

**Earth sciences, environmental sciences
and environmental studies
2007**

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Preface

Subject benchmark statements provide a means for the academic community to describe the nature and characteristics of programmes in a specific subject or subject area. They also represent general expectations about standards for the award of qualifications at a given level in terms of the attributes and capabilities that those possessing qualifications should have demonstrated.

This subject benchmark statement, together with others published concurrently, refers to the **bachelor's degree with honours**¹. In addition, some subject benchmark statements provide guidance on integrated master's awards.

Subject benchmark statements are used for a variety of purposes. Primarily, they are an important external source of reference for higher education institutions (HEIs) 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.

Subject benchmark statements also provide support to HEIs 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. Subject benchmark statements allow for flexibility and innovation in programme design and can stimulate academic discussion and debate upon the content of new and existing programmes within an agreed overall framework. Their use in supporting programme design, delivery and review within HEIs is supportive of moves towards an emphasis on institutional responsibility for standards and quality.

Subject benchmark statements may also be of interest to prospective students and employers, seeking information about the nature and standards of awards in a given subject or subject area.

The relationship between the standards set out in this document and those produced by professional, statutory or regulatory bodies for individual disciplines will be a matter for individual HEIs to consider in detail.

This subject benchmark statement represents a revised version of the original published in 2000. The review process was overseen by the Quality Assurance Agency for Higher Education (QAA) as part of a periodic review of all subject benchmark statements published in this year. The review and subsequent revision of the subject benchmark statement was undertaken by a group of subject specialists drawn from and acting on behalf of the subject community. The revised subject benchmark statement went through a full consultation with the wider academic community and stakeholder groups.

QAA publishes and distributes this subject benchmark statement and other subject benchmark statements developed by similar subject-specific groups.

¹ This is equivalent to the honours degree in the Scottish Credit and Qualifications Framework (level 10) and in the Credit and Qualifications Framework for Wales (level 6).

The Disability Equality Duty (DED) came into force on 4 December 2006². The DED requires public authorities, including HEIs, to act proactively on disability equality issues. The Duty complements the individual rights focus of the *Disability Discrimination Act* (DDA) and is aimed at improving public services and outcomes for disabled people as a whole. Responsibility for making sure that such duty is met lies with HEIs.

The Disability Rights Commission (DRC) has published guidance³ to help HEIs prepare for the implementation of the Duty and provided illustrative examples on how to take the duty forward. HEIs are encouraged to read this guidance when considering their approach to engaging with components of the Academic Infrastructure⁴, of which subject benchmark statements are a part.

Additional information that may assist HEIs when engaging with subject benchmark statements can be found in the DRC revised *Code of Practice: Post-16 Education*⁵, and also through the Equality Challenge Unit⁶ which is established to promote equality and diversity in higher education.

² In England, Scotland and Wales

³ Copies of the guidance *Further and higher education institutions and the Disability Equality Duty*, guidance for principals, vice-chancellors, governing boards and senior managers working in further education colleges and HEIs in England, Scotland and Wales, may be obtained from the DRC at www.drc-gb.org/library/publications/disability_equality_duty/further_and_higher_education.aspx

⁴ An explanation of the Academic Infrastructure, and the roles of subject benchmark statements within it, is available at www.qaa.ac.uk/academicinfrastructure

⁵ Copies of the DRC revised *Code of Practice: Post-16 Education* may be obtained from the DRC at www.drc-gb.org/employers_and_service_provider/education/higher_education.aspx

⁶ Equality Challenge Unit, www.ecu.ac.uk

Foreword

The Committee of Heads of Environmental Sciences and the Committee of Heads of University Geoscience Departments formed a joint review group to undertake the revision of the subject benchmark statement for earth sciences, environmental sciences and environmental studies (see Appendix 4). The revised subject benchmark statement was subject to consultation in August 2006 through QAA. Essentially, only minor amendments have been made to the original subject benchmark statement and these have focussed on shifting values within the area, including:

- greater emphasis on sustainability with particular emphasis on the environmental context of sustainability
- greater emphasis on employability
- greater emphasis on the links to and roles of professional bodies
- greater emphasis on interdisciplinarity and problem solving in subject skills
- provision of content statements to accompany performance levels
- greater clarity on the terrain encompassed by programmes in earth sciences, environmental sciences and environmental studies including provision of a Venn diagram.

December 2006

1 Introduction

1.1 Throughout this subject benchmark statement, 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 original benchmarking group's work, there was some scepticism that it would be possible to draft a single subject benchmark statement that encompassed ES3 in a meaningful way. The group believed it succeeded in showing that there is considerable congruence between the three subject areas. This applies particularly to graduate key skills (see paragraph 3.5 and 3.6) 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 and appendices) but there are also key elements of knowledge that all three subject areas embrace (see paragraph 3.4).

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 practical and field-based investigation
- the multidisciplinary and interdisciplinarity 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
- the development of skills for employability and societal contribution in an appropriate context.

2 Mapping the territory

2.1 The diversity of award titles (see appendix 1a) 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 original benchmarking group's approach in this section was to provide general characteristics of the three main programmes in the belief that this leaves institutions free 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 programme overlap, as illustrated heuristically in figure 1 (see Appendix 2).

2.2 The original benchmarking group had 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 benchmarking group believed that ES3 degree programmes share the following important features:

- most tuition has an holistic, multidisciplinary and interdisciplinary 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
- examination of the implications of sustainability and sustainable development.

2.3 ES3 is so broad that it inevitably overlaps with other disciplines. Providers of award titles at the interface (table 1b in appendix 1a and figure 1 in appendix 2) may wish to draw on other relevant subject benchmark 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.

2.4 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.

Degree programmes broadly concerned with earth sciences

2.5 Degree programmes in 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 extraterrestrial 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.

2.6 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.

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

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

2.9 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.

Degree programmes broadly concerned with environmental sciences

2.10 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 extraterrestrial influences
- the scientific study of surface and near-surface physical, chemical, biological and anthropogenic processes operating on the Earth
- modelling environmental phenomena
- problem-solving related to environmental phenomena
- 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
- scientific examination of the implications of sustainability and sustainable development.

2.11 Typical programme elements might include: climatology; climate change; 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.

2.12 Applications of the subject area might include: environmental hazards and risk 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, and natural and semi-natural habitats); and adaptation to environmental and particularly climate change.

2.13 The subject area overlaps on the one hand with the natural sciences (earth, physical, biological and geographical sciences) and on the other hand 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.

Degree programmes broadly concerned with environmental studies

2.14 Degree programmes in environmental studies typically involve:

- studies of the sociological, political, environmental and economic implications of human interactions with the environment
- the relationship between the environment, human health, 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
- examination of the concepts and applications of sustainability and sustainable development.

2.15 Typical programme elements might include: appropriate aspects of environmental science (such as climate change); conservation; economics; business and the environment; environmental management; geographic information systems applications; policy; law; ethics; social equity and social justice with reference to both the natural and built environments.

2.16 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.

2.17 The subject area overlaps with earth and environmental sciences, architecture and landscape architecture, economics, geography, law, politics, sociology, and 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 Subject knowledge and graduate key skills

3.1 The generic knowledge base described in section 3.4 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.

3.2 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.

3.3 Degree programmes should respond to new developments (for example in professional practice) or to recommendations made by accrediting professional bodies (see appendix 1b).

Knowledge

3.4 Examples of subject-specific knowledge are given in appendix 3. However, graduates of programmes in ES3 should understand:

- the need for both a multidisciplinary 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 debates 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 about the world we live in
- the relevance of knowledge and skills acquired on their programme of study to professional activity, responsible citizenship and the world of work.

Graduate key skills

3.5 The term 'graduate key skills' has been employed throughout this subject benchmark statement. The reasons for this are:

- the term 'graduate' implies the skills work is being undertaken in a 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 Skills (DfES) 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.

3.6 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.

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.

Intellectual skills

3.7 The graduate key skills that should be developed in ES3 degree programmes are:

- 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 complex and multidimensional problems in familiar and unfamiliar contexts
- recognising the moral and ethical issues of investigations and appreciating the need for professional codes of conduct.

Practical skills

3.8 The graduate key skills that should be developed in ES3 degree programmes are:

- 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.

Communication skills

3.9 The graduate key skills that should be developed in ES3 degree programmes are:

- 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.

Numeracy and C & IT skills

3.10 The graduate key skills that should be developed in ES3 degree programmes are:

- 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 including geographic information systems
- solving numerical problems using computer and non-computer-based techniques
- using the internet critically as a means of communication and a source of information.

Interpersonal/teamwork skills

3.11 The graduate key skills that should be developed in ES3 degree programmes are:

- 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.

Self management and professional development skills

3.12 The graduate key skills that should be developed in ES3 degree programmes are:

- 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 Teaching, learning and assessment

4.1 The original benchmarking group considered that it was inappropriate to be prescriptive about which teaching, learning or assessment methods should be used by a particular programme. This is because the programmes covered in this subject benchmark 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 Teaching, learning 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 and enquiry-based programmes may develop specific subject-based knowledge and skills.

4.3 The original benchmarking group believed 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 team working, problem-solving, self-management, interpersonal relationships), which are of value to the world of work and active citizenship.

4.4 Existing ES3 programmes have developed and used a very diverse range of learning, teaching and assessment methods to enhance student learning opportunities. They include flexible, blended, virtual and distance learning approaches. 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 as illustrated in appendix 3a, b and c. 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.

- **Excellent** is the performance currently expected of students gaining a First class honours.
- **Typical** is the performance currently expected of students at the Lower/Upper Second class boundary.
- **Threshold** is the minimum performance currently required to gain an honours degree.

5.3 Performance levels are defined for the six main categories of graduate key skills highlighted above 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 above, 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 earth sciences, environmental sciences and environmental studies honours degrees

	Excellent performance	Typical performance	Threshold performance
Intellectual skills (knowledge and understanding)	<p>Knowledge base extending well beyond the directly taught programme.</p> <p>Highly developed ability to integrate lines of evidence from a range of sources to support findings and hypotheses.</p> <p>Thorough understanding of subject-specific theories, paradigms, concepts and principles and an in-depth understanding of more specialised areas.</p> <p>Highly developed ability to consider issues from a wide range of multidisciplinary and interdisciplinary perspectives and to draw on appropriate concepts and values in arriving at a critical assessment.</p> <p>Highly developed ability to analyse, synthesise, summarise and critically evaluate information.</p> <p>Ability to define complex problems and to devise creative, elegant and effective solutions and to evaluate their use in increasingly unpredictable contexts.</p>	<p>Knowledge based on the directly taught programme and some evidence of enquiry beyond that.</p> <p>Ability to integrate lines of evidence from a range of sources to support findings and hypotheses.</p> <p>Understanding of subject-specific theories, paradigms, concepts and principles and some understanding of more specialised areas.</p> <p>Ability to consider issues from a range of multidisciplinary and interdisciplinary perspectives and to draw on appropriate concepts and values in arriving at a critical assessment.</p> <p>Ability to analyse, synthesise, summarise and critically evaluate information.</p> <p>Ability to define complex problems and to devise and evaluate possible solutions in relatively unpredictable contexts.</p>	<p>Knowledge based on the directly taught programme.</p> <p>Basic ability to integrate lines of evidence from a range of sources to support findings and hypotheses.</p> <p>Basic understanding of subject-specific theories, paradigms, concepts and principles.</p> <p>Basic ability to consider issues from a range of multidisciplinary and interdisciplinary perspectives.</p> <p>Basic ability to analyse, synthesise and summarise information.</p> <p>Basic ability to define problems and evaluate possible solutions in relatively predictable contexts.</p>

	Excellent performance	Typical performance	Threshold performance
	Highly developed critical approach to academic literature and other sources of information.	Critical approach to academic literature and other sources of information.	Basic approach to academic literature and other sources of information.
	Recognition and discussion of the moral and ethical dimensions of issues and investigations and the need for professional codes of conduct.	Recognition of the moral and ethical dimensions of issues and investigations and the need for professional codes of conduct.	Ability to describe the moral and ethical dimensions of issues and investigations and the need for professional codes of conduct.
Practical skills	Highly developed ability to describe and record materials in the field and laboratory.	Ability to describe and record materials in the field and laboratory.	Basic ability to describe and record materials in the field and laboratory.
	Ability to interpret practical results with flair.	Ability to interpret practical results in a logical manner.	Basic ability to interpret practical results.
	Highly developed ability to use appropriate laboratory and field equipment competently and safely.	Ability to use appropriate laboratory and field equipment competently and safely.	Basic ability to use appropriate laboratory and field equipment safely.
	Ability to use spatial technologies in addressing problems effectively and appropriately.	Ability to use spatial technologies in addressing problems effectively.	Basic ability to use spatial technologies in addressing problems.
	Highly developed ability to plan, conduct and present an independent project with little or no reliance on guidance.	Ability to plan, conduct and present an independent project with limited reliance on guidance.	Ability to plan, conduct and present an independent project with reliance on guidance.
	Highly developed ability to choose and apply a range of methods to solve problems.	Ability to select and apply a range of methods to solve problems.	Ability to apply a range of methods to solve problems.

	Excellent performance	Typical performance	Threshold performance
	Ability to present research findings in a number of formats with flair.	Ability to present research findings in a number of formats effectively and appropriately.	Basic ability to present results of investigations in a number of formats.
	Highly developed ability to relate investigations to prior work, to be aware of the latest research developments and to reference appropriately.	Ability to relate investigations to prior work and to reference appropriately.	Basic ability to relate investigations to prior work and to reference appropriately.
Communication skills	Ability to communicate highly effectively 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 to a variety of audiences in written, graphical and verbal forms.
	Ability to read and respond to written material critically, efficiently and effectively.	Ability to read and respond to written material efficiently.	Ability to read and respond to written material.
Numeracy and C & IT skills	Ability to collect and record data efficiently and effectively.	Ability to collect and record data.	Ability to collect and record data with guidance.
	Highly developed ability to prepare, process and interpret data using appropriate techniques.	Ability to prepare, process and interpret data using appropriate techniques.	Ability to prepare, process and interpret data using appropriate techniques with guidance.
	Highly developed ability to solve numerical problems using appropriate advanced techniques.	Ability to solve numerical problems using appropriate techniques.	Basic ability to solve numerical problems using appropriate basic techniques.
	Ability to use the internet critically for communication and information retrieval.	Ability to use the internet critically for communication and information retrieval.	Ability to use the internet for communication and information retrieval.

	Excellent performance	Typical performance	Threshold performance
Interpersonal/ teamwork	<p>Ability to work highly effectively in a team as a leader or participant by goal setting and time management.</p> <p>Ability to recognise and respect the views of others.</p>	<p>Ability to contribute effectively to team work.</p> <p>Ability to recognise and respect the views of others.</p>	<p>Some aptitude for and ability to contribute to team work.</p> <p>Ability to recognise and respect the views of others.</p>
Self management and professional development	<p>Highly developed ability to develop the skills necessary for self-managed and lifelong learning (eg independent study, time management, organisational skills).</p> <p>Highly developed ability to identify and work towards targets for personal, career and academic development.</p> <p>Highly developed ability to be adaptable and flexible.</p> <p>Ability to reflect on the process of learning and to evaluate personal strengths and weaknesses.</p>	<p>Ability to develop the skills necessary for self-managed and lifelong learning (eg independent study, time management, organisational skills).</p> <p>Ability to identify and work towards targets for personal, career and academic development.</p> <p>Ability to be adaptable and flexible.</p> <p>Ability to analyse personal strengths and weaknesses.</p>	<p>Basic ability to develop the skills necessary for self-managed and lifelong learning (eg independent study, time management, organisational skills).</p> <p>Basic ability to identify and work towards targets for personal, career and academic development.</p> <p>Ability to be adaptable and flexible.</p> <p>Basic ability to analyse personal strengths and weaknesses.</p>

Appendix 1a - Award titles covered by the subject benchmark statement for earth sciences, environmental sciences and environmental studies

The following table (1a) identifies many of the award titles available for 2006 entry, listed on the Universities and Colleges Admission Service website (www.ucas.com) which are likely to fall within the remit of the subject benchmark statement for ES3. Following that is a shorter listing of titles (table 1b) which, although including the term 'environmental' or related words, are likely to fall at the interface with another. In such cases it will be for institutions to determine against which subject benchmark statement their programmes should be referenced.

Table 1a - Award titles covered by the subject benchmark statement for ES3

Applied earth science(s)	Environmental chemistry
Applied environmental earth science	Environmental conservation
Applied geology	Environmental control
Biodiversity, conservation and environmental management	Environmental earth science(s)
Conservation	Environmental geology
Conservation and biodiversity	Environmental geoscience(s)
Conservation and countryside management	Environmental geotechnics
Conservation and environment	Environmental hazards
Conservation management	Environmental health
Earth and environmental resources	Environmental management
Earth and environmental science(s)	Environmental monitoring
Earth and planetary science	Environmental monitoring and assessment
Earth resources	Environmental monitoring and management
Earth science(s)	Environmental planning
Earth systems	Environmental policy
Ecology conservation and environment	Environmental pollution science
Engineering geology and geotechnics	Environmental protection
Environment and development	Environmental protection (conservation management)
Environment and social justice	Environmental quality and resource management
Environment and social values	Environmental risk management
Environment and society	Environmental risk protection
Environment, culture and science	Environmental science of the Earth and atmosphere
Environmental analysis	Environmental science(s)
Environmental analysis and monitoring	Environmental studies
Environmental and resource geology	Environmental sustainability
Environmental and resource science	Environmental technology
Environmental biogeochemistry	
Environmental biology	
Environmental change and monitoring	

Fossils and evolution
Geochemistry
Geological hazards
Geological oceanography
Geological sciences
Geology
Geophysics
Geoscience
Landscape conservation
Landscape management
Marine environmental science
Meteorology
Natural history

Ocean and climate
Oceanography
Palaeobiology and evolution
Palaeoecology
Planetary science
Rural environmental protection
Science of the environment
Soil science
Surveying and earth resources
Sustainability
Urban and environmental planning
Water resource(s) (management)
Water science

Table 1b - Award titles at the interface

Agriculture
Agronomy
Built environment studies
Development studies
Ecology
Environmental and mining engineering
Environmental and occupational health
and safety management
Environmental archaeology
Environmental design
Environmental engineering
Environmental forensics
Environmental geography
Environmental mathematics
Environmental plant sciences
Environmental technology
Environmental toxicology
Forestry

Geography
Heritage management
Landscape architecture
Landscape ecology
Law
Marine biology
Marine chemistry
Marine studies
Mining
Politics
Quarry engineering
Renewable energy
Rural planning
Sociology
Tourism and the environment
Town and country planning
Waste management

Appendix 1b - Professional bodies offering accreditation

Various professional bodies offer accreditation in the ES3 area. The implications of their requirements may influence programme planners in their consideration of employability and career progression. Current among these professional bodies and societies are:

- The Chartered Institute of Environmental Health
- The Chartered Institute of Water and Environmental Management
- Institute of Ecology and Environmental Management
- Institute of Environmental Management and Assessment
- Institution of Environmental Sciences
- Institute of Materials, Mining and Metallurgy
- Institute of Professional Soil Scientists
- The Geological Society, London
- The Royal Meteorological Society
- other organisations who are 'constituent bodies' of the Society for the Environment.

Appendix 3a - Subject knowledge in 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 extraterrestrial 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 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 challenges

- 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 3b - Subject knowledge in 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 interrelatedness 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.

Interdisciplinary/multidisciplinary 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 challenges

- 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; human adaptation to 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 3c - 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 interrelatedness 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.

Interdisciplinary/multidisciplinary context

- The contribution of the natural sciences (inter alia chemistry, physics, biology, mathematics, geology, physical geography), philosophy, ethics 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 interrelatedness 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; environmental economics; environmental ethics; 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 challenges

- 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 non-governmental organisations 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; human adaptation to 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 4 - Membership of the review group for the subject benchmark statement for earth sciences, environmental sciences and environmental studies

Dr J Andrews	University of Southampton
Mrs JR Blumhof	University of Hertfordshire
Professor DA Eastwood	University of Ulster
Professor JWS Longhurst (Chair)	University of the West of England, Bristol
Professor A Rankin	Kingston University
Ms CR Roberts	University of Gloucestershire
Dr DN Thomas	Kingston University
Mr Philip Holmes (Administrative support)	Institution of Environmental Sciences

Appendix 5 - Membership of the original benchmarking group for the subject benchmark statement earth sciences, environmental sciences and environmental studies

Details provided below are as published in the original subject benchmark statement for earth sciences, environmental sciences and environmental studies (2000)

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

Observers

M Brooks	The Geological Society
LE Craig	Royal Geographical Society

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

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