The value of soil science

WORKING WITH SOIL
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The primary objective of soil science is to better understand how soils work so that society can derive optimum value from the land both now and sustainably into the future. Soil science is relevant to many areas of land management including: food, fibre, fuel and timber production, biodiversity conservation, recreation, water and climate management and land allocation under competing demands for space from our society. Soil science is also key to the restoration of soils that have been subject to harmful industrial intervention, addressing issues such as the re-instatement of contaminated land and mineral extraction sites.

Much attention has been given in recent years to the value and wellbeing that society derives from the natural environment. The Millennium Ecosystem Assessment has been responsible for bringing the concepts of ecosystem services and natural value into common parlance. Society increasingly appreciates the value of soils in human wellbeing and survival, not simply for food and fibre production, but also in regulating the global climate, in water quality and availability, and in sustaining biodiversity above- and below-ground.

Many ecosystem services are founded wholly or partially on processes that take place in the Earth's surface layer, the soil. It is easy to think that most life is above-ground, but there is more life, both in terms of mass and diversity, in the ground beneath our feet than is visible above it. Healthy, functioning soil is an essential component of our planet's life support system.

The value of soil science

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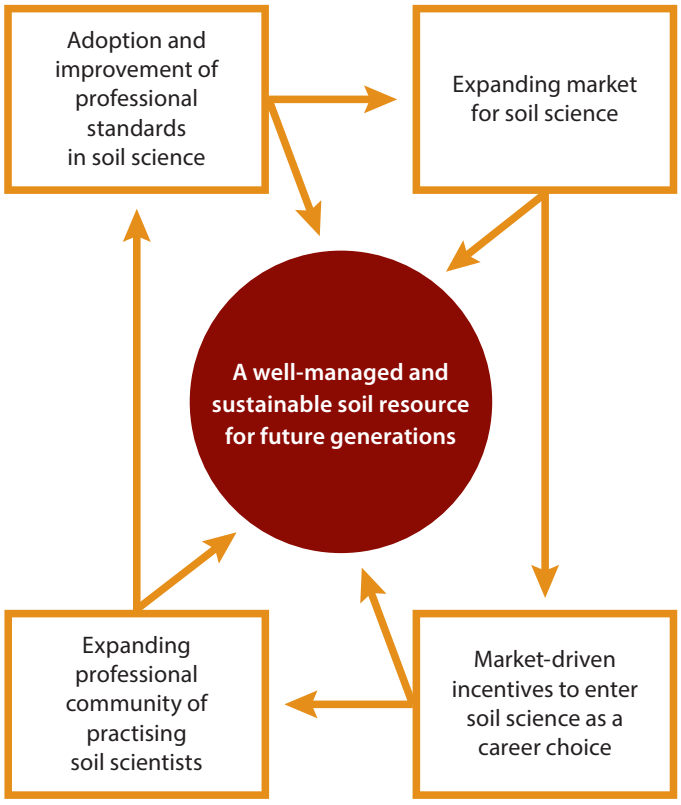
Future aims – a sustainable soil science profession

The British Society of Soil Science (BSSS) is an incorporated charity whose mission is "to advance soil science and to promote a better understanding of soil, nationally and internationally". The promotion of professional standards and competency in soil science contributes to the achievement of our mission. Our aim is for society to view soil science as an important profession and to expect high standards of expertise, knowledge, and professionalism from those practising this valuable branch of science.

In the longer term, BSSS aims to achieve the following three key objectives:

- an active, sustainable, professional community with good levels of recruitment for high-quality early careeer scientists and engineers
- a larger marketplace for professional skills in soil science
- greater recognition of the value of soil science as a profession and career within industry and society as a whole

Success in achieving these aims will help deliver a well-managed and sustainable soil resource to support current and future generations.



Introduction to the Working with Soil scheme

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Introduction

Professional soil science conducted under contract will very often involve one or more of the following generic activities:

- The investigation of soils in the field and their consistent description according to a recognised scheme
- The interpretation of soil profiles, properties and conditions, soil maps and other soil, earth science, climatic or topographic data and information to guide the current or future use and/or management of land for a range of interests
- The identification of the soil resources at a site prior to their excavation, storage and eventual re-instatement

The work may be at a site-specific, local, regional, or national scale and may range across local land practice to national and international policy development and regulation.

This document describes the *Working with Soil* scheme, which sets out the minimum qualifications, skills, and knowledge, which the British Society of Soil Science (BSSS) considers necessary for scientists and engineers working on the above identified aspects of soil science. Ten documents identify minimum competencies for the foundation skills of field soil investigation (Document 1) and a number of commonly-conducted tasks.

Introduction to the Working with Soil scheme

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Who will the scheme benefit and how?

In producing these documents, the Society aims to set and improve standards in professional soil science and to assist clients in identifying and engaging scientists and engineers with the appropriate combination of qualifications, knowledge, and skills to carry out soil-related work to a high standard. Soil is a vital natural resource that delivers many ecosystem services and much economic value. It is important that those advising on soil health, use and management meet professional standards. Society imposes standards on professionals such as doctors, engineers, and lawyers and we should expect no less from those practising professional soil science. It is intended that the scheme will be expanded over time with further task-based documents and related training opportunities.

Our hope is that the scheme will prove of value to those commissioning soil science work and that it is seen as an industry standard and widely adopted across relevant sectors. Its adoption by Government and industry will benefit scientists and engineers, with improved recognition for their qualifications, expertise and skills in soils. Ultimately, we hope that society will benefit from improved and more sustainably managed soil resources.

The documents are freely available as downloads via the Society's website: **www.soils.org.uk**

The Society sets no limitations as to their use and has no objection to their inclusion as annexes in tender or contract documents, but accepts no liability, direct or indirect, for the consequences of their use.

The Working with Soil documents

BSSS PCSS Document 1 – **Foundation skills in field soil investigation, description and interpretation**

BSSS PCSS Document 2 – **Agricultural Land Classification (England and Wales)**

BSSS PCSS Document 3 – **Soil science in integrated soil and water management**

BSSS PCSS Document 4 – **Soil science in soil handling and restoration**

BSSS PCSS Document 5 – **Soil science in land evaluation and planning**

BSSS PCSS Document 6 – **Soil science in the establishment, management and/or conservation of natural habitats and ecosystems**

BSSS PCSS Document 7 – **Soil science for the application of organic materials to land**

BSSS PCSS Document 8 – **Soil science in landscape design and construction**

BSSS PCSS Document 9 – **Research and development leadership**

BSSS PCSS Document 10 – **Soil science in crop and livestock production**

The documents can be downloaded from
www.soils.org.uk

DOCUMENT 1

Foundation skills in field soil investigation, description and interpretation

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Background

The investigation of soils in the field, their consistent description according to a recognised scheme, and the interpretation of soil profiles, properties and conditions are generic foundation skills for professional scientists and engineers employed on tasks that relate to the use and/or management of land. This document identifies the minimum qualifications, skills and knowledge which the British Society of Soil Science (BSSS) considers to be required of scientists and engineers conducting field soil investigations.

Qualifications

Professional soil scientists with competence in these foundation skills are likely to have graduated in a relevant science subject. They will also have a number of years of relevant, regular field soil-based experience and will have, or be adequately qualified for, membership of a relevant professional body such as the BSSS.

Minimum competencies

Skills:

1. The ability to dig and/or auger a soil, or to instruct others to do this, so as to **expose a soil profile** to a relevant depth and to then accurately **identify the sequence of horizons** that comprise the soil profile (natural or manmade) using standard reference documents such as The Soil Survey Field Handbook[1]

2. The **design and development of a soil investigation strategy** that is appropriate to the site or landscape to be investigated, and will generate representative soil information at an appropriate scale. This should be based upon the objectives and context of the study, and an understanding of the likely patterns of soil variability

3. The ability to **read and interpret maps/spatial data** of topography, geology, soil and aerial photography in relation to the interpretation of soil conditions; where and when appropriate, conversance with the use of GIS, GPS and mobile technology

DOCUMENT 1

Foundation skills in field soil investigation, description and interpretation

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4. The application of a relevant scheme of **field soil description** (such as Soil Survey Field Handbook) and the production and recording of accurate, consistent descriptions of soil profiles or materials. This should normally include the ability to describe soil colour (e.g. using a Munsell soil colour chart[2]) including mottling, soil texture, the properties of the soil surface, soil structure, consistence and porosity

5. The consistent **hand texturing** of particle size distribution in the fine earth, and the description of stones by their frequency, size, shape and rock type

6. The ability to **interpret soil horizons, features and materials** and whole profile descriptions to develop an understanding of the soil environment and its variability within a landscape

7. The ability and understanding required to **sample a soil or the soils of a site** for one or more relevant determinands representative of the soil or site and relevant to the objectives of the study. This may involve the collection of aggregated topsoil samples or horizon bag or tin samples

8. The ability and knowledge required to interpret the results of any soil chemical, physical or microbial analysis

9. The ability to **interpret the relationships between soil and landscape, land use and climate**

10. The ability to **produce accurate and understandable verbal and written reports** of the soil conditions (text and map information as appropriate) at or across the investigation site, with an interpretation of these in a way that is relevant to the context of the investigation (this is amplified by other BSSS PCSS documents in this series)

1 Hodgson, J M (1997) Soil Survey Field Handbook. Soil Survey Technical Monograph No 5, Silsoe

2 Munsell Soil Colour Book, Munsell Colour (2009)

Knowledge:

1. An understanding of **soil development processes** and of the influence of relief, geology, climate, vegetation and soil organisms on soil development

2. A basic knowledge of world and European soils and their taxonomy, and a more detailed knowledge of soil development and taxonomy within the United Kingdom

3. An understanding of the potential for **soil heterogeneity** in space and time, and of the factors that cause and influence variability

4. Knowledge of **soil horizon notation** and, where appropriate, of a relevant scheme for soil classification including the identification of diagnostic horizons, features and materials

5. Knowledge of **local soils and land use history affecting the soils** and of the range of soils developed across the UK and Europe, and of information sources for more detailed information

6. Knowledge of **natural soil properties and conditions** that is sufficient to set soil conditions at an investigation site within the context of natural variability

7. Knowledge and application of relevant **Health and Safety, Environmental and Biosecurity regulations,** including any animal or plant health restrictions in force and all relevant safe working practices

8. Knowledge of the **potential impacts of human activity and of land management** on soil properties and processes

9. Particular specialist knowledge of soil and crop nutrition, soil hydrology, and of the influence of soil on plant and animal ecology may be required in particular circumstances and these are detailed in related PCSS competency documents

DOCUMENT 2

Agricultural Land Classification (England and Wales)

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Background

The evaluation of land for its agricultural capability in England and Wales[1] is accomplished by application of the Agricultural Land Classification[2] (ALC). This system is the only approved system for grading land in England and Wales. Professional competence in Agricultural Land Classification builds upon foundation skills in field soil investigation, description and interpretation (BSSS PCSS Document 1).

Qualifications

Professional soil scientists with competence in Agricultural Land Classification will have graduated in a relevant science subject. They will also have a number of years of relevant field experience and will have, or be adequately qualified for, membership of a relevant professional body such as the British Society of Soil Science (BSSS).

1 Similar systems are employed in Scotland and Northern Ireland

2 ALC Revised Guidelines and Criteria for Grading the Quality of Agricultural Land (MAFF, 1988) and Climatological Data for ALC (Met. Office, 1989)

3 Munsell Soil Colour Book, Munsell Colour (2009)

4 Hodgson, J M (1997) Soil Survey Field Handbook. Soil Survey Technical Monograph No 5, Silsoe

Minimum competencies

Skills and Knowledge:

General

1. Fully meet the minimum competency standards of the foundation skills in soil investigation, description and interpretation to demonstrate the ability to investigate, sample, describe and interpret soils in the field in a consistent manner and to professional standards. This is essential to demonstrate competence in ALC and will have been gained from a number of years of field experience of soils

2. Detailed knowledge and understanding of the Agricultural Land Classification system relevant to the site and of the classification of land according to the current published Guidelines and other documents[1, 2, 3, 4] and the ability to apply it accurately and consistently in the classification of an area of land. This will have been gained from regular application of the system in the field over a number of years including under the supervision of an experienced practitioner

3. An up to date awareness and knowledge of existing published and unpublished, paper-based and digital ALC information and sources, both detailed and strategic level surveys, predictive mapping and Open Data sources, together with a knowledge of their uses and limitations

DOCUMENT 2

Agricultural Land classification (England and Wales)

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4. Knowledge of paper and digital topographic, geology and soil maps and other environmental data such as climate and flood risk, including on-line sources, mineral assessment reports and memoirs and other technical sources of reference and of their role in ALC work. An understanding of the derivation and limitations of this information
5. An understanding of GIS, map scales and of the Ordnance Survey National Grid
6. A basic understanding of agriculture, crop and livestock husbandry, land management, and land drainage and how these relate to ALC
7. Knowledge of relevant national regulations and policies including national and local land use planning policy and guidance, and soil protection policies in the UK and Europe
8. The ability to effectively communicate soil information in a simple and relevant form to developers, planners and other relevant professionals with clear statements as to the reliability and certainty of the results
9. The ability to write accurate, concise reports in clear English and in line with best practice examples of ALC survey. The ability to explain survey details if required by Government or other ALC specialists
10. An awareness of the importance of systems of quality assurance and control in all aspects of professional work

Preparations prior to field survey

1. The ability to compile background site physical data (e.g. relief, geology, soils, climate, flood risk, exposure and ALC grade from published, on-line and unpublished sources) and understanding of the limitations of the data obtained
2. An understanding of scale and of how different survey sampling densities may impact on the certainty of results obtained. A knowledge of how to tailor survey density appropriately to the requirements of the client, and understanding of the limitations that might impose
3. The ability to compute gradients from map contours or interpret digital terrain models
4. A thorough knowledge of climatic data interpolation procedures (and any available associated bespoke computer software), and the ability to obtain accurate representative site values
5. An understanding of soil maps, the concepts of soil associations and soil series and their limitations as a background to ALC grading
6. A knowledge of GPS and mobile data technology and its uses and limitations for field survey work

Field survey for Agricultural Land Classification

1. The ability to determine, lay out and work to a relevant sampling strategy
2. **Competency in the Foundation Skills** (field soil investigation, sampling, description and interpretation) as per BSSS PCSS Document 1
3. The ability to accurately and consistently apply the ALC system to soil and other data collected during the field survey, including assessment of soil wetness and droughtiness calculations.
4. An awareness of the causes of ground disturbance and the impact on grading land

Reporting

1. The knowledge and ability to compile an ALC map from background information and data collected during the field survey including an appreciation of the issues around soil variability and the construction of mapping units, and edge mapping of different surveys
2. The ability to write an ALC survey report according to an agreed format
3. Understanding of the principles of quality assurance and the ability to apply these as required by the client
4. The ability to convey the findings of the survey verbally such that they are understood by the client
5. The ability to present and discuss results when subject to detailed scrutiny. This may be by planners, Government or other ALC specialists, barristers, planning inspectors etc when acting as an expert witness

DOCUMENT 3

Soil science in integrated soil and water management

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Background

The evaluation and management of soil can form an important component of integrated soil and water management. The context of such work can be rural or urban catchment management, farm or forestry-based soil management planning, sustainable urban drainage design or pollution prevention on construction sites.

National water protection legislation lays down a framework for future catchment management aimed at the achievement of legally enforceable water and river quality standards. The control of diffuse and point inputs to water bodies from land is a major challenge to organisations and individuals responsible for applying and enforcing this legislation. Many aspects of the use and management of soil within the catchment of a river, lake or underground aquifer will have a bearing on their water quality and the flows of water to them.

The inherent nature of a soil, as well as the way in which it is used and managed, influences its ability to absorb rainwater. Soil science has a part to play in integrated approaches to flood management and protection in both rural and urban environments.

Professional competence in soil science for integrated soil and water management builds upon foundation skills in field soil investigation, description and interpretation (BSSS PCSS Document 1).

Qualifications

Professional scientists and engineers with competence in soil science for integrated soil and water management will have graduated in a relevant science subject. They will also have a second degree and/or a number of years of relevant field experience and will have, or be adequately qualified for, membership of a relevant professional body such as the British Society of Soil Science (BSSS).

DOCUMENT 3

Soil science in integrated soil and water management

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BASIS® Soil and Water accreditation is evidence of adequate and appropriate knowledge and skills for a professional involved in integrated soil and water management. However, for work involving the provision of advice on pesticide use, the professional scientist/engineer should be BASIS qualified and where advice on crop nutrition is involved, the professional scientist/engineer should be FACTS (Fertiliser Adviser Certification and Training Scheme) qualified.

Minimum competencies

Skills:

1. Competency in the Foundation Skills (field soil investigation, description and interpretation) as per BSSS PCSS Document 1
2. An ability to apply the principles of soil science and/or engineering to the investigation and understanding of the interactions between soil and water that are of relevance to the focus and scale of the project
3. The ability to understand soil and water systems and to design and implement a work programme that addresses the client's requirements and leads directly or indirectly to improved understanding and management of the soil-water system
4. The ability to communicate soil science accurately and informatively, verbally and in writing, at all stages of the project with clear statements as to the reliability and certainty of the results

Knowledge:

1. Knowledge of the soils present within the study area or of the chief sources of such information
2. An understanding of the principles of soil-water relations and of soil hydrology
3. An understanding of the fundamentals of soil solute and sediment fate and behaviour
4. An understanding of the systems of soil use and management relevant to the project focus. For agricultural catchments, competency in soil science for crop and livestock production (BSSS PCSS Document 10) will be relevant
5. Knowledge of the impacts of soil use and management on soil hydrology and solute/sediment fate and behaviour appropriate to the focus of the project

DOCUMENT 4

Soil science in soil handling and restoration

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Background

Large amounts of soil are disturbed during the development of land for urban, industrial/retail and transport uses, for installation of energy networks and for the quarrying of aggregates and minerals. In addition, previously excavated soils are re-instated after mineral working and in the restoration of previously despoiled land to green after-use and to create parks, gardens and landscaped areas within the built environment. Professional soil science has an important role to play in ensuring a successful outcome. Professional competence in managing the restoration of land after soil disturbance builds upon foundation skills in field soil investigation, description and interpretation (BSSS PCSS Document 1). The competencies outlined in BSSS PCSS Documents 6 (Soil science in the establishment, management and/or conservation of natural habitats and ecosystems) and 8 (Soil science in landscape design and construction) will also be relevant depending on the intended after-use of a site.

Qualifications

Professional soil scientists and engineers with competence in soil handling and land restoration will have graduated in a relevant science subject. They will also have a second degree and/or a number of years relevant field experience and will have or be adequately qualified for membership of a relevant professional body such as the British Society of Soil Science (BSSS).

Minimum competencies

Skills and knowledge:

These are described under a number of sub-headings that relate to different tasks. A professionally-competent scientist or engineer should have the skills and knowledge identified under the **General heading** and **all other headings that are relevant** to the tasks required. Professional soil scientists and engineers working in this sector should be familiar with the Defra Construction Code of Practice for the Sustainable use of Soils on Construction Sites (Defra 2009).

General

1. The ability to investigate, sample, describe and interpret soils in the field in a consistent manner and to professional standards (BSSS PCSS Document 1)
2. The ability and knowledge required to interpret the results of any soil chemical, physical or microbiological analyses

DOCUMENT 4

Soil science in soil handling and restoration

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3. Knowledge of relevant European and national regulations and policies, including national and local land use planning policy and guidance, and soil protection policy
4. A working knowledge of the industry being advised, whether quarrying, development, infrastructure installation or landscaping
5. The ability to effectively communicate soil information in a simple and relevant form to developers, planners, landscape architects and earthmoving contractors with clear statements as to the reliability and certainty of the results
6. The ability to write accurate reports and/or method statements, written in clear terms, that communicate the relevant information to site planners, site managers, site personnel and eventual users of restored land
7. An awareness of the importance of systems of quality assurance and control in all aspects of professional work

The characterisation of soil resources

1. The know-how to select appropriate survey and sampling densities to characterise *in situ* and stockpiled soil resources to required levels of certainty
2. Understanding of Health and Safety requirements on site and the ability to compile a risk assessment when requested
3. Familiarity with the use and limitations of GPS for determining sampling locations on site
4. Proficiency in fieldwork practices and procedures such as soil texturing, soil description and the delineation of soil resource units (see BSSS PCSS Document 1)

The provision of advice on soil handling

1. A knowledge of the machines used for handling soils, their capabilities and limitations
2. An awareness of methods of soil handling that minimise physical damage to soils and guidance[1] that describes such methods, including management of stockpiled soil
3. An understanding of soil hydrology and physical and engineering properties such as plastic limit, and their relevance to soil handling
4. The ability to calculate volumes of *in situ* soil layers to be moved as well as soil stored in stockpiles
5. A knowledge and understanding of waste management and/or contaminated land regulations that might restrict the export of soil materials off-site or their management within site
6. Familiarity with British Standards relevant to characterising soil materials already on site or being imported to site[2]
7. The ability to prepare a Soil Management Strategy/Soil Resource Plan[3] and simple method statements for site personnel

The restoration of land

1. The ability to characterise existing substrates on site and make best use of them, including chemical or physical amelioration where necessary
2. Knowledge and experience of the uses of manufactured soils and the use of organic materials for soil creation where natural soils are in short supply
3. Understanding of the specific soil chemical and physical conditions (including the principles of soil engineering) necessary for various restored after uses and landforms, such as woodland, Best and Most Versatile agricultural land, wet meadow, species-rich grassland, commercial landscaping, etc.

The aftercare and assessment of restored land

1. The ability to prepare and/or interpret aftercare plans (for those restored land uses where one is required)[1]
2. The ability to assess soil physical quality and make any recommendations for amelioration to create a 'fit-for-purpose' soil profile[2]
3. The ability to take representative soil samples for chemical analysis and to interpret the results to make recommendations for the use of fertilisers[4], lime or other chemical ameliorants[3]

1 for example the MAFF (2000) Good Practice Guide for Handling Soils

2 e.g. BS3882:2007 Specification for Topsoil and Requirements for Use

3 Defra (2009) Construction Code of Practice for the Sustainable Use of Soils on Construction Sites

4 Might necessitate a FACTS qualification where the use is agricultural; see BSSS PCSS Document 10 Soil science in crop and livestock production

DOCUMENT 5

Soil science in land evaluation and planning

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Background

The evaluation of land for its potential to support different uses and to supply ecosystem services is fundamental to the sustainable use of global land and soil resources by a growing world population. Land evaluation is normally accomplished by the application of one or more relevant international or national land evaluation schemes (including land capability and suitability methodologies) to spatial natural resource information such as soil, terrain and land use/cover maps and climate data. The output from land evaluation is used in a range of contexts. It may be in the planning of the use of land for food or timber production, assessing the sustainability of different development options e.g. new housing or infrastructure projects or the protection of natural resources such as productive agricultural land, groundwater or wetland and peatland ecosystems from urban development or other inappropriate activities. An understanding of the functions of soil and of the ecosystem services that depend on soil functions is relevant.

While some land evaluation includes socio-economic considerations, these normally lie outside the role of the professional soil scientists for whom the focus is the interpretation of soil resources within their physiographic context. Professional competence in soil science for land evaluation therefore depends heavily on an adequate understanding of how soils interact with other components of the natural environment such as climate and topography. It builds on and is additional to foundation skills in field soil investigation, description and interpretation (BSSS PCSS Document 1).

Qualifications

Professional soil scientists with competence in land evaluation will have graduated in a relevant science. They will have a second degree in a relevant subject and/or a number of years of relevant experience (including experience in the field) and will have, or be adequately qualified for, membership of a relevant professional body such as the British Society of Soil Science (BSSS).

DOCUMENT 5

Soil science in land evaluation and planning

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Minimum competencies

Skills:

1. The ability to clearly understand the objectives of the land evaluation project to be undertaken
2. The ability to design, specify and undertake an appropriate desk study and/or field survey campaign that reflects the objectives of the evaluation, the size of the study area, available thematic information, and the required spatial differentiation and levels of confidence of the land evaluation output
3. The ability to collate and critically evaluate available soil, terrain, climate, land cover and other relevant maps, data and information appropriate to the requirements (spatial scale and certainty) of the project
4. The skills and understanding to identify the need for and the ability to specify any further thematic surveys of soil, terrain and/or land cover in line with the project objectives
5. The ability to systematically collect, record and organise information about the land cover, topography, soils and geology of the study area at an appropriate scale and sampling intensity
6. The ability to compile thematic information on land cover, soil, geology, topography and climate in the formats required for application of the land evaluation classifications to be applied in the study. This may require the derivation of secondary attributes such as pedo-transfer functions[1] and their subsequent application
7. The ability to apply appropriate land evaluation classifications to the study area and to critically interpret and evaluate the resulting spatial and property information including the comparison of output from classifications for different potential land uses, management systems or ecosystem services
8. The ability to draw conclusions from the work and to reliably recommend any further work that may be desirable or necessary
9. The ability to effectively communicate the principles, processes and outcomes of land evaluation in a simple and relevant form to clients, developers, planners and other relevant professionals with clear statements as to the reliability and certainty of the results
10. The ability to write accurate, concise reports in clear English and in line with best practice examples of land evaluation that communicate the findings to all interested parties
11. The ability to apply a relevant system of quality assurance to the output of the project

Knowledge:

1. An understanding and technical knowledge of the influence of physical, chemical and biological land and environmental factors on land use and land use potential
2. A general knowledge, previous experience and understanding of land evaluation as a methodology and an awareness of relevant international and national published schemes
3. Sufficient understanding of land evaluation schemes and methodologies, their strengths and weaknesses, to assess those that are relevant and appropriate to the objectives of the project
4. A knowledge and understanding of soil functions and of how these relate to ecosystem services where these form a part of the project including key international and national publications on the subject
5. A knowledge of paper and/or digital topographic, land cover, geology and soil maps, other relevant thematic reports and technical sources of information, and of their role in land evaluation
6. A knowledge of relevant international, regional and national policies and regulations relating to the use and protection of land resources
7. When field work is involved, knowledge of relevant Health and Safety, Environmental and Biosecurity regulations, including any animal or plant health restrictions in force, and all relevant safe working practices
8. An awareness of the importance of systems of quality assurance and control in all aspects of professional work

1 Pedo-transfer functions are predicted soil properties or functions derived from primary soil property data collected during field soil survey

DOCUMENT 6

Soil science in the establishment, management and/or conservation of natural habitats and ecosystems

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Background

The characterisation and management of soil can form an important input to the establishment, management, conservation and restoration of natural habitats and ecosystems. The context of such work can be rural or urban and linked to anything from the sustainable management of protected nature reserves or wildlife communities and the restoration of degraded habitats to the creation of biodiversity on reclaimed land targeted for urban green space.

Soil science is fundamental to all habitat and ecosystem projects, and a lack of understanding of soil systems, soil characteristics and the relationship between soils and biodiversity can lead to the failure of habitat establishment, conservation or management schemes.

Professional competence in soil science in this context builds upon foundation skills in field soil investigation, description and interpretation (BSSS PCSS Document 1), BSSS PCSS Document 4 on soil science in soil handling and restoration, covering aspects of soil storage, handling and the preparation of a Soil Management Strategy and BSSS PCSS Document 3 on soil science in integrated soil and water management.

Qualifications

Professional scientists and engineers with competence in soil science for the establishment, management and/or conservation of natural habitats and ecosystems will have graduated in a relevant science subject. They will also have a second degree and/or a number of years of relevant field experience and will have, or be adequately qualified for, membership of a relevant professional body such as the British Society of Soil Science (BSSS) or the Institute of Ecology and Environmental Management.

DOCUMENT 6

Soil science in the establishment, management and/or conservation of natural habitats and ecosystems

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Minimum competencies

Skills:

1. Competency in the Foundation Skills (field soil investigation, description and interpretation) as per BSSS PCSS Document 1
2. Where soil is to be stripped, stored and/or re-instated, competency in soil handling and land restoration as per BSSS PCSS Document 4
3. The ability to design and implement a programme of exploratory, experimental or research work, if required, that leads to the improved soil information and understanding necessary to achieve the objectives of the project in question
4. The ability to apply the principles of soil science and/or soil engineering to the relevant aspects of nature conservation practice and land management for biodiversity
5. The ability to communicate soil science accurately and informatively, verbally and in writing at all stages of the project with clear statements as to the reliability and certainty of the results

Knowledge and understanding:

1. Knowledge of the soils present within the study area, or of the chief sources of such information, and an understanding of how the soils of the study area fit within the wider landscape
2. An adequate understanding of the role of soil as a physical, chemical and biological system within natural ecosystems
3. An understanding of how alterations to the soil system affect soil properties (soil chemistry, soil physical characteristics and the soil water regime), which can have a resultant impact on biodiversity and ecosystem
4. Sufficient understanding of the relationships between soil and individual organisms (plants and soil-living animals), local biodiversity and habitat types to satisfactorily complete the required work
5. Knowledge of soil management theory and practice associated with nature conservation and habitat management including the impact of soil nutrients on wildlife communities
6. An awareness of restoration ecology theory and ecological restoration practice
7. An adequate knowledge and understanding of international, national and local policy and law relating to the management of wildlife communities and ecological restoration
8. Knowledge of relevant Health and Safety, Environmental and Biosecurity regulations, including any animal or plant health restrictions in force and all relevant safe working practices
9. An awareness of the importance of systems of quality assurance and control in all aspects of professional work

DOCUMENT 7

Soil science for the use of organic materials on land

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Background

A wide range of organic materials including municipal and industrial wastes, livestock manures, and sewage sludge (biosolids) can be applied to land to improve soils, and supply valuable nutrients.

Certain organic materials can be used for agricultural and ecological benefit whilst others may have greater restriction on use within land remediation projects where land will not be used for agricultural production. The reuse, recycling and recovery of a wide range of wastes, by-products and products can have agronomic, economic and environmental benefits.

The legal and regulatory frameworks surrounding the application of organic materials to land is complex and detailed and requires, amongst other things, an informed assessment of potential benefits and risk to the wider environment. A detailed knowledge of the legal and regulatory frameworks is essential for soil scientists and engineers working in this sector.

Professional competence in soil science for the use of organic materials on land builds on foundation skills in field soil investigation, description and interpretation (BSSS PCSS Document 1), and is linked to competency in integrated soil and water management (BSSS PCSS Document 3) and soil science in crop and livestock production (BSSS PCSS Document 10).

Qualifications

Professional soil scientists and engineers with competence in using organic materials will have graduated in a relevant science subject. They will also have a second degree and/or a number of years of relevant field experience. They will have, or will be adequately qualified for, membership of a relevant professional body such as the British Society of Soil Science. The preferred qualification for those advising operations resulting in agricultural benefit is training and certification on the BASIS Fertiliser Advisers Certification and Training Scheme (FACTS), though work prepared by people with relevant academic qualifications, vocational experience, or relevant professional membership is also deemed acceptable.

DOCUMENT 7

Soil science for the use of organic materials on land

WORKING WITH SOIL
setting standards in soil science

For operations resulting in ecological benefit, professional scientists and engineers should ideally hold a preferred qualification, but relevant qualifications, experience, or professional membership are considered acceptable.

Minimum competencies

Skills:

1. Competency in the Foundation Skills (field soil investigation, description and interpretation) as per BSSS PCSS Document 1
2. The ability to assess both benefits and potential risks to environmental and human receptors from the application of the organic material to an area of land
3. The ability to apply the principles of soil science and/or engineering to the relevant aspects of reuse or recovery of the material
4. The ability to state comprehensively the benefits of using organic materials taking into account all relevant regulations and guidance specific to the country in which it is to be used
5. The ability to carry out a site-specific risk assessment of the proposed activity on statutory and non-statutory designations (such as Nitrate Vulnerable Zones, Groundwater Source Protection Zones, and Sites of Special Scientific Interest)
6. The ability to interpret laboratory analysis of the organic material to be used and of the receiving soil and to determine a suitable application rate for its intended purpose
7. For applications to agricultural land, the ability to interpret the additions of plant nutrients through spreading 'waste' materials in relation to recommendations in the AHDB's Nutrient Management Guide (RB209)
8. The ability to communicate soil science and the finding of the work accurately and informatively, verbally and in writing at all stages of the project

Knowledge:

1. Knowledge of the soils present within the study area, or of the chief sources of such information
2. Knowledge of relevant national laws, regulations and guidance including Codes of Good Agricultural Practice and Animal Byproduct Regulations where relevant
3. An adequate understanding of the role of soil as a physical, chemical and biological system in accepting and using organic materials
4. Knowledge and understanding of the potential impact of machinery used in the application of organic materials to land and how risks can be minimised
5. An awareness of the importance of systems of quality assurance and control in all aspects of professional work

DOCUMENT 8

Soil science in landscape design and construction

WORKING WITH SOIL
setting standards in soil science

Background

The characterisation and management of soil and soil materials forms an important part of the design, construction and subsequent management of landscape schemes. The nature and management of soils, whether natural or manmade, influences planting options and the subsequent use of the landscaped area. Landscape projects are often in the urban environment where there are typically many site constraints in additions to the soil limitations. They include public parks, private gardens, sports pitch construction and the soft landscape aspects of infrastructure projects and business and logistics parks.

Soil science is fundamental to all landscape projects and inputs to a number of significant steps in the process of establishing a new landscape scheme, including:

- Soil and site characterisation
- Soil handling, storage and construction of the new landscape
- Landscape scheme design and specification
- Planting and establishment, and
- Ongoing management (aftercare)

This document builds on three other *Working with Soil* professional competency documents. Foundation skills in field soil investigation, description, and interpretation (BSSS PCSS Document 1) details the foundation skills required to characterise soils and soil materials accurately and consistently. BSSS PCSS Document 4 on soil science in soil handling and restoration covers aspects of soil storage, handling, the preparation of a Soil Management Strategy and subsequent restoration. Where semi-natural habitats are to be created on a site, BSSS PCSS Document 6 addresses professional competency in soil science and the establishment, management and/or conservation of natural habitats and ecosystems.

Over and above these documents, soil science has a bearing on the appraisal of different planting options and on the subsequent planting, establishment and ongoing management of plants, trees and grass.

DOCUMENT 8

Soil science in landscape design and construction

WORKING WITH SOIL
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Well-managed soil is a key determinant of the performance and value of public open spaces and private landscapes. The skills and knowledge identified below build on those identified in Documents 1, 4 and 6 and relate to these further aspects of landscaping practice.

Qualifications

Professional scientists and engineers, with competence in soil science for landscape design and construction will have graduated in a relevant science subject. They will also have a second degree and/or a number of years of relevant practical experience and will have, or be adequately qualified for, membership of a relevant professional body such as the British Society of Soil Science. A member of the Landscape Institute may have appropriate experience where their training and work has included soil-related aspects of landscape design, construction and management.

Minimum competencies

Skills:

1. Competency in the Foundation Skills (field soil investigation, description and interpretation) as per BSSS PCSS Document 1
2. Competency in soil science in soil handling and restoration (BSSS PCSS Document 4) and, in particular, the development of a Soil Resource Plan[1] or Soil Management Strategy
3. Where appropriate, competency in soil science in the establishment, management and/or conservation of natural habitats and ecosystems (BSSS PCSS Document 6)
4. Where appropriate, the ability to translate an understanding of the soils, soil materials and soil conditions on the site into qualitative and quantitative advice on pre-planting soil preparation, the implications for planting options and site management post-establishment
5. The ability to interpret site landscape design options and their requirements for soils (from on or off site)
6. The ability to communicate soil science accurately and informatively, verbally and in writing at all stages of the project with clear statements as to the reliability and certainty of the results

Knowledge:

1. An understanding of the relationships and interactions between soil, landscape and plants
2. Knowledge and understanding of soil as a physical, chemical and biological system in supporting the establishment and growth of trees and other landscaping plants
3. Knowledge of relevant Health and Safety and Environmental and Waste regulations and all relevant safe working practices
4. An awareness of the British Standards for soils[2] (topsoil and subsoil) if there is a need for imported soils

1 Defra (2009) Construction Code of Practice for the Sustainable Use of Soils on Construction Sites

2 e.g. BS3882:2007 Specification for Topsoil and Requirements for Use

DOCUMENT 9

Research and development leadership

WORKING WITH SOIL
setting standards in soil science

Background

Research and development into soil science advances knowledge, informs policy and furthers society's ability to use and manage soil resources profitably and sustainably. This document identifies the minimum qualifications, skills and knowledge which BSSS considers to be required of scientists and engineers playing a leading role in soil research and development.

Qualifications

Professional scientists designing and/or directing soil research and development as a project manager, principal investigator or task/team leader are likely to have graduated in a relevant science subject. They will also have a further degree and/or a number of years (usually five or more) of relevant field and/or laboratory soil-based research experience. They will have, or be adequately qualified for, membership of a relevant professional body such as the British Society of Soil Science and may be a Chartered Scientist or Environmentalist. They should be committed to and have a documented record of their continuing professional development.

Minimum competencies

The focus and nature of research and development can be narrow and require scientists with very particular skills and knowledge, possibly including particular sampling and/or analytical techniques. The design and interpretation of a piece of research normally requires a detailed knowledge of previous relevant published work. Evaluation of the suitability of individual scientists in these respects will require examination of their curriculum vitae.

There are also more generic skills and knowledge that are equally important to the successful design, planning, management and conduct of a research project. These are outlined overleaf.

DOCUMENT 9

Research and development leadership

WORKING WITH SOIL
setting standards in soil science

Personal skills:

1. Use of library and IT resources for literature searches and review
2. For field-based research, the ability to describe and classify the soils on which the research is being conducted (see BSSS PCSS Document 1) and to thus place the research within a soil context
3. The ability to produce an accurately costed, soundly based project proposal and to manage a project budget through to completion
4. The ability to carry out a project risk assessment including task-specific hazard assessment

Managerial skills:

1. The ability to provide clear and well-argued scientific direction to a research project or sub-task and those working on the project/task
2. The ability to manage, lead and develop supporting staff, and to enable and resource the project and project team through successful interaction with more senior managers and supporting administrators within their parent organisation

Analytical and problem solving skills:

1. The ability to critically analyse relevant national and international policy objectives, scientific information and data and to identify knowledge gaps or weaknesses so as to determine research objectives
2. The ability to translate research objectives into sound experimental design and to resolve practical problems that would otherwise delay the conduct of the project
3. The ability to analyse results, so as to draw scientific conclusions and to identify the limitations of the results and the context within which they apply
4. The ability to accurately interpret the scientific significance and policy relevance of research outcomes

Communication skills:

1. Use of oral and written communication to convey information effectively and with clarity to a range of audiences (clients, media, other scientists and the general public)
2. The ability to write accurate, concise, comprehensive and logical research proposals, project budgets and project reports and summaries in language that is understandable to the intended readership
3. The ability to contribute soil science expertise and to convey its significance effectively within a multi-disciplinary project team
4. Experience of publishing research findings in peer-reviewed journals

Knowledge:

1. Familiarity with the current state of knowledge of the relevant areas of science within appropriate geographical and other contexts
2. Familiarity, understanding and experience of working to all aspects of the Joint Code of Practice for Research or equivalent project management system
3. An understanding of the importance of soil and of the value of sustainable soil use and management and of the policy and regulatory contexts (national and international) of the research
4. An awareness of the ethics of scientific research
5. A sufficient understanding of the spatial and temporal heterogeneity of soil resources (see BSSS PCSS Document 1) such that the applicability of the research is optimised through its design, execution and interpretation where appropriate
6. Understanding and experience of document, data and sample control and archiving and of the principles of quality assurance including the personal recording of all work carried out on a project
7. Knowledge of relevant health and safety, biosecurity and environmental regulations for work carried out on a project
8. An understanding of the need for continuing personal development

DOCUMENT 10

Soil science in crop and livestock production

WORKING WITH SOIL
setting standards in soil science

Background

Soil management is an important component of sustainable crop and grazing livestock production systems. Moreover, soil fertility is of paramount importance in supporting the sustainable intensification of agricultural production (i.e. simultaneously raising yields, increasing the efficiency with which inputs are used, and reducing the negative environmental impacts of food production). Nutrients, organic matter and lime are added to agricultural soils to optimise soil fertility and crop production. In addition, field operations are used to improve soil structure, create seedbeds and harvest crops. Soil science has a critical role to play in managing arable, horticultural and forage crops and grassland systems for food production and environmental protection.

Professional soil scientists are involved in advising farmers and agronomists on soil and nutrient management practices to optimise agricultural production, enhance soil fertility and minimise pollution risk. Professional competence in soil science for crop and grassland production builds upon foundation skills in field soil investigation, description and interpretation (IPSS PCSS Document 1); and is linked to competencies in Agricultural Land Classification (BSSS PCSS Document 2), integrated soil and water management (BSSS PCSS Document 3) and the use of organic materials on land (BSSS PCSS Document 7).

Qualifications

Professional scientists with competence in soil science for crop and livestock production will have graduated in a relevant science subject (and may also have a second degree) and will have a number of years of relevant experience. They will have, or will be adequately qualified for, membership of a relevant professional body, such as the British Society of Soil Science. They may have the BASIS Soil and Water Management Certificate and should be FACTS (Fertiliser Advisers Certification and Training Scheme) qualified if advising on soil and crop nutrition.

DOCUMENT 10

Soil science in crop and livestock production

WORKING WITH SOIL
setting standards in soil science

Minimum competencies

Skills:

1. Competency in the Foundation Skills (field soil investigation, description and interpretation) as per BSSS PCSS Document 1
2. The ability to apply the principles of soil science to relevant aspects of crop and grassland management
3. The ability to assess soil structural conditions and soil erosion risk, and to advise on management practices to reduce compaction, erosion and loss of organic matter
4. The ability to advise on and interpret the additions of plant nutrients, organic matter and lime to agricultural land in relation to recommendations in AHDB's Nutrient Management Guide (RB209), SRUC Technical Notes or similar industry standard documents
5. The ability to estimate the nutrient requirements of a particular crop and appraise a range of nutrient sources available to clients, prior to constructing nutrient management plans and making fertiliser recommendations to meet crop requirements, with due regard for the environment
6. The ability to give advice on the nutritional requirements of specific crops based on a sound understanding of needs and variables, and environmental considerations
7. The ability to assess the need for irrigation and/or under drainage systems and secondary treatments such as mole drainage and sub-soiling
8. The ability to communicate soil science for crop and grassland management accurately and informatively, verbally and in writing

Knowledge:

1. Knowledge of soil biological, physical and chemical properties, the basis of soil fertility in supporting plant growth, the ways that nutrients are held and exchanged in the soil, and management of the inter-relationships between soil, water and air
2. Knowledge of the impacts of soil use and management on agricultural production and environmental protection
3. An understanding of the potential benefits and impacts of cultivation and the use of farm machinery on soil
4. An understanding of the role, value and nature of different types of organic materials, their storage, handling and spreading properties, and issues involved in assessing the nutrient contribution of organic materials[1]
5. An understanding of the various chemical and physical properties of fertiliser types in order to advise farmers/growers on the most appropriate forms of fertiliser for their specific requirements, and calculate unit costs and undertake cost comparison of different products
6. Knowledge of integrated crop nutrient management and the various factors that, together with fertiliser and organic material applications, can be used to satisfy crop nutrient requirements
7. An understanding of the economic and environmental importance of accurate solid and liquid fertiliser spreading, and of the methods and tests used to ensure accuracy of application
8. An understanding of the fate and behaviour of pesticides and other xenobiotics applied to land
9. An understanding of soil water regimes and the need for and impact of irrigation and/or land drainage/secondary treatments
10. An understanding of different methods of irrigation and the planning of irrigation applications to obtain best crop yield at least environmental damage
11. An understanding of the reasoning behind and requirements of soil related 'cross compliance' requirements
12. Knowledge of legal and environmental issues related to the application of fertilisers and organic materials on agricultural land, including local designations of relevance, such as Nitrate Vulnerable Zones, Water Protection Zones and/or nature conservation designations
13. An understanding of the Code of Good Agricultural Practice for Farmers, Growers and Land Managers (England and Wales) and/or the Prevention of Environmental Pollution From Agricultural Activity (PEPFAA) Code (Scotland)

1 See BSSS PCSS document 7 Soil science for the application of organic materials to land