

Teaching Guide

Topic 4: Water and aquatic food production systems and societies

Topic map

Sub-topic number and name	Learning outcome	Number of lessons (suggested) 1 hour per lesson	Relevant material
4.01 Introduction to water systems	<p>Understand how the hydrological cycle operates as a system.</p> <p>Discuss human impact on the hydrological cycle.</p> <p>Construct and analyse a hydrological cycle diagram.</p> <p>Appreciate that many hydrological cycles are shared internationally and that this can lead to conflict.</p>	3	<p>Pages 162–170</p> <p>Figures 4.01–4.08</p> <p>Self-assessment questions 4.01.01–4.01.04</p> <p>Case study 4.01.01</p> <p>End-of-topic question 1</p>
4.02 Access to fresh water	<p>Understand that the uneven distribution of fresh water and growth in demand for water has led to increasing concern about water security.</p> <p>Evaluate strategies to meet the demand for fresh water.</p> <p>Discuss how freshwater resources that cross international borders can lead to conflict.</p>	4	<p>Pages 171–187</p> <p>Figures 4.09–4.17</p> <p>Self-assessment questions 4.02.01–4.02.04</p> <p>Case study 4.02.01</p> <p>End-of-topic question 2</p>

4.03 Aquatic food production systems	<p>Aquatic systems provide food but must be used sustainably.</p> <p>Aquaculture provides for increased food production.</p>	4	<p>Pages 188–197</p> <p>Figures 4.19, 4.20, 4.24</p> <p>Self-assessment questions 4.03.01</p> <p>Case study 4.03.01</p> <p>End-of-topic question – none</p>
4.04 Water pollution	<p>Pollution of groundwater and surface water are major problems that affect human and other biological systems.</p>	4	<p>Pages 198–210</p> <p>Figures 4.27, 4.28, 4.30; Table 4.06</p> <p>Self-assessment questions 4.04.01, 4.04.03</p> <p>Case study 4.04.01</p> <p>End-of-topic questions 3, 5</p>

Sub-topic 4.01: Introduction to water systems

Overview

Students learned the basics of the hydrological cycle at an earlier stage, but may not be familiar with some advanced terminology. They may also be unfamiliar with the ocean circulatory system and the ways in which it influences the climate and global distribution of water. Students may not be aware of international disputes about water.

Suggested activities

Possible starters

Students could work in groups to complete a diagram of the hydrological cycle and define all the terms they have used. They could compare their efforts with a detailed diagram projected onto the screen.

Students could then consider which elements of the hydrological cycle they have witnessed, and remember when they last witnessed each element. For elements they have not personally witnessed, they could explain why they have not seen them.

Main lesson content

- Students could draw a graph of the distribution (storages) of the Earth's fresh water and discuss the likely importance of each source. This could lead to a consideration of flows in the hydrological cycle.
- Video clips and other illustrations show the impact of human activities on surface runoff and infiltration.
- Students could study world and continental maps to investigate the movements of ocean currents and the precipitation patterns associated with them.



- Students could study hydrographs to examine the relationship between land use, particularly urbanisation, and the discharge of rivers.
- Useful online sources of information and resources include:
 - <http://ww2010.atmos.uiuc.edu> – provides definitions, basic information, relevant photographs and a helpful animation
 - www.euwfd.com/html/hydrological-cycle.html – the Foundation for Water Research (FWR)
 - www.water.usgs.gov/edu/watercycle – USGC Water Science School.

Common misunderstandings and misconceptions

Subdividing the hydrological cycle into inputs, outputs, storages and flows can cause problems. It is important that students understand why an element such as precipitation is an input, and so on.

Supporting struggling students

Animated diagrams and selected video clips are very helpful in helping students to understand movements within the hydrological cycle. Learning clearly worded definitions of the many key terms is important.

Challenging high achievers

More detailed investigations of the impact of ocean circulation systems and the effect of urbanisation on water flows are good extension tasks for the most able and enthusiastic.

Homework suggestions

The self-assessment questions in the textbook supply regular homework tasks. In addition, the teacher support materials offer additional material for homework tasks. The online sources given above are also useful here, for example the definitions and the animation at <http://ww2010.atmos.uiuc.edu>.

Learning key terms for a test in the forthcoming lesson is often a useful exercise at the beginning of a topic.

Cross-references with other sub-topics

1.04 Sustainability, 5.02 Terrestrial food production systems and food choices, 7.02 Climate change – causes and impacts, 8.02 Resource use in society.

Sub-topic 4.02: Access to fresh water

Overview

Students should be aware of the problems of water supply in some parts of the world, but they will probably lack detailed knowledge of the extent of global variations. They should have some background knowledge for most of the areas of knowledge and understanding listed in this section of the syllabus.

Suggested activities

Possible starters

Students could consider their access to fresh water. Is such access uniform in their country, or are there regional variations? Which parts of the world have the highest and lowest levels of access to fresh water?

Main lesson content

- Students should consider all the points in the property in which they live that provide water (sink, bath, washing machine, garden tap, etc.). Has the number of these water points increased over time?
- Are there examples of water pollution in the region in which students live or in other parts of the country?
- How have water supplies been enhanced in the country in which students live? What is the rationale behind the methods of water supply employed?
- Have there been any efforts to conserve water in the local region? If so, how successful have these strategies been?
- Useful online sources of information and resources include:
 - www.who.int/water_sanitation_health - the World Health Organization
 - www.un.org/waterforlifedecade
 - www.wateraid.org/Statistics – this significant non-governmental organisation supplies the hard facts behind the global water crisis.

Common misunderstandings and misconceptions

The detail of the way climate change can disrupt rainfall patterns is probably the most difficult aspect of this sub-topic.

Supporting struggling students

Sequences of annotated diagrams and animations can do much to clarify the impact of climate change.

Challenging high achievers

High achievers might want to study the evidence of climate change impacting on rainfall patterns. They might be attracted by the problems encountered by countries that share drainage basins.

Homework suggestion

In addition to the questions available in the textbook and teacher resources, a range of tasks can be set from the online resources listed above. A useful exercise is for students to explain a particular figure or table from this sub-section of the textbook, as they sometimes do not concentrate fully on illustrations.

Cross-references with other sub-topics

1.04 Sustainability, 5.02 Terrestrial food production systems and food choices, 7.02 Climate change – causes and impacts, 8.02 Resource use in society.

Sub-topic 4.03: Aquatic food production systems

Overview

Aquatic systems provide food, but must be used sustainably. Aquaculture provides for increased food production. Students will be aware that fish are taken from oceans and rivers, but may not be aware of the extent of overfishing or aquaculture.

Suggested activities

Possible starters

Comparison of a traditional fishing boat with a factory ship clearly highlights how the industry has changed.

www.collectionscanada.gc.ca/eppp-archive/100/200/301/ic/can_digital_collections/fisheries_then/scitech/enviro.asp has information about fishing in Canada.

Main lesson content

- Introduce the range of food sources from aquatic systems, including plants (seaweed), molluscs, fish and mammals. Local foods could be studied here.
- Identify the most productive areas of the sea (coastal zones where upwelling provides nutrients) and those that are unproductive and the reasons for this.
- The correlation between fishing methods and diminishing stocks must be made and linked to conservation efforts using modern technology as well as quotas and restrictions on nets.
http://education.nationalgeographic.co.uk/education/encyclopedia/sustainable-fishing/?ar_a=1 has useful information covering management and fishing practices.
- Aquaculture must be considered from the positive aspect of provision of more food for humans and the negative aspects of pollution and habitat loss. The following websites provide information and useful links to other sources:
 - www.maineaquaculture.com/Teacher_Resources/teacher_resources.html
 - www.seafoodwatch.org/resources/educator-resources
- Two separate fisheries and their management strategies must be considered. Examples and case studies are given in the textbook.
- Harvesting of seals, whales and dolphins is controversial, and students should examine the rights of indigenous communities as well as commercial interests. The stance of Greenpeace is interesting here. The charity's website summarises it:
www.greenpeace.org/canada/Global/canada/pr/2014/08/GreenpeacehonoursClydeRiversfirstbowheadwhalehuntinoveracentury.pdf

Common misunderstandings and misconceptions

Students may fail to grasp what maximum sustainable yield (MSY) is and think that there is an everlasting supply of fish from the sea. (The Newfoundland case study is helpful in dispelling this misunderstanding.)

Students may have an emotional response to the killing of whales, which should be measured against the needs of indigenous peoples.

Supporting struggling students

A simple consideration of a species (such as the dodo) that failed to survive because it was 'over harvested' may be more accessible than considering a population of fish that students may believe are present in abundance.

Challenging high achievers

The most able could study how the use of antibiotics in fish farms can damage wild stocks and how escaped captive fish are a problem.

Homework suggestion

Visit a local market or store and assess how many fish are endangered species, farmed species and newly popular species, and suggest reasons why.

Cross-references with other sub-topics

Topic 3 Biodiversity and conservation, 5.02 Terrestrial food production systems and food choices, 8.04 Human population carrying capacity.

Sub-topic 4.04: Water pollution

Overview

Pollution of groundwater and surface water are major problems that affect human and other biological systems.

Suggested activities

Possible starters

Show an image of (or visit) a polluted ocean or waterway and ask students to list as many pollutants as they can. A nice starter video can be found at:
http://education.nationalgeographic.co.uk/education/media/what-water-pollution/?ar_a=1

Main lesson content

- Divide students into groups to investigate different aspects of pollution: runoff, sewage, industry, domestic, oil, litter, plastics, and so on.
- Investigate abiotic factors in a local waterway (with care if pollution is present) using data loggers to measure pH and temperature, and analysis kits to measure nitrates and phosphates. Two sites should be compared.

- Collect and identify indicator species:
www.bbc.co.uk/schools/gcsebitesize/science/edexcel/problems_in_environment/pollutionrev3.shtml and <http://thewaterproject.org/community/student-resources/water-related-education-materials-for-high-school>
- Calculate a biotic index or use reference material to compare different locations.
- Biochemical oxygen demand (BOD) is different in different water sources, and www.absorblearning.com/media/item.action?quick=v3 and www.echalk.co.uk/Science/biology/Eutrophication/eutrophication.html have nice animations of eutrophication.
www.bbc.co.uk/schools/gcsebitesize/science/edexcel/problems_in_environment/pollutionrev4.shtml presents a revision summary.
- Discuss water pollution management strategies (reduce activities that produce pollutants; reduce the release of pollutants; remove pollutants) using Figure 3 from the Environmental Systems and Societies (ESS) specification (*Environmental systems and societies guide*) as a guide. Students should consider their own activities and how these contribute to water pollution.

Common misunderstandings and misconceptions

Students may think that litter is the only pollutant.

Supporting struggling students

Calculating biotic index can be difficult for some. Such students should be encouraged to understand the meaning and consequence of the data if calculation is a problem.

Challenging high achievers

The best students should be able to evaluate pollution management methods and discuss the relative benefits of each.

Homework suggestion

Research and identify dead zones in the oceans or freshwater systems and explain the reasons for their formation.

Cross-references with other sub-topics

5.02 Terrestrial food production systems and food choices, 8.03 Solid domestic waste.