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Subject Benchmark Statement

Earth Sciences, Environmental Sciences and Environmental Studies

October 2019

Contents

How can I use this document?

This is the Subject Benchmark Statement for Earth Sciences, Environmental Sciences and Environmental Studies. It defines the academic standards that can be expected of a graduate, in terms of what they might know, do and understand at the end of their studies, and describes the nature of the subject.

The UK Quality Code for Higher Education (Quality Code) sets out the Expectations and Core practices that all providers of UK higher education are required to meet. Providers in Scotland, Wales and Northern Ireland must also meet the Common practices in the Quality Code.

The Quality Assurance Agency for Higher Education (QAA) has also published a set of Advice and Guidance, divided into 12 themes, and a number of other resources that support the mandatory part of the Quality Code. Subject Benchmark Statements sit alongside these resources to help providers develop courses and refine curricula but are not part of the regulated requirements for higher education providers in the UK.

This Statement is intended to support you if you are:

- involved in the design, delivery and review of courses of study in earth sciences, environmental sciences and environmental studies or related subjects
- a prospective student thinking about studying this subject, or a current student of the subject, to find out what may be involved
- an employer, to find out about the knowledge and skills generally expected of a graduate in this subject.

Subject Benchmark Statements provide general guidance for articulating the learning outcomes associated with the course but are not intended to represent a national curriculum in a subject or to prescribe set approaches to teaching, learning or assessment. Instead, they allow for flexibility and innovation in course design within a framework agreed by the subject community.

It may be helpful to refer to relevant Advice and Guidance when using this statement.

Explanations of unfamiliar terms used in this Subject Benchmark Statement can be found in QAA's Glossary.

About the Statement

This Subject Benchmark Statement is for bachelor's degrees with honours[1] in earth sciences, environmental sciences and environmental studies.

It has been produced by a group of subject specialists drawn from, and acting on behalf of, the subject community. The process is facilitated by QAA, as is the full consultation with the wider academic community and stakeholder groups each Statement goes through.

In order to ensure the continuing currency of Subject Benchmark Statements, QAA initiates regular reviews of their content, five years after first publication, and every seven years subsequently, or in response to significant changes in the discipline.

Relationship to legislation

Higher education providers are responsible for meeting the requirements of legislation and any other regulatory requirements placed upon them, for example by funding bodies. This Statement does not interpret legislation, nor does it incorporate statutory or regulatory requirements. The responsibility for academic standards remains with the higher education provider who awards the degree.

Higher education providers may need to consider other reference points in addition to this Statement in designing, delivering and reviewing courses. These may include requirements set out by professional, statutory and regulatory bodies (PSRBs), and industry or employer expectations.

Sources of information about other requirements and examples of guidance and good practice are signposted within the Subject Benchmark Statement where appropriate. Individual higher education providers will decide how they use this information.

Summary of changes from the previous Subject Benchmark Statement (2014)

This version of the Statement forms its fourth edition, following initial publication of the Subject Benchmark Statement in 2002 and review and revision in 2007 and 2014.

This latest version of the Statement is the consequence of the revision to the UK Quality Code for Higher Education which was published in 2018. It has been revised to update references to the Quality Code and other minor changes within the sector. Changes have been made by QAA and confirmed by the Chair of the most recent review group.

There have been no revisions to the subject-specific content of the statement.

[1] Bachelor's degrees are at level 6 in *The Framework for Higher Education Qualifications in England, Wales and Northern Ireland* and level 10 in *The Framework for Qualifications of Higher Education Institutions in Scotland*, as published in The Frameworks for Higher Education Qualifications of UK Degree-Awarding Bodies

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 The review group recognises that the Subject Benchmark Statement covers a wide range of subjects. While each could be seen as a distinct area in its own right, it is clear that there is sufficient overlap between the subjects that a single Statement is appropriate. This applies particularly to generic skills and the graduate knowledge components of the three subject areas.

1.3 ES3 is characterised by the following common features:

- a focus on understanding Earth systems in order to learn from the past, understand the present and influence the future
- an emphasis on practical (especially field-based) investigation
- multidisciplinary and interdisciplinary approaches
- working across a range of spatial and temporal scales
- the development of skills in observation and analysis to support decision-making in the light of uncertainty
- an appreciation of societal contribution and context
- the development of professional skills for employability.

1.4 There are a number of PSRBs that cover the range of subjects in ES3. Some of these offer accreditations for courses, higher education and a variety of membership opportunities, including chartered status for individuals. The range of relevant PSRBs changes over time but notable organisations currently include the Chartered Institution of Water and Environmental Management, The Geological Society of London, the Institution of Environmental Sciences, the Chartered Institute of Ecology and Environmental Management, and the Institute of Environmental Management and Assessment. Many others cover more specialist aspects such as air quality, water quality, or subjects allied to ES3 but linked to other subjects, such as engineering and agriculture.

1.5 Sustainability is a fundamental part of many subject areas associated with ES3 and is built into most curricula. This aspect of ES3 may also influence curricula in other subject areas, as the emphasis grows on the importance of providing all graduates with the necessary skills to promote a sustainable society. Sector agencies have worked together to produce guidance for higher education providers in implementing education for sustainability across subject areas.

1.6 This Subject Benchmark Statement covers the subjects as delivered at bachelor's degree with honours level (generally leading to the award of BSc or sometimes BA), but there are a number of other award levels that may also benefit from this guidance. Foundation degrees (FdSc) may provide a pathway towards an honours degree and hence the skills and knowledge base (including the emphasis on appropriate professional and practical skills) given here may be useful for those developing foundation degree curricula. This Statement does not cover taught postgraduate courses specifically but is relevant for the design of the earlier stages of integrated master's courses and will also be useful for the development of higher education in apprenticeships.

2 Subject coverage and knowledge

2.1 The ES3 heading (and even each component subject) encompasses a very wide diversity of courses and award titles. The original benchmarking group (2000) identified the following important shared features:

- tuition based on holistic, multidisciplinary and interdisciplinary approaches
- the integration of fieldwork, experimental and theoretical investigations underpinning the learning experience, especially in Earth and environmental sciences (although this may also be important 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.

2.2 The first review group (2007) made relatively minor amendments to the original Statement to focus on shifting values within the area, including greater emphasis on:

- sustainability with particular emphasis on the environmental context of sustainability
- employability
- the links to and roles of professional bodies
- interdisciplinarity and problem solving
- provision of content statements to accompany performance levels
- clarity on the terrain encompassed by courses in Earth sciences, environmental sciences and environmental studies.

2.3 ES3 is so broad that it inevitably overlaps with other subjects, and higher education providers may also make use of other relevant Subject Benchmark Statements. Specialist subjects such as oceanography, meteorology and soil science may form components of broader ES3 courses or form degree courses in their own right.

Subject knowledge for degree courses broadly concerned with Earth sciences

2.4 Each honours degree has its own characteristics, underpinned by a detailed rationale for its content, nature and organisation. While it is recognised that courses vary considerably in the depth and specificity to which they treat subjects, it is anticipated that all graduates have appropriate knowledge of the main aspects of the Earth sciences, as listed.

- A holistic view of the present and past interactions between components of the Earth system, including the effects of extraterrestrial influences on these interactions.
- The cycling of matter and the flows of energy into, between and within the solid Earth, the Earth's surface, the hydrosphere, the atmosphere and the biosphere.
- The study of the biological, chemical and physical processes that underpin our understanding of the structure, materials and processes relevant to the Earth and planetary bodies.
- The central paradigms in the Earth sciences: uniformitarianism (the present is the key to the past); the extent of geological time; evolution (the history of life on Earth); and plate tectonics.
- Geological time, including the principles of stratigraphy, the stratigraphic column, the methods of geochronology, the rates of Earth processes, major events in Earth history, the evolution of life as revealed by the fossil record, the quaternary and Anthropocene.

- Collection and analysis of Earth science data in the field and subsurface, the appropriate presentation, manipulation and extrapolation of these sometimes incomplete data in both two and three dimensions, including the generation of geological maps and cross sections.
- The study of structures, materials and processes that includes an appreciation of temporal and spatial variations at appropriate scales.
- The study of the structure, composition and materials of the solid Earth (core, mantle, crust, asthenosphere, lithosphere and so on), the hydrosphere, the atmosphere, the cryosphere and the biosphere, and the processes operating within and between them.
- An understanding of other planetary bodies.
- Earth science terminology, nomenclature and classification of rocks, minerals, fossils, and geological structures.
- The identification of rocks, minerals, fossils, and geological structures.
- Surveying and measurement both in the field and laboratory, and using quantitative and instrumental techniques.
- An awareness that the understanding and knowledge gained from the subject and its application has to be considered within a wider socio-economic and environmental context.

2.5 Typical components may include:

- engineering geology
- geochemistry
- geological mapping
- geomorphology
- geophysics
- geographic information systems and remote sensing applications
- hydrogeology
- igneous and metamorphic petrology
- local and global tectonics
- mineralogy
- mineral deposits
- natural hazards
- palaeobiology
- palaeoclimatology
- palaeontology
- petroleum geology
- petrology
- sedimentology
- stratigraphy
- structural geology

2.6 Applications may include:

- the exploration, development and remediation/storage of Earth resources (for example, hydrocarbons, minerals, water, carbon dioxide sequestration, aggregates and radioactive waste)
- using past climates to understand climate change and the impact on the environment and society
- civil engineering (for example, land restoration, site investigations and waste disposal)
- geohazards (for example, flooding, earthquakes, volcanic eruptions and landslides).

Subject knowledge for degree courses broadly concerned with environmental science

2.7 Each honours degree has its own characteristics, underpinned by a detailed rationale for its content, nature and organisation. While it is recognised that courses vary considerably in the depth and specificity to which they treat subjects, it is anticipated that all graduates have appropriate knowledge of the main aspects of the environmental sciences, as listed.

- A holistic approach to study of the complexity and interconnections of the Earth's systems and processes.
- The scientific study of physical, chemical, biological and anthropogenic processes operating on the ecosystems.
- Major environmental processes on scales from global to organismal, and, where appropriate, to the molecular and atomic levels of organisation.
- The importance of timescale, from geological to the short term, on the impacts of natural and human-induced activities on the ecosystem.
- The spatial scale, from global to local, of human impacts on the environment and responses to environmental change.
- The nature, organisation, complexity, sustainability and interconnections of humans and the ecosystems.
- A scientific and interdisciplinary approach to identifying, understanding and managing the Earth's processes and the ecosystem.
- The principles of energy consumption, resource extraction and waste disposal arising from the fulfilment of human needs.
- Monitoring, modelling and managing natural and human-induced environmental changes and behaviour.
- The principles of sustainability and the use of sustainable approaches to manage the natural cycles.
- Key concepts of environmental instruments, for example, environmental impact assessment, management and policy; risk-based management; environmental engineering approach; sustainability and sustainable development; and precautionary principles.
- The role of institutions, organisations and other stakeholders in managing and regulating the human impact on the environment.
- The role of environmental and sustainability professions in contributing to policy and practice, influencing behaviour and delivering positive change to environmental performance.
- Risks presented by a changing environment.
- The use of scientific and technological information and tools to inform decision-making processes and environmental management.
- A holistic approach to resolve a broad spectrum of environmental issues and enhance environmental performance.
- The options for remediation of environmental impacts available to human society.

2.8 Typical components may include:

- air, land and water pollution
- biodiversity
- biogeochemical cycles
- climate change
- conservation
- ecology

- ecological processes
- energy sources production and use
- environmental engineering
- environmental impact assessment
- environmental limits to economic or population growth
- environmental modelling
- environmental monitoring
- environmental pollution control
- green industry
- human adaptation to climate change
- life cycle analysis
- resource management
- sustainability and sustainable development
- water resource utilisation.

2.9 Applications may include:

- monitoring and remediation of contamination and pollution (for example, contaminated land, air and water)
- green industries and technologies (efficient resource utilisation, reduction in environmental impact)
- modelling and prediction of environmental impacts at different scales
- scientific and technological responses to climate change (including conservation of biodiversity, carbon sequestration).

Subject knowledge for degree courses broadly concerned with environmental studies

2.10 Each honours degree has its own characteristics, underpinned by a detailed rationale for its content, nature and organisation. While it is recognised that courses vary considerably in the depth and specificity to which they treat subjects, it is anticipated that all graduates have appropriate knowledge of the main aspects of environmental studies, as listed.

- A holistic approach to study of the complexity and interconnections of the Earth's systems and processes.
- The cycling of matter and the flows of energy into and within the Earth's systems and their role in supporting life.
- The nature, organisation, complexity, sustainability and interconnections of human systems.
- The history and current evidence of natural and human-induced environmental change.
- The consequences for the environment of energy consumption, resource extraction and waste disposal arising from the fulfilment of human needs.
- The sociological, political and economic implications of human interactions with the environment.
- The relationship between the environment and human cultures and values.
- The use of scientific and technological information to inform decision-making processes and environmental management.
- The options for remediation of environmental impacts available to human society.
- The role of institutions, organisations and other stakeholders in managing and regulating human interaction with the environment.
- The concepts and applications of sustainability and sustainable development.

- The importance of timescale, from geological to the short term, in considering the environmental impact of human activity.
- The spatial scale, from global to local, of human impacts on the environment and responses to environmental change.
- Interdisciplinary/multidisciplinary context: the contribution of the natural sciences, social sciences, technology, philosophy and ethics to the identification, understanding and, where appropriate, resolution of environmental issues and concerns.

2.11 Typical components may include:

- business and the environment
- climate change and human adaptation
- conflict and cooperation in environmental decision-making
- demand for, and consequences of, resource use
- environmental auditing
- environmental economics and valuation
- environmental ethics
- environmental impact assessment
- environmental legislation and regulations, including global conventions and treaties
- environmental limits to economic/population growth
- environmental management, including environmental management systems
- environmental policy formulation
- food supply, demand and scarcity
- green design and innovation
- principles of environmental science
- role of institutions in regulation and management of the environment
- rural and urban planning
- social equity and social justice
- sustainability and sustainable development.

2.12 Applications may include:

- environmental governance (including non-governmental organisations, public policy, local, national and international government)
- environmental management (for example, sustainable land management, greening business and industry)
- environmental education and training (such as carbon literacy, education for sustainability, development).

3 Subject-specific and generic skills

3.1 There are a number of subject-specific and generic skills that are applicable to all degree courses in ES3. However, each higher education provider decides on the exact content and emphases of their degree course(s) and its constituent parts.

3.2 The point at which the different skills are introduced and the level of engagement with them by students is decided by those responsible for developing individual curricula.

3.3 Subject-specific and generic skills expected to be demonstrated by students graduating from a higher education provider may be categorised under the following areas:

- intellectual skills (knowledge and understanding) associated with subject-specific theories, paradigms, concepts and principles
- practical skills associated with laboratory and field situations and including the ability to plan, implement, analyse and report investigations safely and ethically
- communication skills associated with a range of media and targeted at a range of audiences
- personal and professional skills associated with the identification of individual needs and requirements and including adaptability and flexibility in both independent and team working.

4 Teaching, learning and assessment

4.1 This Subject Benchmark Statement is not prescriptive about which teaching, learning or assessment methods are used by a particular course. Staff involved in course design and delivery are able to justify their choices in terms of the learning outcomes. Such methods are made explicit to students taking the course concerned.

4.2 Teaching, learning and assessment are interlinked as part of the curriculum design process and methods chosen are appropriate to develop the knowledge and skills identified in Sections 2 and 3. Research and scholarship informs the curriculum design of all ES3 courses. Research-led and enquiry-based courses may develop specific subject-based knowledge and skills.

4.3 It is impossible for students to develop a satisfactory understanding of ES3 without significant exposure to field-based learning and teaching and the related assessment. The integration of fieldwork with other learning methods is core to achieving skills such as the ability to visualise and extrapolate data in three dimensions or understanding the application of practical methodologies. Much of the advancement in knowledge and understanding in these 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. Field-based studies allow students to develop and enhance many of the generic skills (for example, team working, problem-solving, self-management and interpersonal relationships) which are of value to the world of work and active citizenship.

4.4 Students are introduced to a range of appropriate data sources, software and technologies (for example, for geographical information systems, remote sensing, 3D modelling and statistical analysis) that include industry standard techniques so that students are able to apply this knowledge on entering employment.

5 Benchmark standards

5.1 In this section, threshold levels of performance are indicated for the subject-specific and generic skills developed by students. The benchmark standards describe what a student should be able to do on completion of an honours degree in ES3, measured through appropriate assessment strategies. It is recognised that not all learning outcomes may be objectively assessed. It is important to emphasise that levels of performance above the threshold are established in terms of the shared values of the academic community as moderated internally and externally by academic quality procedures. Generally, a student demonstrates achievement across all four categories, but it is recognised that their performance may vary between them.

Intellectual skills (knowledge and understanding)

5.2 Graduates of an honours degree in ES3 demonstrate:

- knowledge and understanding of subject-specific theories, paradigms, concepts and principles
- an ability to integrate evidence from a range of sources to test findings and hypotheses
- an ability to consider issues from a range of interdisciplinary and multidisciplinary perspectives
- an ability to analyse, synthesise, summarise and critically evaluate information
- an ability to define complex problems and to develop and evaluate possible solutions
- a critical approach to academic literature, data and other sources of information.

Practical skills

5.3 Graduates of an honours degree in ES3 demonstrate an ability to:

- conduct fieldwork and laboratory investigations competently (as appropriate)
- describe and record observations in the field and laboratory
- interpret and evaluate practical results in a logical manner
- undertake laboratory and fieldwork ethically and safely
- plan, conduct and present an independent project with appropriate guidance
- prepare, manipulate and interpret data using appropriate techniques
- use appropriate numerical and statistical techniques
- use appropriate technologies in addressing problems effectively.

Communication skills

5.4 Graduates of an honours degree in ES3 demonstrate:

- an ability to communicate effectively to a variety of audiences using a range of formats
- good interpersonal communication skills to enable effective team working
- an ability to argue a case in an effective manner.

Personal and professional skills

5.5 Graduates of an honours degree in ES3 demonstrate an ability to:

- work effectively as a team member
- recognise and respect the views of others
- demonstrate an awareness of the importance of risk assessment and relevant legislation
- develop the skills for autonomous learning
- identify and work towards targets for personal, career and academic development
- reflect on the process of learning and to evaluate personal strengths and weaknesses
- display an appreciation of developing their graduate skills relevant to career pathways.

Appendix: Membership of the benchmarking and review groups for the Subject Benchmark Statement for Earth Sciences, Environmental Sciences and Environmental Studies

Membership of the review group for the Subject Benchmark Statement for Earth Sciences, Environmental Sciences and Environmental Studies (2019)

The fourth edition, published in 2019, was revised by QAA to align the content with the revised UK Quality Code for Higher Education, published in 2018. Proposed revisions were checked and verified by the Chair of the Subject Benchmark Statement for Earth Sciences, Environmental Sciences and Environmental Studies review group from 2014.

Phil Wheater, Professor Emeritus	Manchester Metropolitan University Committee of Heads of Environmental Sciences
Dr Alison Felce	QAA

Membership of the review group for the Subject Benchmark Statement for Earth Sciences, Environmental Sciences and Environmental Studies (2014)

Pam Furniss	The Open University
Dr Douglas Paton	University of Leeds
Dr Diane Purchase	Middlesex University
Professor Hugh Rollinson	University of Derby
Professor Phil Wheater (Chair)	Manchester Metropolitan University Committee of Heads of Environmental Sciences
Dr Anne Wheeler	Higher Education Academy

QAA Officers

Brigitte Stockton	QAA
Janet Bohrer	QAA

The following employers and external stakeholders were invited to provide feedback on the subject benchmark statement

British Geological Survey
Environment Agency
London Waste Ltd
Royal Geographical Society
Thames Water Ltd

Student reader

Mr Elliot Loveless	University of Manchester

Membership of the review group for the Subject Benchmark Statement for Earth Sciences, Environmental Sciences and Environmental Studies (2007)

Dr J Andrews	University of Southampton
Mrs J R Blumhof	University of Hertfordshire
Professor D A Eastwood	University of Ulster
Professor J W S Longhurst (Chair)	University of the West of England, Bristol
Professor A Rankin	Kingston University
Ms C R Roberts	University of Gloucestershire
Dr D N Thomas	Kingston University
Mr P Holmes (Administrative support)	Institution of Environmental Sciences

Membership of the original review group for the Subject Benchmark Statement for Earth Sciences, Environmental Sciences and Environmental Studies (2000)

Details provided below are as published in the original Subject Benchmark Statement.

Mrs J R Blumhof	University of Hertfordshire
Dr C J R Braithwaite	University of Glasgow
Dr P J Carey	University of Greenwich
Professor H Colley	Oxford Brookes University
Professor S A Dalton	Manchester Metropolitan University
Professor D A Eastwood	University of Ulster
Dr A Grant	University of East Anglia
Professor S J Hill	University of Plymouth
Professor J W S Longhurst	University of the West of England, Bristol
Dr D A C Manning	University of Manchester
Professor C McCann	University of Reading
Ms C R Roberts	Cheltenham and Gloucester College
Professor S Sparks	University of Bristol
Dr D N Thomas	Kingston University
Professor RCL Wilson	The Open University
Dr N Woodcock	University of Cambridge
Dr H King (Secretary)	University of Southampton
Observers	
M Brooks	The Geological Society
L E 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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