Edexcel GCSE Geography A

Practical support to help you deliver this Edexcel specification

Edexcel GCSE Geography A, Geographical Themes and Challenges, offers a thematic approach to studying geography. The content is split into physical and human geography. As with all GCSEs, the guided learning hours are 120 hours over 2 years. This document provides a topic guide for teaching Component 1, Topic 3 that centres can adapt to fit their own contexts and teaching styles. It is meant as an example approach only and is not intended to be prescriptive. The topic guides indicate resources that you can use to support your teaching. This document can be edited and updated over time to develop a resource bank. These are only suggestions and you are encouraged to use a wide range of resources to suit the needs of your own students.

The advised teaching time for Topic 3: Ecosystems, biodiversity and management, is 15 guided learning hours: roughly 1 hour per Key idea sub-section (a, b, c). This requires some blending together of the detailed content. The guidance below includes suggestions about contextualisation or stretch challenges that may be suitable for more able students, as well as expected lesson outcomes for those less able. Please note that these are suggestions only and not specific syllabus requirements.

The two- and three-year course planners suggest appropriate times to introduce this material. For example, in centres studying over three years, you might want to cover this topic in the summer term of year 9, when deciduous trees should be in full leaf cover. Centres studying over 2 years might also like to follow this sequence but in year 10. There is also the opportunity for ICT-based computer suite work researching the UK's large-scale ecosystems or presentations on the located examples of the Tropical rainforest and Deciduous forest. At this time of year, the ICT suites in schools are often less busy, as exam classes have left. It may be a good idea to teach Topic 2 before Topic 3 so that some knowledge on climate can be reinforced.

Each Key idea is broken down into sub-sections (a, b, c), and roughly 1 hour should be spent on each of these. There is a quick overview of the breadth of the Key idea followed by a more detailed explanation of the key concepts and processes, examples of teaching strategies, guidance on integrating geographical skills, and a summary of the key terminology required. The structure is suggestive, not prescriptive.

Synoptic linkages and case study nesting

No in-depth case studies are required for this topic, just two located examples (Tropical rainforest and Deciduous woodland). Located examples signposted by the globe are not 'in-depth case-studies', just a named place taught as part of one key idea. These can be nested within the in-depth case studies to give them a wider place/locational context. So for example, Brazil could be studied for Topic 5, Global development 'an emerging country'. Rio de Janeiro or Sao Paulo could be studied as a major city in a developing country for Topic 4, and then the Amazon rainforest as the located example for this topic.

There are some synoptic links between this topic and others. For example, the potential threats to ecosystems could result from climate change and the climatic factors influencing ecosystems, which links to Topic 2: Weather hazards and climate. There is some focus on the UK's distinct ecosystems, which links in well to Topic 1: The changing landscapes of the UK, Key idea 1.2.

Topic Booklet for Component 1, Topic 3: Ecosystems, biodiversity and management

Introduction

Quick overview

It is likely that Key ideas 3.2 and 3.3 are the only areas that are less familiar to GCSE level. Most teachers should find the all the other Key ideas familiar topic areas either at KS3 or GCSE, especially 3.4 and 3.5 – Tropical rainforests and Deciduous woodlands, including factors that influence these ecosystems, how the biodiversity adapts, threats, management and the goods and services that they provide.

There are 7 key ideas in total.

Ecosystem overview:

- Key idea 3.1: Large-scale ecosystems are found in different parts of the world and are important.
- Key idea 3.2: The biosphere is a vital system.
- Key idea 3.3: The UK has its own variety of distinctive ecosystems that it relies on.

Tropical rainforests:

- Key idea 3.4: Tropical rainforests show a range of distinguishing features.
- Key idea 3.5: Tropical rainforests' ecosystems provide a range of goods and services, some of which are under threat.

Deciduous woodland

- Key idea 3.6: Deciduous woodland shows a range of distinguishing features.
- Key idea 3.7: Deciduous woodlands' ecosystems provide a range of goods and services, some of which are under threat.

The aim of this topic pack is to get an overview of the distribution of the world's large-scale ecosystems and their characteristics and to understand the factors that influence their distribution. It will provide help with understanding the resources that they provide and how these resources are being increasingly exploited. This topic pack will provide an overview of what is required to teach about these two biomes. This will include the interdependence of biotic and abiotic factors, characteristics of the biodiversity, examples of the goods and services they provide, the various threats, and the sustainable management of these two ecosystems.

Key idea 3.1–3.3

Teaching approach over 5 hours

Lesson 1 (1hr)	3.1a – Distribution and characteristics of the world's large-scale ecosystems.
Lesson 2 (1hr)	3.1b – The role of climate and local factors in influencing the distribution of different large-scale ecosystems.
Lesson 3 (1hr)	3.2a – The biosphere is a vital system: how the biosphere provides resources for people but is also increasingly exploited.
Lesson 4 (1hr)	3.3a – The distribution and characteristics of the UK's main terrestrial ecosystems (moorlands, heaths, woodlands, wetlands).
Lesson 5 (1hr)	3.3b – The importance of marine ecosystems to the UK as a resource and how human activities are degrading them.

Lesson 1: Distribution and characteristics of global ecosystems

Overview

The first lesson could be about building up a picture or getting an overview of where the world's major ecosystems (biomes) are and what they are like in terms of the characteristics of their climate, vegetation and animals (flora and fauna).
The characteristics of the climate are influenced by their geographical location. Students should then be in a position to think about characteristics such as temperature range, annual rainfall patterns, length of growing season, common types of vegetation and animals. Links may be made here to the global atmospheric circulation from Topic 2, if this has been studied.

- More able students should be able to clearly locate these ecosystems on a world map and have good factual knowledge of each ecosystem.
- Less able students should be able to provide an outline of the characteristics for these large-scale ecosystems.

Key concepts and processes

Much of the content for Key idea 3.1a is nothing new for GCSE level.

A useful starting point is a world biome map such as the one found here. These can be found in most school atlases. A summary table like the one below may be useful for students to complete, or they may wish to annotate their own biome maps (the table below is only a brief summary). Students could be given the biome characteristics and, after discussion, could match the characteristics to the correct biome. It is worth remembering that the Tropical rainforest and Temperate forest are studied in detail later in this topic so you may only wish to introduce these at this point.

Ecosystem	Location	Precipitation	Temperature	Vegetation	Animals
Tropical rainforest	Amazon, Brazil	Total annual rainfall between 2000mm and 2200mm.	Small range between 26° C and 30° C.	Four layers made up of emergent, canopy, under-canopy, shrub layer. Lianas grow up the trees, epiphytes grow on the trees, evergreen appearance.	Sloths Monkeys Armadillo Snakes Insects
Temperate forest	UK, Europe	Total annual rainfall around 1000mm.	Temperature range between 4°C and 18°C.	Four layers made up of canopy, sub-canopy, herb and ground. Oak is a dominant species. Trees lose their leaves in winter.	Rabbits Deer
Boreal forest	Russia	Total annual rainfall around 500mm	Temperature range between -10°C and 15°C	Evergreen trees with needles (less transpiration) and thick bark (protection from cold), shallow roots.	Deer Wolves Black bears
Tropical grassland	East Africa	Distinctive wet (May–October) and dry seasons.	Small temperature range between 25°C and 30°C.	Scrub, grasses and occasional trees, e.g. acacia.	Many animals migrate long distances in search of food. Wildebeest Giraffes Elephants
Temperate grassland	Pampas, Argentina	Total annual rainfall around 500mm	Temperature range between 10°C and 18°C.	Distinctively devoid of trees. Buffalo grasses.	Foxes Skunks Small herds of guanacos Bush dogs Many bird species
Deserts	Great Sandy Desert, Australia	Very low and unpredictable	Average temperature range between 30°C and 35°C. However, there can be massive difference between day and night.	Shrubs, cacti, very little vegetation.	Camels Dingoes Kangaroo

Guidance on teaching

Many students confuse the location of deserts and rainforests (thinking the former are at the equator, while not appreciating that rainforests need heat and sun). There is often a misconception that places closer to the equator are always hot and dry. Integrated skill 1 should be focused on here: Use of world maps to show the location of global biomes.
For more able students there is the opportunity to link some understanding from Topic 2 Key idea 2.1a: global atmospheric circulation and how it influences the climate of some of the large-scale ecosystems.

1. Use each of the prompts below to write something about the map of the biomes.
2. In the N/E/W/S (side of)
3. Mainly located above / between … latitude
4. Close to…
5. Inland / on the coast of
6. Unevenly distributed, evenly
7. Next to / surrounded by
8. (Relatively) biggest area in
9. (Relatively) smallest area in
10. Occupies
11. Borders
12. Not all of…
13. Anomalies
14. Place the prompts around the map, drawing a line to where you are looking so I can check your thinking.
15. Be careful and save yourself work; **only describe** – don't explain.

Lesson 2: The role of climate and local factors in influencing the distribution of large-scale ecosystems

Overview

Climate plays a major role in the distribution of the world's large-scale ecosystems. The ecosystems' climates differ and can influence what grows there. For example, Tropical rainforests have the greatest amount of biodiversity on earth because they have a warm, constant temperature, lots of sunlight and high levels of moisture (equatorial climate). This provides a continuous growing season where plants and animals can thrive.

- More able students might explain the role of the global atmospheric circulation cells in influencing the distribution of large-scale ecosystems.
- Less able students might just concentrate on the role that latitude plays.

Key concepts and processes

Climate

The Earth's spherical shape means the sun's rays strike the tropics in a more intensely concentrated way than at the poles. So, around the tropics the sun's energy provides a lot of heat and light for vegetation to grow. In the polar regions a

lack of heat and light limits vegetation growth. That's why tundra has less diversity of vegetation and amount of vegetation than the tropical rainforests.

Around the tropics, warm, humid air rises, condensing to form a broken line of thunderstorms, sustaining the world's **tropical rainforests.**
From the tops of these storms, air flows north and south, where it sinks to produce high-pressure regions with hot, dry air: the deserts.
At the opposite extreme are the smaller, weaker polar cells (from 60–70° latitudes to the poles). Here, the air is very dry and stable. The cold air sinks and flows away from the poles.

In between, in the mid-latitudes, warm, moist air from the subtropics meets cold, dry air from high latitudes, bringing unsettled wet weather typical of the temperate zones. See http://www.metoffice.gov.uk/climate-guide/climate/what-affects-climate. Concepts that are less familiar might be the influence of the ITCZ (Intertropical Convergence Zone). There are some useful slides on this in the Getting Ready to Teach PowerPoint. The ITCZ is responsible for the rainy season in West Africa. It is not present all year round, but its path is conditioned by the position of the overhead sun, which it follows. It brings rain to West Africa, first as it reaches the coast in early March, then later to Kano, where rains arrive in late April, and finally to Timbouctou in Mali, where rains normally arrive in late May. This helps to explain why there are seasonal rains in tropical grasslands in West Africa.

Local factors

Altitude	For every 100 metres of ascent, temperatures decrease by roughly 1°C. The air becomes less dense and does not hold heat as easily.
Prevailing wind	Winds blowing across oceans will bring moisture and rainfall, whereas winds blowing across warmer continents bring warm dry air.
Soils	Different vegetation requires different soil types. Thinner soils such as in the Boreal forests contain less organic matter, and may be more acidic, whereas in the Tropical rainforest soils are more nutrient-rich because of the decaying litter layer.
Distance from the sea	Land heats and cools faster than the sea. Therefore, coastal areas have a lower temperature range than areas inland. On the coast, winters are relatively mild and summers are cool. Inland, temperatures are higher in the summer and colder in the winter.
Ocean currents	Warm ocean currents, especially in the North Atlantic, moderate the land temperatures of cold areas.
Relief/Topography	Hills and mountains play a decisive part in local weather patterns, especially where moist air is forced to rise and cool, forming precipitation.

Guidance on teaching

Global atmospheric circulation is a seemingly complex but quite logical explanation of different climate regions around the world. Many students confuse the location of deserts and rainforests (thinking the former are at the equator, while not appreciating that rainforests need heat and rain). Starting with this misconception often leads students to develop a logical appreciation of the importance of latitude

for temperature and its consequent impact on air-pressure at the equator, and in turn the rainforest ecosystem. Integrated skill 2 – there is an opportunity here to compare climate graphs from different biomes.
See question 7b(ii) in the SAMS pack for Specification A P21.
There are some useful slides about tropical rainforests in western Africa in the Getting Ready to Teach resources on the Spec A Edexcel website.

Lesson 3: The biosphere is a vital system: How the biosphere provides resources for people but is also increasingly exploited

Overview

The third lesson should tackle Key Idea 3.2a by focussing on the importance of the biosphere as a resource. It is often said that the biosphere is the Earth's life support system. Although it provides many resources for people, such as food, medicines, minerals, water and fuel resources, it also plays a vital role in regulating the gases that make up the atmosphere. For example, the tropical rainforests are often referred to as the lungs of the Earth. They are a vital carbon store and release oxygen.

However, the main focus of this Key idea is on the resources that the biosphere produces and the fact that people are exploiting these more and more. The focus on 'goods and services' comes later in the located examples of Tropical rainforests and Deciduous woodland. However, it could be incorporated into this part of your teaching.

- More able students may undertake some wider background reading from the Millennium Ecosystem Assessment http://www.millenniumassessment.org/en/index.html They could try to make a judgement on whether one way of exploiting the biosphere is better than another, for example, is commercial use better or worse? (or medicines, building materials, fuel resources etc.)
- Less able students may make a list of the resources they have used this week that come from the biosphere.

Key concepts and processes

Students should know how the biosphere provides resources for people, including food, medicine, building materials and fuel resources (goods and services). Students should also understand how these resources are being exploited. This could be done in a teacher-led way, or there is an opportunity for students to do group work and research various resources. There is a useful *National Geographic* article in June 2016 about the Peru rainforest – lots of striking images about life and changes there – students could deconstruct the photographs. Presentations and feedback could then help to build up a picture and a table like the example on the next page.

The biosphere provides resources for people but these resources are becoming increasingly exploited.

Students could complete a table like the one below.

Resource	Where in the biosphere it can be found	How it is exploited by humans
Food • Fish, fruits, nuts, replacing natural vegetation with crops.		
Medicine • Quinine, periwinkle, aloe plants, poppies for morphine.		
Building material • Timber, clay bricks, cereal plants used for roofing.		
Fuel • Animal dung, timber, biofuels.		

Guidance on teaching

These resources need to be covered over the course of one lesson in a 'light touch' way. Be careful not to go into too much detail (a lesson could easily be spent on each resource). An overview is required. It is about making students aware of how much we depend on the biosphere for things we use on a daily basis and how, if we are not careful, these resources may be exploited to the point where it is not sustainable to continue using them. This British Geological Survey website is a useful resource: http://www.bgs.ac.uk/mineralsuk/mineralsYou/whyDo.html

Lesson 4: The distribution and characteristics of the UK's main terrestrial ecosystems.

Overview

In the fourth lesson, students need to know where the UK's main ecosystems (moorland, heathland, woodland, wetlands) are, and be able to describe the characteristics of them.

- More able students may want to use the UK National Ecosystem Assessment report, which has an in-depth view of the UK's ecosystems. They could discuss which one of the UK's main ecosystems is the most valuable.
- Less able students could focus on plotting the distribution on maps.

Key concepts and processes

The UK has distinctive ecosystems. Students need to know where they can be found and their characteristics.

Ecosystem	Distribution	Characteristics
Moorland	Found in upland areas where rainfall levels tend to be high. In the UK they occur mainly above 250 metres, so can be found in the Pennines, North Yorkshire, the Cheviot Hills on the Scottish Borders and most of upland Scotland such as the Cairngorms.	Moorlands are heavily influenced by people. Most of the UK's moorlands would have been covered by trees and shrubs at some point. However, over time the moorlands of the UK have been heavily used as grazing land. High altitude, strong winds, heavy rainfall and cloud cover can restrict the growth of plants. Common plants are heather and bracken. Common animals are deer, foxes and grouse.
Heathland	Found in lowland areas of southern UK such as the New Forest, Surrey Heaths and parts of Suffolk.	Heathland forms on porous sandy soils. These lack fertility as nutrients can be easily washed out and the soil can be acidic. Lowland heathland is often dominated by heather, ling and gorse, and if poorly managed, bracken or silver birch may also be present. Common plants are heather and gorse. Common animals are rabbits.
Woodland	Woodland covers around 12% of the UK land area, making the UK one of the least wooded areas in Europe. At least 80% of UK woodland is less than 100 years old.	Some woodlands are dominated by deciduous broadleaved trees that lose their leaves in winter. Some woodlands are coniferous woods which have needle-like leaves. Common plants are bluebells and ferns. Common animals are deer and badgers.
Wetland	Wetlands include open waters, floodplains, rivers, streams and ponds. Floodplains are a key location of wetlands such as the River Severn and the Somerset Levels.	Most wetland environments contain waterlogged soils that are extremely fertile and so support a lot of vegetation. Common plants include reeds and bulrushes. Common animals are otters and many types of birds.

Guidance on teaching

These ecosystems need to be covered over the course of one lesson in a 'light touch' way. Be careful not to go into too much detail (a lesson could easily be spent on each ecosystem). An overview is required. It is about making students aware of where these ecosystems are in the UK, and what their typical characteristics are in term of vegetation and animals. A 'Maps from Memory' exercise could be useful here. Students could work in groups of four and take turns to go out and memorise a map, photo or characteristics and come back in and reproduce it. Integrated skill 3 – Interpret GIS maps. There is an opportunity here to locate these ecosystems using GIS by using the basic tools from Google Earth. Google Earth allows you to put overlays onto the map or symbols to locate the ecosystems.

Lesson 5: The importance of marine ecosystems to the UK as a resource and how human activities are degrading them

Overview
The fifth lesson has more focus on marine ecosystems. Students need to know how human activities such as overfishing, the extraction of oil and gas and the development of industry can cause problems for marine ecosystems.
Students need to understand how important the marine ecosystems around the UK are as resources. They should also be able to explain how human activities can put pressure on these ecosystems.

- More able students may undertake some wider background reading from the UK Marine Ecosystem Assessment. An enquiry-based approach could look at whether the UK's marine ecosystems can be exploited forever. There are a range of possible answers here: no if we overexploit, yes if we work sustainably.
- Less able students should be able to discuss the importance of marine ecosystems.

Key concepts and processes

Marine environments hold a vast wealth of resources that we rely on and use on a daily basis, from fuel sources to food supplies. Most of our oil and gas reserves lie beneath the sea floor, and many are yet to be discovered. Energy is generated from waves, tidal currents, tidal barrages and offshore wind. Exhausted offshore oil and gas wells can be used to store the carbon dioxide produced by burning fossil fuels. Around the world, more people are relying on marine environments for food, and to help support recreation and tourism. The world's oceans can also help to regulate our climate by absorbing greenhouse gases and releasing oxygen.

Themes covered in this lesson might include food (from fishing), aquaculture (the farming or culturing of fish, molluscs, crustaceans), recreation, tourism, education, flood and storm protection, climate regulation and nutrient cycling.

How are human activities degrading the UK's marine ecosystems?
Overfishing, pollution from oil spills, pressures from extracting oil and gas, pressures from tourism in popular coastal resorts, more recently the increased use of marine environments for renewable energy. For example, over the last 10 years there has been a significant increase in the number of offshore wind farms. Although they are a renewable source of energy, their construction does interfere with ecosystems on the sea bed.

Guidance on teaching

The Marine Management Organisation (https://www.gov.uk/government/organisations/marine-management-organisation) is a useful starting pointing point, and there are also some good clips on YouTube. Students could produce a factsheet on one aspect of the UK's marine ecosystem from the following: characteristics, importance, benefits, how humans are degrading them, and then share them with each other.

Key vocabulary for Key idea 3.1–3.3

Large-scale ecosystems	Biosphere and resources	UK ecosystems
Ecosystem Distribution Altitude Biome Climate Global atmospheric circulation	Biosphere Resource Finite resource Renewable resources Exploitation Biodiversity	Terrestrial Moorlands Heathlands Woodlands Wetlands Deciduous Coniferous Aquaculture Overfishing

Further reading

- Large-scale ecosystems. www.worldbiomes.com
- The role of climate in influencing the distribution of ecosystems. http://www.metoffice.gov.uk/climate-guide/climate/zones
- UK Ecosystems http://www.millenniumassessment.org/en/Index-2.html
- This is a useful resource: the UK National Ecosystem Assessment. http://uknea.unep-wcmc.org/Home/tabid/38/Default.aspx
- Use the map from page 4 of the UK National Ecosystem Assessment Report, showing broad UK habitats: http://uknea.unep-wcmc.org/LinkClick.aspx?fileticket=BNpVOJWKNxA%3d&tabid=82

Key idea 3.4–3.5

Teaching approach over 5 hours

Lesson 1 (1hr)	3.4 a–b – The biotic and abiotic characteristics of the tropical rainforest and the interdependence of these characteristics. The role of energy flows and nutrient cycling.
Lesson 2 (1hr)	3.4c – Why rainforests have high levels of biodiversity and how the biodiversity adapts to the environment.
Lesson 3 (1hr)	3.5a–b – The goods and services that rainforests provide. How climate change presents a threat to the structure, functioning and biodiversity of rainforests.
Lesson 4 (1hr)	3.5c – Economic and social causes of deforestation.
Lesson 5 (1hr)	3.5d – The sustainable management of the tropical rainforest.

Lesson 1: Biotic and abiotic characteristics of tropical rainforest ecosystems (climate, soils, water, plants, animals and humans); The interdependence of these characteristics; The role of energy flows and nutrient cycling (Gersmehl model)

Overview

There is a lot to cover this lesson, but by the end students need to know the biotic (living) and the abiotic (non-living) characteristics of the TRF. They should be able to explain how these interact together in order for the TRF ecosystem to function properly. They should also understand how nutrients are cycled within the TRF and how energy flows through the ecosystem.

- More able students should be able to clearly draw and explain the nutrient cycle model. They should be able to comment on whether biotic or abiotic factors drive the nutrient cycle more.
- Less able students could make a mind map of the biotic and abiotic factors.

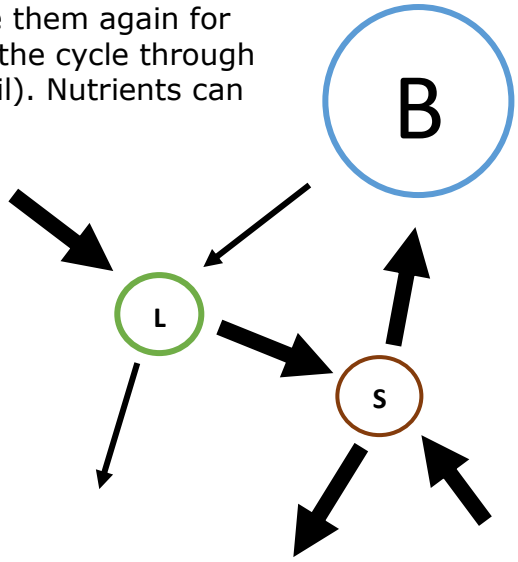
Key concepts and processes

Students need to understand that in order for any ecosystem to function properly, two important processes need to take place.

1. **Nutrient cycling** – Nutrients are essential for organisms to grow and survive. The nutrient cycle moves important nutrients (such as nitrogen, phosphorus and potassium) around the ecosystem between the living and non-living environment. Put simply, the deciduous trees in the rainforest lose their leaves, these fall to the ground, decompose and release the stored nutrients back into the soil. The trees will then take up these nutrients and use them again for growing. However, nutrients can also be lost from the cycle through surface run-off and leaching (washed out of the soil). Nutrients can also be added through precipitation.

   The Gersmehl model is used to represent where the nutrients are stored, how they move around the ecosystem and how they can exit or enter the ecosystem. The larger the circle, the larger the store of nutrients, and similarly the larger the arrow the more nutrients there are in the transfer pathway.

   B=Biomass, L=Litter, P=Precipitation, R=Run-off, Le=Leaching, W=Weathering, S=Soil.



2. **Energy flows** – Energy is passed through the TRF ecosystem via the food chain. A network of food chains is called a food web. TRF contain more species of animals than any other ecosystem on earth, and so food webs are complex but, put simply, the primary producers such as plants get their energy from the sun, these are then eaten by primary consumers (herbivores), which are then eaten by secondary consumers (carnivores), which are then eaten by tertiary consumers. When an organism dies it is eaten by microbes and the nutrients are recycled.

Guidance on teaching

Students should be able to draw and label the Gersmehl model. Or complete a 'back to back' exercise where students sit back to back and describe the model to their partner so that the partner can reproduce it accurately – this forces them to use the right vocabulary and to describe the different sizes of the elements in the diagram. It is important that they understand the proportional size of the nutrient pathways and stores. They should know that most nutrients in the TRF are stored in the biomass, with the least in the soil (high levels of rainfall cause leaching). With regard to energy flows, students should be able to produce a simple food chain for the TRF. It is also important to note that not all the energy is passed on, which is why there are usually only 4 trophic levels. Not everything gets eaten (bones), energy gets lost immediately (respiration), and energy is lost through faeces. Integrated skill 4 – Use and interpretation of nutrient-cycle diagrams and food-web diagrams.

See question 7d(iii) in the SAMS pack for Specification A P23. Soil store – smaller in Tropical Rainforest (TRF) (1) – as the nutrient uptake is higher in TRF and there is greater amount of leaching due to more rainfall in TRF (1). Litter store – smaller in the TRF (1) as the rate of decomposition is much greater because of the high humidity (1). Arrows are generally larger in TRF as the rate of nutrient recycling is much faster between stores (1) due to climate and biodiversity, meaning that transfer is more likely in TRF (1).

Lesson 2: Why rainforests have high levels of biodiversity and how the biodiversity adapts to the environment.

Overview

Lesson 2 on Tropical rainforests should focus on how the biodiversity adapts to the climate. TRF have the greatest biodiversity (amount and type of different species of plants and animals) on Earth. It is estimated that 50% of the world's plant and animal species live in Tropical rainforests. A typical 5-hectare area of TRF contains 750 tree species, 1,500 species of flowering plants, 400 bird species, 150 butterfly species and 100 reptile species.

Students need to understand the why the biodiversity is so high and how it adapts to the tropical environment.

- More able students should be able to explain how biodiversity is linked to climate.
- Less able students should be able to describe how biodiversity adapts to climate.

Key concepts and processes

Why is biodiversity so high?

- High constant temperatures with very little range (26°C to 30°C).
- High levels of rainfall (convectional) around 2000mm per year.
- High humidity.
- Good levels of sunlight all year.
- Constant growing season.
- High nutrient levels.

How does biodiversity adapt to the environment?

Vegetation	Animals
Plants adapt to high levels of rainfall – thick waxy leaves with pointed drip tips.	Many animals have adapted to living in the canopy where there is plenty of food.
Trees have large crowns (where they absorb sunlight) with very few branches.	Animals hunt at night when they have more energy and it is cooler.
Large trees have buttress roots to support them.	Many animals are camouflaged to avoid predators.
Epiphytes grow on the trees.	Some animals have a good sense of smell or hearing because of low light levels on the forest floor.
Fungi have adapted to take nutrients from dead organic matter in the litter layer.	Animals learn to swim or have webbed feet because of the many rivers in TRF.
Evergreen appearance due to constant growing season, even though many trees are deciduous.	
Trees' roots spread far horizontally due to thin soils.	

Guidance on teaching

Students should be able to name some of the different plants and animals that have adapted to the TRF environment. One way of teaching this Key idea is to use the four-layered structure of the TRF. An annotated diagram, showing the different plant and animal adaptations for each of the four stratified layers. Students could 'mix and match' them – recognising that some may be linked in more than one way.

Four distinct stratified layers make up the structure of the TRF: Emergent layer, Main canopy, Under-canopy, Shrub/Litter layer.

There would also be an opportunity here to reinforce integrated skill 2. See question 7d(iii) in the SAMS pack for Specification A P23.

Lesson 3: The goods and services that rainforests provide. How climate change presents a threat to the structure, functioning and biodiversity of rainforests.

Overview

In lesson 3 students need to know the different goods and services provided by TRF, including foodstuffs, medicines, timber and recreation potential.
Students should be able to explain how climate change could threaten the structure, functioning and biodiversity of rainforests. This could be linked back to the last lesson to see how climate change may threaten the adaptations made by the plants and animals in the TRF.

- More able students could undertake wider background research on the impacts of climate change.
- Less able students may produce mind-maps of the impacts.

Please see Question 7d iv on page 24 of the SAMs. This is a difficult question that requires students to 'Assess' whether climate change is a greater threat to tropical rainforests than to deciduous woodland, so it is important that students can compare the two ecosystems. It would be good practice to expose students to these types of questions – i.e. whenever you've talked about one aspect of tropical forests, remind students that they need to be able to compare this aspect to temperate forests.

Key concepts and processes

This element on goods and services maybe covered alongside the goods and services of the deciduous woodland. This will avoid repetition but also allow students to compare and contrast the two ecosystems.

How do I know if something is a good or service?
This can confuse students. You could get them to think of it like this: a **good** is something you can physically hold in your hands, such as medicine, wood, food, minerals, etc. A **service** is something you can't hold in your hands, such as tourism or recreation, the hydrological cycle, large numbers of trees to prevent flooding or store carbon dioxide, etc.

How can climate change threaten the structure, functioning and biodiversity?
The most likely increase in global temperatures is likely to be between 2°C–3°C by 2100 (IPCC). The structure, functioning and biodiversity of the TRF will be threatened by this because they rely on the climate.

- The Amazon drainage basin will become drier as it receives less rainfall.
- More periods of drought.
- Less rainfall would result in changes to biodiversity.
- Fewer trees would mean less transpiration and therefore less convectional rainfall.
- There may be more distinct wet and dry seasons.
- More and more species could be threatened by extinction.
- Greater chance of wildfires.
- Sea level rise would threaten the Amazon river delta region.

Guidance on teaching

A good starting point might be to produce a mind-map of all the goods and services that TRF provide. For climate change threats to the TRF, knowledge gained from Topic 2 may be useful here. A useful website to build up an overview of the threats is this one from the Met Office and the Amazalert website:
http://www.eu-amazalert.org/home
http://www.metoffice.gov.uk/research/news/amazon-diebackhttp://www.metoffice.gov.uk/research/news/amazon-dieback
It could provide an opportunity for class research or group presentations on the impacts.

See question 7d(iv) in the SAMS pack for Specification A P23.

Lesson 4: Economic and social causes of deforestation.

Overview

Lesson 4 should focus on the economic and social causes of deforestation.
A very familiar topic for both KS3 and GCSE level. A popular located example is likely to be the Amazon rainforest.

- More able students should be able to evaluate and assess the causes of deforestation. For example, which leads to the worst impact or more long-term impact?
- Less able students may need a framework to help them like the one below.

Key concepts and processes

Economic causes	Social causes
Logging, timber	Population pressure – (over 180 million people) since 1960 the government have wanted to open up the interior of the Amazon.
Extension of agricultural land for cattle ranching – Brazil is the leading producer of beef.	Expanding cities. Cities like Parauapebas have grown rapidly due to workers arriving to work in the iron-ore mines.
Land required for growing soybeans – this was Brazil's leading export for a period in the 2000s and has helped Brazil pay off debts.	An opportunity for landless people to own their own plot of land.
Minerals – the largest concentration of mineral resources is at Carajas, where there are large deposits of gold, iron ore, nickel, copper, manganese and bauxite (a key ingredient for making aluminium).	Exploiting the Amazon to reduce poverty.
HEP	
Building roads – (especially paving roads, e.g. BR163)	
Shifting cultivation	

Guidance on teaching

These key ideas provide an opportunity for students to research their chosen located example such as the Amazon, so these lessons don't necessarily have to be teacher-led. However, students may need some guidance. One activity could be to put a graph showing the rates of deforestation in the middle of a sheet of paper and put two borders around it. Within the first border, label everything that is 'blatantly obvious' about the graph, and then in the outer border, extend these points to show why they might help us draw some kind of conclusion about deforestation. A useful BBC documentary on the causes and consequences of deforestation in the Amazon can be found on YouTube, called Battle for the Amazon, although many others are available. Integrated skill 5 – There is an opportunity here to use and interpret line graphs showing the range of future global population projections, and population in relation to the likely available resources.

Lesson 5: The sustainable management of the tropical rainforest.

Overview

This area of sustainable management of the Tropical rainforests is nothing new for GCSE level. However, there does need to be a focus on the political and economic factors that have contributed to their sustainable management.
The areas to focus on are governance, commodity value and ecotourism. Ecotourism is probably better understood by students than the other two.

Key concepts and processes

These are just a few examples of management.

Governance	**Commodity value**	**Ecotourism** (e.g. Una Eco park, Atlantic Forest, Brazil)
New laws and legislation	Selective logging (maximum sustainable yield)	Supporting, educating and training local people
Setting up national parks	Promoting responsible management and use, e.g. Forest Stewardship Council.	Local people involved in making decisions
IBAMA – **Brazilian Institute of the Environment and Renewable Natural Resources**	Forest management and monitoring plans.	Employment of local people as guides and hotel workers
The role of NGOs in sustainable management, e.g. Greenpeace	Education and training	Reducing overconsumption of waste
Selling of carbon credits		Marketing tourism responsibly

Guidance on teaching

Make sure that students have a clear idea about what sustainable management means – when the level of exploitation is not greater than the ability of the tropical rainforest to replace itself. They need to understand that many people and indeed countries need to use the tropical rainforest, but not at the expense of the long-term future of the forest.

A located example is required here, so the Amazon rainforest could be a popular example. It is important that students have good factual and location knowledge rather than just a generic reference to the Amazon. For example, they may make reference to the iron ore project in Serra dos Carajas, gold prospecting in the Tapajos river basin, or HEP at Belo Monte or the Tapajos River Dam Complex.

Key vocabulary for Key idea 3.1–3.3

Tropical rainforests	Goods and services	Deforestation & management
Biotic Abiotic Biodiversity Nutrient cycle Stratified layers Buttress roots Drip tips Camouflage Epiphytes Adaptation Food chain Food web Precipitation Biomass Soil Litter Leaching Decomposition Structure Functioning	Goods Services Ecotourism Carbon sink Regulate climate	Social Economic Logging Ranching Mining Shifting cultivation Exploitation Sustainable management

Further reading

Tropical rainforest located example – Amazon rainforest

www.amazonwatch.org
http://www.mining-technology.com/projects/carajas/
http://www.greenpeace.org.uk/blog/forests/how-cattle-ranching-chewing-amazon-rainforest-20090129
http://rainforests.mongabay.com/0812.htm
http://www.amazonconservation.org/ourwork/livelihoods_ecotourism.html

Key idea 3.6–3.7

Teaching approach over 5 hours

Lesson 1 (1hr)	Key idea 3.6a+b The biotic and abiotic characteristics of deciduous woodlands and the interdependence of these characteristics. The role of energy flows and nutrient cycling.
Lesson 2 (1hr)	Key idea 3.6c Why deciduous woodlands have moderate levels of biodiversity and how the biodiversity adapts to the environment.
Lesson 3 (1hr)	Key idea 3.7a+b The goods and services that deciduous woodlands provide. How climate change presents a threat to the structure, functioning and biodiversity of deciduous woodland.
Lesson 4 (1hr)	Key idea 3.7c Economic and social causes of deforestation of deciduous woodland.
Lesson 5 (1hr)	Key idea 3.7d The sustainable management of deciduous woodlands.

Lesson 1: The biotic and abiotic characteristics of deciduous woodlands and the interdependence of these characteristics; the role of energy flows and nutrient cycling

Overview
This lesson follows a similar format to the tropical rainforest Key idea 3.4 a+b. Again there is a lot to cover in this lesson, but by the end students need to know the biotic (living) and the abiotic (non-living) characteristics of deciduous woodland. They should be able to explain how these interact in order for deciduous woodland to function properly. They should also understand how nutrients are cycled within and how energy flows through the ecosystem.

Key concepts and processes

The biotic and abiotic factors are the same as TRF (climate, water, soil, plants, animals, humans). It would be useful to compare the Gersmehl model of the TRF with the one for deciduous woodland. Students should understand why the circles representing the stores would be a different size, and the width of the arrows representing the transfer of nutrients. Biomass is much smaller than the TRF, with the litter and soil slightly larger. This is an opportunity for students to consider why there are differences. Students could explore why deciduous woodland is so different from tropical rainforest.

In terms of energy flows, students should have an understanding of basic food webs and examples of primary producers, primary consumers, secondary consumers and tertiary consumers.

Guidance on teaching

Students should be able to draw and label the Gersmehl model. It is important that they understand the proportional size of the nutrient pathways and stores. They should be able to describe both the biotic and abiotic factors affecting ecosystems.

See question 7d(iii) in the SAMS pack for Specification A, p.23.

Lesson 2: Why deciduous woodlands have moderate levels of biodiversity and how the biodiversity adapts to the environment.

Overview

This lesson follows a very similar format to the TRF lesson on biodiversity and adaptations. Deciduous woodland has a moderate biodiversity. Like TRF it has stratified multi-layers with a distinctive shrub, herb or moss layer, a lower tree layer and a canopy layer often dominated by broadleaved trees such as oak, ash, elm, beech or maple. The main feature of deciduous woodland is the appearance and disappearance of the canopy with the seasons. Deciduous trees also play a key role in water storage and provide habitats for animal hibernation, and are a source of food and a factor in bird migration.

- More able students should be able to describe in detail the characteristics of each layer and how plants and animals have adapted to living in the deciduous woodland.
- Less able students could annotate a diagram showing the different layers.

Key concepts and processes

Why is biodiversity moderate?

- No extreme temperatures. Range 4°C–17°C.
- Rainfall (often frontal) around 1000mm per year.
- Moderate humidity.
- Good levels of sunlight in the summer, but shorter days in the winter.
- Growing season for around 7 months of the year.
- Good nutrient levels in the autumn when leaves fall to supply the soil.

Vegetation	Animals
Trees shed their leaves in winter due to lower light and heat levels.	Most animals have to adapt to the changing seasons.
Moisture is lost through the broad fleshy leaves.	Some animals, such as hedgehogs, hibernate during winter months.
Water is not always available through the cold soil in winter.	Some animals, such as squirrels, store food in the ground in preparation for the colder winter months.
Broad leaves intercept rainfall and light in summer. Tree roots are deep.	Many birds migrate to Africa for the winter and return in late spring.
Canopy layer has dominant vegetation around 20–30m high.	
Herb layer consists of non-woody plants such as bluebells.	
Ground layer often dark and damp. Brown earth soils around 30cm deep.	

Lesson 3: The goods and services that deciduous woodlands provide; how climate change presents a threat to the structure, functioning and biodiversity of deciduous woodland

Overview

This lesson will focus on the goods and services that deciduous forests provide, such as timber, fuel, tourism, recreation and educational value. This lesson will also cover how they may be threatened by climate change. Once this has been covered, it is important that students can then explain and compare the differences between tropical rainforest and deciduous woodland.

- More able students may wish to explain why goods, services, structure, functioning and biodiversity of deciduous woodland differ from that of tropical rainforest.
- Less able students will be able to describe the differences.

Please see Question 7d iv on page 24 of the SAMs. This is a difficult question that requires students to 'assess' whether climate change is a greater threat to tropical rainforests than to deciduous woodland, so it is important that students can compare the two. It would be good practice to expose students to these types of questions – i.e. whenever you've talked about one aspect of temperate forests, remind students that they need to be able to compare this aspect to tropical forests.

Key concepts and processes

This element on goods and services may be covered alongside the goods and services of the tropical rainforest. This will avoid repetition but will also allow students to compare and contrast the two ecosystems.

How do I know if something is a good or service?
This can confuse students. You could get them to think of it like this: a **good** is something that you can physically hold in your hands such as wood; a **service** is something you can't hold in your hands, such as the tourism or recreation value.

How can climate change threaten the structure, functioning and biodiversity?

- Recent climate change has not had any major impacts on the structure or functioning.
- Many deciduous trees live a long time and indeed can even be used as a evidence to monitor climate change (dendrochronology).
- Deciduous trees are good at adapting to climate change.
- Trees may be felled by more extreme weather events (storms).
- Milder winters could cause fruiting and flowering to be earlier in the season.
- Pests and diseases may not be killed off during milder winter periods.
- Breeding, migrating and hibernating patterns for animals and birds may also alter with a changing climate.

Guidance on teaching

It is probable that the goods and services element is best taught via a located example, although there is only a requirement to have a located example for Key idea 3.7d. Climate change issues can be discussed using this link from the Forestry Commission website: http://www.forestry.gov.uk/fr/climatechangeengland

See question 7d(iv) in the SAMS pack for Specification A P23.

Lesson 4: Economic and social causes of deforestation of the deciduous woodland.

Overview
This lesson on the social and economic causes of deforestation is likely to have a UK focus and be taught within the chosen located example.

- More able students may explore whether the UK should continue to deforest or whether the time for deforestation is now over.
- Less able students may produce a table/summary of the social/economic causes of deforestation of deciduous woodland.

Key concepts and processes

The social and economic causes of deforestation will depend on location, but are likely to be based around timber/wood production, land required for farming and recreation and population pressures.

- Coniferous trees grow faster than deciduous trees, so timber can be extracted sooner.
- Most of the land in the UK that is suitable for farming was cleared of deciduous woodland centuries ago.
- Deciduous woodland can be affected by pesticides and herbicides that are sprayed onto crops.
- The UK's population has grown significantly over the last 60 years. Deciduous woodland is cleared for housing.
- The number of vehicles on the UK's roads has increased significantly as the population has grown. More roads are required, so woodland is cleared.

Guidance on teaching

There are many different opportunities here for group work, research or presentations. Integrated skill 6 – Use GIS to identify the pattern of forest loss.

For example, you could use this map to show the global pattern of forest loss in 2014, as well as how it changed from 2001. Students could be asked to explain the patterns shown, ie. why have certain regions, countries or particular forest locations been hit harder than others by deforestation?

A more complex map here provides the opportunity to pick 'example locations' where you can zoom to an area and a short summary is given explaining what the GIS map is showing.

Lesson 5: The sustainable management of deciduous woodlands.

Overview

A located example is required for Key idea 3.7d. Popular located examples for a located deciduous woodland are likely to be Epping Forest, the New Forest, Sherwood Forest, Grizedale Forest or the National Forest, but any fairly large deciduous woodland that is used for recreation and managed in a sustainable way can be used.

- More able students may assess the different approaches to which their located woodland is managed in a sustainable way. They may consider which is the most important approach.
- Less able students may produce a summary of the various approaches.

Key concepts and processes

What is sustainable forest management?

Sustainable forestry (as defined at the Helsinki conference) is: 'The use of forests and lands in such a way, and at such a rate, that maintains their biodiversity, productivity and regenerative capacity'.

Perhaps a more up-to-date definition might be: 'The use and management of forests in such a way that their environmental, social, cultural, recreational and economic characteristics are preserved for future generations'.

Features of deciduous woodland sustainable management can include the following:

Woodland management	• Restricting large-scale clear felling on steep slopes • Controlling post-logging soil erosion • Pollarding to prevent trees toppling over • Designating woodland SSSIs or Special Conservation Areas (SCA) • Marketing and selling sustainable timber products by Forestry Stewardship Council (FSC)
Wildlife management	• Monitor grazing • Fencing off areas of forest against animal grazing • Encourage growth and development of a variety of habitats and ecological niches • Preventing invasive species
Recreation	• Well managed visitor centres • Signposted woodland trails • Car parks • Designated cycle trails • Well managed activities, e.g. Go Ape
Education	• The Forestry Commission plays a valuable role

Some ways of achieving sustainable management include:

- When deciduous trees are cut down for timber they are always replaced by more deciduous species.
- Using pesticides and herbicides sparingly to avoid any damage to the woodland.
- The Forestry Commission runs courses in sustainable woodland management for private woodland owners, and supports volunteers in conservation work.

Guidance on teaching

A good starting point for information is the Forestry Commission:
http://www.forestry.gov.uk/sustainableforestry
A located example of a deciduous woodland is required here, although all of Key ideas 3.6 and 3.7 may have been based around an example.

Key vocabulary for Key idea 3.6–3.7

Deciduous woodland	Goods and services	Deforestation & management
Biotic Abiotic Biodiversity Nutrient cycle Energy flow Hibernate	Goods Services Recreation	Social Economic Sustainable management Pollarding SSSI

Further reading

Deciduous woodland located example Epping Forest
http://www.cityoflondon.gov.uk/things-to-do/green-spaces/epping-forest/Pages/default.aspx
http://www.visiteppingforest.org/