Unit 27: Geospatial Technology and Sustainable Development

Unit code: T/602/6012

QCF Level 3: BTEC National

Credit value: 5

Guided learning hours: 30

Aim and purpose

This unit provides learners with a knowledge of geospatial technologies and their applications in managing resources. Learners will explore geographic information systems (GIS), related technologies such as remote sensing (RS), global positioning systems (GPS) and their application in various sectors of the economy, with the aim of ensuring better resource management. The unit is intended to help learners develop knowledge and skills in the application of geospatial technologies.

Unit introduction

The use of geospatial technologies has shown a consistent growth over the years across different sectors. This is attributable to its capability in allowing users to collect, organise, visualise and analyse data in new and highly practical ways. By providing the opportunity to place layer on layer of data over a basemap, technology has enabled users and managers to calculate and even predict the complex phenomena and make intelligent decisions in relation to sustainable resource management.

Numerous industries have benefited in some way from the application of geospatial technology and the ability to unravel environmental, social, economic, political and global issues is increasingly evident. Therefore, it is highly likely that learners from many different sectors where geography is relevant will encounter some kind of geospatial technology during their lifetime and an early introduction to these technologies is becoming essential.

There is a need to give learners knowledge and skills in:

- GIS, RS, GPS and other relevant emerging geospatial technologies
- techniques in spatial data acquisition
- processing and analysis of geographic information
- the application of geospatial technologies in sustainable resource management.

This unit will give learners an appreciation of some of the most commonly used geospatial technologies and enable them to develop practical skills in their application. This, in turn, will enable learners to explore the nature and values of geospatial technologies and techniques in solving/managing geographical issues. They will also gain an understanding of how to input, query and map geographical data using relevant hardware and software.

Learning outcomes

On completion of this unit a learner should:

1 Know the principles of geographical information management

2 Understand the application of geospatial technologies for sustainable development

3 Be able to plan the use of geospatial technologies to solve problems.

Unit content

1 Know the principles of geographical information management

Geospatial technologies: GIS; RS; GPS; definition of terms; principles of the technologies; components; types of imageries in RS; hardware and software; benefits of geospatial technologies

Importance of cartographic principles: relevance of coordinate systems eg longitude and latitude, UTM; map scales (UK geography); projections

Geographical data: data representations eg raster, vector, networks; advantages and disadvantages

2 Understand the application of geospatial technologies for sustainable development

Role of geospatial technologies in sustainable resource management: importance; role eg decision support, optimisation, monitoring, change detection, location analysis, designing, planning, implementation

Applications in environment management: objectives and use of geospatial technologies in the environment sector eg natural hazard management, agriculture, climate change, conservation, forestry, watershed management, marine and coastal management, mining and exploration

Application in public and private sector: objectives; use of geospatial technologies in public and private sector eg health, emergency and disaster management, public safety, transportation, engineering, law enforcement and intelligence, marketing, utilities, telecommunications, facilities management, dispatch services, logistics, banking and finance, insurance, sales and retail, real estate, land administration, civil engineering, elections, public works, surveying, economic development and planning

Limitations of geospatial technologies: ethical issues; privacy; accuracy; metadata

3 Be able to plan the use of geospatial technologies to solve problems

Data capture: data creation using GIS, RS, GPS; extraction/mining; digitisation; data sources; vendors

Data management and output: data management processes eg storage, databases, file management; output types; visualisation

Data processing and spatial analysis: spatial analysis and data integration techniques eg queries, overlays, buffers, descriptive summaries, measurement, transformation, manipulations, geocoding

Planning for utilisation of geospatial technology: scientific method; health and safety; risk assessments and relevance in application of geospatial technologies; identifying aims and objectives, identification of required resources (data, tools and/or equipment required)

Geospatial technologies proposal: defining aims; methods and methodology eg strategy, steps; time management; monitoring progress and evaluation of outcomes/strategies

Assessment and grading criteria

In order to pass this unit, the evidence that the learner presents for assessment needs to demonstrate that they can meet all the learning outcomes for the unit. The criteria for a pass grade describe the level of achievement required to pass this unit.

Assessment and grading criteria		
To achieve a pass grade the evidence must show that the learner is able to:	**To achieve a merit grade the evidence must show that, in addition to the pass criteria, the learner is able to:**	**To achieve a distinction grade the evidence must show that, in addition to the pass and merit criteria, the learner is able to:**
P1 describe the major types of geospatial technologies for information management [IE4]	**M1** discuss the advantages and disadvantages of different data models in geographic information systems	**D1** discuss how the use of different geospatial technologies can influence the management or development of a selected resource.
P2 describe, using relevant examples, the importance of cartographic principles for geographic data [IE2]		
P3 explain the role of geospatial technologies in sustainable environmental resource management, including relevant applications [IE6]	**M2** evaluate the benefits and limitations of geospatial technologies for two selected industries or sectors	
P4 describe valid methods used in capturing and sourcing geographical data [IE4]	**M3** evaluate the application of geospatial technologies in the management of a selected natural resource.	
P5 explain the appropriate techniques used in analysing geographic data [IE4]		
P6 design a valid proposal for the application of geospatial technologies for a selected natural resource.		

PLTS: This summary references where applicable, in the square brackets, the elements of the personal, learning and thinking skills applicable in the pass criteria. It identifies opportunities for learners to demonstrate effective application of the referenced elements of the skills.

Key			
	IE – independent enquirers	RL – reflective learners	SM – self-managers
	CT – creative thinkers	TW – team workers	EP – effective participators

Essential guidance for tutors

Delivery

Tutors delivering this unit have opportunities to use a wide range of techniques. Lectures, seminar presentations, fieldwork, discussions, guest speakers, internet and/or library-based research and personal and/or industrial experience can all be used to motivate and maintain learners' interest. However, most importantly, the use of ICT facilities, GIS software, GPS and digital maps is valuable for this unit.

Health and safety issues concerning outdoor aspects of this unit must be addressed by tutors, especially when undertaking fieldwork.

Learning outcome 1 should be delivered within the context of providing learners with essential knowledge of the principles and components of geospatial technologies. Learners should gain an appreciation of the benefits of using geospatial technologies. Essential concepts such as projections, scale and coordinate systems must be explained clearly, and linked to data models within geographical information systems. The advantages and disadvantages of each of the data models should also be explored. Tutors should start introducing learners to the GIS software which will be used throughout the unit. The use of practical ICT sessions and GPS units is highly encouraged to give learners hands-on experience. There is a wealth of GIS software and geographic data online that will help familiarise learners with geographical information systems as well as enhance their learning experience. Combined classroom and outdoor activities could include the basic use of GPS units to track movement, infrastructures and street furniture for visualisation on a variety of maps.

For learning outcome 2, the links between resource management and aims of sustainable development should be discussed. These should then be linked with the potential of using geospatial technologies to achieve some of these aims. A sector-by-sector analysis is encouraged to expose objectives and application of geospatial technologies in achieving sustainable resource development objectives. Case studies would be useful here and the analysis of these case studies should show some of the limitations of geospatial technologies. Guest speakers from local enterprises using GIS, such as local planning agencies, civil engineers, urban development agencies, marketing or real estate firms, could enrich learners' experience. Learners should be given the opportunity to carry out research on how different industries use geospatial technologies.

Learning outcome 3 requires learners to plan the use of geospatial technologies and should build on their experience in learning outcome 1. A combination of formal lectures and tutor-guided practical exercises will help ensure that this learning outcome is met. It is essential that learners be given several opportunities to practise after the initial guided exercise. Learners should be exposed to field data collection as well as desktop data gathering. Methods and techniques that could be used to turn the data into useful information (integration, visualisation and outputting) should follow. The use of scientific methods and the relevance of SMART objectives should be stressed to help learners appreciate their relevance in designing, executing and monitoring projects/tasks.

Outline learning plan

The outline learning plan has been included in this unit as guidance and can be used in conjunction with the programme of suggested assignments.

The outline learning plan demonstrates one way in planning the delivery and assessment of this unit.

Topic and suggested assignments/activities and assessment
Introduction and overview of the unit and relevance to sustainable development.
Assignment 1: Essentials of Geospatial Technologies (P1, P2, M1) Tutor introduces the assignment brief.
Theory sessions: introduction of the technologies (GIS, RS and GPS), components and their benefits. Brief discussion on the coordinate systems. Activities could include use of Google Earth images (illustrate remote sensing), GPS units and location and attributes records (combining the three to make the learners see GIS). A survey of garbage/trash can or other street furniture (this can be used to test hypothesis later for learning outcome 3). Theory/practical sessions: explanation of the coordinate systems and their importance (with some examples) and attributes such as projections and map scales. Discussion with clear examples on different data models and their advantages and disadvantages. Activities could include data classification exercise (individual activity). Furthermore, learners could be given different datasets and asked the following: state the data model, identify location (ie record coordinates), print map to specified scale, state projections.
Individual learner research/study.
Individual tutorial support.
Assignment 2: Review of Application of Geospatial Technologies (P3, M2, D1) Tutor introduces the assignment brief.
Theory sessions: introduction of the role of geospatial technologies in sustainable development. This could be linked to the benefits of geospatial technologies previously discussed. Theory sessions: discussion on objectives in environmental management, encouraging learners to think about how geospatial technologies can be used to achieve these. Introduction of private and public sector objectives, with learners asked to highlight the differences. Group presentation of case studies whereby learners present objectives and how geospatial technologies have been applied. Learners could be presented with relevant case studies or allowed to select their own. The exploration of these case studies should also reveal the limitations of geospatial technologies; tutors should help highlight this during sessions.
Guest speaker from local planning authority/environmental agency/public safety to explain application of geospatial technologies in their line of work.
Individual learner research/study.
Individual tutorial support.

Topic and suggested assignments/activities and assessment
Assignment 3: Geospatial Application Design (P4, P5, P6, M3)
Tutor introduces the assignment brief.
Theory/practical sessions: tutor introduces data collection methods and sources of data for geospatial application, explaining the need for data management, and illustrating the different ways of outputting geographical information. Guided practical exercises using different sources of data as well as different data sources. Theory/practical sessions: introduction of spatial analysis and basic techniques in spatial data analysis. Using previous session's activities (datasets collated), learners could explore the dataset using different spatial data analysis techniques. Theory/practical session: review of scientific methods, and importance of health and safety in relation to geospatial technologies. Tutor outlines the relevance of planning in the implementation of geospatial technologies. Tutor stresses the relevance of SMART in setting objectives and links this to the identification of resources required to achieve the objective. Tutor presents group of learners with a scenario/problem which can be solved/managed using geospatial technologies and asks them to design a solution. Theory session: review of importance of SMART in defining aims/objectives, difference between methods and methodology, importance of setting a timeframe in proposals, methods of monitoring progress and how to evaluate the outcomes of the solutions designed. All this should be tied to group practical exercises centred on using SMART for designing and executing projects.
Individual learner research/study.
Individual tutorial support.
Unit review and evaluation.

Assessment

For P1, learners need to describe the major types of geospatial technologies for information management and their relevant features. For P2, learners should describe, using relevant examples, the importance of cartographic principles for geographic data. Evidence could take the form of a short report.

For M1, learners need to discuss the advantages and disadvantages of different data models in geographic information systems. They are expected to use adequate examples to clarify their points. Evidence could be in the form of a report or information leaflet.

For P3, learners need to explain the role of geospatial technologies in sustainable environmental resource management, backed up with relevant examples of applications. Evidence for this criterion could be in the form of an illustrated report.

For M2 and D1, learners need to evidence their understanding of the application of geospatial technologies across different sectors of the economy. For M2, learners need to give a detailed evaluation of the benefits and limitations of using geospatial technologies for two selected industries or sectors. Learners should give views or evidence to support their statements. For D1, a 'before' and 'after' analysis should be given and learners need to discuss how geospatial technologies have brought about changes in the way things are done and what impact these changes have had on the management of a selected resource. Case studies/examples are useful in this respect. Evidence for these criteria could be in the form of an article or information leaflet.

For P4, P5 and P6, learners need to demonstrate their ability to use data capture methods, spatial data analysis techniques and plan a geospatial system application. For P4, learners need to give a clear, valid description of methods used in capturing data as well as major sources of geographical data. For P5, learners need to explain in detail appropriate techniques used to analyse geographical data to meet specified objectives. For P6, learners should plan how they would use geospatial technologies to manage a natural resource. This is expected to be a valid proposal of how the resource could be managed using geospatial technologies.

For M3, learners need to evaluate their solutions/design in the management of resources within their selected enterprise. Learners should demonstrate a holistic knowledge of geospatial technologies, data and limitations as well as anticipate and adapt to changing situations. Evidence could be in the form of a presentation, supported by an assessor's observation record/witness statement to confirm achievement.

Programme of suggested assignments

The table below shows a programme of suggested assignments that cover the pass, merit and distinction criteria in the assessment and grading grid. This is for guidance and it is recommended that centres either write their own assignments or adapt any Edexcel assignments to meet local needs and resources.

Criteria covered	Assignment title	Scenario	Assessment method
P1, P2, M1	Essentials of Geospatial Technologies	You are a GIS officer presenting geospatial technologies to senior management.	Written report/ information leaflet.
P3, M2, D1	Review of Application of Geospatial Technologies	You are a science reporter explaining applications of geospatial technologies to your readers.	Illustrated report.
P4, P5, P6, M3	Geospatial Application Design	You are a GIS officer presenting a proposal for GIS implementation.	Presentation. Observation record. Report.

Links to National Occupational Standards, other BTEC units, other BTEC qualifications and other relevant units and qualifications

This unit forms part of the BTEC Environmental Sustainability sector suite. This unit has particular links with the following units in the BTEC Environmental Sustainability suite:

Level 3
Science for Environmental Technicians
The Business Environment
Understanding Principles of Physical and Biological Environmental Processes
Undertake an Extended Investigative Project in the Environmental Sustainability Sector
Using Statistics in Science
Pollution Control and Management
Sustainable Construction
Understanding Coastal Management
Scientific Practical Techniques
Urban Environment
Sustainable Transport

Essential resources

Learners need access to basic ICT facilities including GIS software and GPS units. Digital maps/images and internet access should be available to help underpin learners' knowledge of the concepts and issues covered in the unit.

Tutors delivering this unit should have a good level of experience in GIS, geography and environmental sciences.

Employer engagement and vocational contexts

Learners require access to a variety of information sources (maps, images, data etc) on the environment. Centres should develop good links with environmental agencies/organisations, development corporations, governmental agencies, and councils and invite guest speakers to discuss issues particular to the locality. Fieldwork trips are strongly encouraged.

Indicative reading for learners

Textbooks

Chiras D D and Reganold J P – *Natural Resource Conservation: Management for a Sustainable Future* (Pearson, 2010) ISBN 9780132251389

Chrisman N – *Exploring Geographic Information Systems* (John Wiley & Sons, 2002) ISBN 9780471314257

Clarke K C – *Getting Started with Geographic Information Systems* (Prentice Hall, 2010) ISBN 9780131494985

Greene R and Pick J – *Exploring the Urban Community: A GIS Approach* (Pearson, 2005) ISBN 9780130175762

Heywood I, Cornelius S and Carver S – *An Introduction to Geographical Information Systems* (Prentice Hall, 2002) ISBN 978013061 1987

Huggett R, Lindley S, Gavin H and Richardson K – *Physical Geography: A Human Perspective* (Hodder Arnold, 2004) ISBN 9780340809624

Jenks M and Jones C (Editors) – *Dimensions of the Sustainable City* (Springer, 2009) ISBN 9781402086458

Lein J K – *Environmental Decision Making: An Information Technology Approach* (Blackwell Science, 1997) ISBN 9780865424661

Longley P, Goodchild M, Maguire D and Rhind D – *Geographic Information Systems and Science* (John Wiley & Sons, 2001) ISBN 9780471892755

O'Connor P – *GIS for A-Level Geography* (The Geographical Association, 2008) ISBN 97818437721 01

Websites

Department for Environment, Food and Rural Affairs	www.defra.gov.uk
Environment Agency	www.environment-agency.gov.uk
ESRI UK	www.esriuk.com
Geographical Association GIS Hub	www.geography.org.uk/resources/gisstartshere
Multi-Agency Geographic Information in the Countryside	www.magic.gov.uk
Office for National Statistics	www.ons.gov.uk
Ordnance Survey GI page	www.ordnancesurvey.co.uk/oswebsite/gi
Penn State University GI e-education portal	www.e-education.psu.edu/ natureofgeoinfo/ c1_p1.html
Royal Geographical Society GIS Hub	www.gis.rgs.org/whatisgis.html
VDS Technologies Data page	www.vdstech.com/map_data.htm
A vision of Britain through time	www.visionofbritain.org.uk
WHO Scientific Assessment Tools	www.who.int/heli/tools/en
World Resources Institute	www.wri.org
Worldmapper – seeing the world in a different way	www.worldmapper.org/textindex/text_index.html

Journals

Computers, Environment and Urban Systems

International Journal of Geographical Information Science

Transactions in GIS

Delivery of personal, learning and thinking skills

The table below identifies the opportunities for personal, learning and thinking skills (PLTS) that have been included within the pass assessment criteria of this unit.

Skill	When learners are ...
Independent enquirers	describing the major types of geospatial technologies describing the importance of cartographic principles for geographic data explaining the role of geospatial technologies in sustainable environmental resource management describing valid methods used in capturing and sourcing geographical data explaining the appropriate techniques used to analyse geographic data.

Although PLTS opportunities are identified within this unit as an inherent part of the assessment criteria, there are further opportunities to develop a range of PLTS through various approaches to teaching and learning.

Skill	When learners are ...
Creative thinkers	participating in group work or class discussions, generating ideas and exploring possibilities asking questions to extend their thinking in relation to geospatial technologies and their application
Reflective learners	carrying out field surveys to explore practical use of GPS technology presenting findings from fieldwork in a variety of formats
Team workers	collaborating with others to work towards a common goal during fieldwork
Self-managers	working on assessments, organising their time and resources, prioritising actions and dealing with competing pressures, including personal and work-related demands
Effective participators	writing a proposal supported with a persuasive case for action planning for the implementation of GIS in an enterprise.

Functional skills – Level 2

Skill	When learners are ...
ICT – finding and selecting information	
Use appropriate search techniques to locate and select relevant information	researching information on application of geospatial technologies across different sectors
Select information from a variety of sources to meet requirements of a complex task	researching information on data models and cartographic principles
ICT – developing, presenting and communicating information	
Enter, develop and refine information using appropriate software to meet requirements of a complex task	producing the essentials of geospatial technology report
Use appropriate software to meet the requirements of a complex data-handling task	collecting data as part of geospatial application design
Combine and present information in ways that are fit for purpose and audience	producing a plan/proposal for implementation of GIS
Mathematics – interpreting	
Interpret and communicate solutions to multistage practical problems in familiar and unfamiliar contexts and situations	carrying out spatial data analysis and making reasoned inferences
Draw conclusions and provide mathematical justifications	carrying out spatial data analysis and making reasoned inferences
English – Speaking, Listening and Communication	
Make a range of contributions to discussions in a range of contexts, including those that are unfamiliar, and make effective presentations	discussing the application of geospatial technologies
English – Reading	
Select, read, understand and compare texts and use them to gather information, ideas, arguments and opinions	researching the application of geospatial technologies across different sectors
English – Writing	
Write a range of texts, including extended written documents, communicating information, ideas and opinions, effectively and persuasively	producing reports on geospatial application design.