teaching triple science
quick guide

Water quality and climate change

A scientist sampling pollution levels in a creek after flood and release of sewage into water.

What's eutrophication?

The quality of our freshwater lakes, streams and rivers has deteriorated as a result of eutrophication. Eutrophication is the overloading of plant nutrients to our lakes, streams and rivers, and it has a direct impact on the organisms which are at the bottom of the food chain (these organisms are called primary producers).

Facts

Of all ecosystems, freshwater ecosystems will have the highest proportion of species threatened with extinction due to climate change.

Up to 20% of the world's population live in river basins that are likely to be affected by increased flood hazard by the 2080s in the course of climate change.

The most serious threat facing the Baltic Sea is eutrophication because of its extensive ecological and economic consequences. Eutrophication will drastically diminish the biodiversity of the Baltic Sea as well as reduce its recreational value.

Activity

Consider the importance of lakes, streams and rivers. Draw up a list of the uses of lakes for recreational and industrial purposes. Describe how changes in the water quality would:

a) affect these uses
b) impact on the ecology of the system.

The survival of primary producers, of which algae are an example, is dependent upon the chemical composition of the water they inhabit. Eutrophication tends to have a negative impact on freshwater ecology because high concentrations of nutrients lead to high growth rates of primary producers such as algae.

You might consider this to be a good thing, since if there are more algae, more food is available for insects and fish. However, it results in low oxygen concentration in the water because plants and algae respire overnight, thereby consuming oxygen.

The removal of oxygen affects all aquatic life. Fish are among the first to suffer from low oxygen concentration and die due to suffocation. Not only is oxygen removed, but the blanket of decaying algae that forms on top of the water also makes ecosystem recovery difficult, particularly in rivers with low flows.

The problems of eutrophication may be made worse by climate change for two main reasons. First, warmer waters contain less dissolved oxygen than colder waters, increasing the risk of oxygen depletion and the number of fish deaths. Second, parts of the country, such as south-east England, are becoming dryer, and less water means higher concentrations of nutrients in the available waters. It is likely that, as a result of climate change, there will be a rapid increase in the population of algae in our freshwater systems, and this will affect the overall productivity of lakes, streams and rivers – and also impact human health.

Terms

Aquatic environment
An environment located in a body of water, either saltwater or freshwater.

Eutrophication
A term describing a body of water becoming enriched in dissolved nutrients.

Primary producers
Organisms at the bottom of the food chain.

Algae
Diverse group of photosynthetic organisms found in aquatic environments.

Biogeochemistry
The science of biological, geological, chemical and physical processes that govern natural systems.

Photosynthetic
Able to perform photosynthesis: the process by which sunlight provides energy to synthesise organic materials.

Debate and issues in this field of research

Water environments are among the most common to be found; not surprising since over 70% of the Earth's surface is covered with water. Humans rely on fresh water but only 1% of available water is accessible for our daily water needs. Maintaining and sustaining freshwater environments is vital to all human settlements, and requires understanding of the factors affecting primary producers. Because primary producers form the base of the food chain, they are indicators of the health of a system. Algae are primary producers that carry out photosynthesis to grow: one of their requirements is nutrients such as nitrogen and phosphorus. Nitrogen and phosphorus are washed into our rivers and lakes from fertilisers and manures spread on croplands, and as discharge from wastewater treatment plants and industrial sources. Increasing nutrient concentration leads to excessive growth of primary producers, which can result in a rapid increase in the population of algae.

The negative impact of eutrophication to lakes and rivers has economic as well as environmental consequences. This is because eutrophication affects recreational activities (tourism), the value of shoreline properties, and it increases the cost of treatment for drinking waters.

We need to develop robust water management practices to cope with eutrophication and the impact of climate change on our streams, rivers and lakes. We need to find ways of securing our water supply and water quality, and these can only be researched through an understanding of what is needed in order to sustain healthy aquatic ecosystems.

Questions

What are some of the sources responsible for eutrophication?

What adaptation measures could be used to lessen eutrophication?

If increased droughts affect nutrient concentration, what about the other extreme? What is the impact of floods?

Web links

Intergovernmental panel on climate change
www.ipcc.ch

Evaluating the impacts of global change on European freshwater ecosystems
www.eurolimpacs.ucl.ac.uk

Water Information System for Europe
http://ec.europa.eu/environment/water/index_en.htm

Recovery from acidification and eutrophication
www.ceh.ac.uk/sci_programmes/AcidificationandEutrophication.htm

Earth and space science
www.teachersdomain.org/sci/ess/index.html

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About the Quick Guide series

Over 50% of scientists and engineers responding to a survey conducted by the Royal Society felt that schools were a key audience for their research. They believed that communicating research findings to this audience was an important way of making sure that the general public is well informed about science and technology. On that basis, the Triple Science Support Programme and the UK Research Councils have collaborated to publish Quick Guides on a range of extension topics in physics, chemistry and biology (Triple Science GCSEs). The guides are written specifically for teachers by researchers working in the field. For more information about the Triple Science Support Programme and to download all the Quick Guides please go to www.triplescience.org.uk