Teaching Guide

Topic 1 Foundations of environmental systems and societies

Topic map

Sub-topic number and name	Learning outcome	Number of lessons (suggested) 1 hour per lesson	Relevant material
1.01 Environmental value systems	There are a wide range of EVSs. Historical events affect the development of an EVS.	2.5	Pages 2–15 Figures 1.01, 1.02 Self-assessment questions 1.01.01–1.01.03 Case studies 1.01.01, 1.01.02 End-of-topic question 6
1.02 Systems and models	The systems approach is useful in studying environmental issues and does not reduce them to one process.	3.5	Pages 16–23 Figures 1.05, 1.07, 1.08 Self-assessment questions 1.02.01 Case study 1.02.01 End-of-topic questions 1, 2
1.03 Energy and equilibria	The laws of thermodynamics can be applied to natural systems. Systems may be in equilibrium or stable states, and positive and negative feedback affect these states.	5	Pages 24–30 Figures 1.10, 1.13, 1.15 Self-assessment questions 1.03.01 Case study 1.03.01 End-of-topic questions 3, 4
1.04 Sustainability	Environmental indicators such as ecological footprint can assess	2.5	Pages 31–38 Figures 1.18 Self-assessment questions 1.04.01, 1.04.02

	sustainability. Sustainable development means that the needs of the present can be met without compromising the future.		Case study 1.04.01 End-of-topic question 5
1.05 Humans and pollution	There are many types of pollution caused by humans. Different levels of management of pollution are important.	2.5	Pages 39–47 Figures 1.20, 1.21 Self-assessment questions 1.05.01 Case studies 1.05.01, 1.05.02 End-of-topic question 5

Sub-topic 1.01: Environmental value systems

Overview

This sub-topic is likely to be entirely new to most students, who are unlikely to have encountered environmental value systems (EVSs) before. It is important to outline the historical influences of EVSs found in different societies and to explore the wide range of different EVSs, which all have their own world view and implications.

Students will be able to gain experience of viewing the environment from the point of view of someone from a completely different cultural perspective and to explore the importance of history in developing an EVS.

Suggested activities

Possible starters

Video or reference material on the Greenpeace Save the Whale campaign is available from the Greenpeace website. This is thought-provoking and a good way to start discussions.

Main lesson content

- Students should research historical influences and present their findings to the class. Minamata Bay, *Silent Spring*, and the Gulf of Mexico oil spill are all useful topics.
- Teachers should define and explain the ecocentric, technocentric and anthropocentric viewpoints. Groups of students can propose solutions to a world problem, with different groups taking the viewpoint of each of the three categories.

Common misunderstandings and misconceptions

Students may feel that one EVS is 'right' and others 'wrong'. It is important to emphasise that even if we personally disagree with an EVS, others will value it and be able to justify their views.

Supporting struggling students

Students may need confidence to speak out and give their own views. Over the ESS course, they should be encouraged to justify their own EVS.

Challenging high achievers

The best students should be able to evaluate the implications of EVSs on the environment.

Homework suggestion

Historical research.

Cross-references with other sub-topics

3.04 Conservation, 5.03 Soil and conservation, 7.02 Climate change, 8.02 Resource use in society.

Sub-topic 1.02: Systems and models

Overview

The systems approach is used to study complex issues in the environment. It is used because it simplifies interactions between parts of the system but can give a better overview of what is happening than a simple study of individual processes.

Suggested activities

Possible starters

The systems approach will be new to most students. Begin with the analogy of a familiar object such as a bicycle to develop the concept of examining all the parts of a 'system' to understand how it functions.

Main lesson content

- With this new concept, a teacher-led explanation of the components of a system and how they are presented will be needed. Definitions of storages, flows, and inputs and outputs can be made with reference to a familiar local ecosystem.
- Students should then be provided with information to draw their own system diagram.
- Open, closed and isolated systems must be discussed. A bottle garden or an aquarium is a useful tool to demonstrate a closed system. www.scienceclarified.com/everyday/Real-Life-Biology-Vol-3-Earth-Science-Vol-1/Earth-Systems-How-it-works.html has helpful information.

Common misunderstandings and misconceptions

Definitions of inputs, outputs and storages can be problematic, and the concept of a 'model' with certain inaccuracies can be challenging.

Supporting struggling students

Diagrams are very helpful in visualising the systems approach. These can be simple at first; for example, the carbon cycle is likely to be familiar. More abstract ideas of open, closed and isolated systems can be added later.

Challenging high achievers

The system diagrams of Odum and Sankey are not required, but provide useful extension work for top students (www.tes.co.uk/teaching-resource/sankey-diagrams-6086431).

Homework suggestion

Research the biosphere in Arizona (http://archive.bio.ed.ac.uk/jdeacon/biosphere/biosph.htm) – a closed system that was set up to include humans. What were its aims and why did it fail?

Cross-references with other sub-topics

4.01 Introduction to water systems, 5.01 Introduction to soil systems, 5.02 Terrestrial food production systems and food choices.

Sub-topic 1.03: Energy and equilibria

Overview

Having introduced systems in Sub-topic 1.02, this sub-topic considers alternative stable states of systems. The laws of thermodynamics are needed to show how energy flow occurs in a system and feedback mechanisms, both positive and negative, drive systems to tipping points or stability, respectively.

Suggested activities

Possible starters

Review students' knowledge of energy gained from other subjects. Energy transformation from one form to another is vital to the sub-topic, so familiar examples such as heating water (electricity to heat) and solar power (light to electricity) are useful starting points.

Main lesson content

- Equilibrium is the main concept needed here; this can be discussed using analogies such as the ball in the bowl (Figure 1.13 of the textbook).
- Equilibria may be stable, as in the case of a stable ecosystem where there are few changes. Students can suggest their own examples of stable local ecosystems.
  A pendulum is a good example of a steady state where oscillations in the short term can be seen. Unstable systems can reach a tipping point, which can be demonstrated with

the ball analogy. www.learner.org/courses/envsci/unit/pdfs/unit4.pdf provides some good background examples.

- These theoretical concepts must be extended to natural systems, and the concept of stabilising negative feedback must be built in. Body- or room-temperature thermostats are good introductions here.
- Resilience and the way a system is protected from a tipping point can be discussed in terms of a system that is stable (e.g. a rainforest) and one that has passed a tipping point and cannot return (e.g. an area suffering desertification). www.ecotippingpoints.org/resources/publication-journal-of-policy-studies.html has articles that consider international examples.

Common misunderstandings and misconceptions

Many students struggle with the laws of thermodynamics and need a descriptive rather than numerical explanation. Entropy is particularly problematic to some.

Supporting struggling students

Examples of tipping points involving human activities such as forest clearance can help.

Challenging high achievers

Ask high achievers to consider how they experience the second law, for example how disorder tends to increase, ultimately leading to the death of an organism, and how organisms maintain order in their bodies and stay alive by constantly inputting energy into their body systems.

Homework suggestion

Compare a variety of systems and discuss their resilience (e.g. an Arctic ecosystem and an ocean ecosystem).

Cross-references with other sub-topics

2.02 Communities and ecosystems, 5.02 Terrestrial food production systems and food choices, 7.01 Energy choices and security.

Sub-topic 1.04: Sustainability

Overview

Most students are likely to have a general idea of sustainability and understand that sustainability means using resources for our present needs without compromising the future. The sustainability of all systems can be examined and assessed using indicators such as ecological footprints. The importance of environmental impact assessments (EIAs) in large scale development is also introduced here.

Suggested activities

Possible starters

What does sustainability mean? Can we keep removing resources from the Earth? Overfishing, which is dealt with later in the course, is a good starting point, although other local examples may be relevant.

Main lesson content

- Students should research the origin of some everyday items to discover their source and identify 'natural capital'.
- A local industry could be used to evaluate the meaning of 'natural income'.
- The Millennium Ecosystem Assessment (available online) provides information on environmental indicators.
- Students should examine an EIA (e.g. of the Three Gorges Dam) and evaluate its worth.
- Ecological footprints are valuable in assessing an individual's or a country's use of resources (http://education.nationalgeographic.co.uk/education/media/human-footprint-interactive/?ar_a=1 or http://footprint.wwf.org.uk).

Common misunderstandings and misconceptions

Some students may find the terminology used here confusing. Natural capital, natural resources and natural income are revisited later in the course, so students will have the opportunity to consolidate their knowledge during their studies.

Supporting struggling students

Students are most likely to struggle with the complexities of EIAs. They can be supported by examining each aspect of an assessment (such as that of the Three Gorges Dam) in turn and considering the factors measured, how they can be summarised, and the potential for 'political' decision making.

Challenging high achievers

This sub-topic is revisited in more detail later, but high achievers might enjoy researching sustainable use of a resource in their local environment, for example how supermarkets encourage reuse of plastic bags.

Homework suggestion

Students can use data available on the internet to draw up their own ecological footprint and assess the sustainability of their own lifestyle.
http://education.nationalgeographic.co.uk/education/media/human-footprint-interactive/?ar_a=1 could be useful.

Cross-references with other sub-topics

Topic 8 Human systems and resource use.

Sub-topic 1.05: Humans and pollution

Overview

Pollution is caused by human disturbance of ecosystems. Pollutants are added more quickly than the rate at which they can be removed or naturally broken down (biodegraded), and so affect living organisms in the environment. Pollution management in general terms is introduced here, with specific systems (air, water and soil) dealt with in subsequent topics.

Suggested activities

Possible starters

Videos of pollution incidents are readily available and provide a powerful introduction to human actions. This could be linked with Sub-topic 1.01 and the Gulf of Mexico oil spill or Greenpeace action in the Arctic. This is an introduction to later chapters that cover the details of pollution, so an overview is all that is required if Sub-topic 1.05 is taught separately.

Main lesson content

- Students could identify as many sources of pollution as possible and categorise them and their sources. Categories should include point source, non-point source, persistent, biodegradable, acute and chronic.
- DDT can be used as an example of a pollutant which has costs and benefits that must be assessed. www.scienceheroes.com/index.php?option=com_content&view=article&id=309&Itemid=263 presents different viewpoints.

Common misunderstandings and misconceptions

The timescale of the effect of a pollutant is often misunderstood.

Supporting struggling students

It is unlikely that students will struggle with this introduction to pollution. The topic will be considered in more detail later in the course.

Challenging high achievers

The most able students should research the difference between primary and secondary pollutants and identify local examples.

Homework suggestion

Students could compile a list of pollutants that they as individuals add to the environment, and consider whether they could reduce their own pollution footprint.

Cross-references with other sub-topics

Topic 3 Biodiversity and conservation, Topic 6 Atmospheric systems and societies, 8.04 Human population carrying capacity.