United Nations Educational, Scientific and Cultural Organization

IHE DELFT Institute for Water Education in partnership with UNESCO

Study Guide

Academic Programme 2020 - 2022

Programme information

Environmental Science

Table of content

ES Programme Committee

Prof. Ken Irvine
Chair, Representing specialization coordinator AAES and LWM

Carel Keuls
Advisor knowledge management

Floor Felix
Secretary

Dr Jaap Evers
Member, Programme coordinator

Dr Peter van der Steen
Member, Specialization coordinator EST and IMETE

Dr Leon Hermans
Member, Specialization coordinator EPM

Dr Angeles Mendoza-Sammet
Member, MSc research coordinator

Alice Law
Member, Student representative 2019-2021

To be elected
Member, Student representative 2020-2022

Introduction

Problems and challenges

Unsustainable management of natural resources hampers the development of mankind and contributes to the unequal distribution of economic welfare. Pollution, depletion of resources and disintegration of ecological functions are of global, regional and local concern. Considering the anticipated economic development and increase in standards of living in developing regions, these issues will become even more urgent in the future. Thus it is not surprising that wise management of our precious (water) resources, environmental conservation, alleviation of poverty and sustainable development are high on the agenda of global concerns *(World Summit, Johannesburg 2002; World Water Vision, The Hague 2000; UNCED Conference, Rio de Janeiro 1992; UN Conference on the Human Environment, Stockholm 1972)*

It is now widely acknowledged that, to prevent continued environmental degradation and the decline of human society, interactions between man and the environment have to be sustainable. Sustainability depends on the delicate balance between the use and the conservation of our environmental resources. The challenge to sustainable development, then, is to stimulate further expansion of living standards worldwide while minimising and counteracting the negative impacts on the environment.

Aim of the programme

The aim of the Environmental Science programme is to provide professionals with the knowledge and skills necessary to contribute, directly or indirectly, to the conservation and wise-use of natural resources for the benefit of society. Successful participants will

(i) develop the capacity to carry out independent scientific and technical research and assessments on environmental issues,
(ii) learn to analyse and assess environmental systems and problems,
(iii) be able to propose sustainable solutions to environmental problems and
(iv) contribute to the development of policies and strategies for environmental planning.

Our Approach

To address environmental problems and find sustainable solutions, we must understand the processes that sustain the natural systems, how the systems function and how they interact with each other and with human society. A thorough understanding of how natural systems respond to human actions and interventions is crucial. Through knowledge of the dynamics, functioning and processes of natural systems and an appreciation of the delicate balance between the use and the conservation of our natural resources, improvement of quality of life for human society and sustainable development can be achieved. To equip professionals with the required capacities, the Environmental Science programme offers a systems approach that investigates different subsystems and the interactions between them at the global, regional and local scale, but without losing sight of the overall picture. In exploring the complexities of the human-environmental system the programme seeks a balance between the disciplines taught and the added value of bringing these disciplines together in one coherent programme. Furthermore, the approach of IHE is problem-oriented with a primary focus towards developing countries. This means that the value of the achieved knowledge and skills is measured in terms of applicability of the science, technology, engineering, planning and policies to environmental management. Planning and good policy-making in Environmental Science is based on an understanding of how ecosystems work, how they respond to defined human actions and what remediation actions may be taken to reinvigorate the dynamism of sustainability and biodiversity conservation. As the concept of sustainable development needs its own unique elaboration in contexts where living conditions of large populations are in a critical stage and environmental protection is seen as a luxury, the programme provides tailored approaches and

specific knowledge to serve these conditions. In environmental science education, the development of knowledge together with skills is essential. In the IHE approach, lectures by experts in the field are complemented by assignments, exercises, laboratory and fieldwork and group-work. Innovative distance learning and electronic interactive educational tools support the programme, while further innovations and developments to link up with IHE's global network of partner institutions are ongoing.

Scope of the programme and specializations

Environmental Science is a broad field; any Master Programme in this field is necessarily limited. The IHE Master Programme in Environmental Science provides an overview of the field with emphasis on aquatic and wetland ecosystems and water related issues such as water-related policies, water quality management, nutrient cycles, water pollution control, natural systems for wastewater treatment, and the functioning and use of wetlands. Within this scope the programme offers three Delft-based specializations (Environmental Science & Technology-EST, Environmental Planning & Management-EPM, and Applied Aquatic Ecology for Sustainability-AAES) and two joint specializations (Limnology & Wetland Management-LWM, and Environmental Technology & Engineering-IMETE) that lead to a Master of Science (MSc) Degree.

Delft-based specializations

The programme starts with a foundation part of four modules. The foundation part of the taught programme facilitates a baseline of learning and knowledge across the cohort of students and places strong emphasis on integrating different academic fields and on developing academic skills and attitude of critical thinking and (self)assessment (Fig. 1).

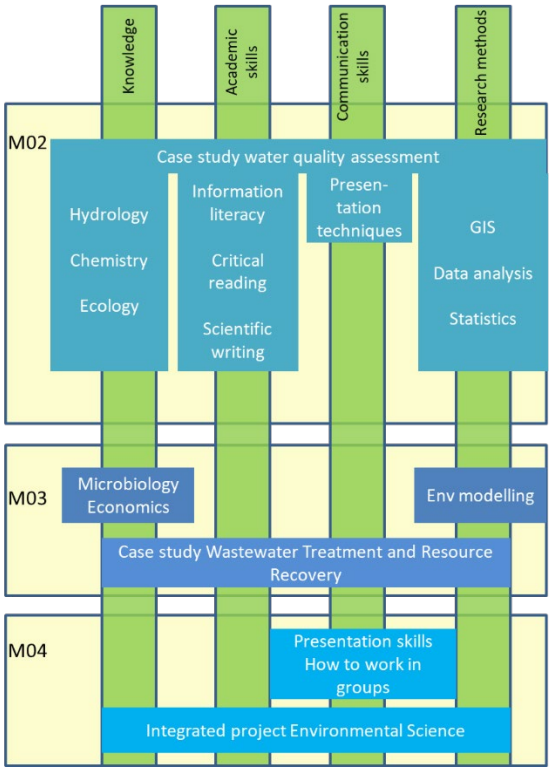


Fig. 1 Overview of the ES foundation modules

After the foundation phase, each specialization offers six specialisation specific taught modules, two of which are electives (Table 1). Although the content of each specialisation is fixed, the students are

allowed to exchange modules with agreement of the Programme Coordinator. This enables the Programme Coordinator to ensure a coherent programme for each individual, i.e. avoiding students have to re-study topics they have already proven knowledge on, but also caters for students who might have well-motivated grounds to develop their own study track.

Table 1 Overview of the Delft-based ES programme

EST	EPM	AAES
To provide an integrated course for scientists, technologists and engineers who have an interest in research and development, with the knowledge and skills to address environmental problems and interact with stakeholders, managers and policy makers for appropriate remedial actions.	To provide scientists and engineers who wish to specialise in environmental planning and management with the know-how and skills for strategic development, policymaking and decision-making in the environmental arena.	To provide an integrated course for scientists and engineers responsible for water quality maintenance / improvement in river catchments with a thorough understanding of the natural processes in aquatic ecosystems and to enable them to apply this knowledge for the sustainable management of healthy ecosystems and good water quality in a multidisciplinary setting.
Introduction to water for development		
Introduction Environmental science 1		
Introduction Environmental science 2		
Integrated project Environmental science		
Environmental process technology	Water & environmental law	Applied ecology and bioassessment
Environmental systems analysis	Environmental systems analysis	Environmental systems analysis
Water quality assessment & monitoring	Water & environmental policy analysis	Water quality assessment & monitoring
Industrial resource management and cleaner production	Environmental planning and implementation	River and floodplain rehabilitation
International fieldtrip		
Ecotechnologies*	Env assessment for water-related policies and development*	Aquatic ecosystems processes and applications*
Solid waste management**	Strategic planning for river basins and deltas**	Wetlands for livelihood and conservation**
Elective Summer course		
Applied environmental management		
MSc research proposal development		
MSc thesis part		

*or select another module from the ES programme

**or select another module from any other programme

The International fieldtrip and the related module Applied environmental management are obligatory for all Delft-based ES students, as is the MSc research proposal development module.

Joint specializations

Table 2 provides an overview of the content of the two joint specializations, LWM and IMETE.

Table 2 Overview of the joint specializations LWM and IMETE

<table>
<tr><th>LWM</th><th>IMETE</th></tr>
<tr><td>To provide scientists and engineers, interested in aquatic research and development, with the knowledge and understanding of the structure and functioning of aquatic and wetland ecosystems for their management and wise use, and interact with stakeholders, managers and policy makers for the development of best practices.</td><td>To provide scientists and engineers with the knowledge and understanding to apply and develop environmental technologies and engineering techniques, with a strong focus on multidisciplinary and problem-based technology development and to offer a wide range of environmental technology solutions in an international environment.</td></tr>
<tr><td>Programme in Austria</td><td>Programme in Prague</td></tr>
<tr><td rowspan="4">Programme in Kenya</td><td>Environmental process technology</td></tr>
<tr><td>Elective project/communication and writing skills for engineers</td></tr>
<tr><td>Water quality assessment & monitoring</td></tr>
<tr><td>Industrial resource management and cleaner production</td></tr>
<tr><td>Data analysis and modelling for aquatic ecosystems</td><td>International fieldtrip</td></tr>
<tr><td>Aquatic ecosystems processes and applications</td><td>Ecotechnologies</td></tr>
<tr><td>Wetlands for livelihood and conservation</td><td>Internship</td></tr>
<tr><td>Elective Summer course</td><td rowspan="4">Programme in Ghent</td></tr>
<tr><td>Applied environmental management</td></tr>
<tr><td>MSc research proposal development</td></tr>
<tr><td>MSc thesis part</td></tr>
</table>

Academic skills development

Throughout the programme a number of academic skills will be trained and practiced in the various modules (Table 3). During various assignments these skills will be assessed and will thus contribute to the module marks. Depending on the specialization, specific research skills will be developed, which can be applied during the final thesis research. Model rubrics will be used throughout the programme to help students in developing their skills.

Table 3 academic skills trained in the various modules

module	Scientific ethics	Information literacy	Critical reading	Scientific writing	Oral presentation, discussion and debating	Research skills
ES02TMA	ev-based pol making	info res and retrieval	critical reading	inquiry	presentation fieldwork	field and lab sampling & analysis, statistics, GIS
ES03TMA					oral presentation, report	modelling, microbiology lab
ES04TMA	Turnitin lit review	collect 15 papers	read 15 papers	lit review report, group report, policy brief	oral presentation, presentation policy brief	research question formulated
ES05TI	drawing correct conclusions from experimental data			laboratory reports		laboratory experiments, data interpretation, report writing
WM05						
ES05A	permit application, collection and preservation of samples, ethical reporting of findings	data collection, analysis, interpretation	review and interpret papers	individual and group report	discussion of papers	design field campaign, field sampling, analysis, interpretation, report writing
ES06TMA		data analysis from case studies	discuss papers		oral presentation and discussions	
ES07TAI			reading papers	Laboratory report, written report		laboratory sessions, data analysis, GIS and open source data
ES07M	roles policy analysts in decision-making, plagiarism, referencing	collecting articles case study	analysing references	write issue paper	oral presentations and discussions	full cycle from problem definition to paper
ES08TI	discussion plagiarism, corporate social responsibility	collecting various data	reading article	writing report	presenting article reading, powerpoint, poster	data analysis and interpretation
ES08M	reflection on personal integrity issues	collecting papers	reading and presenting paper	personal and group report	oral presentations and discussions, high level round table	analyse and assess the quality of environmental plan
ES08A	study different rehabilitation cases and reflect on trade-offs between human and ecosystem needs	collect information and literature about rehabilitation case	read and interpret papers	individual report	group presentation	analyse case, assess rehabilitation needs, decide on rehabilitation strategy
ES09TMAI	plagiarism, referencing			individual and group report		field sampling and analysis, GIS
ES09L	drawing correct conclusions, referencing	data collection	reading papers	individual report	group presentation	quantitative analysis, data management and analysis, modelling

ES10T		data collection		writing report		data analysis and interpretation, lab work
ES10M	ethic, moral, professional duties of water professionals, plagiarism, referencing	searching and reviewing literature	review and analyse assessment report	lecture on writing, assessment report	oral presentation, various discussions	full cycle from review to paper
ES10AL	plagiarism, referencing and process of peer review	searching and reviewing literature	reviewing and interpreting papers	write scientific paper	oral presentation, discussions	complete research project
ES11T	plagiarism, correct referencing	data collection	document reading, comparison of information from different sources	group report	oral presentation, debates (in small groups and then as a class)	data analysis and interpretation, design of innovative technical solutions
ES11M	reflection on environmental ethics	data collection	reviewing papers		oral presentation, various discussions	various related to strategic planning
ES11AL	Turnitin, using info w/o judgement, respecting confidentiallity, openness (a.o. to criticism), carefulness and respect for (views of) peers	literature study, semi-structured interviews	literature review	individual report	oral presentation for stakeholders, various discussions	full cycle
ES13TMAL	correct referencing, drawing conclusions from limited data	searching and reviewing literature	read scientific papers and grey literature	management plan	oral presentation, working in groups	investigation of different topics, DPSIR analysis, management plan

Final Qualifications

EST Specialization

Knowledge and understanding

1. be able to place the knowledge gained through their own specialization into a broader understanding of contemporary global water issues, challenges, debates and developments
2. understand the required basic chemical, physical, (micro)biological and ecological principles commonly applied in the field of environmental science
3. understand the socio-economic dimensions of environmental systems
4. understand different common practices and approaches in river basin and environmental management
5. identify the way to prevent environmental pollution through resource management and application of re-use technologies
6. identify the way polluted water, waste, gas, soils and sediments can be treated to reduce environmental risk

Applying knowledge and understanding

1. formulate research questions and hypotheses, select and apply research methods, theories and techniques, and prepare a research plan
2. conduct independent research
3. contribute to multidisciplinary and creative problem solving
4. contribute to the development of knowledge and integrate it with knowledge from other field
5. integrate disciplinary knowledge and skills in an environmental science context
6. collect, process and analyse field data
7. develop, design and apply technologies for the prevention and remediation of environmental pollution by searching scientific information, conducting scientific research in the field of environmental technology and engineering, and reporting their findings by means of scientific reports and papers

Making judgements

1. identify relevant research, ideas and approaches from literature and other sources in view of their potential for helping understand or solve particular water-related problems
2. critically discuss, as well as comparatively evaluate and judge existing knowledge, ideas and approaches against each other, well as against own research approaches and outcomes
3. recognize and address ethical and sustainability dimensions in professional practice
4. use research outcomes to inform well-founded, original conclusions, solutions or recommendations
5. critically analyse and evaluate a range of options for the prevention or remediation of environmental problems under prevailing socio-economic conditions

Communication

1. communicate and present effectively , both in writing and orally, employing the appropriate information and communication technologies
2. debate and defend findings and insights, in a clear, systematic and convincing manner
3. cooperate effectively in multi-/interdisciplinary and intercultural teams

Lifelong learning skills

1. have the competencies to further develop and expand their knowledge and skills on their own initiative

EPM Specialization

Knowledge and understanding

1. be able to place the knowledge gained through their own specialization into a broader understanding of contemporary global water issues, challenges, debates and developments
2. understand the required basic chemical, physical, (micro)biological and ecological principles commonly applied in the field of environmental science
3. understand the socio-economic dimensions of environmental systems
4. understand different common practices and approaches in river basin and environmental management
5. understand how the legal, cultural, technical, ethical, socio-economic, and/or political context influences environmental planning and management, and sustainable outcomes, from local to global levels
6. analyse policy and planning instruments to improve management of water and natural resources
7. analyse concepts, methods and tools for strategic decision-making such as policy analysis, planning and environmental and social impact assessment

Applying knowledge and understanding

1. formulate research questions and hypotheses, select and apply research methods, theories and techniques, and prepare a research plan
2. conduct independent research
3. contribute to multidisciplinary and creative problem solving
4. contribute to the development of knowledge and integrate it with knowledge from other field
5. integrate disciplinary knowledge and skills in an environmental science context
6. collect, process and analyse field data
7. apply and reflect upon concepts, methods and tools for strategic decision-making
8. design and implement water and environmental plans for various levels of decision-making

Making judgements

1. identify relevant research, ideas and approaches from literature and other sources in view of their potential for helping understand or solve particular water-related problems
2. critically discuss, as well as comparatively evaluate and judge existing knowledge, ideas and approaches against each other, well as against own research approaches and outcomes
3. recognize and address ethical and sustainability dimensions in professional practice
4. use research outcomes to inform well-founded, original conclusions, solutions or recommendations

Communication

1. communicate and present effectively , both in writing and orally, employing the appropriate information and communication technologies
2. debate and defend findings and insights, in a clear, systematic and convincing manner
3. cooperate effectively in multi-/interdisciplinary and intercultural teams

Lifelong learning skills

1. have the competencies to further develop and expand their knowledge and skills on their own initiative

AAES Specialization

Knowledge and understanding

1. be able to place the knowledge gained through their own specialization into a broader understanding of contemporary global water issues, challenges, debates and developments
2. understand the required basic chemical, physical, (micro)biological and ecological principles commonly applied in the field of environmental science
3. understand the socio-economic dimensions of environmental systems
4. understand different common practices and approaches in river basin and environmental management
5. understand and evaluate the physical, biogeochemical, and ecological processes related to the functioning of natural and degraded aquatic ecosystems

Applying knowledge and understanding

1. formulate research questions and hypotheses, select and apply research methods, theories and techniques, and prepare a research plan
2. conduct independent research
3. contribute to multidisciplinary and creative problem solving
4. contribute to the development of knowledge and integrate it with knowledge from other field
5. integrate disciplinary knowledge and skills in an environmental science context
6. collect, process and analyse field data
7. integrate stakeholder objectives and scientific knowledge to create management objectives for the sustainable management, restoration, and conservation of aquatic ecosystems

Making judgements

1. identify relevant research, ideas and approaches from literature and other sources in view of their potential for helping understand or solve particular water-related problems
2. critically discuss, as well as comparatively evaluate and judge existing knowledge, ideas and approaches against each other, well as against own research approaches and outcomes
3. recognize and address ethical and sustainability dimensions in professional practice
4. use research outcomes to inform well-founded, original conclusions, solutions or recommendations

Communication

1. communicate and present effectively , both in writing and orally, employing the appropriate information and communication technologies
2. debate and defend findings and insights, in a clear, systematic and convincing manner
3. cooperate effectively in multi-/interdisciplinary and intercultural teams
4. effectively communicate the responses of lakes, rivers, and wetlands to anthropogenic pressures to stakeholders and peers

Lifelong learning skills

1. have the competencies to further develop and expand their knowledge and skills on their own initiative

LWM Specialization

Knowledge and understanding

1. to demonstrate understanding of natural environmental processes, the socio-economic concepts underlying functioning and exploitation of environmental systems, and of the complex interrelationship between protection and wise use of environmental resources;
2. to describe the rationale for an integrated and interdisciplinary approach for the sustainable management of water and environmental resources;
3. to identify the impacts of human activities on freshwater ecosystems in different socio-economic contexts;
4. to demonstrate knowledge and understanding of the international water quality guidelines;
5. to name and explain concepts, instruments and technologies for protection and remedial actions of freshwater ecosystems.

Applying knowledge and understanding

1. to design, optimise and interpret environmental monitoring and assessment schemes (including statistics and modelling) in order to gain an understanding of problems, trends, causes and effects;
2. to design, optimise and interpret environmental monitoring and assessment schemes for freshwater ecosystems;
3. to apply general scientific methods (including statistics and environmental modelling) for the development and application of scientific and technological approaches, concepts and interventions to address problems of freshwater ecosystems;
4. to conduct research, independently/in multidisciplinary teams, incl. formulation of research questions and hypotheses, selection and application of research methodologies and techniques and the formulation of well-founded conclusions and recommendations.

Making judgements

1. to critically analyse and evaluate a range of options and alternatives for the prevention or remediation of environmental problems, under different socio-economic, cultural and legal contexts, and under often data-poor conditions;
2. to critically analyse and evaluate a range of options and alternatives for the prevention or remediation of problems related with freshwater ecosystems, under different socio-economic and legal contexts, and under often data-poor conditions;
3. to contribute in interdisciplinary teams in developing solutions for prevention/remediation of aquatic ecosystem problems by linking scientific knowledge to engineering interventions and management decisions in different cultural/socio-economic contexts.

Communication

1. to communicate, debate and defend, clearly and systematically, findings and generated insights, and provide rational underpinning of these in oral and written presentations to a variety of audiences.

Lifelong learning skills

1. to demonstrate academic attitude and learning skills (incl. thinking in multidisciplinary dimensions and distinguishing main issues from minor ones), to enhance and keep up-to-date the acquired knowledge and application skills in an independent manner.

IMETE Specialization

Knowledge and understanding

1. be able to place the knowledge gained through their own specialization into a broader understanding of contemporary global water issues, challenges, debates and developments
2. understand the required basic chemical, physical, (micro)biological and ecological principles commonly applied in the field of environmental science
3. understand the socio-economic dimensions of environmental systems
4. understand different common practices and approaches in river basin and environmental management
5. identify the way to prevent environmental pollution through resource management and application of re-use technologies
6. identify the way polluted water, waste, gas, soils and sediments can be treated to reduce environmental risk

Applying knowledge and understanding

1. formulate research questions and hypotheses, select and apply research methods, theories and techniques, and prepare a research plan
2. conduct independent research
3. contribute to multidisciplinary and creative problem solving
4. contribute to the development of knowledge and integrate it with knowledge from other field
5. integrate disciplinary knowledge and skills in an environmental science context
6. collect, process and analyse field data
7. develop, design and apply technologies for the prevention and remediation of environmental pollution by searching scientific information, conducting scientific research in the field of environmental technology and engineering, and reporting their findings by means of scientific reports and papers

Making judgements

1. identify relevant research, ideas and approaches from literature and other sources in view of their potential for helping understand or solve particular water-related problems
2. critically discuss, as well as comparatively evaluate and judge existing knowledge, ideas and approaches against each other, well as against own research approaches and outcomes
3. recognize and address ethical and sustainability dimensions in professional practice
4. use research outcomes to inform well-founded, original conclusions, solutions or recommendations

Communication

1. communicate and present effectively , both in writing and orally, employing the appropriate information and communication technologies
2. debate and defend findings and insights, in a clear, systematic and convincing manner
3. cooperate effectively in multi-/interdisciplinary and intercultural teams

Lifelong learning skills

1. have the competencies to further develop and expand their knowledge and skills on their own initiative

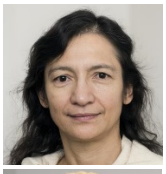
ES specialization and module coordinators

Peter van der Steen, specialization coordinator EST, IMETE
ES04TMA-Integrated project Environmental science
ES05TI-Environmental Process Technology

Leon Hermans, specialization coordinator EPM

John Simaika, specialization coordinator AAES
ES05A-Applied ecology and bioassessment
ES08A-River and floodplain rehabilitation
ES09TMAI-International fieldtrip

Edwin Hes, specialization coordinator LWM
ES11AL-Wetlands for livelihood and conservation



Dr Angeles Mendoza-Sammet, MSc research coordinator
ES07M-Water and environmental policy analysis
ES10M-Environental assessment for water-related policies & development
ES14TMAL-MSc research proposal development

Anne van Dam
ES09L-Data analysis and modelling for aquatic ecosystems

Capucine Dupont
ES11T-Solid waste management

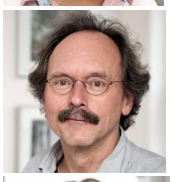
Jaap Evers
ES03TMA-Introduction to Environmental science 2
ES08M-Environmental planning & implementation
ES11M-Strategic planning for river basins and deltas

Gretchen Gettel
ES10AL-Aquatic ecosystems processes and applications

Ken Irvine
ES06TMA-Environmental systems analysis

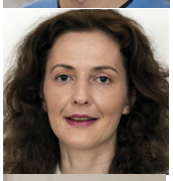
Frank Jaspers
WM05-Water & environmental law

Eldon Raj
ES08TI-Industrial resource management and cleaner production



Erik de Ruijter van Steveninck
ES02TMA-Introduction to Environmental science 1

Jack van de Vossenberg
ES10T-Ecotechnologies



Konstantina Katsanou
ES07TAI-Water quality assessment and monitoring

Wim Douven
ES13TMAL-Applied environmental management