QAA MEMBERSHIP

Subject Benchmark Statement

Earth Sciences, Environmental Sciences and Environmental Studies

March 2022

Contents

About this Statement

This document is a QAA Subject Benchmark Statement for Earth Sciences, Environmental Sciences and Environmental Studies that defines what can be expected of a graduate in the subject, in terms of what they might know, do and understand at the end of their studies. Subject Benchmark Statements also describe the nature and characteristics of awards in a particular subject or area. Subject Benchmark Statements are published in QAA's capacity as a membership organisation on behalf of the higher education sector. A summary of the Statement is also available on the QAA website.

This Subject Benchmark Statement covers the subjects as delivered at bachelor's degree with honours level (including degrees with placement years and generally leading to the award of BSc or sometimes BA), integrated master's degrees and taught postgraduate degrees (generally leading to the award of MSci, MSc or sometimes MA). Foundation degrees (FdSc) may provide a pathway towards an honours degree and hence the guidance on skills and knowledge base, including the emphasis on appropriate professional and practical skills, given here may be useful for those developing foundation degree curricula. Research degrees are not addressed in this Subject Benchmark Statement.

Key changes from the previous Subject Benchmark Statement include:

- a revised structure for the Statement which includes the introduction of cross-cutting themes of:
  - equality, diversity and inclusion
  - education for sustainable development
  - employability, entrepreneurship and enterprise education
- a comprehensive review updating the context and purposes of Earth Sciences, Environmental Sciences and Environmental Studies, including course design and content in order to inform and underpin the revised benchmark standards.

How can I use this document?

Subject Benchmark Statements are often used by higher education providers in the design and development of new courses in the relevant subject, as they provide a framework for specifying intended learning outcomes in an academic or vocational discipline. They are also used as a reference point when reviewing or revalidating degree courses. They may be used by external examiners in considering whether the design of a course and the threshold standards of achievement are comparable with other higher education providers. They also provide professional, statutory and regulatory bodies (PSRBs) with the academic standards expected of students.

Subject Benchmark Statements provide general guidance for articulating the learning outcomes associated with a 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.

You may want to read this document if you are:

- involved in the design, delivery and review of courses in Earth Sciences, Environmental Sciences and Environmental Studies
- a prospective student thinking about undertaking a course in Earth Sciences, Environmental Sciences and Environmental Studies

- an employer, to find out about the knowledge and skills generally expected of Earth Sciences, Environmental Sciences and Environmental Studies graduates.

Relationship to legislation and regulation

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

The regulatory status of the Statement will differ with regard to the educational jurisdictions of the UK. In England, Subject Benchmark Statements are not sector-recognised standards as set out under the Office for Students' regulatory framework. However, they are specified as a key reference point, as appropriate, for academic standards in Wales under Quality Assessment Framework for Wales and in Scotland as part of the Quality Enhancement Framework. Subject Benchmark Statements are part of the current quality requirements in Northern Ireland. Because the Statement describes outcomes and attributes expected at the threshold standard of achievement in a UK-wide context, many higher education providers will use them as an enhancement tool for course design and approval, and for subsequent monitoring and review, in addition to helping demonstrate the security of academic standards.

Additional reference points

Higher education providers are likely to consider other reference points in addition to this Statement in designing, delivering and reviewing courses. These may include requirements set out by PSRBs and industry or employer expectations. QAA has also published Advice and Guidance to support the Quality Code which will be helpful when using this Statement, for example, in course design, learning and teaching, external expertise and monitoring and evaluation.

Explanations of unfamiliar terms used in this Subject Benchmark Statement can be found in QAA's Glossary. Sources of information about other requirements and examples of guidance and good practice are signposted within the Statement where appropriate.

1 Context and characteristics of an Earth Sciences, Environmental Sciences and Environmental Studies degree

Context

1.1 Throughout this Subject Benchmark Statement, Earth Sciences, Environmental Sciences and Environmental Studies are referred to collectively as ES3. The subject areas are also referred to individually and in combination where appropriate.

1.2 The wider context for this Subject Benchmark Statement is the ongoing climate emergency and biodiversity crisis, as well as other threats to the natural environment. These require action at every level, from global and national political commitment to practical measures at a local level. Graduates in ES3 subjects will be required to ensure actions and decisions are based on sound science, and that they take into account equity, equality, diversity and inclusivity to deliver long-term, sustainable solutions.

1.3 The review group recognises that the Subject Benchmark Statement covers a wide range of subjects. While each subject could be seen as a distinct area in its own right and each honours degree has its own characteristics, underpinned by a detailed rationale for its content, nature and organisation, it is clear that there is sufficient overlap between the subjects that a single Statement is appropriate.

1.4 For the purpose of this Subject Benchmark Statement, it has been decided to combine the subject coverage and knowledge for environmental sciences and environmental studies where possible. The previous versions of this Statement already show many common aspects to both subjects, especially in terms of subject knowledge content. With the integration of equality, diversity and inclusion (EDI) and sustainability in the Subject Benchmark Statements as well as the imperatives of considering the interactions between the social, economic and environmental components of sustainable development, even more overlaps are evident in environmental sciences and environmental studies. 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 sciences and studies as listed, and their relationship to sustainable development. However, the distinguishing features of each subject in terms of typical components and applications are also emphasised and listed. Combining the subject coverage and knowledge for environmental sciences and studies does not affect the Earth science content of the Subject Benchmark Statement.

1.5 Note that the term ‘environment’ as used throughout this document should be interpreted as inclusive in its scope and should be taken to include all livings things, both human and non-human.

Characteristics of an ES3 degree

1.6 ES3 is characterised by the following common skills and knowledge:

- a focus on understanding physical, chemical and biological Earth systems in order to learn from the past, understand the present and influence the future
- an appreciation of societal contribution and context
- an emphasis on practical investigation
- multidisciplinary and interdisciplinary approaches
- the ability to work 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
- the ability to recognise and understand complex relationships through systems thinking
- the development of professional skills and competencies that enhance employability
- an understanding of the contribution the subject knowledge, skills and behaviours can make towards a sustainable future.

1.7 There are a number of PSRBs that cover the range of subjects in ES3. Some of these offer accreditations for programmes, professional development courses 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.

Equality, diversity and inclusion

1.8 Equality, diversity and inclusivity (EDI) are integral to the ES3 disciplines, not only informing pedagogical practice but also as subject knowledge. Inclusion of diverse groups is critical to the development of subject learning communities, yet these groups may encounter multiple barriers to engagement. ES3 communities have a duty to confront and encourage the dismantling of all barriers to engagement and participation in our disciplines. Equality Impact Assessments may be a useful mechanism to explore these issues. ES3 communities can commit to creating safe, inclusive and supportive environments that value diversity and encourage discussion, learning and the co-production of ES3 curricula.

1.9 EDI can be explored in discipline contexts and by challenging discipline identities and stereotypes, including the impact of colonialism, embedding diverse representation within curriculums, broadening interdisciplinary and cross-disciplinary perspectives and particularly valuing different cultural perspectives, ways of knowing and lived experience. The ES3 subjects are a route to justice through delivery of the UN Sustainable Development Goals and diverse perspectives are essential to confronting global grand challenges. To achieve this, academic programmes in ES3 disciplines cultivate graduates who are culturally aware, show ethical behaviour, consideration and respect and who can reflect on equality in the context of their discipline. They will also be proficient in systems thinking, flexibility, interdisciplinarity and open to different ways of thinking and practising.

Sustainability

1.10 The terms sustainability and sustainable development are frequent inclusions in the ES3 disciplines as they are vital to managing Earth resources to promote the long-term well-being of the planet and all its inhabitants. It is important to note that sustainability is not solely about the environment. It is an ongoing process of addressing social, environmental and economic concerns to create a better world, and, as such, has particular relevance to the ES3 disciplines and positive graduate outcomes.

1.11 The application of sustainable development in the higher education sector takes place through Education for Sustainable Development (ESD) which is the process of creating curriculum structures and subject-relevant content to support and enact sustainable development. As stated in the UNESCO 2019 definition, ‘ESD is holistic and transformational education which addresses learning content and outcomes, pedagogy and the learning environment. It achieves its purpose by transforming society’, a vision which is

consistent with the aspirations of the ES3 disciplines. An understanding of the United Nations Sustainable Development Goals (SDGs) is essential to this vision.

1.12 To support the inclusion of sustainable development within the ES3 disciplines, users should refer to the QAA and Advance HE Education for Sustainable Development Guidance to address teaching and learning for sustainable development, key competencies, learning outcomes and assessment within the curricula.

Employability, entrepreneurship and enterprise

1.13 Employability is the set of competencies, demonstrated by a combination of knowledge, skills and behaviours, that make individuals more likely to gain employment and be successful in their chosen occupations, benefiting themselves, society and the economy. It includes problem identification and solving, innovation, creativity, expression, communication and practical action. Entrepreneurship enhances employability by promoting personal development. It fosters those attributes that enable students to transition into successful graduates, actively participating in society and identifying opportunities to enable them to develop a meaningful career combined with the creation of cultural, social and economic value. These attributes apply equally across ES3, although the emphasis within the learning outcomes of the subjects will differ. Developing close links with employers and involving them in curriculum and assessment design will contribute positively to graduate employability. Employability and entrepreneurship focus on competencies (knowledge, skills and behaviours) and cross-cutting, transferable themes such as business awareness, professional ethics, health and safety codes and personal motivation.

1.14 In the context of the Earth sciences, employers will be looking for competence with the selection, application and interpretation of appropriate numerical, digital, qualitative and quantitative techniques and the ability to understand the Earth system in four dimensions.

1.15 In the context of environmental sciences and studies, employers will be looking for competence with emerging good practice, survey and data analysis techniques, knowledge of current legislation and policy, and the ability to identify the impacts on the environment from activities

1.16 To support the inclusion of employability, entrepreneurship and enterprise within the ES3 disciplines, users should refer to the QAA document Enterprise and Entrepreneurship Education: Guidance for UK Higher Education Providers.

2 Distinctive features of an Earth Sciences, Environmental Sciences and Environmental Studies degree

Design

2.1 The ES3 subjects are rooted in sustainability. They are both multidisciplinary and interdisciplinary by nature, overlapping with science and humanity-based disciplines, including biology, chemistry, geography, informatics and physics. The subjects are inherently practical and practical skills are embedded in ES3 curricula. Research and scholarship also inform the curriculum design of all ES3 courses. Courses are focused on the delivery of subject-specific intended learning outcomes and are innovative, flexible and inclusive in their design, paying due regard to decolonising the curriculum, including challenging conceptual frameworks and dismantling subject practices that perpetuate inequities. Courses allow students to reflect upon their learning and the application of their knowledge for a sustainable society. Outcomes include knowledge and skills that provide graduates with a wide range of competencies, preparation for future employment and awareness of key challenges in sustaining a habitable planet.

Accessibility

2.2 In this Statement, we approach accessibility as the inclusive design of curriculum and pedagogy that does not exclude any individual from participation. Individuals and marginalised groups experience a variety of barriers to participation, many of which are intersectional. These barriers are purposefully addressed in the ES3 subjects so that all learners can equally access and thrive, with inclusive practices a pedagogical norm. While inclusive curriculum design should enable all learners to participate fully, flexibility is required, and reasonable adjustments may be needed in practice. The ES3 subjects are visual and graphic subjects traditionally underpinned by laboratory and field-based approaches, which can sometimes be exclusionary. Ensuring that all students can participate in such activities may require a mix of strategies, including careful design of curricula and field programmes and leveraging accessible technologies. Health, safety and well-being of participants should be included in risk assessments, including any specific risks a student with protected characteristics may face. A choice of blended learning through online learning and practical exercises can enable a wide range of learners to engage, making for effective teams and group work rather than reinforcing otherness.

Progression

2.3 Over the course of a bachelor's degree with honours (FHEQ Level 6; FQHEIS SCQF Level 10), a student studying for a degree in the ES3 subject area will progress from one year of study to the next, in line with the regulations and processes for each institution. However, it is expected that in each year, the attainment of certain levels of knowledge, expertise and experience are achieved. These will build towards the final achievement of meeting all of the threshold-level subject-specific and generic skills listed in this Statement. Integrated master's degrees (FHEQ Level 7; FQHEIS SCQF Level 11) require one further academic year of study and it is expected that at the end of this further year, students are able to demonstrate increased critical thinking, evaluation skills and independence. In a standard three-year undergraduate honours degree course, students may exit earlier and be eligible for a Certificate of Higher Education, a Diploma of Higher Education or an honours degree, depending upon the levels of study completed to a satisfactory standard. Scottish bachelor's degrees with honours are typically designed to include four years of study, which relates to the structure of Scottish primary and secondary education.

2.4 Where relevant, upon graduation from an undergraduate degree, it would normally be expected that a student who had achieved a second-class degree or higher would be capable of, and equipped for, undertaking postgraduate study in Earth Science, Environmental Science, Environmental Studies or associated sustainability disciplines and would also be equipped for entering courses that cross and combine disciplines.

2.5 Joint honours undergraduates will achieve elements of the specific and generic skills for the subject but will add others according to the subjects covered in a joint programme.

Flexibility

2.6 Programmes offered may include full-time, part-time or distance learning. Programmes may offer a diversity of blended learning approaches combining classroom, laboratory, field and virtual opportunities. ES3 subjects are broad in scope so there may be instances where institutions specialise in particular areas of ES3. Programmes may provide international opportunities, virtual exchanges or professional experiences.

Partnership

2.7 Students can be considered as partners both in course design and with external bodies such as PSRBs. External experts support and enrich courses; contributions may include visiting lecturers, advisory boards (including industry and public bodies), PSRB professional guidance, accreditation and standards, and professional organisations. Programmes may include work-based learning such as placements, vocational modules and work-related projects. Apprenticeship degrees integrate taught elements of the course with workplace experience, which is further described in QAA's Higher Education in Apprenticeships Characteristics Statement.

Monitoring and review

2.8 A major feature of academic quality assurance and enhancement at a higher education institution is having in place monitoring and regular review processes for the courses it delivers. Degree-awarding bodies routinely collect and analyse information and undertake periodic course review according to their own needs. They will draw on a range of external reference points, including this Statement, to ensure that their provision aligns with sector norms. Monitoring and evaluation is a periodic assessment of a course, conducted internally or by external independent evaluators. Evaluation uses information from both current and historic monitoring to develop an understanding of cohort demographics, student achievement and to inform future course planning. Such an evaluation also enables an understanding of the nature and extent of awarding gaps and is critical in being able to eradicate these.

2.9 Externality is an essential component of the quality assurance system in the UK. Higher education providers will use external reviewers as part of periodic review to gain an external perspective on any proposed changes and ensure threshold standards are achieved and content is appropriate for the subject.

2.10 External examination currently in use across the UK higher education sector also helps to ensure consistency in the way academic standards are secured by degree-awarding bodies. Typically, external examiners will be asked to comment on the types, principles and purposes of assessments being offered to students. They will consider the types of modules on offer to students, the outcomes of a cohort and how these compare to similar provision offered within the UK. External examiners produce a report each year and make recommendations for changes to modules and assessments (where appropriate). Subject

Benchmark Statements, such as this one, can play an important role in supporting external examiners in advising on whether threshold standards are being met in a specific subject area.

3 Content, structure and delivery

Earth Sciences

3.1 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 and skills of the main aspects of the Earth sciences, as listed below.

- The concepts and applications of sustainable development and systems thinking. This should be consistent with the QAA and Advance HE Education for Sustainable Development Guidance.
- The formation of the Earth and other planets and their place within the solar system.
- 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 fossil record, the methods of geochronology, the rates of Earth processes and major events in Earth history.
- The structure, composition and materials of the solid Earth, the hydrosphere, the atmosphere, the cryosphere and the biosphere; the processes operating and the cycling of matter and energy within and between them.
- The study of the biological, chemical and physical processes that underpin our understanding of Earth and planetary systems.
- The study of structures, materials and processes that includes an appreciation of temporal and spatial variations at appropriate scales.
- The formation of igneous, metamorphic and sedimentary rocks.
- The identification of rocks, minerals, fossils and geological structures and their relevant terminology, nomenclature and classification.
- Collection and analysis of Earth science data of the surface and subsurface, and the appropriate presentation, manipulation, modelling and extrapolation of these (sometimes incomplete) data in four dimensions.
- Observation and interpretation of field-based data (in situ and virtual) from first principles.
- Surveying and measurement, both in the field and laboratory, using quantitative and instrumental techniques.
- The use of qualitative and quantitative data, an understanding of using data sets and an appreciation of how to assess data quality and uncertainty.
- The importance of Earth sciences in resource management and the mitigation of, and adaptation to, environmental hazards, including climate change.
- An awareness that the understanding and knowledge gained from the subject and its application is considered within a wider socioeconomic and environmental context.
- An understanding of the ethical issues surrounding the legacy and uses of the discipline, engaging in contemporary debates and appreciating the need for decolonisation.
- The importance of equality, diversity and inclusivity in the practice of the discipline.

- An awareness of field work codes of practice and an ability to confidently complete health and safety risk assessments.

3.2 Typical components may include:

- Earth materials
- economic geology
- energy geoscience
- engineering geology
- environmental hazards
- geochemistry
- geoconservation
- geoethics
- geographic information systems and remote sensing applications
- geological mapping
- geomorphology
- geophysics
- hydrogeology and hydrology
- igneous and metamorphic processes and petrology
- mineralogy
- natural resources
- oceanography and marine science
- palaeobiology
- palaeoclimatology and climate change
- palaeontology
- sedimentology
- seismology
- soils
- stratigraphy
- structural geology
- sustainable geoscience
- tectonics: local and global
- volcanology
- urban geoscience.

3.3 Applications may include:

- the role of Earth sciences in meeting the UN Sustainable Development Goals
- the sustainable exploration, management, development, remediation and storage of Earth resources (for example, minerals, water, aggregates, hydrocarbons, carbon dioxide and radioactive waste)
- the energy transition and alternative forms of energy that underpin the route to decarbonisation
- the use of past climates to understand climate change and its impact on the environment and society
- the use of engineering geology and geotechnical engineering approaches in activities that include land restoration, site investigations, geohazard assessment, waste disposal and the development of civil engineering infrastructure and other construction activities
- the mitigation and management of geohazards (for example, flooding, coastal erosion, earthquakes, volcanic eruptions and landslides)

- an awareness that the understanding and knowledge gained from the subject and its application has to be considered within a wider socioeconomic and environmental context.

Environmental Sciences and Environmental Studies

3.4 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 and skills of the main aspects of environmental sciences and environmental studies, as listed below.

- The concepts and applications of sustainable development and systems thinking. This should be consistent with the QAA and Advance HE Education for Sustainable Development Guidance.
- A holistic approach to the study of the complexity and interconnections of the Earth's systems and processes.
- The principles of sustainability and the use of sustainable approaches to manage natural and human-induced cycles of resource use.
- The importance of timescale (geological, present, short term, long term and future) on the impacts of natural and human-induced activities on ecosystems.
- The spatial scale, from global to local, of human impacts on the environment and responses to environmental change.
- The interconnections and inter-dependencies of all organisms within natural and managed ecosystems.
- The positive and negative impacts of development on the environment and management tools for addressing them.
- The impacts of environmental change on humans, non-humans and infrastructure.
- Monitoring, modelling and managing natural and human-induced environmental changes and behaviour.
- Understand how to predict, mitigate and manage risks presented by a changing environment and human pressures.
- Understanding uncertainty and how it applies to current and future decision-making.
- The role of institutions, organisations, governance structures and other stakeholders in managing and regulating human impacts on the environment.
- The importance of environmental sciences and studies in resource management and the mitigation of, and adaptation to, environmental hazards, including climate change.
- Observation and interpretation of field-based data (in situ and virtual) from first principles.
- The use of qualitative and quantitative data, an understanding of using data sets and an appreciation of how to assess data quality and uncertainty.
- Developing relevant and appropriate digital skills and technology.
- An awareness that the understanding and knowledge gained from the subject and its application is considered within a wider socioeconomic and environmental context.
- Understand the ethical issues surrounding the legacy and uses of the discipline, engage in contemporary debates and appreciate the need for decolonisation.

- The importance of equality, diversity and inclusivity in the practise of the discipline
- Awareness of field work codes of practice and ability to confidently complete health and safety risk assessments.

3.5 Typical components may include:

- agriculture
- air quality
- aquaculture and fisheries management
- biodiversity and biodiversity loss
- carbon management
- circular economy
- climate change and its mitigation and adaptation
- conservation, including conservation of biota, and environmental stewardship
- ecology
- ecosystem services and natural capital
- energy sources production and use
- environmental ethics
- environmental policy, legislation and regulation (including global conventions and treaties)
- environmental and societal impact assessment
- environmental economics
- environmental management systems
- environmental modelling
- environmental monitoring
- environmental pollution
- forestry
- food security
- life cycle analysis
- nature-based solutions
- resource extraction, management and use
- soils
- sustainability and sustainable development
- sustainable waste resource management
- water resources.

3.6 Applications may include:

- the role of environmental sciences and studies in meeting the UN Sustainable Development Goals
- the energy transition and alternative forms of energy that underpin the route to decarbonisation
- a holistic and multidisciplinary approach to resolve a broad spectrum of environmental issues and enhance environmental performance
- the 'greening' of industries and technologies (efficient resource utilisation and reduction in environmental impact)
- the modelling and prediction of environmental impacts at different scales
- the social, cultural, scientific and technological responses to climate change (including conservation of biodiversity, carbon sequestration and nature-based solutions)
- the informing of environmental policy, legislation and governance (including non-governmental organisations, public policy, local, national and international government)

- the pursuit of sustainable cities and communities through green design and innovation
- the understanding of ecosystem services and their benefit to society and biodiversity management.

Environmental Sciences only content

3.7 A degree programme in Environmental Sciences is normally expected to include the following subjects in addition to the combined content in paragraph 3.2, with graduates expected to demonstrate knowledge and understanding in these areas:

- the scientific study of physical, chemical, biological and anthropogenic processes operating on ecosystems
- major environmental processes on scales from global to organismal, and, where appropriate, to the molecular and atomic levels of organisation
- a scientific and multidisciplinary approach to identifying, understanding and managing the Earth's structure, processes and ecosystems
- the use of scientific and technological information and tools to inform decision-making processes and environmental management
- observation and interpretation of field-based data (in situ and virtual) from first principles
- surveying and measurement, both in the field and laboratory, using quantitative and instrumental techniques.

3.8 Typical components in addition to those addressed in the environmental sciences and studies section may include:

- biogeochemical cycles
- environmental engineering
- principles of environmental science.

3.9 Applications in addition to those addressed in the environmental sciences and studies section may also include:

- the monitoring, remediation and management of contamination and pollution (for example, contaminated land, air and water)
- the modelling of future impact on society from climate and environmental change
- the calculation of carbon footprints using a full range of data sources to underpin the route to decarbonisation
- the use of data to inform industrial and corporate environmental management practices
- the modelling of biodiversity loss to support ecosystem resilience.

Environmental Studies only content

3.10 A degree programme in Environmental Studies is normally expected to include the following subjects in addition to the combined content in paragraph 3.2, with graduates expected to demonstrate knowledge and understanding in these areas:

- the history and current evidence of natural and human-induced environmental change
- the sociological, political and economic implications of human interactions with the environment
- the relationship between the environment and human cultures and values.

3.11 Typical components in addition to those addressed in the environmental sciences and studies section may include:

- conflict and cooperation in environmental decision-making
- environmental justice and social equity (at local, national and international and intergenerational scales)
- environmental philosophies
- indigenous environmental knowledge and practice
- values-based ethics.

3.12 Applications in addition to those addressed in the environmental sciences and studies section) may also include:

- the use of environmental philosophies and ethics in the resolution of environmental issues and concerns
- the inclusion of indigenous communities, their knowledge and their role in managing the environment.

Teaching and learning

3.13 Teaching is about engaging all learners to facilitate their knowledge and understanding and the subsequent application of concepts and processes. It is inclusive of all students. It includes curriculum design, the selection and delivery of content, the method and type of assessment, moderation and reflection. Learning is the process of gaining knowledge and skills through the processes of being taught, studying, experience and practice.

3.14 This Subject Benchmark Statement does not specify which methods of teaching or learning should be employed in relevant courses; however, learning outcomes should be achievable through the methods utilised and clearly articulated to the learners.

3.15 Teaching and learning are interlinked as part of the curriculum design process and methods chosen should be inclusive and appropriate to develop the knowledge and skills identified in sections 1 and 2. Research-led and enquiry-based courses may develop specific subject-based knowledge and skills.

3.16 The ES3 subjects are characterised by the integration of practical work, especially field-based activities, with theoretical studies. Courses therefore offer all students opportunities for significant field-based learning and teaching to foster skills such as the ability to visualise and extrapolate data in three dimensions or understand the application of practical methodologies. Much advancement in knowledge and understanding in these subject areas is founded on accurate observation and recording in the field and the collection of empirical data for analysis. Developing field-related practical and research skills is therefore important for students wishing to pursue careers in ES3-related sectors. Field-based studies allow students to develop and enhance many graduate attributes and transferable skills, for example leadership, team working, problem-solving, self-management and interpersonal relationships, which are of value to their employability, entrepreneurship and active citizenship. Activities should be designed to be inclusive to all students. If required, reasonable adjustments should be arranged in order to enable all students to take part in practical work and fieldwork activities.

3.17 ES3 subjects have sustainability at their core. Teaching and learning should be clearly underpinned by education for sustainable development to achieve positive graduate outcomes and teaching and learning methods should embody sustainability principles and solutions.

Assessment

3.18 Assessment strategy is an integral part of course design. This Subject Benchmark Statement is not prescriptive about which assessment methods are used on courses. Authentic assessment approaches, based on tasks likely to be encountered in the workplace, can benefit employability outcomes for graduates and ease the transition from university to the workplace.

3.19 Assessment is inclusive for all students. It is designed in a way that facilitates learning and supports students to succeed, and it is clearly linked to the specified learning outcomes or desired competencies. Where appropriate, modified and alternative provision with reasonable adjustments is available to avoid EDI barriers.

3.20 Feedback is an important part of the assessment cycle and can be provided in a variety of formats. Formative feedback can benefit student performance and, when used appropriately, boost student confidence and outcomes. The opportunity for personal reflection, and peer and self-assessment is also a valuable component of assessment. Such feedback and reflection can enable transformative learning and is closer to workplace reality.

3.21 Examples of authentic assessment types include, but are not limited to:

- practical (especially field and lab-based) investigations
- research-led and enquiry-based, reflective evaluations of real-life case studies, working across a range of spatial and temporal scales
- case reports based on skills in observation and analysis to support decision-making in the light of uncertainty
- oral accounts and presentations of processes and issues, including an appreciation of societal contribution and context.

3.22 Where appropriate, assessments take multidisciplinary and interdisciplinary approaches and are clearly underpinned by education for sustainable development to achieve positive graduate outcomes.

4 Benchmark standards

Introduction

4.1 This Subject Benchmark Statement sets out the minimum threshold standards that a student will have demonstrated when they are awarded an honours degree in ES3. Demonstrating these standards over time will show that a student has achieved the range of knowledge, understanding and skills expected of graduates in ES3.

4.2 The vast majority of students will perform significantly better than the minimum threshold standards. Each higher education provider has its own method of determining what appropriate evidence of this achievement will be and should refer to Annex D: Outcome classification descriptions for FHEQ Level 6 and FQHEIS Level 10 degrees. This Annex sets out common descriptions of the four main degree outcome classifications for bachelor's degrees with honours: 1st, 2:1, 2:2 and 3rd.

Threshold level

Intellectual skills (knowledge and understanding)

4.3 Graduates with an honours degree in ES3:

- have a knowledge and understanding of subject-specific theories, paradigms, concepts and principles
- integrate evidence from a range of sources to test findings and hypotheses
- consider and appraise issues from a range of multidisciplinary and interdisciplinary perspectives
- analyse, synthesise, summarise, appraise and critically evaluate information
- define complex problems and develop and evaluate possible solutions
- develop and test hypotheses to inform and design investigations (and experiments)
- plan, conduct and present an independent project with appropriate guidance
- take a critical approach to academic literature, data and other sources of information
- have confidence and competence in dealing with uncertainty in data and systems response.

Practical skills

4.4 Graduates of an honours degree in ES3:

- conduct fieldwork and laboratory investigations competently (as appropriate)
- describe and record observations effectively in the field and laboratory
- interpret and evaluate practical results in a logical manner
- undertake laboratory and fieldwork ethically and safely with an appreciation of appropriate codes of conduct and legal requirements
- gather, prepare, process and interpret data using appropriate techniques
- use appropriate numerical, statistical and qualitative techniques
- use appropriate technologies in addressing problems effectively.

Communication skills

4.5 Graduates of an honours degree in ES3:

- communicate effectively with a variety of audiences using a range of formats and media
- have good interpersonal communication skills to enable effective team working
- acknowledge and understand different perspectives
- effectively articulate and synthesise an argument
- present a case in an influential and persuasive manner.

Personal and professional skills

4.6 Graduates with an honours degree in ES3:

- reflect on the process of learning and evaluate personal strengths and weaknesses
- develop the skills for autonomous learning
- plan and organise workloads, including project management
- develop leadership qualities
- work effectively as a team member
- work online and remotely as well as in person
- demonstrate professional behaviours
- display an appreciation of developing graduate skills relevant to career pathways
- recognise the importance of planning for personal, career and professional development, including identifying and working towards targets
- recognise and respect the views of others
- demonstrate an understanding of the importance of risk assessment and associated legislation for health, safety and well-being
- recognise the importance of equality, diversity and inclusivity and develop behaviours that support EDI
- appreciate the need to act and work in an ethical and sustainable manner and in compliance with relevant legislation.

4.7 In addition to the competencies developed over the course of their programme, graduates of integrated master's courses will have gained significant specialism in a specific subject area through developing and leading an independent research project. Graduates of integrated master's courses will demonstrate the ability to independently interrogate the relevant literature, applying ideas, techniques and data to a range of questions, demonstrating key skills and working independently to design and carry out a project to address important practical questions.

4.8 At postgraduate (MSc or MA) level it is expected that students will build on the competencies listed above that are developed in their undergraduate studies but focus in greater depth on a specific aspect of the subject area, achieving knowledge and skills to enhance their employability.

5 List of references and further resources

QAA and Advance HE (2021) Education for Sustainable Development Guidance
www.qaa.ac.uk/quality-code/education-for-sustainable-development

HEA (2016) Framework for Embedding employability in higher education
www.heacademy.ac.uk/system/files/downloads/embedding-employability-in-he.pdf

QAA (2018) Enterprise and Entrepreneurship Education: Guidance for UK Higher Education Providers
www.qaa.ac.uk/quality-code/enterprise-and-entrepreneurship-education

QAA (2019) Characteristics Statement: Higher Education in Apprenticeships
www.qaa.ac.uk/quality-code/characteristics-statements

QAA (2019) Annex D: Outcome classification descriptions for FHEQ Level 6 and FQHEIS Level 10 degrees
www.qaa.ac.uk/quality-code/qualifications-frameworks

6 Membership of the Advisory Groups for the Subject Benchmark Statement for Earth Sciences, Environmental Sciences and Environmental Studies

Membership of the Advisory Group for the Subject Benchmark Statement for Earth Sciences, Environmental Sciences and Environmental Studies (2022)

Dr Sian Davies-Vollum (Chair)	University of Derby
Dr Tom Argles	The Open University
Professor Debbie Bartlett	University of Greenwich
Martin Baxter	Institute of Environmental Management and Assessment
Dr Samira El Boudamoussi	Imperial College of Science, Technology and Medicine
Georgia Clarke	QAA Coordinator
Richard Howell	Environment Agency (Retired)
Dr Rebekah Humphreys	University of Wales Trinity Saint David
Professor Simon Kemp	University of Southampton
Kevin Kendall	QAA Officer
Professor Linda Kirstein	University of Edinburgh
Dr Christina Manning	Royal Holloway and Bedford New College
Dr Alicia Newton	The Geological Society
Dr Rana Parween	University Centre Askham Bryan
Bitsy Pout	University of Southampton
Professor Diane Purchase	Middlesex University
Dr Nicholas Ray	Nottingham Trent University
Dr Alison Stokes	University of Plymouth
Dr Rebecca Williams	University of Hull
Dr Bethan Wood	University of Glasgow

QAA would like to thank Professor Elizabeth Cleaver, Professor Michael McLinden and the Disabled Students' Commission for their valued contributions to the development of the Statement.

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

Details provided below are as published in the third edition of the Subject Benchmark Statement.

Professor Phil Wheater (Chair)	Manchester Metropolitan University

	Committee of Heads of Environmental Sciences
Pam Furniss	The Open University
Mr Elliot Loveless (Student Reader)	University of Manchester
Dr Douglas Paton	University of Leeds
Dr Diane Purchase	Middlesex University
Professor Hugh Rollinson	University of Derby
Dr Anne Wheeler	Higher Education Academy
Brigitte Stockton	QAA Officer
Janet Bohrer	QAA Officer

The following employers and external stakeholders were invited to provide feedback on the Subject Benchmark Statement.

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

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

Details provided below are as published in the second edition of the Subject Benchmark Statement.

Professor J W S Longhurst (Chair)	University of the West of England, Bristol
Dr J Andrews	University of Southampton
Mrs J R Blumhof	University of Hertfordshire
Professor D A Eastwood	University of Ulster
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 Advisory 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.

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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 R C L 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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