NAS RA
INTERNATIONAL SCIENTIFIC
EDUCATIONAL CENTER

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MODERNIZATION OF ENVIRONMENT PROTECTION STUDIES PROGRAMMES FOR ARMENIA AND GEORGIA
MENVIPRO

COURSE COMPARATIVE ANALYSIS
INTERNATIONAL SCIENTIFIC-EDUCATIONAL CENTER OF NAS RA

YEREVAN 2019

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INTRODUCTION

The study visits to European universities: University of Tuscia (Italy), Instituto Superior Tecnico de Lisboa (IST UL) (Portugal), National Research Council of Italy – Terrestrial Ecosystem Research Institute (Italy) and Institute of Geosciences and Geography of Martin-Luther-Universitaet Halle-Wittenberg (Germany) aimed to familiarize the Armenian partners of MENVIPRO (Modernization of Environmental Protection Studies programmes for Armenia and Georgia) Erasmus+ capacity building project with environmental education offered by the aforesaid universities operating in and representing the academic portrait in different countries. The study visits proved to be informative and productive: the invited professors and administrative staff shared detailed information with the Armenian participants enabling them to observe the educational process from various perspectives, specifically in terms of structuring environmental-related academic programs in the second cycle of education (Master's degree) laying great stress on the structure, content and quality assurance in the courses embedding the program. The European partner universities and institutions have effective procedures and valuable practice of providing environmental education which can be tailor-made to suit and cater the needs of Armenian HEIs.

YEREVAN 2019

PROJECT BACKGROUND

MODERNIZATION OF ENVIRONMENT PROTECTION STUDIES PROGRAMMES FOR ARMENIA AND GEORGIA

Project number: 598232-EPP-1-2018-1-IT-EPPKA2-CBHE-JP

Project acronym: MENVIPRO

Duration: 36 months (2018-2021)

Applicant (Coordinator): Universita Degli Studi Della Tuscia – Italy

EU partners

- Consiglio Nazionale Delle Ricerche – Italy
- Giraf Pm Services Gmbh – Germany
- Martin-Luther-Universitaet Halle-Wittenberg – Germany
- Universidade De Lisboa – Portugal

Partner countries

Armenia

- Center for Ecological-Noosphere Studies of NAS RA
- National Academy of Sciences of the Republic of Armenia represented by International Scientific-Educational Center of NAS RA (ISEC NAS RA)
- Gavar State University (GSU)

Georgia

- Georgian Research and Educational Networking Association
- Ilia State University
- The University of Georgia

Project Summary

The overall objective of the project is to significantly improve the quality of MSc. studies in the field of Environment Protection in Armenia and Georgia on the basis of complex modernization of the curricula in line with the Bologna principles, Salzburg principles of EAU and best European practice. The curricula development will be firmly based on the analysis of the best practice obtained in Europe, target countries and beyond and incorporate the latest innovations in educational technologies. The focus will be on close relations between postgraduate studies and research activities in order to equip the graduates with cutting edge knowledge and practical skills. University-society-industry links will play also a key role to guarantee high employability of graduates. In order to radically modernize the MSc. education in EP – technology-intensive domain of knowledge, the project will establish a unique inter-University education and research facility, which will be used for student projects, collaborative projects with external

stakeholders and demonstration activities to reinforce links to the University environment and promote environment-friendly mindsets. The ERLEP will represent one of the major tangible outcomes of the project and will define the quality standards of postgraduate studies in the field of EP for many years. Moreover, the ERLEP will provide the access to a modern laboratory infrastructure and enable various projects between Universities and external stakeholders.

URBAN ECOLOGY

Course Comparative Analysis

Urban ecology is a subfield of ecology that deals with the interactions of plants and animals (including humans) within urban and suburban environments and study of how urban communities and other high-population developments affect the natural resources and ecosystems around them. The course is intended for students and aims at developing a science-based ecological perception, acquiring comprehensive knowledge in building an environmentally friendly habitat, gaining relevant decision-making skills. Key issues to be addressed include the status of urban geo-sociosystem and forecasting the ways of its development as a whole, interaction of its components, the influence of urban environment on adjacent sites and their ecosystems. This course, Urban Ecology, is already taught at Department of Environmental Protection and Nature Management of ISEC https://www.isec.am/en/departments/environmental-protection-and-nature-management.html. The information has been collected through different websites of EU universities for the implementation of syllabi comparative analysis which allows identifying the most relevant and similar courses to "Urban Ecology" subject to modernization. The details of the similar courses offered by foreign universities are presented here which have been compared with Urban Ecology course offered by ISEC.

The three universities are as follows:

1. University of Reading (https://www.reading.ac.uk/module/document.aspx?modP=BI3EF7&modYR=1415),
2. University College Dublin (http://www.ucd.ie/)
3. University of Tuscia (UNITUS) (http://www.unitus.it/it/unitus).

The University of Reading is a public university located in Reading, Berkshire, England. It was founded in 1892 as University College, Reading, a University of Oxford extension college. The University has been arranged into 16 academic schools since 2016. Reading was ranked 35th in the UK amongst multi-faculty institutions for the quality (GPA) of its research and 28th for its Research Power in the 2014 Research Excellence Framework. In total, 98% of the University's research is labelled as "internationally recognised", 78% as "internationally excellent" and 27% as "world leading". "Urban Ecology" is the selected course at the University of Reading.

The University College Dublin is a research university in Dublin, Ireland. It has over 1,482 faculty and 32,000 students, and it is Ireland's largest university. CD is consistently ranked as one of the best in Europe on worldwide metrics. As of 2019, it was ranked by the QS World University Rankings as 193rd in the world. This University offers a course in "Urban Environment".

University of Tuscia is located in Viterbo, with campuses in and around its historical centre. University of Tuscia was founded in 1979 and quickly developed into what it is

today: the hub of culture and learning in the province, offering courses suited to the requirements of local, national and international students. The educational activities are managed by six Departments offering 15 undergraduate programmes, 17 second-level degree programmes and 2 single cycle degree programmes. The title of the course in UNITUS is "Applied Ecology of Urban Environment".

Additional details about the study processes and courses are provided in the below table.

European example from	**University of Reading** **Urban Ecology**	**University College Dublin** **Urban Environment**	**University of Tuscia (UNITUS) Ecology of Urban Environment/Applied Ecology in Urban Environment**	**ISEC course to be modernized in Armenia** **Urban Ecology**
University/Program Profile				
Criterion A: University Profile				
Classic or applied	Classic	Both	Both	Both (Research University)
Overall number of students	14521 https://www.topuniversities.com/universities/university-reading	32000 http://www.ucd.ie/	Not available	800
Number of Environment protection related disciplines	3	3	Not available	2
Number of Environment protection students	Not available	Not available	Not available	13
Criterion B: Program/discipline profile				
Theoretical or applied	Both (Theoretical + Applied)	Both (Theoretical + Applied)	Both	Both (Theoretical + Applied)
Number of students	Not available	Not available	18	13
Role/part of the selected course(s) in the study program	This course provides a detailed knowledge of the ecology of urban areas, both in the context of urban areas	In this course is particularly values the application of academic	Urban environmental quality	Urban ecology is one of the mandatory courses at the Department of

	in the wider landscape as well as ecology within urban areas and so it is one of main courses of environmental disciplines in the Reading University	learning to the urban environment of Dublin in particular through collaborative engagement with external stakeholders and it is one of main courses of Environmental disciplines at the University College Dublin		Environmental Protection and Nature Management. It is the study of how urban communities and other high-population developments affect the natural resources and ecosystems around them.
Criterion C: Course type				
Bachelor or master level	Master Level	Master Level	Master Level	Master Level
Year/semester of studies (1/2/…)	1/1	1/1, 1/2	2nd semester of last year	1/2
Selective or mandatory	Mandatory	Mandatory	Selective	Mandatory
Theoretical / applied	Both	Both	Both	Both

Criterion D: Relations to other courses in the program				
Prerequisite courses	An adequate Bachelor's degree with a minimum grade must be proven for admission to this Master's degree program	Applicants should have a minimum of an honours degree or international equivalent at Bachelor level.	5 CFU Chemistry; 5 CFU Biology; 5 CFU Forestry	Sustainable Development, Environmental Monitoring and Measurement Devices
Outcome courses	1. State and describe the variation in the definition of "urban areas", and how this may impact the synthesis of urban ecology studies 2. Describe and discuss patterns of variation in the	1. Relevant professional or voluntary experience may be considered as part of the application process. 2. Applicants whose first language is not English must also	N/A	Landscape Planning

	structure of urban areas, including in the context of socioeconomic divisions 3. Compare and contrast the impact of urbanization on the distribution, density and community structure of different taxonomic groups including mammals, birds and invertebrates 4. Describe the role of human migration as a mechanism for the "global homogenization" of urban flora and fauna 5. Describe and discuss evidence for and against the impact of wildlife and natural landscapes within urbanized areas on human health and well-being, and how this may be managed for the benefit of society 6. Discuss how urban areas could be managed for the benefit of wildlife, including e.g. the design of urban gardens, urban nature reserves and by using "green	demonstrate English language proficiency of IELTS 6.5 (no band less than 6.0 in each element), or equivalent.			

	roofs". Emphasis will be given to possible limitations and benefits of these different approaches			
If the course is a part of a group/cluster (from which it can be selected), other courses in this group	No data	No data	Phytotechnologies	Urban ecology is not a part of a course group/cluster
Criterion E: Department teaching a course *Non-graduating / Graduating / Other*	*Graduating*	*Graduating*	*Graduating*	*Graduating*
Criterion F: Course load				
Overall number of credits according to ECTS regulations	10 [5 ECTS credits]	level 9 NQF, credits 90	6 ECTS	3 ECTS (90 hours)
Number of credits associated with particular course activities (lectures / tutorials / practical work / homework / etc.)	Lectures – 20 hours Guided independent study-80 hours Total hours for module-100 hours	Total hours for module-90 credits with 60 credits of taught modules and a 30 credit thesis.	No data	Lectures – 1 ECTS Practical and self-study – 2 ECTS 3 credits 1st midterm exam: up to 4 points (20%) 2nd midterm exam: up to 4 points (20%) Final exam: up to 10 points (50%) Attendance: up to 2 points (10%)
Criterion G: Pedagogy				
Traditional place-based learning	+	+	No	+
Blended learning	No data	No data	Partially	+

Flipped classroom	No data	No data	NO	-
MOOC	–	–	Partially	-
Project-based learning	-	+	Partially	+
Inquiry-based learning	+	+	Yes, in the practical part	+
Collaborative learning	No data	+	NO	+
Game-based learning	No data	-	NO	-
Criterion H: Assessment				
Exams (how many, oral / written / test-like)	2 times per semester (a two-hour examination requiring two answers from four questions). **Requirements for a pass:** A mark of 40% overall.	No data	1 (practical + oral)	1st midterm written exam 2nd midterm oral exam Final oral exam
Testing (how often)	By examination in August/September	No data	No	2 times per semester
Grade computation (contribution of each course activity to the final grade, availability of extra credits)	Written exam-70 Written assignment including essay-30	No data	N/A	Contribution of each course activity (100%): *Component 1 - Attendance, up to 2 points (10%)* *Component 2- 1st exam, up to 4 points (20%)* *Component 3 - 2nd exam, up to 4 points (20%)* *Component 4 - final exam, up to 10 points (50%)*
Criterion I: Teaching resources				
Teaching hours	There will be two 50-minute lectures each week; these will involve the use of video material where appropriate and small-group discussions. Students will acquire additional information from directed reading allied to the lecture	No data	30-18	24

	material.			
Preparatory hours	No data	No data	N/A	0
Teaching assistants (grading / tutorials)	No data	No data	4	0
Labs and field	-	-	3	8
Criterion J: Use of professional tools				
Name of the tool(s) used (lab devices/systems, software solutions, etc.)	No data	University has an ideal urban laboratory to develop and engage in collaborative projects and let the students to develop as spatially-sensitive global citizens and encourage them to be reflective and critical thinkers.	Gas analyser, Specifind, itree	All necessary equipment, especially for determination organic and inorganic compounds, trace elements etc, which helps us to carry out multidisciplinary investigation in urban ecology.
Supported activities (tutorials, home work)	Students will be expected to read papers and other literature indicated by the lecturer. The course textbook will be: Urban Ecology by K.J. Gaston. Students will be advised of the appropriateness of web-based articles.			Professional literature, some laws connected to plants, soils, air, water etc
Overall role of the tool (essential instrument that must be learnt or one way to help learn the rest the material easier)	No data	Graduate students innovative teaching and learning methodologies in the online and face-to-face environment. As well as small-group seminars, project-based		The role of tools application is developing abilities to choose sampling methods and sampling design, to perform analytical method selection, statistical analysis of data

		learning and teamwork, fieldwork is a core element of the MSc Urban Environment programme.		obtained.
Criterion K: Use of TEL-systems				
Name and type of the tool used (if any)	No data	No data	No data	Not applicable
Supported activity (assessment, home works, exam preparation)	Students will be expected to read papers and other literature indicated by the lecturer. The course textbook will be: Urban Ecology by K.J. Gaston. Students will be advised of the appropriateness of web-based articles.	No data	No data	Assessment of homework Providing literature Exam preparation
Role on the course (mandatory component / extra credit opportunity / fully optional supplementary tool)	Mandatory	Mandatory	No data	Mandatory
Criterion L: Course statistics				
Average number of students enrolled in the course	No data	No data	18	7
Average percentage of students successfully finishing the course	No data	No data	18	88%
Average grades distribution	No available data	No available data	26/30	15.7
Percentage of international students	Not available	No available	16	0
Overall student demographics (gender, age, nationality, scholarships, etc.)	Not available	Not available	N/A	*Male: 18%; Female: 82%* *Nationality: Armenian (100%)* *Scholarships –*

				6%
Average rating of the course by students	Not available	Not available		4.4
Criterion M: Course competency profile				
Outcome competencies of the course (computing-related must learn in it)	By the end of the course, students will be expected to be able to: 1.Describe and discuss the history of urban areas as a form of human habitation, and how these are likely to change in the future 2. State and describe the variation in the definition of "urban areas", and how this may impact the synthesis of urban ecology studies 3. Describe and discuss patterns of variation in the structure of urban areas, including in the context of socioeconomic divisions 4.Compare and contrast the impact of urbanization on the distribution, density and community structure of different taxonomic groups including mammals, birds and invertebrates 5.Describe the role of human migration as a mechanism for the "global homogenization" of urban flora and fauna 6.Describe and discuss traits which appear to allow certain species to persist within urban areas, with particular	1. Focused on integrating technical skills (e.g. GIS) with fieldwork and lectures to provide a comprehensive understanding of dynamic urban environments. 2. International perspective on global cities but uses Dublin (a multi-cultural city that is undergoing transformation) as a testbed for exploring urban environments. 3. Draws upon expertise at UCD across a range of disciplines. Provides freedom to specialise in areas of interest.	Defining proper strategies and plans to improve the resilience of the urban areas using green infrastructure, also in a context of climate changes - design phyto-technological systems to improve soil and water quality in polluted areas - defining monitoring plans to support the management of green infrastructures	*The students will learn how to* -assess ecological status of all constituents of urban ecosystem: sociosphere, biosphere, lithosphere, hydrosphere, atmosphere; - generate and bring forward scientifically sound decisions regarding mitigation of manmade effects on natural environment and improvement of ecological situation in cities; - conduct the ecological expertise, -develop technologies for protection and recovery of urban ecosystems.

	reference to birds 7. Describe and discuss how the urban landscape has led to modifications in selected behavioural traits within some species 8. Compare and contrast the ecology of cats and dogs both within urban areas and in the wider landscape. 9. State and discuss the potential impacts of roads on the ecology of a range of taxonomic groups 10. Describe and discuss the role of urban wildlife in the transmission of diseases to humans and companion animals, including commensal rodents and carnivores 11. Describe and discuss the range of nuisance conflicts arising between humans and urban wildlife and how these are managed at present, and how they may be managed in the future 12.Describe and discuss evidence for and against the impact of wildlife and natural landscapes within urbanized areas on human health and well-being, and how this may be managed for the benefit of society 13.Discuss how urban			

	areas could be managed for the benefit of wildlife, including e.g. the design of urban gardens, urban nature reserves and by using "green roofs". Emphasis will be given to possible limitations and benefits of these different approaches 14. Discuss how continuing patterns of global urbanization are likely to impact global biodiversity			
Prerequisite competencies of the course (what a student must know before taking it)	An adequate Bachelor's degree with a minimum grade must be proven for admission to this Master's degree program	Applicants should have a minimum of an honours degree or international equivalent at bachelors level. • Relevant professional or voluntary experience may be considered as a part of the application process. • Applicants whose first language is not English must also demonstrate English language proficiency of IELTS 6.5 (no band less than 6.0 in each	Ecophysiology	BSc in Biology, Geography, or related Natural and Earth Sciences, as well as physics, chemistry, biology, engineering, mathematics, or computing-related subjects

		element), or equivalent		

The comparative analysis of syllabi taught in University of Reading, College Dublin University, University of Tuscia and ISEC allows making the following conclusions: Program profiles for University of Reading, College Dublin, University of Tuscia and ISEC are different in statistical parameters (overall number of students; number of environmental protection related disciplines, etc.)

- Course settings: there are some similar and different points, which, in terms of content, are not significant. The number of students is similar to that of University of Tuscia (18) and ISEC (13). In University of Tuscia, the course name is Ecology of Urban Environment/Applied Ecology in Urban Environment and only this course is selective.
- Teaching aspects: pedagogical methods are perfect in comparison to universities especially ISEC and Dublin College University which are very similar as they are research-based. Criterion G (Pedagogy) matches perfectly. Criterion H (Assessment) differs due to different number of granted credits and teaching hours. Criterion I (Teaching resources) is incomparable partially since the relevant information is not available but teaching hours are very similar (University of Tuscia: 30-18 hours) (ISEC: 24 hours) and labs and field works (University of Tuscia: 3 hours) (ISEC: 8 hours).
- Use of technology matches only for Dublin College Univeristy, University of Tuscia and ISEC, which are very important for teaching (Criterion J, K).
- Course statistics (Criterion L) for Reading and Dublin universities are not available, but could be compared between University of Tuscia (average number of student enrolled in the course: 18; average percentage of students successfully finishing the course: 18; average grades distribution: 26/30) and ISEC (average number of student enrolled in the course: 7; average percentage of students successfully finishing the course: 88%; average grades distribution: 15.7).
    - Course content (Criterion M) matches partially. Smaller number of teaching hours is alloted to each environmental compartment at ISEC as compared to University of Reading and Dublin College University. There are some similarities connected to green infrastructure parts in the course of University of Tuscia (Ecology of Urban Environment/Applied Ecology in Urban Environment) between of ISEC Urban ecology course, which is not in other EU universities.

To conclude, this course comparative analyzes the overall goal and main outcomes, teaching aspects, and other features of "Urban Ecology" syllabus harmonized with other similar syllabi taught at leading European universities. The differences are as follows: at the University of Reading more attention is paid to biological aspects but the main orientation at Dublin College University is a geographical aspect, while the course offered by University of Tuscia also refers to the forestry. As for ISEC, the studied subject called

"Urban Ecology" has ecological characters. Consequently, course load, applied tools, teaching resources, ECTS and so on are specific to the university and country as well.

ENVIRONMENTAL MONITORING AND MEASUREMENT DEVICES

Course Comparative Analysis

The information collected during the visits to EU partner universities for the comparative analysis of syllabi allows identifying the most relevant topics in the courses similar to "Environmental Monitoring and Measurement Devices" taught at ISEC which should be modernized.

During the visits, Dr. Chiara Baldacchini from University of Tuscia (UNITUS) presented a lecture on "Air Quality Monitoring" course and Dr. Fernando P. Carvalho from the Instituto Superior Técnico / Campus Tecnológico Nuclear of the Universidade de Lisboa (ULISBOA) delivered a lecture on "Environmental Radioactivity Monitoring" course offered by their universities. The presentation by Dr. Chiara Baldacchini provided details on:

- Proposed subsection on Air Quality Monitoring and Environmental Radioactivity Monitoring
- Experimental approaches and related techniques
- Possible integrated laboratory activity
- Proposed ECTS
- Proposed bibliography

Although this information will be considered for the modernization of the syllabus at ISEC, it is not considered in the table below with the comparative analysis of several courses because "Air Quality Monitoring" is not taught at UNITUS. The comparative analysis of "Environmental Radioactivity Monitoring" presented by Dr. Fernando P. Carvalho (ULISBOA) and "Environmental Monitoring and Measurement Devices" (ISEC) is considered in the table below because of highly specialized content of "Environmental Radioactivity Monitoring" syllabus. Nevertheless, this information will be used for the development of other syllabus, "Environmental Radiation Protection", within MENVIPRO project.

For the purpose of the comparative analysis, we compiled data on the syllabus of "Environmental Monitoring" (https://fenix.ciencias.ulisboa.pt/degrees/ecologia-e-gestao-ambiental-564500436615250/disciplina-syllabir/564680825254546) taught in ULISBOA and compared with "Environmental Monitoring" module taught in Northumbria University Newcastle (UK) and with "Environmental Monitoring Strategies" module taught in University of Trier (Germany), and the relevant ISEC course in Armenia. The information was retrieved from the official websites of the aforementioned universities. Both collaborators, Dr. Baldacchini and Dr. Carvalho, approved the selected modules as relevant based on the data available on the official websites of Northumbria and Trier universities.

Ranking of Northumbria University Newcastle is available at https://www.timeshighereducation.com/world-university-rankings/northumbria-university

The detailed description of "Environmental Monitoring" module of "Environmental Monitoring, Modelling and Reconstruction MSc", Northumbria University Newcastle is available at https://www.northumbria.ac.uk/study-at-northumbria/courses/environmental-monitoring-modelling-and-reconstruction-msc-dtfemm6/modules/ke7029-environmental-monitoring/

Ranking of Trier University is available at https://www.timeshighereducation.com/world-university-rankings/trier-university

The detailed description of "Environmental Monitoring Strategies" module of MSc Environmental Sciences, Trier University, Germany, is available on https://www.uni-trier.de/fileadmin/fb6/fb6/studium/Modulhandbuecher/4_UNI_TR_FB_6_Modulhandbuch_MSC_ES_Reakkred_final_Mai_2013.pdf

Additional details about the study processes and courses are provided in the table below.

European example from	**ULISBOA**	**Northumbria University Newcastle**	**Trier University**	**ISEC course to be modernized in Armenia**
University/Program Profile				
Criterion A: University Profile				
Classic or applied	Both	Both	Both	Both (Research University)
Overall number of students	49769	26675	13331	800
Number of Environment protection related disciplines	5	6	5	2
Number of Environment protection students	No data available	Not available	1662	13
Criterion B: Program/discipline profile				
Theoretical or applied	Both (Theoretical + Applied)	Both (Theoretical + Applied)	Both (Theoretical + Applied)	Both (Theoretical + Applied)
Number of students	Not available	Not available	Not available	13
Role/part of the selected course(s) in	The context of environmental	In this module you will learn	Man changes the environment and	The overall goal of the syllabus is

the study program	monitoring. Anthropogenic impacts and their measurement. Monitoring efforts at global, national and local scales. Legal framework for environmental monitoring. Types of monitoring and its specificities. Selection of ecological indicators. Defining metrics and reference states. Temporal and spatial distribution of the sampling effort. Design of sampling networks. Selection of points of impact and control. Sampling methodologies. Organization and quality control of data. Development of databases and their management. Statistical analysis of monitoring data. Detection impacts through BACI (Before-After-Control-Impact) approaches. Analysis of time series data.	how to plan and implement measurements to assess the status of the natural environment. You will learn how to develop appropriate sampling strategies and how to conduct a wide range of methods spanning chemical, physical and biological to gain a thorough understanding of the environment. You will develop a broad range of highly employable skills in collection, modelling and analysis of environmental and socially important data-sets.	the environment changes people. Exploring and understanding the relationships between the two systems is at the heart of the geography, environmental bioscience, and environmental geoscientific study programs offered by the Department of Spatial and Environmental Sciences. Especial ly in times of climate change and scarcer resources and the associated changes in living conditions and societies, these disciplines are required - and correspondingly interesting.	to develop students' knowledge about modern environmental monitoring programs, main analytical methods, familiarize with some field and laboratory devices and develop the ability to assess environmental pollution levels.

	Production of technical and non-technical reports. Monitoring opportunities for the advancement of scientific knowledge. Analysis of case studies.			
Course Settings				
Criterion C: Course type				
Bachelor or master level	Master Level	Master Level	Master Level	Master Level
Year/semester of studies (1/2/…)	1/1	1/1,2	2/1	1/1
Selective or mandatory	Mandatory	Mandatory	Optional / Mandatory	Mandatory
Theoretical / applied	Both	Both	Both	Both
Criterion D: Relations to other courses in the program				
Prerequisite courses	To apply for the course, students must have completed their undergraduate degree or legal equivalent, preferably in Biology, or related areas	A minimum of a 2:2 honours degree or equivalent in relevant subjects including geography, natural and earth sciences, as well as physics, chemistry, biology, engineering, mathematics, or computing-related subjects. Applicants with professional or voluntary experience will also be considered.	An adequate Bachelor's degree with a minimum grade must be proven for admission to this Master's degree program	BSc in Biology, Geography, or related Natural and Earth Sciences, as well as physics, chemistry, biology, engineering, mathematics, or computing-related subjects

Outcome courses	No data	No data	No data	Environmental Geochemstry; Environmental Statistics; Urban Ecology.
If the course is a part of a group/cluster (from which it can be selected), other courses in this group	No data	No data	No data	None
Criterion E: Department teaching a course *Non-graduating / Graduating / Other*	*Graduating*	*Postgraduate*	*Graduating*	*Graduating*
Criterion F: Course load				
Overall number of credits according to ECTS regulations	6 ECTS (180 hours)	20 ECTS (20 hours per 1 ECTS)	5 ECTS (150 hours)	3 ECTS (90 hours)
Number of credits associated with particular course activities (lectures / tutorials / practical work / homework / etc.)	Not available	Not available	Not available	Lectures – 1 ECTS Practical and self-study – 2 ECTS
Teaching aspects				
Criterion G: Pedagogy				
Traditional place-based learning	+	+	+	+
Blended learning	No data	No data	No data	+
Flipped classroom	No data	No data	No data	–
MOOC	–	–	–	–
Project-based learning	+	+	+	+
Inquiry-based learning	+	+	+	+
Collaborative learning	+	+	No data	+
Game-based learning	No data	No data	No data	–
Criterion H: Assessment				
Exams (how many, oral / written / test-like)	1 final oral exam	Two oral exams during two semesters	Advanced examination effort: term paper	1st midterm written exam 2nd midterm oral

			Final module examination: oral examination (20 minutes)	exam Final oral exam
Testing (how often)	No data	No data	No data	2 times per semester
Grade computation (contribution of each course activity to the final grade, availability of extra credits)	Not available	Not available	Without proportional weighting in the final grade (5/120)	Contribution of each course activity (100%): *Component 1 - Attendance, up to 2 points (10%) Component 2- 1st exam, up to 4 points (20%) Component 3 - 2nd exam, up to 4 points (20%) Component 4 - final exam, up to 10 points (50%)*
Criterion I: Teaching resources				
Teaching hours	180	100	90	24
Preparatory hours	No data	Not available	No data	0
Teaching assistants (grading / tutorials)	No data	20	No data	0
Labs and field	No data	80	40	8
Use of technology				
Criterion J: Use of professional tools				
Name of the tool(s) used (lab devices/systems, software solutions, etc.)	No data available	Delta V Advantage Isotope Ratio Mass Spectrometer Flash 2000 Elemental Analyser Perkin Elemer Optima 8000 Inductively Coupled Plasma Optical Emission Mass Spectrometer	Laboratory of Institute for BioGeoAnalytics, Environmental Sample and Biobanks - IBU	Portable aspirator Portable XRF analyser Innov X-5000 Portable RAD 7 radon detector Horiba U-10 water quality checker SEM/EDX Gamma-ray spectrometry system GC/MS

		Los Gatos Ultraportable Grennhouse Gas Analyser High Precision Micromill Centrifuges Refrigeration and Fume Hoods High Performance Computing (HPC) cluster, Small Unmanned Aerial Systems (sUAS).		MS Office IBM SPSS Visual Sampling Plan
Supported activities (tutorials, home works)	No data	No data	No data	Professional literature, Instructions
Overall role of the tool (essential instrument that must be learnt or one way to help learn the rest the material easier)	No data	Students spend much of your time in our Palaeo and Environmental Research Laboratories, where Northumbria's ongoing investment in STEM facilities has created world-leading resources for collaborative research. Perform analyses in our Stable Isotope Laboratory, analyse 'big data' using climate and ice-flow models on our High Performance Computing (HPC) cluster, and monitor	No data	The role of tools application is developing abilities to choose sampling methods and sampling design, to perform analytical method selection, statistical analysis of the obtained data.

		previously inaccessible landscapes with Small Unmanned Aerial Systems (sUAS).		
Criterion K: Use of TEL-systems				
Name and type of the tool used (if any)	No data	No data	No data	Not applicable
Supported activity (assessment, home works, exam preparation)	No data	No data	No data	Assessment of homework Providing literature Exam preparation
Role on the course (mandatory component / extra credit opportunity / fully optional supplementary tool)	Mandatory	Mandatory	Optional/Mandatory	Mandatory
Course statistics				
Criterion L: Course statistics				
Average number of students enrolled in the course	No available data	No available data	Planned Group Size: 15	7
Average percentage of students successfully finishing the course	No data	No data	No data	88%
Average grades distribution	No available data	No available data	No available data	15.7
Percentage of international students	No available data	Not available	Not available	0
Overall student demographics (gender, age, nationality, scholarships, etc.)	Not available	Not available	Not available	*Male: 18%; Female: 82%* *Nationality: Armenian (100%)* *Scholarships* – 6%
Average rating of the course by students	Not available	Not available	Not available	4.4
Course content				
Criterion M: Course competency profile				

Outcome competencies of the course (computing-related must learn in it)	The course provides the concepts and methodological tools necessary for the development and review of environmental monitoring programs. It is intended that students develop a solid understanding of literature and the scientific basis for environmental monitoring, and contact with their practices in processes of post-impact assessment, assessment of mitigation and compensation for impacts applications and monitoring of environmental restoration activities, among others. In this context, the course aims to give students the ability to (i) develop monitoring programs (e.g, selection of indicators, design of networks and definition of sampling effort), (ii) implement and coordinate	*Knowledge & Understanding:* • MLO1: critically evaluate and apply appropriate monitoring types and be aware of the uncertainties associated with them. • MLO2: demonstrate how monitoring approaches are used to gain detailed understanding of environmental processes and changes. Intellectual / Professional skills & abilities: • MLO3: select appropriate monitoring strategies to assess diverse environmental challenges and questions. • MLO4: demonstrate ability to set-up, collect and interpret monitoring datasets. Personal Values Attributes (Global /	*The overall aims of the module are:* • to provide a grounding in ecological research techniques both in the field and laboratory • to explain and evaluate the terminology, theoretical principles and practical limitations of air, water and soil pollution monitoring and control systems • to explain monitoring/control techniques and strategies for air, water and soil pollutants • to assess the roles of local, national and international agencies with respect to the management of air, water and soil quality. • to provide transferable skills in team work and individual skills in data collection and	*The students will learn*: • Armenian and international standards applicable in the environmental monitoring system • monitoring features of different environmental compartments, • main and emerging pollutants and controlled processes; • key analytical methods and their limitations. *Students will learn how to*: • choose sampling method and sampling design, • collect environmental sample and quality assurance of field activity, • perform in situ measurements, • choose the relevant analytical method, • perform statistical treatment of data,

	the implementation of these programs, (iii) collect and analyze the data, and (iv) disseminate and publish the results.	Cultural awareness, Ethics, Curiosity) (PVA): • MLO5: effective communication of the results of monitoring in a consultancy-style report to clearly communicate results and develop recommendations based on findings.	data analysis	• assess the level of pollution.
Prerequisite competencies of the course (what a student must know before taking it)	To apply for the course, students must have completed their undergraduate degree or legal equivalent, preferably in Biology, or related areas	A minimum of a 2:2 honours degree or equivalent in relevant subjects including geography, natural and earth sciences, as well as physics, chemistry, biology, engineering, mathematics, or computing-related subjects. Applicants with professional or voluntary experience will also be considered.	An adequate Bachelor's degreewith a minimum grade must be proven for admission to this Master's degree program	BSc in Biology, Geography, or related Natural and Earth Sciences, as well as physics, chemistry, biology, engineering, mathematics, or computing-related subjects

The comparative analysis of the syllabi taught in ULisboa, Northumbria University Newcastle, Trier University, and ISEC allows arriving at the following conclusions:

1. Program Profiles for ULisboa Northumbria University Newcastle, Trier University and ISEC are different in statistical parameters (overall number of students; number of environmental protection related disciplines, etc.)
2. Course settings (Criterion C-F) perfectly match among these three universities.
3. Teaching aspects: Criterion G (Pedagogy) matches perfectly. Criterion H (Assessment) differs due to different number of granted credits and teaching hours. Criterion I (Teaching resources) is incomparable since the relevant information is not available.
4. Use of technology matches partially (Criterion J, K). Particularly some devices that are used in Nortumbria University are not available at ISEC. The data on ULisboa, Laboratory of Institute for BioGeoAnalytics, Environmental Sample and Biobanks of Trier University courses are not sufficient for comparison.
5. Course statistics (Criterion L) for European universities are not available and the comparison is not applicable.
6. Course content (Criterion M) matches partially. We note that smaller number of teaching hours is allocated to each environmental compartment at ISEC as compared to Northumbria University Newcastle and Trier University.
7. The modernized syllabus will include project-based learning related to air quality assessment by different methods: SEM (to be obtained within the MENVIPRO) and aspiration proposed by Dr. Baldacchini (UNITUS).

With this analysis, the overall goal and main outcomes, teaching aspects, and other features of syllabus "Environmental Monitoring and Measurement Devices" can be harmonized with similar syllabi taught in leading European universities. It is noted that differences in the content of courses are based on the demand for environmentalists' skills in different countries. Consequently, course load, applied tools, teaching resources, ECTS, etc. are specific to the university and country as well.

ENVIRONMENTAL RADIATION PROTECTION

Course Comparative Analysis

The information collected during the visits to EU partner Universities for the development of syllabi is used at the present stage in the comparative analysis presented herein. This comparative analysis aims at identifying topics in similar courses that may be relevant to "Environmental Radiation Protection" course to be newly developed at ISEC.
During the visits to EU partner Universities plenty of information was made available. Particularly in Lisbon, Dr. Fernando P. Carvalho from the Instituto Superior Técnico / Campus Tecnológico Nuclear of the Universidade de Lisboa (ULISBOA) presented the course entitled "Environmental Radioactivity Monitoring" proposed by ULISBOA. This presentation included details on:

- course requirements and description,
- proposed program,
- case studies,
- proposed field activity,
- proposed laboratory equipment and experiment,
- proposed ESTC,
- required bibliography.

Although "Environmental Radioactivity Monitoring" lecture covered only a part of "Environmental Radiation Protection" syllabus aimed for Armenia, it will be useful for the development of "Environmental Radiation Protection" course within MENVIPRO project.

In order to make a more detailed analysis of the modernized syllabus, the comparison analysis with "Environmental Radiation" syllabus provided by Técnico Lisboa – ULISBOA (Portugal) (available on: https://fenix.tecnico.ulisboa.pt/cursos/mpsr/disciplina-syllabir/283003985068208) and "Experimental Radioecology" module provided by University of Oslo (Norway) was performed. The information was taken from official websites of the aforementioned universities. Mentioned syllabi were selected jointly with Dr. Carvalho as the most relevant to the newly developed syllabus for "Environmental Radiation Protection" course.

Ranking of the University of Oslo is available at https://www.timeshighereducation.com/world-university-rankings/norwegian-university-life-sciences

The detailed description of "Radiation Protection and Radiation Safety" module, University of Oslo, Norway, is available at https://www.uio.no/studier/emner/matnat/fys/nedlagte-emner/FYS-KJM9570/index.html

Additional details about the study processes and courses are provided in the below table.

European example from	Técnico Lisboa, ULISBOA	University of Oslo	ISEC newly developed syllabus in Armenia
University/Program Profile			
Criterion A: University Profile			
Classic or applied	Both	Both	Both (Research University)
Overall number of students	49769	28007 (2017)	800
Number of Environment protection related disciplines	5	3	2
Number of Environment protection students	No data available	No data available	12
Criterion B: Program/discipline profile			
Theoretical or applied	Both	Both	Both
Number of students	No available data	No available data	13
Role/part of the selected course(s) in the study program	Mandatory Radiation Protection and Security addresses a set of multidisciplinary, cutting-edge topics across a range of scientific and technological domains. Ionizing radiation (IR) has applications in various sectors such as Health, Industry, Environment, Research, Services, Security and Energy, in which aspects of Radiological Protection can not be neglected.	Mandatory Interaction of ionizing radiation with matter – with emphasize on biological systems and radiological protection. External and internal dosimetry. Dosimetric measurement techniques in radiation protection. Stochastic effects of ionizing radiation from high doses and high dose rates to low doses and low dose rates for both high and low LET radiation. Risk models and assessment of health risks from exposure to ionizing radiation based on radiobiological and epidemiological knowledge. Deterministic effects of ionizing radiation. Health hazards of exposure to non-ionizing radiation and	Mandatory The purpose of this particular syllabus is to familiarize students with the environmental distribution and sources of natural and artificial radionuclides, their measurement and identification, uptake and transfer through food chains, effects of radiation on human being and other organisms, environmental radiation protection standards.

		electromagnetic fields. Evolution of the radiation protection system – practices and intervention related to medical and industrial use of radiation sources, contamination of the environments, etc. Quantities in radiological protection. Dose constraints and derived limits. Radiation sources – natural and man-made sources. Shielding of radiation sources and protective measures. Regulatory aspects - radiation protection regulations, recommendations and standards. International conventions and recommendations. Natural and man-made sources of radioactivity in the atmospheric, terrestrial and marine environment. Release of radioactivity to the environment - doses and consequences for man and the environment; fauna and flora included. Remedial measures and preventative measures to limit exposure and consequences for man and environment. Radiation safety related to ionizing radiation sources and nuclear facilities. Consequences of fallout from nuclear accidents and use of nuclear weapons. Nuclear safeguards and security. Nuclear	

		accident preparedness. Management of radioactive waste.	
Course Settings			
Criterion C: Course type			
Bachelor or master level	Master Level	Postgraduate	Master Level
Year/semester of studies (1/2/…)	1/1	1/1,2	1/1
Selective or mandatory	Mandatory	Optional/Mandatory	Mandatory
Theoretical / applied	Both	Both	Both
Criterion D: Relations to other courses in the program			
Prerequisite courses	Biology, Biology, Biotechnology, Biotechnology, Chemistry, Chemical Engineering, Environmental Sciences, Environmental Engineering, Radiology, Nuclear Medicine or Radiotherapy; undergraduate courses in Physics, Physics Engineering, Superiors of Health Technologies, or related scientific areas.	Bachelor degree in physics or chemistry. Some background knowledge about radioactivity and radiation	BSc in Biology, Geography, or related Natural and Earth Sciences, as well as physics, chemistry, biology, engineering, mathematics, or computing-related subjects
Outcome courses	No data	No data	Environmental Geochemstry; Environmental Statistics; Urban Ecology.
If the course is a part of a group/cluster (from which it can be selected), other courses in this group	No data	No data	None
Criterion E: Department teaching a course *Non-graduating / Graduating / Other*	*Graduating*	*Postgraduate*	*Graduating*

Criterion F: Course load			
Overall number of credits according to ECTS regulations	6 ECTS (180 hours)	10 ECTS (100 hours)	3 ECTS (90 hours)
Number of credits associated with particular course activities (lectures / tutorials / practical work / homework / etc.)	No data available	No data available	Lectures – 1 ECTS Practical and self-study – 2 ECTS
Teaching aspects			
Criterion G: Pedagogy			
Traditional place-based learning	+	+	+
Blended learning	No data available	No data available	+
Flipped classroom	No data available	No data available	–
MOOC	–	–	–
Project-based learning	+	+	+
Inquiry-based learning	+	+	+
Collaborative learning	+	+	+
Game-based learning	No data available	No data available	–
Criterion H: Assessment			
Exams (how many, oral / written / test-like)	1 final oral exam	1 final oral exam	1st midterm written exam 2nd midterm, oral exam Final oral exam
Testing (how often)	No data available	No data available	2 times per semester
Grade computation (contribution of each course activity to the final grade, availability of extra credits)	No data available	Letter grades The grading scale with letter values is a descending scale where A is the best grade, E the lowest pass grade and F is fail. The assessment is based on defined, qualitative criteria for each grade in the grading scale. *A – Excellent* *An excellent performance, clearly outstanding. The candidate demonstrates excellent judgement and a high degree of*	Contribution of each course activity (100%): *Component 1 - Attendance, up to 2 points (10%)* *Component 2- 1st exam, up to 4 points (20%)* *Component 3 - 2nd exam, up to 4 points (20%)* *Component 4 - final exam, up to 10 points (50%)*

		independent thinking. *B – Very good* *A very good performance. The candidate demonstrates sound judgement and a very good degree of independent thinking.* *C – Good* *A good performance in most areas. The candidate demonstrates a reasonable degree of judgement and independent thinking in the most important areas.* *D – Satisfactory* *A satisfactory performance, but with significant shortcomings. The candidate demonstrates a limited degree of judgement and independent thinking.* *E – Sufficient* *A performance that meets the minimum criteria, but no more. The candidate demonstrates a very limited degree of judgement and independent thinking.* *F – Fail* *A performance that does not meet the minimum academic criteria. The candidate demonstrates an absence of both judgement and independent thinking.*	
Criterion I: Teaching resources			
Teaching hours	56	80	24
Preparatory hours	No data available	No data available	0
Teaching assistants (grading / tutorials)	No data available	No data available	0
Labs and field	14	20	8
Use of technology			

Criterion J: Use of professional tools			
Name of the tool(s) used (lab devices/systems, software solutions, etc.)	Facilities of Tecnológico e Nuclear Campus	Facilities of Department of Physics	Automess 6150 AD 6/H InSpector 1000 Portable RAD 7 radon detector Gamma-ray spectrometry system MS Office IBM SPSS Visual Sampling Plan
Supported activities (tutorials, home works)	Excursions	No data available	Professional literature, Instructions
Overall role of the tool (essential instrument that must be learnt or one way to help learn the rest the material easier)	No data available	No data available	The role of tools application is developing abilities to choose sampling methods and sampling design, to perform analytical method selection, statistical analysis of data obtained.
Criterion K: Use of TEL-systems			
Name and type of the tool used (if any)	No data available	No data available	Not applicable
Supported activity (assessment, home works, exam preparation)	No data available	No data available	Not applicable
Role on the course (mandatory component / extra credit opportunity / fully optional supplementary tool)	Mandatory	Mandatory	Mandatory
Course statistics			
Criterion L: Course statistics			
Average number of students enrolled in the course	No data available	No data available	Not applicable
Average percentage of students successfully finishing the course	No data available	No data available	Not applicable
Average grades distribution	No data available	No data available	Not applicable
Percentage of international students	No data available	No data available	Not applicable

Overall student demographics (gender, age, nationality, scholarships, etc.)	No data available	No data available	Not applicable
Average rating of the course by students	No data available	No data available	Not applicable
Course content			
Criterion M: Course competency profile			
Outcome competencies of the course (computing-related must learn in it)	To develop and to strengthen the students' knowledge regarding environmental radioactivity resulting from existing exposure, planned exposure and emergency exposure situations. Get the students acquainted with concepts and methodologies related to the monitoring and assessment of the radioactivity in the environment, as well as with the capabilities and limitations of the different measurement techniques. To present the potential applications of radioactivity in environmental sciences, namely the use of natural and anthropogenic radionuclides as tracers of complex environmental processes	To understand the basis for radiation protection and radiation safety, including the health effects and risks associated with radiation exposure, so that the candidate will be able to make his/her own independent judgements of risks, protective measures, etc. and acquire the necessary background knowledge to fill a position as health physicist.	*The students will acquire knowledge of:* ➢ sources of radiation in the environment, ➢ distribution of natural and artificial radionuclides, ➢ transport and transfer of radionuclides in the environment, ➢ principles of environmental impact and risk assessment ➢ radiation protection standards in case of emergency situations.
Prerequisite competencies of the course (what a student must know before taking it)			BSc in Biology, Geography, or related Natural and Earth Sciences, as well as

			physics, chemistry, biology, engineering, mathematics, or computing-related subjects

The comparative analysis of the syllabi taught in ULISBOA, University of Oslo, and the newly developed syllabus at ISEC allows arriving at the following conclusions:

1. Program Profiles for ULisboa University of Oslo and ISEC are different in statistical parameters (overall number of students; number of environmental protection related disciplines, etc.)
2. Course Settings (Criterion C-F) matches partially. The most profound program is proposed by the University of Oslo at the postgraduate level with more attention paid to the biological effects of ionizing radiation. However, the main topics and their order match perfectly in case of all examined syllabi.
3. Teaching aspects - Criterion G (Pedagogy) matches perfectly. Criterion H (Assessment) differs due to different number of granted credits and teaching hours and the level of education, as well. Criterion I (Teaching resources) is incomparable since the relevant information is not available.
4. Use of technology matches partially (Criterion J, K). Particularly some devices (alpha spectrometry, liquid scincilation spectrometry, etc.) used in ULISBOA are not available in ISEC. The data on facilities of Department of Physics of University of Oslo is not sufficient to carry out the comparison.
5. Course statistics (Criterion L) for European universities are not available and such comparison is not applicable for the newly developed syllabus.
6. Course content (Criterion M) matches perfectly. It is noteworthy that smaller number of teaching hours is allotted to each topic in ISEC as compared to ULISBOA and University of Oslo.

With this analysis, the overall goal and main outcomes, teaching aspects, and other features of syllabi in use in some EU countries can be harmonized with the new "Environmental Radiation Protection" to be taught in Armenia. In particular, there are good prospects for harmonization with similar syllabi taught in ULISBOA and University of Oslo. The differences noticed in the content of courses in different countries are based on the demand for environmentalists' skills and, consequently, the course load, applied tools, teaching resources, ECTS, etc. are specific to each university and country as well.

ENVIRONMENTAL STATISTICS

Course Comparative Analysis

The information collected during the visits to EU partner universities for the implementation of syllabi comparative analysis allowed identifying the most relevant and similar course to that of "Environmental Statistics" in University of Tuscia (UNITUS), belonging to "Industrial Biotechnologies for Health and Well-being" study program, which is offered within the Department for Innovation in Biological, Agrofood and Forestry Systems.

The content of the course in UNITUS is "Biostatistics and Experimental Data Analysis" and is similar to the proposed content of "Environmental Statistics" which will be newly developed to be taught in Armenia.

Additional details about both courses at EU University and in Armenia are provided in the table below.

European example from	University of Tuscia (UNITUS)	New course to be developed in Armenia
University/Program Profile		
Criterion A: University Profile		
Classic or applied	Applied	Both (Research University)
Overall number of students	49769	800
Number of Environment protection related disciplines	7 Bachelor courses and 7 Master courses considering DIBAF and DAFNE Departments	2
Number of Environment protection students	No data available	13
Criterion B: Program/discipline profile		
Theoretical or applied	Applied	Both
Number of students	No data available	13
Role/part of the selected course(s) in the study program	No data available	"Environmental Statistics" course will provide theoretical grounds and practical skills regarding the statistical analysis of environmental data.
Course Settings		
Criterion C: Course type		
Bachelor or master level	Master Level	Master Level
Year/semester of studies (1/2/…)	1st year, 1st semester	1/2

Selective or mandatory *Theoretical / applied*	Mandatory Applied	Mandatory Applied
Criterion D: Relations to other courses in the program		
Prerequisite courses	No prerequisite courses in the program	No prerequisite courses in the program
Outcome courses	No outcome courses in the program	Environmental Geochemistry; Food Safety and Risk Assessment
If the course is a part of a group/cluster (from which it can be selected), other courses in this group	No data	None
Criterion E: Department teaching a course *Non-graduating / Graduating / Other*	*Graduating*	*Graduating*
Criterion F: Course load		
Overall number of credits according to ECTS regulations	6 ECTS	3 ECTS
Number of credits associated with particular course activities (lectures / tutorials / practical work / homework / etc.)	4 ECTS to lectures, 2 ECTS to practicals	Lectures – 1 ECTS Practicals – 2 ECTS
Teaching aspects		
Criterion G: Pedagogy		
Traditional place-based learning *Blended learning* *Flipped classroom* *MOOC* *Project-based learning* *Inquiry-based learning* *Collaborative learning* *Game-based learning*	Collaborative learning in the practical part	Blended learning
Criterion H: Assessment		
Exams (how many, oral / written / test-like)	The students should positively pass two practical proofs during the course or one final practical proof. Then, they can sustain the oral examination.	1st midterm written exam 2nd midterm oral exam Final oral exam
Testing (how often)		2 times per semester
Grade computation (contribution of each		Contribution of each course activity (100%): *Component 1 - Attendance, up to 2 points*

course activity to the final grade, availability of extra credits)		*(10%)* *Component 2- 1st exam, up to 4 points (20%)* *Component 3 - 2nd exam, up to 4 points (20%)* *Component 4 - final exam, up to 10 points (50%)*
Criterion I: Teaching resources		
Teaching hours *Preparatory hours* *Teaching assistants (grading / tutorials)* *Labs and field*	Teaching hours 48- out of which 16 practicals During the course, practical exercises will be carried out during which students will be able to apply what was explained during the theoretical lessons and analyze experimental data, related to techniques and applications of biotechnological interest, using a special software.	24 0 0 8
Use of technology		
Criterion J: Use of professional tools		
Name of the tool(s) used (lab devices/systems, software solutions, etc.) *Supported activities (tutorials, home works)* *Overall role of the tool (essential instrument that must be learnt or one way to help learn the rest the material easier)*	Power point application during lectures. Excel application for data processing and statistics during laboratory activities.	R statistics, Excel Books, manuscripts and guidelines Not applicable
Criterion K: Use of TEL-systems		
Name and type of the tool used (if any) *Supported activity (assessment, home works, exam preparation)* *Role on the course (mandatory component / extra credit opportunity / fully optional supplementary tool)*	None	None
Course statistics		
Criterion L: Course statistics		
Average number of students enrolled in the	30	Not applicable

course		
Average percentage of students successfully finishing the course	No data available	Not applicable
Average grades distribution	No data available	Not applicable
Percentage of international students	No data available	Not applicable
Overall student demographics (gender, age, nationality, scholarships, etc.)	No data available	Not applicable
Average rating of the course by students	No data available	Not applicable
Course content		
Criterion M: Course competency profile		
Outcome competencies of the course (computing-related must learn in it)	Learning objectives The course aims to provide the tools needed to analyze experimental data using the most appropriate statistical analysis tools, with the help of theoretical lessons, practical lessons and use of software. At the end of the course, students will be able to analyze experimental data. Expected learning results KNOWLEDGE AND UNDERSTANDING At the end of this educational activity, in a context of exercise or exam, the student will have to demonstrate to have acquired the knowledge of the basic elements of statistics and the development of data analysis skills related to experimental studies in the field of biotechnologies, in agreement with the program. APPLYING KNOWLEDGE AND UNDERSTANDING	Learning objectives The course aims to provide the tools needed to analyze environmental data using the most appropriate statistical analysis tools, with the help of theoretical lessons, practical lessons and use of software. At the end of the course, students will be able to analyze environmental data. *The students will learn how to*: • determine the optimum number of environmental samples to obtain statistically reliable data, • create and interpret different statistical graphs, • study the relationship between two or more variables, • apply multivariate statistical analysis methods such as CA and PCA to environmental data.

	At the end of this educational activity, the student will have to demonstrate to be able to understand the statistical approaches and data analysis and to be able to choose, among these, those most suitable to solve problems of interest, critically analyzing the results. MAKING JUDGMENTS At the end of the training, the person must be able to analyze and interpret the experimental results obtained and discuss them in a logical manner.	
Prerequisite competencies of the course (what a student must know before taking it)	The course is in a graduating study program. To have access to it, students should have already obtained the bachelor, including also a "Mathematics and Statistical Principles" study program (7 ESTC).	Knowledge of algebra

The gathered information, as well as the peculiarities of teaching process in European partner university and in Armenia allow drawing the following concluding remarks:

1. As "Environmentral statistics" course should be newly developed, the information on the number of students etc. is missing.
2. In both cases, the course materials include common aspects of statistics which students must know, as well as both courses are target-oriented and based on the incorporation of all teaching and practical materials, softwares etc.
3. Use of softwares matches partially due to the license issues and features of open source statistical programs such as R statistics.

The prerequisites vary, as the students applying for Master's degree programs at ISEC have various backgrounds (sometimes, even students from humanities may apply for "Environmental Protection and Nature Management" Master's degree program), the general prerequisite is the knowledge of Algebra.

SOIL QUALITY MONITORING

Course Comparative Analysis

The information collected during the visits to the EU partner universities showed that there is a lack of similar course in "Water Quality Monitoring". Therefore, the Consortium decided to replace the abovementioned course with "Soil Quality Monitoring" which will be newly developed for Master's degree students studying at ISEC, Armenia. The proposed new course, "Soil Quality Monitoring", has an analogous course in UNITUS DIBAF department called "Monitoring Soil Quality" (http://www.unitus.it/en/dipartimento/dibaf/scienze-forestali-e-ambientali/articolo/presentazione6).

"Monitoring Soil Quality" course provided to UNITUS Master's degree students by the professor Maria Cristina Moscatelli is a part of *Forestry and Environmental Sciences* and includes the following chapters:

I. Introduction,
II. Indicators of soil quality and health,
III. Soil organic matters (SOM),
IV. Soil microbial biomass,
V. Mineralization processes (C & N mineralization),
VI. Soil enzymes,
VII. Drivers of global soil change,
VIII. How to plan a monitoring activity.

Additional details about the study processes and courses are provided in the below table.

European example from	University of Tuscia (UNITUS)	New course developed in Armenia
University/Program Profile		
Criterion A: University Profile		
Classic or applied	Applied	Both (Research University)
Overall number of students	49769	800
Number of Environment protection related disciplines	7 Bachelor courses and 7 Master courses considering DIBAF and DAFNE Departments	2
Number of Environment protection students	No data available	13
Criterion B: Program/discipline profile		

Theoretical or applied	Both	Both
Number of students	30/40	13
Role/part of the selected course(s) in the study program	"Monitoring Soil Quality" course provides theoretical bases and tools to start a monitoring program	"Soil Quality Monitoring" course will provide theoretical grounds regarding the features of soil of different areas, highlight the main parameters and methods how to measure and assess soil quality.
Course Settings		
Criterion C: Course type		
Bachelor or master level	Master Level	Master Level
Year/semester of studies (1/2/…)	1st year, 1st semester	2/1
Selective or mandatory	Mandatory	Mandatory
Theoretical / applied	Both	Both
Criterion D: Relations to other courses in the program		
Prerequisite courses	No prerequisite courses in the program	Environmental Statistics, Environmental Monitoring and Measurement Devices
Outcome courses	No outcome courses in the program	Thesis
If the course is a part of a group/cluster (from which it can be selected), other courses in this group	No data	None
Criterion E: Department teaching a course *Non-graduating / Graduating / Other*	*Graduating*	*Graduating*
Criterion F: Course load		
Overall number of credits according to ECTS regulations	6 ECTS	3 ECTS
Number of credits associated with particular course activities (lectures / tutorials / practical work / homework / etc.)	5 ECTS lectures, 1 ECTS laboratory practical classes/working group activities etc.	Lectures – 1 ECTS Practical and self-study – 2 ECTS
Teaching aspects		

Criterion G: Pedagogy		
Traditional place-based learning *Blended learning* *Flipped classroom* *MOOC* *Project-based learning* *Inquiry-based learning* *Collaborative learning* *Game-based learning*	Blended learning	Blended learning
Criterion H: Assessment		
Exams (how many, oral / written / test-like) *Testing (how often)* *Grade computation (contribution of each course activity to the final grade, availability of extra credits)*	1 final written test	1st midterm written exam 2nd midterm oral exam Final oral exam 2 times per semester Contribution of each course activity (100%): *Component 1 - Attendance, up to 2 points (10%)* *Component 2- 1st exam, up to 4 points (20%)* *Component 3 - 2nd exam, up to 4 points (20%)* *Component 4 - final exam, up to 10 points (50%)*
Criterion I: Teaching resources		
Teaching hours	48	24
Preparatory hours	No data available	0
Teaching assistants (grading / tutorials)	*1 laboratory technician during practical classes*	0
Labs and field	No data available	8
Use of technology		
Criterion J: Use of professional tools		
Name of the tool(s) used (lab devices/systems, software solutions, etc.) *Supported activities (tutorials, home works)* *Overall role of the tool*	Power point application during lectures and working group activities Excel application for data processing and statistics during laboratory activities	Soil sampling kit In situ pH meter Books, manuscripts and guidelines Not applicable

(essential instrument that must be learnt or one way to help learn the rest the material easier)		
Criterion K: Use of TEL-systems		
Name and type of the tool used (if any)	None	None
Supported activity (assessment, home works, exam preparation)		
Role on the course (mandatory component / extra credit opportunity / fully optional supplementary tool)		
Course statistics		
Criterion L: Course statistics		
Average number of students enrolled in the course	2017/2018 - 23 students	Not applicable
Average percentage of students successfully finishing the course	80%	Not applicable
Average grades distribution	25-26/30	Not applicable
Percentage of international students	80-90%	Not applicable
Overall student demographics (gender, age, nationality, scholarships, etc.)	No data available	Not applicable
Average rating of the course by students	Good	Not applicable
Course content		
Criterion M: Course competency profile		
Outcome competencies of the course (computing-related	1. Acknowledge soil as a living, dynamic, vulnerable resource	1. Learn soil features of urban, mining and agricultural areas 2. Know a basic set of indicators to

must learn in it)	2. Learn concepts of soil quality, health and security 3. Know a basic set of indicators to monitor soil quality 4. Learn how to choose the right indicators in relation to specific case studies in forest environment	monitor soil quality 3. Learn how to choose the right indicators in relation to specific case studies in anthropogeincally impacted environment
Prerequisite competencies of the course (what a student must know before taking it)	Suggested prerequisites: Soil science, Biochemistry and Microbiology	Not applicable

The collected information, as well as the features of teaching process in the European partner university and in Armenia allow arriving at the following concluding remarks:

- The limited number of ESTC credits of newly developed "Soil Quality Monitoring" course is restricting the incorporation of the entire teaching materials from the European analogous course.
- Considering the local features of soil and environmental issues in Armenia, as well as the material provided to students within other courses of Master's degree program, "Soil Quality Monitoring" newly developed course will mainly focus on soil features of urban, mining and agricultural areas targeting environmental pollution issues and parameters controlling and affecting the soil quality.

ENVIRONMENTAL GEOCHEMISTRY

Course Comparative Analysis

The information compiled from EU universities and project consortium on "Environmental Geochemistry" course for comparative analysis showed that the most similar course for Master's students is offered by the University of Naples Federico II (http://www.international.unina.it/), Italy.

The table summarizes the results of the comparison:

Criterion/ Details	European example from University of Naples Federico II	Environmental Geochemistry course at ISEC (Armenia)
University/Program Profile		
Criterion A: University profile		
Classic or applied:	Both	Both (Research and educational Center)
Overall number of students	78324	*800*
Number of Environment protection related disciplines	*5 (Geology and applied geology; Chemical and Environmental Toxicology; Natural Science; Forest and Environmental Sciences; Environmental and land engineering)*	*2*
Number of Environment protection students	300	*15*
Criterion B: Program/discipline profile		
Theoretical or applied	Applied	Both
Number of students	50	13 (2018/2019)
Role/part of the selected course(s) in the study program	Course is specific to student selecting the topic A1(Mineralogical, petrographic and geochemical disciplines) among 4 available.	The course is mandatory for students.
Course Settings		
Criterion C: Course type		
Bachelor or master level	Master	Master
Year/semester of studies	2nd year/ 1st semester	2nd year/ 1st semester
Selective or mandatory	Selective	Mandatory
Theoretical / applied	Both	Both
Criterion D: Relations to other courses in the program		
Prerequisite courses	*Mathematics, Chemistry, Geochemistry, Petrography, Geology, Geomorphology,*	Environmental monitoring and measurement devices, research logic, thematic cartography

	Geophysics.	
Outcome courses	None	None
If the course is a part of a group/cluster (from which it can be selected), other courses in this group	Geochemical site characterization and risk analysis; Isotope geochemistry and its applications; Technological and environmental applications of industrial minerals	No, it is not a part of any course.
Criterion E: Department teaching a course		
Non-graduating / Graduating / Other:	Graduating	Graduating
Criterion F: Course load		
Overall number of credits according to ECTS regulations	6 ECTS	4 ESTC
Number of credits associated with particular course activities (lectures / tutorials / practical work / homework / etc.):	4 ECTS for lectures; 2 ECTS for laboratory (practicals)	No data
Teaching Aspects		
Criterion G: Pedagogy		
Blended learning *Flipped classroom* *MOOC* *Project-based learning* *Inquiry-based learning* *Collaborative learning* *Game-based learning*	Blended learning: yes (in room equipped with media centers connected to the web)	*Blended learning:* + *Flipped classroom:* - *MOOC:* - *Project-based learning:* - *Inquiry-based learning:* + *Collaborative learning*: - *Game-based learning:* +
Criterion H: Assessment		
Exams (how many, oral / written / test-like) *Testing (how often)* *Grade computation (contribution of each course activity to the final grade, availability of extra credits)*	1 exam every month for three times after the course completion then 1 exam every two months. Exam consists of written and oral tests. The written test consists of answering to 15 multiple choice questions. The oral exam consists of a discussion on lecture topics. No tests during the course Course activities are not used for final grade. Final grade is the result of the final exam.	Assessment is based on: *- 2 midterm exams (including 1 written and 1 oral exams)* *- 1 final exam – oral* every 3rd lesson is testing, mostly oral Contribution of each course activity (100%): Component 1 - Attendance, up to 2 points (10%) Component 2- 1st exam, up to 4 points (20%) Component 3 - 2nd exam, up to 4 points (20%) Component 4 - final exam, up to 10 points (50%)

Criterion I: Teaching resources		
Teaching hours *Preparatory hours* *Teaching assistants (grading / tutorials)* *Labs*	*Teaching:* ***56*** *Preparatory:* ***none*** *Teaching assistants:* ***1*** *Labs:* ***1***	*Teaching:* **24 lectures,** practical **8** *Preparatory hours*: **none** *Teaching assistants:* **none** *Labs: -88*
Use of Technology		
Criterion J: Use of professional tools		
Name of the tool(s) used (lab devices/systems, software solutions, etc.) *Supported activities (tutorials, home works)* *Overall role of the tool (essential instrument that must be learnt or one way to help learn the rest the material easier)*	Open source GIS software for mapping; Microsoft Excel, Kaleidagraph for statistical analysis of geochemical data. *Laboratory (practicals); Homeworks* Essential for the lab activity	Lab and field equipment, computers Lab, practical activities and homework essential for lab, practical activities and research
Criterion K: Use of TEL-systems		
Name and type of the tool used (if any) *Supported activity (assessment, home works, exam preparation)* *Role on the course (mandatory component / extra credit opportunity / fully optional supplementary tool)*	None	None
Course Statistics		
Criterion L: Course statistics		
Average number of students enrolled in the course	**8**	7
Average percentage of students successfully finishing the course	90 %	88 %
Average grades distribution	27/30	15.6/20
Percentage of international students	15 %	0 %
Overall student demographics (gender, age, nationality, scholarships, etc.)	No data	78 % female, 100 % Armenian, 6%
Average rating of the course by students	No data	4.9/5
Course Content		
Criterion M: Course competency profile		
Outcome competencies of the course (what students must learn in it)	The students must be able to apply their knowledge and understanding, and problem	Course will provide knowlede on basic geochemical processes, phenomena, geochemical methods

	solving abilities in the multidisciplinary contexts related to Environmental Geochemistry. Students may know how to elaborate even complex discussions concerning the various topics studied, the acquisition and reprocessing of geochemical environmental data	and features of research, will provide necessary theoretical and practical knowledge and skills to assess the ways, types, scale, levels, hazards and risks of pollution of various compartments of the environment. It will also give an opportunity to get acquainted with possible measures to reduce environmental pollution levels. The knowledge gained is important for a wide range of environmental sciences, applied geology and geography etc.
Prerequisite competencies of the course (what a student must know before taking it)	Knowledge of geochemistry, fundamentals of statistics and GIS mapping techniques.	Basic principles of chemistry, biology, geography, geology. Computer skills, knowledge of languages (Russian, English).

The comparative analysis of data shows that there are essential differences between UNF and ISEC in “Criterion A and B” mostly in terms of students' number, including students in environmental protection. The course is mandatory for ISEC students and is selective for one of the topics of the UNF master course. Both courses are taught in the same semester and both include theoretical and applied parts. Prerequisites of course are different as well; ISEC course is a complete course. The overall number of credits is more in UNF, and the testing and teaching system is completely different. Comparison of ''Criterion J” shows that the practical tools are more focused in UNF. TEL-systems are not used by both universities. Differences between average number of students enrolled and finishing the course is more or less the same. In a broad sense, the focus and outcomes for students are the same in two courses.

The comparison of the data given in table and the syllabus of the UNF allowed concluding that

1. At ISEC, the course is more about "environmental" part of "Environmental geochemistry" course, as it targets at environmentalists rather than geologists.
2. At ISEC, course theoretical part is dominating. As a rule, students at ISEC come from different disciplines which require paying more attention to theory.
3. The main differences are due to fewer credits and teaching hours of the course at ISEC and geochemical features and environmental issues in Armenia.
4. The comparison was very useful specifically in terms of the practical part of the course. Most themes will not be changed drastically due to the features of Armenian geochemistry, background of students and the chair, in general, but the pratical part of the course will be revised, as it is more interesting and comprehensive at UNF.

FOOD SAFETY RISK ASSESSMENT

Course Comparative Analysis

It is important to note that during the visits to EU partner Universities for the implementation of syllabus comparative analysis the discussions were organized, particularly regarding the quality of syllabi development. The definition and probable changes of "defense" with "protection" was also discussed during the presentation within the frames of the study visit to University of Tuscia. After that the importance of integration of food safety and risk assessment was discussed with Professor Merendino in order to avoid from overlapping with the course of risk assessment. It was agreed with Professor Merendino to investigate European best practices and select most relevant and similar course which was "Food Safety" and "Risk Assessment" studied in Wageningen University & Research (WUR). Wageningen University & Research (WUR) is a globally leading university and research organization in the fields of agriculture, healthy food and the living environment. Wageningen University is one of the few universities in Europe with the ability to offer education and research in all fields of food safety, which includes not only technical disciplines such as microbiology and toxicology, but also the legal, economic, risk management and communication aspects of food safety.

Additional details about the Wageningen University & Research (WUR) study processes and course are provided in the below table.

CRITERION/ DETAILS	EUROPEAN EXAMPLE FROM WAGENINGEN UNIVERSITY & RESEARCH	COURSE TO BE MODERNIZED IN ARMENIA
University/Program Profile		
Criterion A: University profile		
Classic or applied:	Applied *(Research and education combined)*	Both *(Academic)*
Overall number of students	12 000 including[1]: *Bachelor's students - 5655* *Master's students - 5822* *Other enrolments -523* Percentage of international students: *Bachelor's students - 3%* *Master's students - 40 %*	*800*
Number of Environment protection related disciplines	*55*[2]	*1*
Number of Environment protection students	Environmental Sciences (BMW)[1] *1st year Bachelor's students - 60*	*Master's students - 15*

[1]*Annual report Wageningen UR 2017 (source: https://www.wur.nl/upload_mm/b/0/4/77eb4b5b-78f7-4143-a2dc-6dce1f77dc2b_Jaarverslag%20WUR%202017%20definitief_UK_Totaal_LR.PDF).*
[2]*Source:https://ssc.wur.nl/Handbook/Programme/MES*

	All students - 168 Environmental Sciences (MES) *1st year Master's students - 97* *All students – 336*	
Criterion B: Program/discipline profile		
Theoretical or applied	Applied	Both theoretical or applied
Number of students	56	13
Role/part of the selected course(s) in the study program	Food safety risk assessment is one of the thesis track-related subjects but as a part of the specialization of Applied Food Safety.	Food safety risk assessment will become one of the compulsory courses of Environmental Protection and Nature Management Master's degree program. "Food Safety Primary Protection" subject for several years was as an elective course, but the aim and scope of that curriculum was different and didn't include the part of risk assessment.
Course Settings		
Criterion C: Course type		
Bachelor or master level	Master level	Only for master level
Year/semester of studies	1st year/ period 5 (March/April)	1st year/1st semester
Selective or mandatory	Mandatory as a thesis track-related subject (compulsory unless advised otherwise). *Note:* Compalsory for specialization of applied food safety.	Mandatory
Theoretical / applied	Applied	Theoretical
Criterion D: Relations to other courses in the program		
Prerequisite courses	Toxicology; Advanced Food Microbiology.	Not required
Outcome courses	Food safety risk management Thesis	Thesis
If the course is a part of a group/cluster (from which it can be selected), other courses in this group	Food safety risk assessment is one of the thesis track-related subjects and it is compulsory unless advised otherwise[3], other subjects are: *MSc Food safety risk assessment* *MS thesis food safety risk assessment*	Food safety risk assessment is not a part of a course group/cluster
Criterion E: Department teaching a course		

[3] *https://www.wur.nl/en/Education-Programmes/master/MSc-programmes/MSc-Environmental-Sciences/Thesis-tracks/Environmental-Toxicology.htm*

Non-graduating / Graduating / Other:	Food safety risk assessment is a compulsory part of "Applied Food Safety" Master's degree programme (graduating) at Education unit (department) of food microbiology.	Graduating
Criterion F: Course load		
Overall number of credits according to ECTS regulations	6 credits	4 credits
Number of credits associated with particular course activities (lectures / tutorials / practical work / homework / etc.):	Credits 6.00 Teaching method Contact hours Lecture 24 Tutorial 4 Practical 20 Group work 5	1st midterm exam: up to 4 points (20%) 2nd midterm exam: up to 4 points (20%) Final exam: up to 10 points (50%) Attendance: up to 2 points (10%)
Teaching Aspects		
Criterion G: Pedagogy		
Blended learning *Flipped classroom* *MOOC* *Project-based learning* *Inquiry-based learning* *Collaborative learning* *Game-based learning*	Collaborative learning	Collaborative learning
Criterion H: Assessment		
Exams (how many, oral / written / test-like) *Testing (how often)* *Grade computation (contribution of each course activity to the final grade, availability of extra credits)*	The minimum mark for PGO is 5.5 and constitutes 30% of the final mark. The exam is composed of closed (50%) and open questions (50%), it constitutes 70% of the final mark, and a minimum of 5.5 is required to pass.	Assessment is based on: *- 2 midterm exams (including 1 written and 1 oral exams)* *- 1 final exam - oral* Contribution of each course activity (100%): *Component 1- Attendance, up to 2 points (10%)* *Component2- 1st exam, up to 4 points (20%)* *Component 3- 2nd exam, up to 4 points (20%)* *Component 4- final exam, up to 10 points (50%)*
Criterion I: Teaching resources		
Teaching hours *Preparatory hours* *Teaching assistants (grading / tutorials)* *Labs*	Teaching method Contact hours Lecture 24 Tutorial 4 Practical 20 Group work 5	Total 90 hours, including: *lecture - 24 hours* *practical - 8 hours* *individual/ self-work- 58 hours*

Use of Technology		
Criterion J: Use of professional tools		
Name of the tool(s) used (lab devices/systems, software solutions, etc.) *Supported activities (tutorials, home works)* *Overall role of the tool (essential instrument that must be learnt or one way to help learn the rest the material easier)*	The course is set-up as integration between lectures, practicals, computer sessions, videos and excursion.	The course is set-up as integration between lectures, practice lessons, computer sessions and videos.
Criterion K: Use of TEL-systems		
Name and type of the tool used (if any) *Supported activity (assessment, home works, exam preparation)* *Role on the course (mandatory component / extra credit opportunity / fully optional supplementary tool)*	The information is not available	-
Course Statistics		
Criterion L: Course statistics		
Average number of students enrolled in the course	**56**	New curriculum
Average percentage of students successfully finishing the course	-	-
Average grades distribution	-	
Percentage of international students	40	0%
Overall student demographics (gender, age, nationality, scholarships, etc.)	-	
Average rating of the course by students	-	
Course Content		
Criterion M: Course competency profile		
Outcome competencies of the course (what students must learn in it)	This course is a combination of formal lectures, case studies, laboratory classes and written and oral presentations. In the case studies, small groups of students will work on a risk assessment of different food products, which will be finalised by a group report. The course will provide an overview of the most important bacterial, myco- and fycotoxins, their presence and	The food safety risk assessment course will be a combination of the basics of food safety, protection and chemical risk assessment. Taking into consideration the fact that the course is elaborated for MSc students in the field of environmental protection and nature management the case studies will be linked to the environmental contaminants,

	mechanisms of toxic action and detoxification mechanisms. Bacterial virulence mechanisms and host responses will be discussed, including dose-response relationships. The effect of processing (e.g. heating) on food safety, including survival of pathogens, formation of heterocyclic amines, PAKs and oxidation products are reviewed. Microbiological and Toxicological risk assessment will be discussed including predictive modelling techniques and genetic polymorphisms for detoxication in man. In addition, during the practical course experience with rapid detection of microbial toxins and with benchmark dose modelling of dose response curves of chemical contaminants will be obtained. After successful completion of this course students are expected to be able to: - describe the occurrence of food-borne pathogens and provide an inventory of their toxins and actions; - debate the effect of processing on the occurrence of toxic compounds and the level of pathogens present; - distinguish host responses to pathogens and their toxins; - discuss the role of the gut microbiota in toxicological risks of food-borne chemicals; - compare and apply dose response models; - define and present tools for setting up (combined) microbiological and toxicological risk evaluations; - explain the results of a combined microbiological and toxicological risk assessment in an oral	heavy metals, POPs, pesticides, radionuclides etc. Both the private part of the subject and the general will be planned highlighting the importance of chemical risk assessment. After successful completion of this course students are expected to be able to: - describe the occurrence of food-borne pathogens and provide an inventory of their toxins and actions; - debate the effect of the occurrence of contaminates; - distinguish acute and chronic risk assessment mythologies; - discuss the toxicological risks of food-borne chemicals; - compare and apply dose response models; - define and present tools for setting up (combined) chemical and toxicological risk evaluations; - explain the results of chemical and toxicological risk assessment in an oral presentation and a written report.

	presentation and a written report.	
Prerequisite competencies of the course (what a student must know before taking it)	Food microbiology	Prior to the course it is assumed that students have basic knowledge of biology and biochemistry.

The comparative analysis allows making the following recommendations:

Wageningen University is one of the few universities in Europe with the ability to offer education and research in all fields of food safety. This includes not only technical disciplines such as microbiology and toxicology, but also the legal, economic, risk management and communication aspects of food safety. Food safety and food safety risk assessment are included in the learning programs of the University, but basics of food safety module for 2 credits is online meanwhile food safety risk assessment course for 6 credits is mandatory for the specialization of applied food safety. It is worth mentioning that University is offering a lot of linked courses such as food hazard, food safety risk management, food safety economics, food law, but ISEC must incorporate them in one course which must include hazards, economic and legal parts as well as risk assessment part, so the best solution will be to elaborate one course, food safety risk assessment, into 4 credits, which will highlight environmental aspects of food safety and risk assessment. The main case studies will be focused not only on microbiological and fungal issues but also will include chemical risk assessment particularly the risk assessment of environmental contaminants POPs, heavy metals etc.

The outcomes of comparative analysis of syllabi of Wageningen University and the developed new curriculum at ISEC allow making the following conclusions:

- Program Profiles of Wageningen University is different. The WUR is one of the few universities in Europe with the ability to offer education and research in all fields of food safety. The overall number of students; the number of environmental protection related disciplines does not also match due to the fact that WUR is a first University in Europe in the field of environment and food.
- Criterion C and D match partially. WUR has perfect link and prerequisite for food safety risk assessment and logistic continuation of the course with risk management, total 12 credits. ISEC doesn't have a course requisite, so the lecturer must involve the basics of food safety also in this course within the frame of 4 credits highlighting the aspects of chemical risk assessment.
- Course Settings (Criterion C-F) match partially. ISEC will have 4 credits, including the basics of food safety, so the microbiological part will be shortened.
- Teaching aspects (Pedagogy) will be organized in compliance with WUR requirements. Criterion H (Assessment) will be taken into consideration. Usually at

ISEC there are no multiple choice questions, but for the group work and quizzes kahoot can be considered as an effective tool for teaching. Criterion I (Teaching resources) will be harmonised with WUR.

- Use of technology matches partially due to the difference in infrastructures. Anyway, the private visits to the labs and productions will be organised for students to match that parameter, as well.
    - Course content (Criterion M) matches partially. At ISEC, the courses are planned for smaller number of credits.

With this analysis, the overall goal and main outcomes, teaching aspects, and other features of "Food Safety Risk Assessment" syllabus will be developed taking into consideration the similar syllabi at Wageningen University.

ENVIRONMENTAL TOXICOLOGY

Course Comparative Analysis

The issues concerning ISEC "Environmental Toxicology" course modernization was discussed during the visits to partner Universities. Particularly, the colleagues from University of Tuscia presented detailed information on "Applied Ecology and Ecotoxicology course". Taking into consideration the fact that this course is designed for a master's degree program in marine ecology, together with colleagues from University of Tuscia we decided to find the most relevant course intended for the Environmental Sciences master's program. Eventually, the collected information about the EU Universities for the implementation of sullabus comparative analysis allows us to identify the most relevant and similar course which is "Environmental Toxicology" course at Wageningen University & Research (WUR). Wageningen University & Research (WUR) is a globally leading university and research organization in the fields of agriculture, healthy food, and the living environment. It is important to note that the Environmental Sciences master's program in Wageningen has its roots in the natural, technological, and social sciences. Students gain insight into the socio-economic causes and the characteristics of pollution and degradation of the natural environment, including the effects on human beings, the atmosphere, ecosystems, and other organisms. It is noteworthy that this two-year program is based on an interdisciplinary approach. Students learn to develop analytical tools and models, as well as technologies, socio-political arrangements, and economic instruments to prevent and control environmental and sustainability issues[4].

Additional details about the Wageningen University & Research (WUR) study processes and course are provided in the below table.

CRITERION/ DETAILS	EUROPEAN EXAMPLE FROM WAGENINGEN UNIVERSITY & RESEARCH	COURSE TO BE MODERNIZED IN ARMENIA
University/Program Profile		
Criterion A: University profile		
Classic or applied:	Applied *(Research and education combined)*	Both *(Academic)*
Overall number of students	12 000 including[5]: *Bachelor's students - 5655* *Master's students - 5822* *Other enrolments - 523* Percentage of international	*800*

[4] *Source: https://www.wur.nl/en/Education-Programmes/master/MSc-programmes/MSc-Environmental-Sciences.htm*

[5] *Annual report Wageningen UR 2017 (source: https://www.wur.nl/upload_mm/b/0/4/77eb4b5b-78f7-4143-a2dc-6dce1f77dc2b_Jaarverslag%20WUR%202017%20definitief_UK_Totaal_LR.PDF).*

	students: *Bachelor's students - 3%* *Master's students - 40 %*	
Number of Environment protection related disciplines	*3* [6]	*1*
Number of Environment protection students	Environmental Sciences (BMW)[1] *1st year Bachelor's students - 60* *All students - 168* Environmental Sciences (MES) *1st year Master's students - 97* *All students - 336*	*Master's students - 15*
Criterion B: Program/discipline profile		
Theoretical or applied	Applied	Both theoretical or applied
Number of students	No available data	13
Role/part of the selected course(s) in the study program	Environmental Toxicology is one of the thesis track-related subjects and part of the MSc program Environmental Sciences when selecting the thesis track Environmental Toxicology.	Environmental Toxicology is one of the compulsory courses of at Department of Environmental Protection and Nature Management.
Course Settings		
Criterion C: Course type		
Bachelor or master level	Both for bachelor and master level	Only for master level
Year/semester of studies	1st year/ period 5 (March/April)	1st year/1st semester
Selective or mandatory	Mandatory as a thesis track-related subject (compulsory unless advised otherwise). *Note: Restricted Optional for MES Environmental Sciences.*	Mandatory
Theoretical / applied	Both theoretical and applied	Theoretical
Criterion D: Relations to other courses in the program		
Prerequisite courses	Not specified	Not required
Outcome courses	Environmental Risk Assessment of Chemicals	Food Safety Risk Assessment *(which will be newly developed in the frame of MENVIPRO project)*
If the course is a part of a group/cluster (from which it can be selected), other courses in this group	Environmental Toxicology is one of the thesis track-related subjects and it is compulsory unless advised otherwise[7], other subjects are: *Environmental Risk Assessment of Chemicals* *MSc Internship Toxicology*	Environmental Toxicology is not a part of a course group/cluster

[6] *Source: https://ssc.wur.nl/Handbook/Master*

[7] *https://www.wur.nl/en/Education-Programmes/master/MSc-programmes/MSc-Environmental-Sciences/Thesis-tracks/Environmental-Toxicology.htm*

	MSc Thesis Toxicology	
Criterion E: Department teaching a course		
Non-graduating / Graduating / Other:	*Other:* Environmental Toxicology is a specialisation of the sub-department of Toxicology	Graduating
Criterion F: Course load		
Overall number of credits according to ECTS regulations	6 credits	4 credits
Number of credits associated with particular course activities (lectures / tutorials / practical work / homework / etc.):	Exam: 60% of overall credits Practical skills: 20% of overall credits Case simulation: 20% of overall credits	1st midterm exam: up to 4 points (20% of overall credits) 2nd midterm exam: up to 4 points (20% of overall credits) Final exam: up to 10 points (50% of overall credits) Attendance/active participation: up to 2 points (10% of overall credits)
Teaching Aspects		
Criterion G: Pedagogy		
Blended learning *Flipped classroom* *MOOC* *Project-based learning* *Inquiry-based learning* *Collaborative learning* *Game-based learning*	Collaborative learning	Collaborative learning
Criterion H: Assessment		
Exams (how many, oral / written / test-like) *Testing (how often)* *Grade computation (contribution of each course activity to the final grade, availability of extra credits)*	Assessment is based on three outcomes: *- exam: in this exam the theoretical base of environmental toxicology is assessed, using multiple choice questions (60%);* *- practical skills: this is tested with a written report and a group presentation. This also include work attitude (20%);* *- case simulation: the students work on a group assignments dealing with a case study. Students are evaluated by their (joint) poster and pitch presentation (20%).*	Assessment is based on: *- 2 midterm exams (including 1 written and 1 oral exams)* *- 1 final exam - oral* Contribution of each course activity (100%): *Component 1 - Attendance, up to 2 points (10%)* *Component 2- 1st exam, up to 4 points (20%)* *Component 3 - 2nd exam, up to 4 points (20%)* *Component 4 - final exam, up to 10 points (50%)*
Criterion I: Teaching resources		
Teaching hours *Preparatory hours* *Teaching assistants (grading /*	Total 99 hours, including: *lecture - 24 hours* *practical - 72 hours*	Total 90 hours, including: *lecture - 24 hours* *practical - 8 hours*

tutorials) *Labs*	*excursion (one day) - 3 hours* In the practical part of the course students study the toxic properties of 1 specific toxicant themselves. Applying a set of modern in vitro assays students address the mutagenicity, cytotoxicity, estrogenicity and general toxicity of the compound.	*individual/ self-work- 58 hours* In the practical part of the course students study the toxic properties of specific toxicants using the literature data. A particular focus will be on characterization of the absorption, distribution, metabolism and excretion (ADME) of contaminant.
Use of Technology		
Criterion J: Use of professional tools		
Name of the tool(s) used (lab devices/systems, software solutions, etc.) *Supported activities (tutorials, home works)* *Overall role of the tool (essential instrument that must be learnt or one way to help learn the rest the material easier)*	The course is set-up as an integration between lectures, practicals, computer sessions, videos and excursion. Lectures and the excursion provide detailed information on the relevant topics of the course. An intensive practical enables students to acquire hands-on experience in designing, performing and analysing experimental dose-response studies. Group assignment focuses on a case study based on a computer simulation model[8].	The course is set-up as an integration between lectures, practicals, computer sessions and videos. Lectures provide detailed information on the relevant topics of the course. During the self-works/home work students do literature assignments, then write a report. Lectures also include an overview of scientific sources for toxicological data, important legislation, and examples of the differences between the various authorities working in the field.
Criterion K: Use of TEL-systems		
Name and type of the tool used (if any) *Supported activity (assessment, home works, exam preparation)* *Role on the course (mandatory component / extra credit opportunity / fully optional supplementary tool)*	No available information No available information Mandatory for students working on thesis in the field of environmental toxicology	Not applicable Home work and support for exam preparation Course provides valuable knowledge which can help students to get acquainted with other environment protection related disciplines
Course Statistics		
Criterion L: Course statistics		
Average number of students enrolled in the course	No available data	7
Average percentage of students successfully finishing the course		88 %
Average grades distribution		17.7 out of 20 point
Percentage of international students		0 %
Overall student demographics (gender, age, nationality,		78 % female, 100 % Armenian

[8] *Source: https://ssc.wur.nl/Handbook/Course/TOX-30806*

scholarships, etc.)		
Average rating of the course by students		4.43 out of 5 point
Course Content		
Criterion M: Course competency profile		
Outcome competencies of the course (what students must learn)	After successful completion of the course students are expected to be able to: 1. summarise the most relevant terms, principles and methods in environmental toxicology; 2. distinguish the main sources and types of environmental pollutants and assess their potential environmental fate; 3. evaluate the characteristics of compounds, organisms and ecosystem for their consequences for environmental fate and effect propagation; 4. design and execute toxicological dose-response experiments in a comprehensive way, analyze and critically discuss the results (written); 5. create an experimental approach with meaningful endpoints to assess the environ-mental and human risks for a topical environ-mental contamination case; 6. get acquainted with different roles of the stakeholders in the risk assessment process, integrating the knowledge and expertise gained in the course in a computer simulation case study; 7. give due consideration to the ethical, legal, social and policy implications of environmental toxicological research, uncertainties and communication.	After successful completion of the course students are expected to be able to: 1. summarise the most relevant terms, principles and methods in environmental toxicology; 2. distinguish the main sources and types of environmental contaminants/toxicants and their potential adverse effects; 3. describe the relationship between dose and response; 4. describe the mechanisms of toxicity of environmental contaminants (principles of toxicokinetics and toxicodynamics); 5. have knowledge in risk assessment and management of contaminants.
Prerequisite competencies of the course (what a student must know before taking it)	Prior to the course it is assumed that the information of chapters 7 and 8 of the book used in the course (*Walker, C.H.; Sibly, R.M.; Hopkin, S.P.; Peakall, D.B. (2006). Principles of Ecotoxicology*) is	Prior to the course it is assumed that students have a high-school familiarity with biology and chemistry, but no prior knowledge of environmental toxicology.

	known to the students.	

In general, it can be concluded that both courses are designed to give an overview of different aspects playing a role in the challenging field of environmental toxicology. Nevertheless, the comparative analysis indicates some differences (*course type, course load, teaching resources*) which can be explained not only by insufficient technical capacities of ISEC (*particularly, for carrying out in vitro assays of compound mutagenicity, cytotoxicity, and estrogenicity*) but also by the number of students involved in the course. Moreover, "Environmental toxicology" course in ISEC should not focus on risk assessment and management of contaminants, as it will be considered within the frames of other courses (*e.g., food safety risk assessment*). At the same time, it is important to stress that after course students have to get acquainted with different principles and approaches for the elimination and prevention of adverse effects of toxic substances on the environment and human health.

Overall, the comparative analysis allows taking into account the main content of the "Environmental toxicology" course at Wageningen University & Research in the process of modernization of "Environmental toxicology" course at ISEC.

APPLIED REMOTE SENSING

Course Comparative Analysis

During the visits to the EU partner Universities for the implementation of syllabuscomparative analysis we have identified "Principles of Remote Sensing and Modeling" course presented by Professor Raffaelle Casa from University of Tuscia (Italy). The presentations provided details on:

- Objectives of the course
- Expected results and knowledge
- Program
- Lectures and practical applications (exercise)
- Suggested references
- Assessment methodology

Thus, the information about the course taught in University of Tuscia was provided by Professor Raffaele Casa. Additional information was gained from the official website http://olddibaf.unitus.it/web/insegnamenti.asp?codice=16341&anno=2014.

Another course "Applied Remote Senisng" is offered by Martin Luther University Halle-Wittenberg (Germany). The information about the course taught at Martin Luther University Halle-Wittenberg (Germany) was prodided by Professor Cornelia Glaesser.

Based on these two courses, the analogous course is planned to be developed at ISEC in Armenia.

Additional details about the course taught are provided in the below table:

European example from **University of Tuscia (Italy)**	European example from **Martin Luther University Halle-Wittenberg (Germany)**	New course to be developed at **ISEC (Armenia)**
University/Program Profile		
Criterion A: University profile: **University of Tuscia** *Classic or applied: Applied* *Overall number of students: > **7700*** *Number of Environment protection related disciplines – N/A*	**Criterion A:** University profile: **Martin Luther University Halle-Wittenberg** *Classic or applied: Classic* *Overall number of students:* 19,901 *Number of Environment protection related disciplines – 4 (*Geographie; International Area	**Criterion A:** University profile: **ISEC** *Classic or applied: **Research-based university*** *Overall number of students: **800 (2018)*** *Number of Environment protection related discipline: 2* *Number of Environment protection students: 13*

Number of Environment protection students- N/A	Studies; Management of natural resources; Applied Geosciences*)* *Number of Environment protection students* **Bachelor: 537** (as per 31.10.2018) **Master: 394** (as per 31.10.2018)	
Criterion B: Program/discipline profile *Theoretical or applied:* ***Both*** *Number of students –N/A* *Role/part of the selected course(s) in the study program:* ***The course aims to give an introduction to the concepts of optical remote sensing with particular emphasis on the applications in environmental studies using also a number of practical cases.***	**Criterion B:** Program/discipline profile *Theoretical or applied:* ***Both*** *Number of students* –20 *Role/part of the selected course(s) in the study program :* ***The course aims to introduce the theory and applications of spatial analysis, modeling and visualization in landscape analysis, using remote sensing data. During the course, students are trained in software familiarization and methods for processing and visualization in scientific work.***	**Criterion B:** Program/discipline profile *Theoretical or applied:* ***Both*** *Number of students -* ***13*** *Role/part of the selected course(s) in the study program:* ***Mandatory course for Master students***
Course Settings		
Criterion C: Course type *Bachelor or master level:****Master*** *Year/semester of studies (1/2/…) –* ***N/A*** *Selective or mandatory –* ***N/A*** *Theoretical / applied:* ***Both***	**Criterion C:** Course type *Bachelor or master level:****Master*** *Year/semester of studies (1/2/…) –* ***1*** *Selective or mandatory:* ***Selective*** *Theoretical / applied:* ***Both***	**Criterion C:** Course type *Bachelor or master level:* ***Master*** *Year/semester of studies (1/2/):2/1* *Selective or mandatory:* ***Mandatory*** *Theoretical / applied:* ***Applied***
Criterion D: Relations to other courses in the program *Prerequisite courses:* ***N/A*** *Outcome courses:* **N/A** *If the course is a part of a group/cluster (from which it can*	**Criterion D:** Relations to other courses in the program *Prerequisite courses:* Geomatic (M01d) (desirable) *Outcome courses:* **N/A** *If the course is a part of a group/cluster (from which it can be selected), other courses in this*	**Criterion D:**Relations to other courses in the program *Prerequisite courses:****GIS, Complex Geoecological mapping, Environmental Statistics*** *Outcome courses:* *If the course is a part of a group/cluster (from which it can be selected), other courses in this*

be selected), other courses in this group: ***N/A***	*group:* ***N/A***	*group:* ***N/A***
Criterion E: Department teaching a course: ***DIBAF*** *Non-graduating / Graduating / Other:* ***Graduating***	**Criterion E:** Department teaching a course: **Department of Remote Sensing and Cartography** *Non-graduating / Graduating / Other:* ***Graduating***	**Criterion E:** Department teaching a course: **GIS and Remote Sensing Department** *Non-graduating / Graduating / Other:* ***Graduating***
Criterion F: Course load *Overall number of credits according to* ***ECTS regulations – 6 ECTS*** *Number of credits associated with particular course activities (lectures / tutorials / practical work / homework / etc.):* ***N/A***	**Criterion F:** Course load *Overall number of credits according to* ***ECTS regulations – 5 ECTS*** *Number of credits associated with particular course activities (lectures / tutorials / practical work / homework / etc.):* ***N/A***	**Criterion F:** Course load *Overall number of credits according to ECTS regulations:* ***4*** *Number of credits associated with particular course activities: lectures / tutorials -/ practical work / homework / etc.):* ***lectures, practicals – 1 ECTS*** ***Individual (self-student studing) – 3 ECTS*** ***lectures, practicals***
Teaching aspects		
Criterion G: Pedagogy ***Traditional place-based learning*** ***Project-based learning*** ***Inquiry-based learning*** ***Collaborative learning***	**Criterion G**: Pedagogy ***Traditional place-based learning*** ***Project-based learning Inquiry-based learning Collaborative learning***	**Criterion G**: Pedagogy ***Traditional place-based learning*** ***Project-based learning*** ***Inquiry-based learning*** ***Collaborative learning***
Criterion H: Assessment **Knowledge of the theory and ability to apply the methods learned are evaluated trough the solution of complex practical cases, where clear knowledge of remote sensing basis, concepts and tools available is needed. The exam can be given in written or oral forms and the choice is left to the student.**	**Criterion H:** Assessment **in-between presentation (oral) final report (written) final report grade is the final module grade**	**Criterion H:** Assessment **Assessment is based on:** **- 2 midterm exams (including 1 written and 1 oral exams)** **- 1 final exam - oral** **Contribution of each course activity (100%):** **Component 1 - Attendance, up to 2 points (10%)** **Component 2- 1st exam, up to 4 points (20%)** **Component 3 - 2nd exam, up to 4 points (20%) Component 4 - final exam, up to 10 points (50%)**
Criterion I: Teaching resources ***Teaching hours – 40 hours***	**Criterion I:** Teaching resources ***Teaching hours – 45 hours***	**Criterion I:** Teaching resources ***Teaching hours – 24 hours***

Labs - 8 hours ***Teaching assistants (grading / tutorials)- N/A***	***Preparatory hours –60 hours*** ***Teaching assistance – 5 hours*** ***Field exercise with preparation and postprocessing - 10***	***Labs – 8 hours*** ***Preparatory hours –N/A*** ***Teaching assistance – N/A***
Use of technology		
Criterion J: Use of professional tools *Name of the tool(s) used:* *Lab devices/systems:* *software solutions:* ***QGIS, ESA toolboxes (e.g. SNAP), freeware tools(e.g. EnMAP toolbox QGIS for hyperspectral data), Matlab, Python, R*** *Supported activities:*	**Criterion J**: Use of professional tools ***software solutions:*** **ArcGIS, MS Office, R-Studio, ENVI, Erdas Imagine**	Criterion J: Use of professional tools *Name of the tool(s) used:* *lab devices/systems:* ***PCs, Open Data Cube, eBee Drone, GNSS*** *software solutions:* ***QGIS, ENVI, Agisoft/Pix4D*** *Supported activities:* ***tutorials, home-work, hands-on activities***
Criterion K: Use of TEL-systems **N/A**	**Criterion K**: Use of TEL-systems **Technology-Enhanced Learning Systems** • **ILIAS [German for "Integrated Learning, Information and Work Cooperation System"]** • **Audience Response Systems (ARSnova)**	**Criterion K**: Use of TEL-systems **N/A**
Course statistics		
Criterion L: Course statistics **N/A** *Average number of students enrolled in the course* *Average percentage of students successfully finishing the course* *Average grades distribution* *Percentage of international students* *Overall student demographics (gender, age, nationality, scholarships, etc.)*	**Criterion L:** Course statistics *Average number of students enrolled in the course:* ***15*** *Average percentage of students successfully finishing the course:* **90%** *Average grades distribution:* **2.3 (good)** *Percentage of international students:* **0%** *Overall student demographics (gender, age, nationality, scholarships, etc.):* ***N/A***	**Criterion L:** Course statistics **N/A** *Average number of students enrolled in the course:* *Average percentage of students successfully finishing the course:* *Average grades distribution:* *Percentage of international students:* *Overall student demographics (gender, age, nationality, scholarships, etc.):* *Average rating of the course by*

Average rating of the course by students	*Average rating of the course by students: **N/A***	*students:*
	Course content	
Criterion M: Course competency profile *Outcome competencies of the course:* Students are expected to gain knowledge and understanding of: • the fundamental principles of the data used and methods • applying knowledge and understanding needed for the practical application, in particular for the data collection, preparation and corrections. The applications and examples will also provide with the necessary background to develop their own judgment capacity in relation to the applicability of the methods in their specific cases. *Prerequisite competencies of the course:* No prerequisits	**Criterion M**: Course competency profile *Outcome competencies of the course:* Learning objectives: • Acquisition of spatial geodata by using remote sensing methods, • Methods and strategies for the analysis of remote sensing data. Topics: • Physical and mathematical principles of remote sensing, data preprosecing and remote sensing analyses, • Image Classification Techniques in Remote Sensing, • Index-based Assessment of vegetation • Selected Application Examples. *Prerequisite competencies of the course:* ***N/A***	**Criterion M**: Course competency profile *Outcome competencies of the course:* *Prerequisite competencies of the course:* Statistics

The comparative analysis of two syllabi at University of Tuscia (Italy), Martin Luther University Halle-Wittenberg (Germany) and ISEC allows arriving at the following conclusions:

- The key point is that three courses (two in Parner Universities and one to be developed by ISEC) are master courses.
- Course load (Criterion E-F) and Teaching aspects (Criterion G -Pedagogy) match very well.
- Criterion H (Assessment) differs but not so much. The assessment is carried out via written and oral mid-term and final exams.

- Use of technology generally matches (Criterion J). All three universities use GIS and Remote Senisng software and toolboxes. The use of Technology-Enhanced Learning Systems (TEL-system) in the Martin Luther University Halle-Wittenberg is noteworthy.
- Course competency profile (Criterion M) matches generally.

The comparative analysis of both course shows that program profiles for the partner universities has basic guidance for the development of newly proposed course despite the differences, mainly in course load, teaching resources, ECTS, which are conditioned with the specific features of the educational programs of the country. The differences will be revised and the courses will be adapted step by step.

GEOSPATIAL DATA MANAGEMENT & GEOCOMPUTATION FOR SUSTAINABLE DEVELOPEMENT

Course Comparative Analysis

The information collected during the visits to the EU partner universities for the implementation of syllabi comparative analysis allows identifyինգ that the partner ıniversities are of high proficiency in Information technology related courses, however, the concept of Special Data Infrastructures (SDI) is well developed at University of Geneva (Switzerland), in partnership with which CENS/ISEC develop "Spatial Data Infrastructure and Data Management" Master's degree course within the frames of Swiss-Armenian ARPEGEO project early in 2013 and which underpins "***Geospatial Data Management & Geocomputation for Sustainable Developement***" course.

Thus, experiencing difficulties with finding analogous courses in partner Universities, however, we have decided to modernize "***Geospatial Data Management & Geocomputation for Sustainable Developement***" course based on a modern course currently offered at University of Geneva (Switzerland) entitled "Geomatics for a Sustainable Environment", which gives a ***certificate of advanced studies (CAS)*** to any persons who interested in /or involved in environmental sustainability and natural capitals: biodiversity, water resources and ecosystem services.

The information about course of CAS was gained from the official website https://www.unige.ch/formcont/cours/casgeomatics.

Course description and requirements; proposed program, ESTC

"Geomatics for a Sustainable Environment" course is organized and developed by the enviroSPACE laboratory of Institute for Environmental Sciences and the Faculty of Sciences at University of Geneva.

The geographic information systems in environmental sustainability is of interest to young graduates, PhD students, experienced professionals who want to upgrade their knowledge and skills, employees and consultants from international organizations and from national or regional authorities in charge of these topics.

Additional details about the course are provided in the below table.

European example from **University of Geneva (Switzerland)**	New course to be developed in **CENS/ISEC (Armenia)**
University/Program Profile	
Criterion A: University profile: **University of Geneva (UNIGE)** *Classic or applied:* ***Applied*** *Overall number of students:* ***> 16000 students (2016)***	**Criterion A:** University profile: **ISEC** *Classic or applied:* ***Research-based university*** *Overall number of students:* ***800 (2018)*** *Number of Environment protection related*

Number of Environment protection related disciplines – N/A *Number of Environment protection students- N/A*	*discipline: 2* *Number of Environment protection students: 13*
Criterion B: Program/discipline profile *Theoretical or applied:* ***Both*** *Number of students 2017: 11 attendees; 2018: 9 attendees; 2019: 12 attendees* *Role/part of the selected course(s) in the study program :* ***This is a certificate of advanced studies (CAS) course for any person who is interested in /or involved in environmental sustainability and natural capitals: biodiversity, water resources and ecosystem services. This CAS is targeting in particular Swiss and foreign experts in GIS interested in environmental sustainability, young graduates, PhD students, experienced professionals who want to upgrade their knowledge and skills, employees and consultants from international organizations and from national or regional authorities in charge of these topics. It is providing attendees with an overview of the various existing tools and approaches to tackle the multidisciplinary environmental challenges.***	**Criterion B:** Program/discipline profile *Theoretical or applied:* ***Both*** *Number of students - 13* *Role/part of the selected course(s) in the study program:* ***Mandatory course for Master students.***
Course Settings	
Criterion C: Course type *Bachelor or master level:* ***a Cerificate of Advanced Studies (CAS) course*** *Year/semester of studies (1/2/…) –* ***N/A*** *Selective or mandatory –* ***N/A*** *Theoretical / applied:* ***Both***	**Criterion C:** Course type *Bachelor or master level:* ***Master*** *Year/semester of studies (1/2/…):* ***2/1*** *Selective or mandatory:* ***Mandatory*** *Theoretical / applied:* ***Applied***
Criterion D: Relations to other courses in the program *Prerequisite courses:* ***The course applicants must have:*** ***A recognized university degree (Bachelor, Master, PhD or equivalent)*** ***Relevant professional experience or research related to to geomatics and environment,*** ***Good computer skills, especially in GIS software.*** *Outcome courses:* ***Be able to design and develop environmental projects using geomatics tools*** ***Master the main geomatic, statistical and computer tools in the environmental field***	Relations to other courses in the program *Prerequisite courses:* ***GIS, complex geoecological mapping, fundamentals of sustainable development,*** *Outcome courses:* ***Applied Remote Sensing*** *If the course is a part of a group/cluster (from which it can be selected), other courses in this group:* ***N/A***

Become a player aware of the natural capital management in decision making at any scale and in all types of institution. *If the course is a part of a group/cluster (from which it can be selected), other courses in this group:* ***N/A***	
Criterion E: Department teaching a course *Non-graduating / Graduating / Other:* Institute for Environmental Sciences and Faculty of Sciences enviroSPACE laboratory ***Non-Graduating***	**Criterion E:** Department teaching a course *Non-graduating / Graduating / Other: GIS and Remote Sensing Department* ***Graduating***
Criterion F: Course load *Overall number of credits according to ECTS regulations –* ***10 ECTS*** *Number of credits associated with particular course activities (lectures / tutorials / practical work / homework / etc.):* ***N/A*** ***Teaching:*** ***1 ECTS (28 hours remotely: Module 1:MOOC)*** ***4 ECTS(90 hours in presence Module 2a: summer school),*** ***Dissertation: 145 hours (5 ECTS)*** ***Each module is a subject to an evaluation in order to be accredited***	**Criterion F:** Course load *Overall number of credits according to ECTS regulations: 4* *Number of credits associated with particular course activities:* *lectures / tutorials -/ practical work / homework / etc.):* ***lectures, practical s – 1 ECTS*** ***Individual (independent studies) – 3 ECTS*** ***lectures, practicals***
Teaching aspects	
Criterion G: Pedagogy ***<u>Module 1</u>: MOOC (massive open online course)*** ***<u>Module 2A</u>: Place-based learning*** ***<u>Module 2B</u>: Project-based learning*** ***Collaborative learning***	**Criterion G**: Pedagogy ***Traditional place-based learning*** ***Project-based learning*** ***Inquiry-based learning*** ***Collaborative learning***
Criterion H: Assessment ***The assessment is as follows:*** - ***For the MOOC, the candidate should provide his/her certificate of success:*** - ***For the courses in presence, students should take a small exam at the end of each topic (mostly every day)*** - ***the final disseration is assessed according to precise criteria, both on the layout and on the content***	**Criterion H:** Assessment ***Assessment is based on:*** ***- 2 midterm exams (including 1 written and 1 oral exams)*** ***- 1 final exam - oral*** ***Contribution of each course activity (100%):*** ***Component 1 - Attendance, up to 2 points (10%)*** ***Component 2- 1st exam, up to 4 points (20%)*** ***Component 3 - 2nd exam, up to 4 points (20%)*** ***Component 4 - final exam, up to 10 points (50%)***
Criterion I: Teaching resources ***Teaching hours: 90*** ***Teaching assistants (grading / tutorials)*** ***Labs***	**Criterion I:** Teaching resources ***Teaching hours – 24 hours*** ***Labs – 8 hours*** ***Preparatory hours –N/A***

	Teaching assistance – N/A
Use of technology	
Criterion J: Use of professional tools *Name of the tool(s) used:* *lab devices/systems:* ***PCs, virtual machines (Virtualbox)*** *software solutions:* ***QGIS, GRASS GIS, ,GEOSERVER, GEOnode, Geonetwork, MapX application, Python, Programming Statistics in R, R studio, QSWAT, SWAT-CUP, InVEST)*** *Supported activities:* ***tutorials are available on-line, home-work, hands-on activities***	Criterion J: Use of professional tools *Name of the tool(s) used:* *lab devices/systems:* ***PCs, GeoServer, SDI*** *software solutions:* ***QGIS, OpenGEO, Geonetwork*** *Supported activities:* ***tutorials, homework, hands-on activities***
Criterion K: Moodle ***University of Geneva uses moodle for sharing all the course material and exercices; as the data is too heavy to be uplodaded on Moodle, they use a network server for data***	**Criterion K**: Use of TEL-systems ***Not applicable***
Course statistics	
Criterion L: Course statistics *Average number of students enrolled in the course:* ***12*** *Average percentage of students successfully finishing the course:* ***50% (mainly depends if they provide the final work)*** *Average grades distribution:* ***5.5/6*** *Percentage of international students: really depends on the year; average:* ***36%*** - **2017: 9 locals, 1 EU, 1 USA** - **2018: 7 locals, 2 international (out of EU)** - **2019: 5 locals, 7 international (out of EU)** *Overall student demographics (gender, age, nationality, scholarships, etc.):* ***39% women in average; mostly over 30; many Swiss; few internationals (Italy, USA, Côte d'Ivoire, Niger, Nigeria, Armenia, Sri Lanka);*** *Average rating of the course by students:* ***good***	**Criterion L:** Course statistics *Average number of students enrolled in the course:****7*** *Average percentage of students successfully finishing the course:* ***88%*** *Average grades distribution: 12,54* *Percentage of international students: 0* *Overall student demographics:* *gender:* ***M-19%; F-81%,*** *age:* ***N/A,*** *nationality:* ***Armenian****,* *scholarships:* ***6%****,* *Average rating of the course by students:* ***4.9 (out of a maximum 5).***
Course content	
Criterion M: Course competency profile *Outcome competencies of the course:* • ***Be able to design and develop environmental projects using geomatics tools*** • ***Master the main geomatic, statistical and computer tools in the environmental field*** • ***Become a player aware of the natural capital management in decision making at any scale and in all types of institutions***	**Criterion M**: Course competency profile ***Course aims at indroducing the main components of spatial data infrastructure, global spatial data repositories, giving the main skilles how to use them.*** *Outcome competencies of the course:* • ***Be able to use SDI tools to design,analyse, process, classify and share geospatial data using local and international standards and modern***

Prerequisite competencies of the course: ***Applicants must have good computer skills, especially in GIS software to follow the summer school teachings.***	***GIS and remote sensing methods .*** *Prerequisite competencies of the course:* ***Good computer skills, especially in GIS software.***

The comparative analysis of syllabi at University of Geneva and ISEC allows arriving at the following conclusions:

- The comparative analysis of both courses shows that they have similar goals and outcomes despite the general differences, mainly in course statistics.
- The differences in course load, applied tools, teaching resources, ECTS, and other criteria conditioned with the specific features of educational programs in the countries.

However, we conclude that the modernization of "***Geospatial Data Management & Geocomputation for Sustainable Developement***" course needs basic principals of ***"Geomatics for a Sustainable Environment"*** CAS developed and successfully implemented at University of Geneva.

LANDSCAPE PLANNING

Course Comparative Analysis

The information collected during the visits to EU partner universities for the implementation of syllabi comparative analysis allows identifying the most relevant and similar course to that of "Landscape Planning" which is developed but should be modernized in Armenia.
The information provided below is about the shared degree course "Landscape Planning and Environmental design" offered by University of Tuscia and Sapienza Universita di Roma.

Course description and requirements; proposed program, ESTC

The course is one of the three different bachelore's degree courses offered by the multidisciplinary research and teaching unit of the University DIBAF (Innovation in Biological, agro-food and forestry systems) department. This Bachelor's degree course is the result of the synergy between the former Agriculture Faculty of University of Tuscia and Architecture Faculty of Sapienza Universita di Roma and consists of three-year study programm.

The course aims at:

- covering the growing national and European demand for highly competent technicians who are able to work innovatively and across different disciplines on critical environmental issues from a landscape, urban and socio-economic point of view.
- educating professionals with strong cultural skills for the analysis, planning, management and promotion of rural, peri-urban and urban areas and with infrastructure, landscape and environmental planning.

The theoretical, critical, interpretative, methodological and practical competences that these graduates acquire are the result of an interdisciplinary study plan perfectly integrating knowledge in different areas to allow graduates to be able to work straight away or continue their studies. Therefore, the course offered focuses on the acquisition of knowledge in *earth sciences, biological, agricultural and forestry systems, environmental sciences, city planning and landscape and* on acquiring the methodological tools needed for **planning the environment and the landscape**.
This degree course has the Faculty of Architecture of Sapienza Universita di Roma as its main didactic centre.
The degree provides the necessary requirements to access the following second-cycle degree courses:

- LM-3 (Landscape architecture),
- LM-48 (Environmental, urban and territorial planning)
- LM-73 (Science and forestry and environmental technologies) or similar,
- as well as ***first-level master courses***.

Additional details about the UNITUS DIBAF study processes and course are provided in the below table.

European example from CNR	New course to be developed in Armenia
University/Program Profile	
Criterion A: University profile: **University of Tuscia** *Classic or applied:* *Overall number of students:* ***7748 (2016)*** *Number of Environment protection related disciplines:* ***N/A*** *Number of Environment protection students:* ***N/A***	**Criterion A:** University profile: **ISEC** *Classic or applied:* ***Research-based university*** *Overall number of students:* ***800 (2018)*** *Number of Environment protection related discipline:* ***2*** *Number of Environment protection students:* ***13***
Criterion B: Program/discipline profile *Theoretical or applied:* ***Both*** *Number of students -* ***N/A*** *Role/part of the selected course(s) in the study program:* ***One of three bachelor's degree courses of three-year study programme offered by DIBAF.***	**Criterion B:** Program/discipline profile *Theoretical or applied:* ***Both*** *Number of students -* ***13*** *Role/part of the selected course(s) in the study program:* ***This is a course of two-year Master's degree program offered by ISEC***
Course Settings	
Criterion C: Course type *Bachelor or master level:* ***Bachelor*** *Year/semester of studies (1/2/…) –* ***N/A*** *Selective or mandatory-* ***mandatory*** *Theoretical / applied:* ***Applied***	**Criterion C:** Course type *Bachelor or master level:* ***Master*** *Year/semester of studies (1/2/…):* ***1/2*** *Selective or mandatory:* ***Mandatory*** *Theoretical / applied:* ***Applied***
Criterion D: Relations to other courses in the program *Prerequisite courses:* ***N/A*** *Outcome courses:* ***Second cycle of Bachelor's level courses: Landscape architecture; Environmental, urban and territorial planning; Science and forestry and environmental technologies*** ***First level Master Program: Guides and interpreters of the landscape and cultural heritage*** *If the course is a part of a group/cluster (from which it can be selected), other courses in this*	Relations to other courses in the program *Prerequisite courses:* ***Fundamentals of Landscapes.*** ***Fundamentals of Sustainable Development,*** ***Complex Geoecological Mapping*** ***Geoinformation Systems*** *Outcome courses:* Ecology of Urban Environment, Spatial Data Infrastructure and Management (should be modernized into…" *Geospatial Data Management & Geocomputation for Sustainable Developement*") *If the course is a part of a group/cluster (from which it can be selected), other courses in this*

group	*group: **N/A***
Criterion E: Department teaching a course *Non-graduating / Graduating / Other: **DIBAFE*** *Graduating*	**Criterion E:** Department teaching a course *Non-graduating / Graduating / Other: **GIS and Remote Sensing Department*** ***Graduating***
Criterion F: Course load ***(N/A)*** *Overall number of credits according to ECTS regulations* *Number of credits associated with particular course activities (lectures / tutorials / practical work / homework / etc.)*	**Criterion F:** Course load *Overall number of credits according to ECTS regulations: **3 (30 hours=1ECTS)*** *Number of credits associated with particular course activities:* *lectures / tutorials/ practical work / homework / etc.):* ***lectures, practicals – 1 ECTS*** ***Individual (independent studies) – 2 ECTS***
Teaching aspects	
Criterion G: Pedagogy ***Traditional place-based learning*** ***Project-based learning*** ***Inquiry-based learning*** ***Collaborative learning***	**Criterion G**: Pedagogy ***Traditional place-based learning*** ***Project-based learning*** ***Inquiry-based learning*** ***Collaborative learning***
Criterion H: Assessment ***(N/A)*** *Exams (how many, oral / written / test-like)* *Testing (how often)* *Grade computation (contribution of each course activity to the final grade, availability of extra credits)*	*Criterion H: Assessment* ***Assessment is based on:*** ***- 2 midterm exams (including 1 written and 1 oral exams)*** ***- 1 final exam - oral*** ***Contribution of each course activity (100%):*** ***Component 1 - Attendance, up to 2 points (10%)*** ***Component 2- 1st exam, up to 4 points (20%)*** ***Component 3 - 2nd exam, up to 4 points (20%)*** ***Component 4 - final exam, up to 10 points (50%)***
Criterion I: Teaching resources ***Teaching hours - N/A*** ***Preparatory hours – N/A*** ***Teaching assistants (grading / tutorials) – N/A*** ***Labs– N/A***	**Criterion I:** Teaching resources ***Teaching hours – 24 hours*** ***Labs – 8 hours*** ***Preparatory hours –N/A*** ***Teaching assistance – N/A***
Use of technology	
Criterion J: Use of professional tools ***PCs, GIS softwares***	Criterion J: Use of professional tools ***PCs, smart desk, GIS softwares (QGIS)***
Criterion K: ***Use of TEL-systems N/A*** *Name and type of the tool used (if any)* *Supported activity (assessment, home works, exam preparation)* *Role on the course (mandatory component / extra credit opportunity / fully optional supplementary*	**Criterion K**: Use of TEL-systems ***Not applicable***

tool)	
Course statistics	
Criterion L: Course statistics *Average number of students enrolled in the course* ***– N/A*** *Average percentage of students successfully finishing the course***– N/A** *Average grades distribution***– N/A** *Percentage of international students***– N/A** *Overall student demographics (gender, age, nationality, scholarships, etc.)* ***– N/A*** *Average rating of the course by students***– N/A**	**Criterion L:** Course statistics *Average number of students enrolled in the course:* ***7*** *Average percentage of students successfully finishing the course:* ***88%*** *Average grades:* ***14.87 out of max. 20*** *Percentage of international students:* ***0*** *Overall student demographics:* *gender:* ***M-19%; F-81%,*** *age:* ***N/A*** *nationality:* ***Armenian*** *scholarships:* ***6%,*** *Average rating of the course by students:* ***4.9 (out of a maximum 5).***
Course content	
Criterion M: Course competency profile *Outcome competencies of the course:* **Students gain knowledge in Earth Sciences, biological, agricultural and forestry systems, environmental sciences, city planning and landscape and on acquiring the methodological tools needed for planning the environment and the landscape.** *Prerequisite competencies of the course:* **It is a first level Bachelor's course, so there is no need of special prerequisite competencies.**	**Criterion M**: Course competency profile *Outcome competencies of the course:* ***Students gain knowledge in landscape planning principals in the context of spatial planning for sustainable development.*** *Prerequisite competencies of the course:* ***The fundamentals of landscapes.*** ***The fundamentals of sustainable development,*** ***Complex geoecological mapping*** ***Geoinformation systems***

The comparative analysis of syllabi in University of Tuscia (Italy) and ISEC allows figuring out that:

1. Generally the main aim and outcomes of the courses are almost similar, though the courses are included in the different types of the programs (Master and Bachelor),
2. Both courses use similar set of tools and methods.

It can be conclused from the comperative analysis of two courses that despite the lack of information and differences on several criteria (course load, statistics, etc), due to this shared degree course "Landscape Planning and Environmental Design" the partner University may gradually help with modernization and adaptation of "Landscape Planning course" at ISEC.

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