources exploitation of groundwater, protection of water resources in the light of European Union regulations regarding dangers and sources of groundwater pollution in conjunction with the quality of surface water.

*Course content*

*Classes:* Rules for evaluating the size and quality of water resources. Principles and methods for determining the demand of abstraction of groundwater for existentially-economic purposes. The rules determine the performance of underground water. Determining the need for and methods of treatment recognized raw water intended for consumption. Methods of identifying deficit areas in the water. Risk assessment and identification of actions protective of groundwater. Active protection identification and removal of pollution sources of groundwater.

*Lectures:* History of hydrogeological studies in Poland. Water resources. Overview of regional mineralized water, thermal and recognized as medicinal. Hydrological processes and factors that modify them. Types of genetic and chemical groundwater. Regionalisation of hydrological groundwater in Poland. Characteristics of fresh groundwater. The impact of surface water for groundwater in terms of river basin. Sources of water pollution. Changes in groundwater quality. Threats and protection of fresh water against pollution.

*Learning outcomes*

*Knowledge:* The student knows the basic methods, techniques and tools needed in the performance of procedures related to the protection of water resources in the environment. He has knowledge of the impact of natural and anthropogenic factors on the development of the quantity and quality of groundwater. He has knowledge of the problems of supplying the population with drinking water and its impact on the quality of health.

*Skills:* The student has the ability to find and use information from different sources, necessary for the preparation of records of groundwater resources and the ability to work with hydrological and hydrogeological maps in order to determine the rational management of water resources. The student also the ability to determine the quality and methods of treatment of groundwater accounted for consumption.

*Social competence:* Understands the need to constantly extend and complement the knowledge about the environment, especially in terms of access to good quality water and is aware of the risk of human intervention in the environment and the need for continuous monitoring of environmental factors, in order to protect groundwater resources. In terms of management of groundwater resources, the student can think and act in an entrepreneurial way.

1. **Reconstruction of lakes**

*Educational objective:* Understanding the mechanisms of evolution of lake ecosystems in the context of environmental changes on a local and global scale. Become familiar with the paleolimnological stratigraphic methods.

*Course content*

*Classes:* The meaning and scope of paleolimnological research. The methods and aims of the research of bottom sediments. Methods of sampling for analysis. Selection of equipment for the collection of deposits, depending on the research objectives. Determination of the physical characteristics and components of deposits by Troels-Smith. The evaluation of the transformations and changes in the trophic status of lakes on the basis of bottom sediments. Cores of sediments as a record of the history and evolution of lakes. Assessment of the pace of transformation of lakes based on cartographic data, morphometric traits and the shape and vegetation zones boundary.

*Lectures:* The evolution and succession of lake ecosystems. Aging and disappearance of lakes. The process of sedimentation and accumulation of sediments under different environmental conditions and types of reservoirs. Bottom sediments as a record of human activity on the environment in terms of local, regional and global levels. Lacustrine sediments dating - methods, research goals, scope and significance of the data obtained. Fundamentals of paleoecology. Finding the history of the lakes on the basis of the remains of aquatic organisms in the lake sediments. A lake as an environment enabling reading the history of changes in catchment land use and changes in climatic conditions. Examples of important paleolimnological research programmes for reservoirs in Poland and worldwide.

*Learning outcomes*

*Knowledge:* Knowledge of the evolutionary changes taking place within the lake ecosystems under the influence of natural processes and anthropogenic. Knowledge concerning the mechanisms of formation of sediments in lakes. Basic knowledge about the scope, objectives and effects of stratigraphic studies, qualitative and palynological lacustrine sediments.

*Skills:* Ability to identifying the progress of transformation processes of lakes and to interpret the results of studies of sediments in a way that allows inferences about the past of the lake. Ability to search and retrieve information about changes to the environment on the basis of various cartographic materials.

*Social competence:* Awareness of the existence of short-lived lake ecosystems and their vulnerability to negative external influences. Recognizing the effects of anthropogenic pressure exerted on ecosystems lakeside, feels the need to counteract the changes in their environment.

1. **Threats and conservation of species diversity**

*Educational objective:* Understanding the risks and protect species diversity of communities of aquatic vegetation and vegetation in a coastal zone

*Course content*

*Classes:* Characteristics of the most important communities of aquatic vegetation and vegetation in coastal zone - species characteristics, occurrence, economic importance and nature. Rare and protected species of plants of aquatic vegetation.

*Llecture:* Basic levels of biodiversity. Biodiversity indicators. Macrophytes in freshwater communities in meso- and eutrophic reservoirs of inland waters, plant communities meso- and oligotrophic lakes, pleustonic communities. The vegetation in acoastal zone - rush communities, sedge communities, peatland vegetation. Protected species of aquatic communities and vegetation in coastal zone. Factors contributing to maintain biodiversity.

*Learning outcomes:*

*Knowledge:* Students have knowledge of the risks and protection of species diversity of communities of aquatic vegetation and vegetation in a coastal zone.

*Skills:* Students can identify the factors affecting the state of biodiversity of communities of aquatic vegetation and vegetation in a coastal zone.

*Social competence:* Awareness of the need to protect species diversity of communities of aquatic vegetation and vegetation in a coastal zone.