Earth Sciences, Environmental Sciences and Environmental Studies

Subject benchmark statements

Subject benchmark statements provide a means for the academic community to describe the nature and characteristics of programmes in a specific subject. They also represent general expectations about the standards for the award of qualifications at a given level and articulate the attributes and capabilities that those possessing such qualifications should be able to demonstrate.

This subject benchmark statement, together with the others published concurrently, refers to the ***bachelors degree with honours***.

Subject benchmark statements are used for a variety of purposes. Primarily, they are an important external source of reference for higher education institutions when new programmes are being designed and developed in a subject area. They provide general guidance for articulating the learning outcomes associated with the programme but are not a specification of a detailed curriculum in the subject. Benchmark statements provide for variety and flexibility in the design of programmes and encourage innovation within an agreed overall framework.

Subject benchmark statements also provide support to institutions in pursuit of internal quality assurance. They enable the learning outcomes specified for a particular programme to be reviewed and evaluated against agreed general expectations about standards.

Finally, subject benchmark statements are one of a number of external sources of information that are drawn upon for the purposes of academic review* and for making judgements about threshold standards being met. Reviewers do not use subject benchmark statements as a crude checklist for these purposes however. Rather, they are used in conjunction with the relevant programme specifications, the institution's own internal evaluation documentation, together with primary data in order to enable reviewers to come to a rounded judgement based on a broad range of evidence.

The benchmarking of academic standards for this subject area has been undertaken by a group of subject specialists drawn from and acting on behalf of the subject community. The group's work was facilitated by the Quality Assurance Agency for Higher Education, which publishes and distributes this statement and other benchmarking statements developed by similar subject-specific groups.

The statement represents the first attempt to make explicit the general academic characteristics and standards of an honours degree in this subject area, in the UK.

In due course, but not before July 2003, the statement will be revised to reflect developments in the subject and the experiences of institutions and academic reviewers who are working with it. The Agency will initiate revision and, in collaboration with the subject community, will establish a group to consider and make any necessary modifications to the statement.

* academic review in this context refers to the Agency's new arrangements for external assurance of quality and standards. Further information regarding these may be found in the ***Handbook for Academic Review***, which can be found on the Agency's web site.

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Academic standards - Earth Sciences, Environmental Sciences and Environmental Studies

Contents

1. Introduction

1.1 Throughout this report Earth sciences, environmental sciences and environmental studies are referred to collectively as ES3. The three subject areas are also referred to individually where appropriate.

1.2 During the early stages of the Panel's work, there was some scepticism that it would be possible to draft a single benchmarking statement that encompassed ES3 in a meaningful way. The Panel believes it has succeeded in showing that there is considerable congruence between the three subject areas. This applies particularly to Graduate Key Skills (Section 3.3) and definitions of performance levels (Section 5). There are, of course, significant differences between the graduate knowledge components of the three subject areas (Section 2, Appendices) but there are also key elements of knowledge that all three subject areas embrace (Section 3.2).

1.3 ES3 is characterised by the following common features:

- their focus on the understanding of Earth systems in order to learn from the past, understand the present and influence the future
- their emphasis on field-based investigation
- the multi-disciplinarity and inter-disciplinarity of their approaches
- the range of the spatial and temporal scales that they cover
- the development of graduates capable of using their powers of observation, analysis and imagination to make decisions in the light of uncertainty.

2. Mapping the territory

2.1 Introduction

2.1.1 The diversity of award titles (see Appendix 1) and marked differences of emphasis within courses make it impractical to list all sub-disciplines that might be considered under the ES3 heading, or even within the three subject areas. The Panel's approach in this section is to provide general characteristics of the three main programmes in the belief that this frees institutions to map and justify the positions of their own courses within this broad framework. Such positioning will be qualitative because there is a continuity of some themes, albeit with significant differences in emphasis, across the spectrum of the three subject areas. There are also considerable areas of overlap.

2.1.2 The Panel has a wide remit, ranging from the scientific study of the physical characteristics and environmental systems of the Earth, to the social and political issues of human relationships with the environment. Nonetheless, the Panel believes that ES3 degree programmes share the following important features:

- most tuition has an ***holistic, multi-disciplinary and inter-disciplinary*** approach
- the ***integration*** of ***fieldwork, experimental*** and ***theoretical*** investigations underpins much of the learning experience in Earth and environmental sciences, but may be less significant in, but not absent from, courses in environmental studies
- ***quantitative*** and ***qualitative*** approaches to acquiring and interpreting data
- examination of the exploration for, and exploitation of, physical and biological resources in the context of ***sustainability***.

2.1.3 ES3 is so broad that it inevitably overlaps with other disciplines. Providers of award titles at the interface (eg those listed in Appendix 1) may wish to draw on other relevant Benchmarking Statements. However, it is also important to note that specialist subjects such as oceanography, meteorology and soil science, that properly fall within many ES3 courses, also appropriately form the subject of degree programmes in their own right.

2.1.4 It is stressed that the examples which follow should not be taken as prescriptive but are presented to illustrate the variation in emphasis from subject areas which can be described as natural sciences-based to those characterised as more social sciences or humanities-based.

2.2 Degree programmes broadly concerned with Earth Sciences

2.2.1 Degree programmes in the Earth sciences typically involve:

- a systems approach to understanding the present and past interactions between the processes operating in the Earth's core, mantle, crust, cryosphere, hydrosphere, atmosphere and biosphere, and the perturbations of these systems by extra-terrestrial influences
- the scientific study of the physical, chemical and biological processes operating on and within the Earth
- the structure and composition of the Earth and other planets
- the history of the Earth over geological timescales.

2.2.2 Typical programme elements might include geochemistry, geological mapping, geomorphology, geophysics, Geographic Information Systems and remote sensing applications, hydrogeology, local and global tectonics, mineralogy, ore geology, palaeobiology, palaeoclimatology, palaeontology, petroleum geology, petrology, sedimentology, stratigraphy and structural geology.

2.2.3 Applications of the subject areas might include developing exploration and exploitation strategies for resource industries (eg hydrocarbons, minerals, water), site investigations for civil engineering projects including waste disposal and land restoration, and understanding geohazards such as floods, earthquakes, volcanic eruptions and landslides.

2.2.4 The subject area overlaps with others such as environmental sciences, environmental studies, biology, chemistry, civil engineering, geography, mathematics, mining engineering, petroleum engineering and physics.

2.2.5 The subject area promotes an awareness of the dual context of the subject in society, namely that of providing knowledge and understanding for both the exploitation and the conservation of the Earth's resources.

2.3 Degree programmes broadly concerned with Environmental Sciences

2.3.1 Degree programmes in environmental sciences typically involve:

- a systems approach to understanding the present and past interactions between the processes operating in the lithosphere, cryosphere, hydrosphere, atmosphere and biosphere, and the perturbations of these systems by extra-terrestrial influences
- the scientific study of surface and near-surface physical, chemical, biological and anthropogenic processes operating on the Earth
- the history of the Earth in the context of the period of human occupancy
- the monitoring and management of natural and human-induced environmental changes.

2.3.2 Typical programme elements might include climatology, ecology, environmental biology, environmental chemistry, geochemistry, Geographic Information Systems and remote sensing applications, geomorphology, geophysics, hydrology, meteorology, oceanography, pollution science, Quaternary studies and soil science.

2.3.3 Applications of the subject area might include environmental assessment, impact monitoring, modelling and prediction which provide a framework for decisions concerning environmental management (eg the management of surface and ground water, human, agricultural and industrial waste, natural and semi-natural habitats).

2.3.4 The subject area overlaps on the one hand with the natural sciences (Earth, physical, biological and geographical sciences) and on the other through environmental studies with a broad range of social sciences. The subject area, therefore, requires an understanding of principles and methodologies of the natural and social sciences.

2.4 Degree programmes broadly concerned with Environmental Studies

2.4.1 Degree programmes in environmental studies typically involve:

- studies of the sociological, political and economic implications of human interactions with the environment
- the relationship between the environment, human culture and attitudes
- a foundation of scientific understanding of natural and human-induced environmental processes appropriate to the programme's aims
- the use of scientific information to inform decision-making processes and environmental management.

2.4.2 Typical programme elements might include appropriate aspects of environmental science, conservation, economics, environmental management, Geographic Information Systems applications, policy, law and ethics with reference to both the natural and built environments.

2.4.3 Applications of the subject area might include environmental decision making, environmental auditing, environmental impact assessment and planning, legislative aspects of environmental protection, and environmental education.

2.4.4 The subject area overlaps with the Earth and environmental sciences, architecture and landscape architecture, economics, geography, law, politics, sociology, town and country planning. The discipline, therefore, requires an understanding, not only of the scientific attributes of the environment, but also the cultural and commercial values of societies and of the perspectives about these provided by science and technology.

3. Knowledge and graduate key skills

3.1 Introduction

3.1.1 The generic knowledge base described in Section 3.2 should be applicable to all degree programmes in ES3. However, each institution is free to decide on the exact content and emphases of their degree programme(s) and their constituent parts.

3.1.2 All the skills on the Graduate Key Skills list should feature in undergraduate programmes but the point of introduction and the level of engagement should be decided by the curriculum developers.

3.1.3 Degree programmes should respond to new developments (for example in professional practice) or to recommendations made by accrediting professional bodies.

3.2 Knowledge

3.2.1 Examples of subject-specific knowledge are given in Appendix 2. However, graduates of programmes in ES3 should understand:

- the need for both a ***multi-disciplinary*** and an ***interdisciplinary*** approach in advancing knowledge and understanding of ***Earth systems***, drawing, as appropriate, from the natural and the social sciences
- the ***processes*** which shape the natural world at different ***temporal*** and ***spatial scales*** and their influence on and by human activities
- the ***terminology, nomenclature*** and ***classification*** systems used in ES3
- ***methods*** of acquiring, interpreting and analysing ES3 information with a critical understanding of the appropriate contexts for their use
- issues concerning the availability and ***sustainability*** of resources, for example, the different ***value sets*** relating to the Earth's resources as commodities and / or heritage
- the contribution of ES3 to ***debate*** on environmental issues and how knowledge of these forms the basis for ***informed concern*** about the Earth and its people
- the contribution of their subject to the ***development of knowledge*** of the world we live in
- the ***applicability*** of ES3 to the ***world of work.***

3.3 Graduate key skills

3.3.1 The term Graduate Key Skills has been employed throughout this document. The reasons for this are as follows:

- the term 'Graduate' implies the skills work is being undertaken in an higher education context
- the term 'Key' is used to highlight the fact that the all important Key Skills developed by the Qualifications and Curriculum Authority (QCA) and the Department for Education and Employment (DfEE) are incorporated into our skills list
- early in the skills debate, 'Skills' were narrowly defined and low in cognitive content but they are now associated with a much broader range of activities. These often have a high cognitive content consistent with the expectations of undergraduate programmes.

3.3.2 The Graduate Key Skills that should be developed in ES3 degree programmes are subdivided into the following headings:

- Intellectual Skills
- Practical Skills
- Communication Skills
- Numeracy and Communications and Information Technology (C & IT) Skills
- Interpersonal / Teamwork Skills
- Self Management and Professional Development Skills.

3.3.3 Whereas these skills will normally be developed in a subject-specific context, they have wider applications for continuing personal development and in the world of work.

3.3.4 Intellectual skills

- recognising and using subject-specific theories, paradigms, concepts and principles
- analysing, synthesising and summarising information critically, including prior research
- collecting and integrating several lines of evidence to formulate and test hypotheses
- applying knowledge and understanding to address familiar and unfamiliar problems
- recognising the moral and ethical issues of investigations and appreciating the need for professional codes of conduct.

3.3.5 Practical skills

- planning, conducting, and reporting on investigations, including the use of secondary data
- collecting, recording and analysing data using appropriate techniques in the field and laboratory
- undertaking field and laboratory investigations in a responsible and safe manner, paying due attention to risk assessment, rights of access, relevant health and safety regulations, and sensitivity to the impact of investigations on the environment and stakeholders
- referencing work in an appropriate manner.

3.3.6 Communication skills

- receiving and responding to a variety of information sources (eg textual, numerical, verbal, graphical)
- communicating appropriately to a variety of audiences in written, verbal and graphical forms.

3.3.7 Numeracy and C & IT skills

- appreciating issues of sample selection, accuracy, precision and uncertainty during collection, recording and analysis of data in the field and laboratory
- preparing, processing, interpreting and presenting data, using appropriate qualitative and quantitative techniques and packages
- solving numerical problems using computer and non-computer based techniques
- using the Internet critically as a means of communication and a source of information.

3.3.8 Interpersonal/teamwork skills

- identifying individual and collective goals and responsibilities and performing in a manner appropriate to these roles
- recognising and respecting the views and opinions of other team members
- evaluating performance as an individual and a team member.

3.3.9 Self management and professional development skills

- developing the skills necessary for self-managed and lifelong learning (eg working independently, time management and organisation skills)
- identifying and working towards targets for personal, academic and career development
- developing an adaptable and flexible approach to study and work.

4. Learning, teaching and assessment

4.1 The Panel considers that it is inappropriate to be prescriptive about which learning, teaching or assessment methods should be used by a particular programme. This is because the programmes covered in this Benchmarking Statement encompass diverse disciplinary cultures, and the variable modes of study include a range of patterns of study in addition to the traditional full time degree course. However, staff involved in course delivery should be able to justify their choices of learning, teaching and assessment methods in terms of the learning outcomes of their courses. These methods should be made explicit to students taking the courses concerned.

4.2 Learning, teaching and assessment should be interlinked as part of the curriculum design process and should be appropriately chosen to develop the knowledge and skills identified in section 3 and in the programme specification for the student's degree programme. Research and scholarship inform curriculum design of all ES3 programmes. Research-led programmes may develop specific subject-based knowledge and skills.

4.3 The Panel believes that it is impossible for students to develop a satisfactory understanding of ES3 without a significant exposure to field based learning and teaching, and the related assessment. Much of the advancement in knowledge and understanding in our subject areas is founded on accurate observation and recording in the field. Developing field-related practical and research skills is, therefore, essential for students wishing to pursue careers in ES3. Additionally field-based studies allow students to develop and enhance many of the Graduate Key Skills (eg teamworking, problem-solving, self-management, interpersonal relationships) which are of value to all employers and to life-long learning.

4.4 Existing ES3 programmes have developed and used a very diverse range of learning, teaching and assessment methods to enhance student learning opportunities. These methods should be regularly evaluated in response to generic and discipline-specific national developments and incorporated where appropriate by curriculum developers.

5. Performance levels

5.1 In this section levels of performance are expressed as statements of learning outcomes. These describe what a student should be able to achieve on completion of an honours degree in ES3, demonstrable through appropriate assessment strategies. It is recognised, however, that not all learning outcomes can be objectively assessed. It is important to emphasise that levels of performance can only be established in terms of the shared values of the academic community as moderated internally and externally by academic quality procedures, including the external examiner system.

5.2 Table 1 characterises three levels of performance.

- ***Threshold*** is the minimum performance required to gain an honours degree
- ***Typical*** is the performance expected of students at the lower / upper second class boundary
- ***Excellent*** is the performance expected of students gaining a first class honours.

5.3 Performance levels are defined for the six main categories of Graduate Key Skills in Section 3.3 generally using a hierarchy of terms such as basic ability, ability and highly developed ability. These main categories (and bullet pointed sub-categories) do not constitute an inclusive checklist, nor do they infer any particular weighting. As stated in paragraph 3.1.2, whereas the full range of Graduate Key Skills should feature in undergraduate programmes, their point of introduction and the level of engagement should be decided by curriculum designers.

5.4 To reach a given level of performance at the completion of an honours degree in ES3, students should demonstrate achievement across the six main categories of Graduate Key Skills in Table 1. However, a low performance in one category may be compensated by a higher performance in another.

Table 1: Definition of Performance Levels for ES3 Honours Degrees.

critical approach to academic literature and other sources of information

	THRESHOLD PERFORMANCE	***TYPICAL PERFORMANCE***	***EXCELLENT PERFORMANCE***
	(3rd Class)	(2nd Class)	(1st Class)
INTELLECTUAL (Knowledge and Understanding)	• knowledge based on the directly taught programme	• knowledge based on the directly taught programme and some evidence of enquiry beyond that	• knowledge base extending well beyond the directly taught programme
	• basic ability to integrate lines of evidence from a range of sources to support findings and hypotheses	• ability to integrate lines of evidence from a range of sources to support findings and hypotheses	• highly developed ability to integrate lines of evidence from a range of sources to support findings and hypotheses
	• basic understanding of subject-specific theories, paradigms, concepts and principles	• understanding of subject-specific theories, paradigms, concepts and principles and some understanding of more specialised areas	• thorough understanding of subject-specific theories, paradigms, concepts and principles and an in-depth understanding of more specialised areas
	• basic ability to consider issues from a range of multi-disciplinary and inter-disciplinary perspectives	• ability to consider issues from a range of multi-disciplinary and inter-disciplinary perspectives and to draw on appropriate concepts and values in arriving at a critical assessment	• highly developed ability to consider issues from a wide range of multi-disciplinary and inter-disciplinary perspectives and to draw on appropriate concepts and values in arriving at a critical assessment
	• basic ability to analyse, synthesise and summarise information	• ability to analyse, synthesise summarise and critically evaluate information	• highly developed ability to analyse, synthesise summarise and critically evaluate information
	• basic ability to define and solve routine problems	• ability to define problems, devise and evaluate possible solutions, and to solve both routine and unfamiliar problems	• ability to define problems, devise and evaluate possible solutions, and to solve elegantly routine and unfamiliar problems
	• ability to describe the moral and ethical dimensions of issues and investigations and the need for professional codes of conduct.	• critical approach to academic literature and other sources of information	• highly developed critical approach to academic literature and other sources of information
		• recognition of the moral and ethical dimensions of investigations and the need for professional codes of conduct	• recognition and discussion of the moral and ethical dimensions of investigations and the need for professional codes of conduct

PRACTICAL	• basic ability to describe and record materials in the field and laboratory	• ability to describe and record materials in the field and laboratory	• highly developed ability to describe and record materials in the field and laboratory
	• basic ability to interpret practical results	• ability to interpret practical results in a logical manner	• ability to interpret practical results with flair
	• basic ability to use appropriate laboratory and field equipment safely	• ability to use appropriate laboratory and field equipment competently and safely	• highly developed ability to use appropriate laboratory and field equipment competently and safely
	• ability to use spatial technologies in addressing problems	• ability to use spatial technologies in addressing problems efficiently	• ability to use spatial technologies in addressing problems effectively and appropriately
	• ability to plan, conduct and present an independent project with reliance on guidance	• ability to plan, conduct and present an independent project with limited reliance on guidance	• highly developed ability to plan, conduct and present an independent project with little or no reliance on guidance
	• ability to apply a range of methods to solve problems	• ability to select and apply a range of methods to solve problems	• highly developed ability to choose and apply a range of methods to solve problems
	• basic ability to present results of investigations in a number of formats	• ability to present research findings in a number of formats effectively and appropriately	• ability to present research findings in a number of formats with flair
	• basic ability to relate investigations to prior work and to reference appropriately.	• ability to relate investigations to prior work and to reference appropriately.	• highly developed ability to relate investigations to prior work, to be aware of the latest research developments and to reference appropriately.

COMMUNICATION	• ability to communicate to a variety of audiences in written, graphical and verbal forms	• ability to communicate effectively to a variety of audiences in written, graphical and verbal forms	• ability to communicate highly effectively to a variety of audiences in written, graphical and verbal forms
	• ability to read and respond to written material	• ability to read and respond to written material efficiently	• ability to read and respond to written material efficiently and effectively
NUMERACY AND C & IT	• ability to collect and record data with guidance	• ability to collect and record data	• ability to collect and record data efficiently and effectively
	• ability to prepare, process and interpret data using appropriate techniques with guidance	• ability to prepare, process and interpret data using appropriate techniques	• highly developed ability to prepare, process and interpret data using appropriate techniques
	• basic ability to solve numerical problems using appropriate techniques	• ability to solve numerical problems using appropriate techniques	• highly developed ability to solve numerical problems using appropriate techniques
	• ability to use the Internet for communication and information retrieval.	• ability to use the Internet critically for communication and information retrieval.	• ability to use the Internet critically for communication and information retrieval.
INTERPERSONAL / TEAMWORK	• some ability to contribute to team work	• ability to contribute effectively to team work	• ability to work highly effectively in a team as a leader or participant by goal setting and time management
	• ability to recognise and respect the views of others.	• ability to recognise and respect the views of others.	• ability to recognise and respect the views of others.
SELF MANAGEMENT AND PROFESSIONAL DEVELOPMENT	• basic ability to develop the skills necessary for self-managed and lifelong learning (e.g. independent study, time management, organisational skills)	• ability to develop the skills necessary for self-managed and lifelong learning (e.g. independent study, time management, organisational skills)	• highly developed ability to develop the skills necessary for self-managed and lifelong learning (e.g. independent study, time management, organisational skills)
	• basic ability to identify and work towards targets for personal, career and academic development	• ability to identify and work towards targets for personal, career and academic development	• highly developed ability to identify and work towards targets for personal, career and academic development
	• ability to be adaptable and flexible	• ability to be adaptable and flexible	• highly developed ability to be adaptable and flexible
		• ability to analyse personal strengths and weaknesses.	• ability to reflect on the process of learning and to evaluate personal strengths and weaknesses.

Appendix 1

The following list identifies many of the award titles available for 1999 entry, listed on the UCAS WWW-site, which are likely to fall within the remit of the ES3 Benchmarking Panel. Following that is a shorter listing of titles which although including the term 'environmental' or related words, are likely to fall at the interface with another Panel. In such cases it will be for institutions to determine against which benchmarking statement their courses should be evaluated.

Applied Earth Science(s)

Applied Environmental Earth Science

Applied Geology

Biodiversity, Conservation and Environmental Management

Biodiversity Management

Conservation

Conservation and Biodiversity

Conservation and Countryside Management

Conservation and Environment

Conservation Management

Earth and Environmental Resources

Earth and Environmental Science(s)

Earth and Planetary Science

Earth, Planetary and Space Science

Earth Resources

Earth Science(s)

Ecology

Ecology Conservation and Environment

Energy and Environmental Sustainability

Engineering Geology & Geotechnics

Environmental Analysis

Environmental Analysis and Monitoring

Environmental and Resource Geology

Environmental and Resource Science

Environmental Biogeochemistry

Environmental Biology

Environmental Change and Monitoring

Environmental Chemistry

Environmental Conservation

Environmental Control

Environmental Earth Science(s)

Environmental Geology

Environmental Geoscience(s)

Environmental Geotechnics

Environmental Health (Studies)

Environmental Management

Environmental Monitoring

Environmental Monitoring and Assessment

Environmental Monitoring and Management

Environmental Planning

Environmental Policy

Environmental Pollution Science

Environmental Protection

Environmental Protection (Conservation Management)

Environmental Quality and Resource Management

Environmental Risk Management

Environmental Risk Protection

Environmental Science(s)

Environmental Science of the Earth and Atmosphere

Environmental Sustainability

Environmental Studies

Environmental Technology

Environment and Development

Environment and Social Values

Environment and Society

Environment, Culture and Science

Fossils and Evolution

Geochemistry

Geological Hazards

Geological Oceanography

Geological Sciences

Geology

Geophysics

Geoscience

Landscape Conservation

Landscape Management

Marine Environmental Science

Meteorology

Minerals Surveying Science

Natural History

Oceanography

Palaeobiology and Evolution

Palaeoecology

Planetary Science

Rural Environmental Protection

Science (Environmental)

Soil Science

Surveying and Earth Resources

Sustainability

Urban and Environmental Planning

Water Resource(s) (Management)

Water Science

Award titles at the interface

Agriculture

Agronomy

Built Environment Studies

Ecodesign

Environmental and Mining Engineering

Environmental and Occupational Health and Safety Management

Environmental Archaeology

Environmental Design

Environmental Engineering

Environmental Geography

Environmental Plant Sciences

Environmental Services

Environmental Technology

Environmental Toxicology

Forestry

Geography

Heritage Management

Landscape Architecture

Landscape Ecology

Law

Marine Biology

Marine Chemistry

Marine Studies

Mining

Politics

Quarry Engineering

Rural Planning

Sociology

Town & Country Planning

Appendix 2a

Subject knowledge in the Earth Sciences

Each undergraduate honours degree will have its own characteristics with a detailed rationale for the content, nature and organisation as outlined in the relevant programme specification. While it is recognised that degree courses will vary considerably in the depth and specificity to which they treat subjects, it is expected that all graduates will have appropriate knowledge of the main aspects of Earth science given below.

Earth system science

- An holistic view of the present and past interactions between components of the Earth system and the effects of extra-terrestrial influences on these interactions
- Understanding of the cycling of matter and the flows of energy into, between and within the solid Earth, hydrosphere, atmosphere and biosphere
- The chemistry, physics, biology and mathematics that underpin our understanding of Earth structure, materials and processes.

Major geoscience paradigms

- Uniformitarianism: the present is the key to the past
- The extent of geological time
- Evolution: the history of life on Earth
- Plate tectonics.

Temporal and spatial scales

- Geological time, including the principles of stratigraphy, radiometric dating, the stratigraphic column, rates of Earth processes, major events in Earth history, and the evolution of life as revealed by the fossil record
- The study of structures, materials and processes ranging in scale from atoms to planets.

Earth structure, materials and processes

- Degree programmes in the Earth sciences will encompass studies of the structure and composition of the solid Earth (core, mantle, crust, asthenosphere, lithosphere etc.), the hydrosphere, the atmosphere, the cryosphere and the biosphere and the processes operating within and between them.

The relative coverage of these 'spheres' will vary between courses in geology, Earth sciences, oceanography, meteorology, climatology etc.

Terminology, nomenclature and classification and practical knowledge

- Earth science terminology, nomenclature and classification of rocks, minerals, fossils, and geological structures.
- The identification of rocks, minerals, fossils, and geological structures.
- Collection and documentation of geological information in the field, including the production and interpretation of geological maps.
- Surveying and measurement both in the field and laboratory, and using qualitative, quantitative and instrumental techniques.

Awareness and informed concern of Earth science issues

- The exploration for, and the development and exploitation of, Earth resources
- Geological aspects of human impacts on the environment.
- Geohazards and their impacts on human societies.
- Earth science perspectives on sustainability and social awareness (eg renewable versus non-renewable resources, climate change, the history of life and biodiversity).

Appendix 2b

Subject knowledge in the Environmental Sciences

Each undergraduate honours degree will have its own characteristics with a detailed rationale for the content, nature and organisation as outlined in the relevant programme specification. While it is recognised that degree courses will vary considerably in the depth and specificity to which they treat subjects, it is expected that all graduates will have appropriate knowledge of the main aspects of environmental science given below.

The Earth as a system

- The systems approach to environmental science
- The structure and functioning of the lithosphere, hydrosphere, atmosphere and biosphere
- The cycling of matter and the flows of energy into, between and within the lithosphere, hydrosphere, atmosphere and biosphere
- The complexity and inter-relatedness of the Earth's systems.

Human systems and their interaction with global systems

- The nature and organisation of human systems
- The complexity and inter-relatedness of human systems
- The interaction of human and Earth systems and the role of institutions, organisations and other stakeholders in managing and regulating the human impact on the environment.

Inter-disciplinary/multi-disciplinary context

- The contribution of the natural sciences (inter alia chemistry, physics, biology, mathematics, geology, physical geography) and social sciences (inter alia economics, politics, sociology, human geography) to the identification, understanding and, where appropriate, resolution of environmental issues and concerns.

Activities, patterns, processes, impacts and responses

- The role of the Earth's systems in supporting life
- The consequences for the environment of resource extraction and waste disposal arising from the fulfilment of human needs eg pollution, resource depletion and environmental change
- Human responses to environmental problems: environmental impact assessment, management and policy; risk based management; the precautionary principle; limits to growth; sustainability and sustainable development.

Temporal and spatial scales

- The importance of timescale, from geological to short term, including cycles and feedback mechanisms
- Major environmental processes on scales from the global to organismal, and where appropriate, to the molecular and atomic levels of organisation
- The global to local scale of human impacts on the environment.

Terminology, nomenclature and classification

- Terminology, nomenclature and classification approaches drawn from the natural and social sciences and developed within the discipline itself.

Environmental issues

- Human causes and consequences of environmental impacts.
- The options for remediation of environmental impacts available to human society.
- Environmental concerns such as: biodiversity; food supply, demand and scarcity; population growth; environmental limits to economic or population growth; demand for, and consequences of, water resource utilisation, energy and material production and use, including alternatives; air, land and water pollution; climate change; environmental change; approaches to, and limitations of environmental management systems; role of institutions in regulation and management of the environment; environmental policy formulation, legislation and decision making.

Appendix 2c

Subject knowledge in Environmental Studies

Each undergraduate honours degree will have its own characteristics with a detailed rationale for the content, nature and organisation as outlined in the relevant programme specification. While it is recognised that degree courses will vary considerably in the breadth, depth and specificity to which they treat subjects, it is expected that all graduates will have appropriate knowledge of the main aspects of environmental studies given below.

Human systems and their interaction with global systems

- The nature, organisation, complexity, sustainability and inter-relatedness of human systems
- The interaction of human systems and the Earth's systems
- The role of institutions, organisations and other stakeholders in managing and regulating human interaction with the environment
- The relationship between the environment, human culture and attitudes.

Inter-disciplinary/multi-disciplinary context

- The contribution of the natural sciences (inter alia chemistry, physics, biology, mathematics, geology, physical geography) and social sciences (inter alia economics, politics, sociology, human geography) to the identification, understanding and, where appropriate, resolution of environmental issues and concerns.

The Earth as a system

- The systems approach to environmental study and the structure and functioning of the Earth as a set of systems
- The cycling of matter and the flows of energy into, within the Earth systems and the complexity and inter-relatedness of the Earth's systems.

Activities, patterns, processes, impacts and responses

- The role of the Earth's systems in supporting life and human activities
- The consequences for the environment of resource extraction and waste disposal arising from the fulfilment of human needs eg pollution, resource depletion and environmental change
- Human responses to environmental problems: environmental impact assessment, management and policy development; risk based management; the precautionary principle; limits to growth; sustainability and sustainable development.

Temporal and spatial scales

- The importance of timescale, geological to the short term, in considering the environmental impact of human decisions
- Global to local scales of human impacts on, and responses to, the environment.

Terminology, nomenclature and classification

- Appropriate terminology, nomenclature and classification approaches drawn from the natural and social sciences.

Environmental Issues

- The human causes and consequences of environmental impacts
- The options for remediation of environmental impacts available to human society
- Environmental concerns such as: biodiversity; food supply, demand and scarcity; population growth; environmental limits to economic or population growth; global conventions and treaties; environmental policy formulation, legislation and decision-making; Agenda 21 and its local implementations; role of NGOs in environmental decision making; demand for, and consequences of, water resource utilisation, energy and material production and use, including alternatives; air, land and water pollution; climate change; environmental change; approaches to, and limitations of environmental management systems; role of institutions in regulation and management of the environment; valuation of the environment; conflict and environmental decision making.

Appendix 3

Earth Sciences, Environmental Sciences and Environmental Studies benchmarking group members

Mrs JR Blumhof	University of Hertfordshire
Dr CJR Braithwaite	University of Glasgow
Dr PJ Carey	University of Greenwich
Professor H Colley	Oxford Brookes University
Professor SA Dalton	Manchester Metropolitan University
Professor DA Eastwood	University of Ulster
Dr A Grant	University of East Anglia
Professor SJ Hill	University of Plymouth
Professor JWS Longhurst	University of the West of England, Bristol
Dr DAC Manning	University of Manchester
Professor C McCann	University of Reading
Ms CR Roberts	Cheltenham and Gloucester College of Higher Education
Professor S Sparks	University of Bristol
Dr DN Thomas	Kingston University
Professor RCL Wilson	Open University
Dr N Woodcock	University of Cambridge
Dr Helen King (Secretary)	University of Southampton
Observer: M Brooks	The Geological Society
Observer: LE Craig	Royal Geographical Society

The late Professor Peter Francis of the Open University contributed to discussion at the first two meetings.