

# **INSTITUTE FOR ENVIRONMENT AND SANITATION STUDIES**

## **PHD IN ENVIRONMENTAL SCIENCE**

### **INTRODUCTION**

In recent times there has been an upsurge in reported cases of environmental tragedies in the news media that emphasize the need and the relevance of environmental science as a subject of study. To mention a few of these problems that have attracted the headlines, we have lack of proper management and disposal of solid waste, effluents disposal from both industrial and domestic sources, lack of adequate sewage treatment facility or technology, pollution from the mining sector and discharges into watercourses from excessive use of agrochemicals.

From the global or international world, the Chernobyl, Bhopal and Seveso industrial disasters and the marine oil pollution from the Gulf War and the Sea Empress in Milford Haven cannot be overemphasized. The causes and effects of acid rain and the greenhouse effect, reduction of raw materials and energy sources, effects of tourism and the clearance of tropical rainforests are also on the increase.

Locally, issues relating to solid and liquid waste disposal, mining and environmental degradation, deforestation and the loss of wetlands all have impacts on our society. From a more general perspective, increasing development and population growth has been the anvil of most environment problems.

In view of the complex nature of these problems, finding solutions to them necessitates the social, economic, and political aspects apart from the technical issues involved. The complexity of the problems does not fall under the domain of a particular subject hence the essence of the study of environmental science growing as a discipline in its own right, attracting many other subjects.

### **The Multi-Disciplinary Approach**

Environmental issues are multi-faceted, with ecological, legal, social, economic, political, and ethical dimensions. Because of this, it is important to develop its many aspects simultaneously in order to provide a unified understanding of environmental issues and concerns. In this regard, one may need a programme that is designed to introduce a multidimensional set of environmental questions and that provides a wide range of perspectives to analyze environmental problems.

The Environmental Science Programme of the Institute for Environment and Sanitation Studies working with the Faculty of Science has a well-structured trans-disciplinary course content, which provides the individual with

knowledge and understanding of the fundamental concepts of environmental science and an ability to contribute critically to multi-disciplinary analyses of environmental issues.

The programme integrates political, economic, and social implications with purely scientific information. Some areas of study include chemistry, biology, physics, geology, soil and water sciences, social science such as law as (it applies to the environment) and economics. Projects are therefore mostly designed to amalgamate this concept. However, in a particular instance, the technical solution to a problem may require the services of a specialist, a chemist or a geologist or even a team of specialist from different disciplines.

## **2. RATIONALE**

Reasons for studying Environmental Science at the level of a PhD are numerous. One of such reasons is that the programme provides the individual with the ability to select from relevant varying information the required solution sets to a problem. Apart from the knowledge it entails, the environmental science course enables one to decisively contribute to interdisciplinary relationships and analyses that may not directly relate to environmental issues.

Training in this field of study enables the individual to become professionally and technically qualified to deal with all forms of problems involved in the improvement and management of the environment. Owing to the fact that environmental issues are generally perceived as the effects of industrial and population growth, environmental science has become directly or indirectly connected to other careers. This implies that the course does not necessarily limit an individual to career opportunities within the spheres of the environmental business.

## **3. MISSION, AIMS AND OBJECTIVES**

The mission of the University of Ghana is *“to develop world-class human resources and capabilities to meet national development needs and global challenges through quality teaching, learning, research and knowledge dissemination”*. Using the University’s mission as a base, and considering mission statements from the other Institutes, Faculties, Centres and Programmes in the University, the mission of the Institute for Environment and Sanitation Studies and its programmes is *“To meet the nation's needs for broad-based education, training and research in the science, policy and management of environmental and sanitation processes in the wider African and global context.”* Guiding this mission is our medium term vision which is: *“Within the next 10 years, evolve into an institution that is a “Centre of Excellence” for environmental and developmental issues.”*

To achieve this, we will pursue the following objectives;

- Build and maintain a stakeholder-oriented culture with the primary stakeholders being the people of Ghana,
- Promote and nurture excellence with the understanding that a “Centre of Excellence” has to start with the concept of service excellence at the level of top management,
- Appreciate that people and systems in the Institute must be constantly tuned to stakeholder needs and to management's evolving concept of service excellence,
- Acknowledge that the concept of a “Centre of Excellence” must be a key part of the very structure and operation of the Institute and this concept must guide all its outputs and external contacts,
- Provide an enabling environment for research and educational excellence while challenging the brilliant and empowering the uninformed

The expected outcome of delivering on all of the above objectives, IESS and its programmes shall be the leading academic organization providing training, knowledge and service in Africa on issues relating to environmental management and sanitation. The ultimate goal is to produce the “T” shaped researcher, one that has in-depth detailed understanding on a particular area while at the same time having sufficient grasp of the broad range of issues that would increase the relevance of their research. The Institute and its programmes, by its nature span all university disciplines and Faculties, though the initial Academic unit that the Institute will be affiliated to is the Faculty of Science. The IESS and its programmes sees itself as a nexus for multi and trans-disciplinary research that will help unify research and academic units at the University of Ghana.

#### **4. CAREER PATHS**

Over the years, environmental scientists have developed abilities that most employers request such as, analytical skills, report writing skills, teamwork and problem-solving skills. These skills place environmental science graduates in a better position to apply for a range of jobs. This implies that environmental science graduates generally have a wide multiplicity of job opportunities.

The ESP since its inception in 1998 has produced close to 200 completed M.Phil and PhDs. These post-graduates degree holders have found employment in government departments, in civil society, as academics and in industry. Several cases have arisen in the recent past where a graduating student has confirmed offers of employment from a Government Agency, an International Consulting Company and a large scale industrial concern. To date between 12 and 17% of the M.Phil students go on to do a PhD. Admission to the M.Phil is currently capped at 20 students a year with 80 to 100 applications for admission each year.

#### **5. ADMISSION REQUIREMENTS**

To qualify for admission to pursue a Doctor of Philosophy (PhD) in Environmental Science, the candidate must meet the general admission requirements of the University of Ghana and specific admission criteria from the Department. Each application will be considered individually and the

complete profile of strength and prospects for successful completion of the programme will be evaluated. Admission to PhD will be limited to candidates whose academic and scholastic records show a potential for successful completion of doctoral degree programme. The following qualifications will be considered for entry into the Environmental Science PhD degree programme:

- Applicants with MPhil or equivalent degree can be admitted directly into the PhD programme.
- Applicants with a non-thesis Master's degree (MA/MSc/MPH) with a final grade point average (FGPA) of at least 3.5 out of 4.0 (B+) may be considered for admission to the PhD programme.
- A student in the master's programme (MPhil) with a coursework grade point average (GPA) of at least 3.5 out of 4.0 (B+) and who has demonstrated exceptional ability at the start of the M.Phil Research year, may be upgraded to the PhD programme in consultation with the Supervisory Committee and the Dean of the Faculty of Science.

## **6. DURATION OF PROGRAMME**

The duration of completion of the Doctor of Philosophy degree shall normally be four years for full-time students and six years for part-time students. Full-time students shall be entitled to two years of extension, while part-time students shall have one year of extension.

The minimum and maximum duration for the PhD programme shall conform to the University requirements as specified in the graduate students' handbook. At the end of the first year of study, the candidate will be expected to take a comprehensive examination comprising oral examination and research proposal presentation. The candidate will be expected to pass this examination before proceeding to the research stage.

### **Part-time students**

In addition to the satisfactory completion of the course work, the candidate will be required to give (1) formal oral examination in the form of presentation on the research thesis. The presentation shall cover results to-date of the research. This oral examination will be conducted after the candidate has submitted a written thesis which has been accepted, examined and the candidate has received a pass grade. In addition, the candidate will be expected to have submitted at least one (1) full paper originating from the research to a conference and also, attended and presented a paper at a conference prior to the oral examination.

## **7. PROGRAMME STRUCTURE**

### **a) Course work component**

The course work component is designed to ensure that students acquire academic and methodological training at the highest level. These courses are expected to build up on knowledge acquired from master's level courses with more practical and interactive training. The Graduate Committee and supervisors will decide courses most relevant for a student based on their previous academic record and area of proposed research. The course work component will be made up of Core and Elective courses consisting of a minimum of 18 and a maximum of 24 credits. A minimum of 18 credits must be passed and this must include all core courses for the programme. Up to six (6) credits could be earned from level 600 and up to three (3) credits from level 400 as elective courses.

The coursework component is expected to improve skills in scientific theory, research methodology, qualitative and quantitative analyses. Each course will normally carry three (3) credit units. Four (4) courses, two (2) of which must be in advanced research methodology, qualitative and quantitative analyses are included in the core or mandatory courses. For full-time students, it is expected that the course work component is completed during the first year of the PhD programme, while part-time students have up to two years to complete this component.

Structure of Full time Programme			Structure of Part-time Programme	
Year 1			Year 1 and Year 2	
Semester	1	9 - 12 Credits	Course Work	18 - 24 Credits
Semester	2	9 - 12 Credits		
Year 2			Year 3	
Seminar 1		3 Credits	Seminar 1	3 Credits
Thesis		(-)	Thesis	(-)
Year 3			Year 4	
Seminar 2		3 Credits	Seminar 2	3 Credits
Thesis		(-)	Thesis	(-)
Year 4			Year 5 and Year 6	
Seminar 3		3 Credits	Seminar 3	3 credits
Thesis		48 Credits	Thesis	48 credits
Total Credits		75 - 81	Total Credits	75 - 81

### Course Structure

#### Core Courses (12 credits for Year 1):

Code	Course Title	Credits
FASC 701	Science and Society	3
FASC 702	Advanced Quantitative Research Methods	3
FASC 710	Faculty Wide Seminar	3
ESCI 701	Environmental Management	3
ESCI 702	Emerging Environmental Issues for the 21 <sup>st</sup>	3

#### Core (57 credits for Year 2 - 4):

Code	Course Title	Credits
ESCI 700	Thesis	48
ESCI 720	Seminar I (Year 2)	3
ESCI 730	Seminar II (Year 3)	3
ESCI 740	Seminar III (Year 4)	3

#### Elective Courses (6 - 12 credits Year 1):

Code	Course Title	Credits
ESCI 703	Disaster, Environment and Risk Reduction	3
ESCI 704*	Advanced Environmental Analytical Techniques	3
ESCI 705	Sustainable Sanitation and Health	3
ESCI 706	Focus on Community	3

This can be replaced by CHEM 671 Instrumental Methods for Chemical Analysis as one of the allowed Level 600 courses as an elective.

Normal University of Ghana conventions on semester distribution of courses apply.

## 8. CREDIT REQUIREMENTS FOR GRADUATION

To graduate with PhD degree in Environmental Science, a candidate will be expected to carry out supervised original research and also successfully take and pass between 75 to 81 credits consisting of course work (both core and elective) and a research component made up of original work leading to a thesis and seminars.

**a. Course**

**Work**

The Environmental Science Programme shall organize comprehensive examinations for each doctoral student after taking course work based on the following guidelines:

- a. The comprehensive examination should be in two parts, comprising both written and oral assessments. Both the written and oral assessments should be taken within two weeks.
- b. The format and content of the written assessment will be decided by IESS. Only those who have taught the student should set the written examination questions.
- c. The Oral assessment should basically draw on issues in the written examination. This means that the written paper should precede the oral assessment.
- d. There would be a panel of three or four members constituted by the IESS for the oral assessment part of the comprehensive examination.
- e. The panel for the oral examination should consist of at least one of the student's potential supervisors and at least one of the student's examiners in the written paper, and should be chaired by the Director of IESS or his/her representative
- f. The results of the comprehensive examination should be determined by finding the average of scores obtained in both the written and oral examinations, and the final determination should be PASS or FAIL.
- g. The results of the comprehensive examination should be officially declared and communicated to the student within one week after the oral examination.

**b. Research Component**

Forty-eight (48) credit units will be allocated to thesis research. This thesis give a platform to showcase the ability of the candidate to conceive of and conduct independent research as well as in organizing and presenting findings in a topic in a specific field.

**Thesis**

The thesis format must comply with the IESS guidelines for preparing PhD thesis and the Graduate Handbook Volume 1 (2010). The Environmental Science Programme prefers article-style thesis for doctoral students, this is an option that must be approved by the School of Graduate Studies in each case. The completed thesis will consist of a number of journal-style manuscripts or articles. Articles that have been accepted by journals by time of submission of thesis will enhance the thesis. Such thesis must show a unification of a sequence of articles of publishable quality around a theme, which is the student's original idea. Normally this would consist of a context setting review paper, four to six papers that present the findings of the research and a synthesis paper. Article-style thesis must be based upon

research carried out by the student while registered as a PhD student at the University of Ghana. The student must be the first author or the conceptual lead for each article making up the thesis. A narrative statement should accompany each article clearly spelling out roles and inputs of each author.

### **Seminars**

Candidates would be required to attend seminars and also present seminars every year during the research period of candidature. Seminar would be graded as “pass” or “fail”. Each seminar will earn three credit units.

## **9. COURSE DESCRIPTIONS**

### **CORE COURSES**

#### **FASC 701 Science and Society**

##### **Course Outline**

This course will enable students gain insights in the practice of science as a discipline including major scientific concepts like inductivism are treated as well as the history of science and science itself, an overview of current approaches to research and an understanding of research partnerships, networks and appropriate methods of communicating science depending on audience. The aim of the course is to help students to fit their research to relevant trends and directions for national development. Course content will cover topics such as the basis for the scientific method; conceptual frameworks; the philosophy of science; ethics in research; pure versus applied science debates; approaches to research; science for development and the merit of broader impact criteria; north south/south south collaboration and partnerships; research networks; communicating science to the policy make, lay audience and to media.

#### **FASC 702 Advanced Qualitative Research**

##### **Course Outline**

Sampling distributions and hypothesis testing, Sample size determination, Categorical data and chi-square, Non parametric tests, Principles of Design of Experiments, Analysis of variance and its assumptions, Experiments with single and multiple factors, Orthogonal and multiple Comparisons, Completely Randomized, Randomized Complete Block, repeated measures, cross over and Latin square designs, Nested designs, Fixed, random and mixed effects models, Factorial designs, Confounding, Fractional factorial designs, Split plot designs, Incomplete block designs. Analysis of covariance, Regression models: basic concepts; Regression Model Diagnostics, Categorical data analysis, Logistic regression, univariate and multivariate, Confounding and collinearity in logistic regression, Model selection in logistic regression.

#### **FASC 710 Faculty Wide Seminar**

All students, in the first semester of their first year, must attend a Faculty-Wide Seminar. The form, approach and content of the seminar will be determined by the Faculty of Science. The seminar will be graded by Faculty and a student will have to get 70% to pass.

## **PROGRAMME CORE COURSES**

### **ESCI701 Environmental Management**

#### Course Outline

This course would provide an overview of the key concepts and issues about the management of the environment in Ghana. The topics will be examined largely from a Ghanaian perspective within the global context. These topics will include: environmental statistics, social-ecological system concepts, ecosystem-based management, global and regional governance through multilateral agreements, sustainable development, poverty and globalisation. Specific areas of attention will include biodiversity, fisheries and coastal management, environmental impact assessment, climate change, sustainable tourism, various environmental management and planning tools.

### **ESCI702 Emerging Environmental Issues for the 21<sup>st</sup> Centaury**

#### Course Outline

This course will examine the ramification for Ghana of global environmental issues as derived from the UNEP foresight process and will cover issues such as: aligning governance to the challenges of global sustainability; meeting global environmental challenges and moving towards a green economy; broken bridges: reconnecting science and policy; catalyzing rapid and transformative changes in human behaviour towards the environment; new concepts for coping with creeping changes and imminent thresholds; coping with migration caused by new aspects of environmental change; new challenges for ensuring food safety and food security for 9 billion people; integrating biodiversity across the environmental and economic agendas; boosting urban sustainability and resilience; avoiding degradation of inland waters in developing countries; integrated ocean governance; addressing increasing pressures on coastal ecosystems with adaptive governance; accelerating the implementation of environmentally-friendly renewable energy systems; the need for a new approach for minimizing risks of novel technologies and chemicals; solving the impending scarcity of strategic minerals and avoiding electronic waste

## **C. PROGRAMME ELECTIVE COURSES**

### **ESCI703 Disasters, Environment and Risk Reduction**

#### Course Outline

The course will cover how to mainstream and provide advocacy for Disaster and Risk Reduction (DRR) using environmental resilience. Topics will include; Global data on risk, disasters and ecosystems; link climate change adaptation to DRR; model/assess risk, vulnerability and sustainable development as well as introduce coping capacities and the concept of resilience as well as prevention, post disaster “3Rs” relief, recovery and reconstruction. The course will also link global environmental problems and disasters; major eco-zones, hazards and impact on populations; ecosystem

services and vulnerability reduction; ecological engineering for DRR. The tools, instruments and approaches for Eco-DRR will be linked to approaches such as IWRM, ICZM, Protected areas as well as how ecosystems can be managed to reduce urban risk, Ecosystem and Community based adaptation for DRM.

## **ESCI704 Advanced Environmental Analytical Techniques**

### Course Outline

The aim of this course is to provide insight into some advanced analytical methods used for environmental assessment and deepening knowledge of some sophisticated analytical techniques. This course therefore provides a review of the theoretical background of each instrumental method, as well as a discussion of the general principles of the techniques underlying the instrument design. Students will be shown the utility and actual application of each analytical technique.. The course content will cover Field and Laboratory methods of sample analysis and will include: sampling, sample preparation and analyses, routine and special methods of environmental sample analyses, Understanding of principles of Photometric and spectroscopic techniques: Absorption Spectroscopy using Flame and Electrothermal Atomization, Mass Spectrometry, Ultraviolet/Visible Absorption Spectroscopy and Nuclear Magnetic Resonance Spectroscopy, Chromatographic Techniques, including Gas Chromatography, High-Performance Liquid Chromatography and the hybrid forms such as GC-MS, LC-MS. Also, various air quality measuring devices including Differential CO<sub>2</sub>/H<sub>2</sub>O Gas Analyzer, Multi- function HVAC air quality measuring device as well as various tachometry devices.

## **ESCI 705 Sustainable Sanitation and Health**

### Course Outline

This course is designed to provide students with in-depth knowledge on sustainable sanitation involving systems that are economically viable, socially acceptable and technically and institutionally appropriate and that protect the environment, natural resources and health. The thrust of the course is to facilitate innovative thinking and an analytical approach to sanitation solutions and health promotion. The course will expose students to, frameworks, tools, approaches, methodologies for achieving total sanitation and addressing small and large scale sanitation challenges at the local level.

## **ESCI 706 Focus on Community**

### Course Outline

This course aims at building students' appreciation and understanding of community values, local knowledge and endogenous practices which guide environmental ethics and resource use. The course focuses on local perceptions, traditional knowledge, religious philosophies, customary laws and community leadership within the context of the operation of local government administrative structures. Special emphasis is placed on

underpinning knowledge of best environmental practices at the community and local levels. The course also deals with principles and approaches to participatory action research, knowledge creation and information sharing among community members and scientists that seek to address specific environmental problems and take advantage of available opportunities. In this regard, case studies and lessons are drawn from various parts of the world.

#### **D. SEMINARS**

##### **ESCI 720 SEMINAR I**

All Students must formally defend their research proposal to ensure that the proposed work is relevant, meaningful, viable, feasible and capable of being completed within time frame and resource constraints. The student will present the proposal in a seminar (Seminar I) to the Graduate Committee, academic staff in the discipline and supervisory committee. The presentation shall be graded as 'pass' or 'fail'. The student will have only one more opportunity to present seminar if he/she could not pass in the first instance. The proposal shall be presented to the second semester of the first year for full-time students and not later than the second semester of the second year for part-time students. A student who fails the second time shall be withdrawn from the PhD programme. The Seminar is to be accompanied by a detailed research proposal of between 20 – 30 pages.

##### **ESCI 730 SEMINAR II**

Seminar II will present provisional findings of the research at the beginning of the First Semester of Year Three. This seminar is to be open to the staff of the institute, the supervisory committee and to other PhD students. The seminar will be assessed by not less than three examiners. Failure to pass this Seminar will result in the termination of the PhD Programme and the possible award of an M.Phil on the advice of the School of Graduate Studies.

##### **ESCI 740 SEMINAR III**

Seminar III will complement the final part of the PhD where the candidate presents his research findings in a seminar to the general public and to the supervisory committee at the end of his final thesis year. This is different and distinct from the oral examination which is carried out after the thesis has been submitted. The candidate is expected to take relevant comments from all three required seminars (I, II and III) so as to improve the quality of both thesis and presentation.

#### **10. PROGRAMME APPRAISAL AND MONITORING**

Apart from the normal Annual Reports and External Examiner Reports to the University, it is expected that after year five and year 10 years of operation a major assessment will be made, this peer-assessment with both internal and external components will assess the operations, outputs and contribution to the University and Nation. That is, evaluation with a view to:

- determine the degree of achievement of the PhD program objectives;
- document program strengths and weaknesses in making planning decisions for research focus;
- assess quality assurance and control methods used by the University AQAU to monitor performance;
- see how PhD research contributes to the science base of the Institute;
- promote positive public relations and community awareness co development of research proposals;
- meet public and fiscal accountability requirements for this fee based programme (Tier Two).