BACKGROUND INFORMATION FOR TEACHERS

Under the provisions of the EU Water Framework Directive, all EU member states were required to record the status of their water resources by the end of 2004 and to report to the European Commission by March 2005. The inventory also covered all surface water, including rivers. On the basis of this inventory, monitoring programmes were devised. The results of monitoring are now being used to class all rivers according to water quality categories. Where rivers do not yet meet the quality requirements laid down in the EU Water Framework Directive, steps must be taken to improve quality. This relates not only to the chemical quality of the rivers, i.e. the level of contamination by pollutants, but also and more importantly to the animals and plants living in the water. Their habitat is to be restored to as natural a state as possible.

The EU Water Framework Directive looks at rivers from completely new points of view. It is not the borders of federal states or nation states that are important, but the river basin as a whole. This means taking a holistic view of natural water systems and how they are used from the source to the estuary. The water cycle links rivers and groundwater. When they flood, rivers raise the groundwater table, and conversely when water levels are low in rivers, they are fed by groundwater. Groundwater is our most important drinking water reservoir, and another of the goals of the EU Water Framework Directive is to protect it.

N.B.

Information Sheet 1 provides you and your pupils with an overview of the main contents and objectives of the EU Water Framework Directive. The directive aims to translate into specific requirements the term ”sustainability“ as it relates to the field of water resources management. With this directive it is hoped that good water quality can be achieved across the board by 2015. Sustainability goes further than merely requiring good chemical and biological quality of the water. It looks at the status of the body of water in its entirety, river beds and banks, adjacent flood plains and all tributaries and related bodies of water that make up the river basin as a whole. The legal mandate to protect water quality entails improving wastewater disposal systems at municipal and household level and reducing pollution caused by agriculture, smallholdings, etc. Running water and the surrounding environment are to be restored and rehabilitated. Back-to-nature maintenance and restoration measures that encourage natural development are appropriate parallel steps here, as is the establishment of protection strips along the courses of streams and rivers. This makes it possible to preserve and restore the habitats of flora and fauna. Water protection is, however, not only the duty of the central government. Every one of us can help, for instance, by sponsoring individual bodies of water or parts thereof. In some federal states in Germany, dedicated citizens and experts work together in what are known as ”Water Neighbourhood Schemes“ to preserve and enhance the quality of water resources. You can take a critical look at the objectives of the EU Water Framework Directive to give pupils a tangible experience of education for sustainable development, as related to water protection.

GOAL

Set 1 (”Living Rivers“) of the instruction module on water indicates the importance of the relations between human beings and the rivers along which they settle. The mutual influences and resulting ecological conflicts are presented and worked through. These include the topics wastewater/threat to water quality, flooding and the correlation between these and an inappropriate morphological state of river areas (as a result of river engineering). Pupils can work through the river renaturing process at the end of the unit, taking into account the demands posed by the three factors utilisation, water quality and morphological quality. In terms of scientific literacy, pupils learn to apply their newly acquired scientific knowledge to the field of water. They should be able to recognise the scientific problems involved (threats to rivers and threats posed by rivers) and should be able to draw conclusions on this basis, which will help them make decisions regarding their own everyday behaviour patterns.

POINTS OF CONTACT WITH THE SYLLABUS

- Water – the basis for life
- Insight into the impacts of interventions in the natural balance: water resources, groundwater, lowering of the groundwater table, land reclamation, steppisation, waterlogging, salinisation
- Water – an unusual substance, importance for life on Earth and the environment
- Water in balance: drinking water, process water, wastewater
- Water and sanitation (producing drinking water and treating wastewater)
- Environmental protection in the community: including dealing with water consumption, water catchment
- Water for the industrialised society: Industrial and domestic water consumption and pollution, sealing land surfaces and lowering the groundwater table
- Rivers – a habitat for flora and fauna, biodiversity, the food chain and food network
- People change their environment: Problems: Soil erosion, deforestation, flood risk
- Water resources management: Water resources, water treatment/ water pollution and keeping water clean
- Various water treatment methods (e.g. sewage plant, biological treatment plant)
- Flooding – a threat to the human population
- Renaturing rivers – a solution to the flooding problem?

METHODS

Use proactive and problem-oriented interdisciplinary lessons, with independent learning in groups. Groups can each look at a different aspect of the material or can all work on the same aspect. The materials can be used for pupils, age 14 – 16, in geography, biology, chemistry, mathematics, social studies or political studies.

CONTENTS AND RELATED LEARNING GOALS

The pupils look firstly at the importance of rivers for people. They learn that the courses of rivers are used for human settlement and economic activities. Rivers supply water for drinking and other uses. They provide food, transport routes and many other things. The influence of people on rivers and vice versa is presented, and the resulting ecological conflicts are explored. These should include flooding, which has become extremely topical over the last few years, and the correlation between an inappropriate morphological state (as a result of river engineering) and flooding. Pupils should learn about ways of resolving these problems and should realise the importance of renaturing measures which meet the requirements of the three fields of water utilisation, water quality and morphological quality.

Learning goals in terms of *Gestaltungskompetenz*[1]/key competences as laid out by the OECD:

Pupils learn to apply their newly acquired scientific knowledge to the topic of rivers. They recognise the scientific problems involved (threats to rivers, threats posed by rivers) and can use this knowledge to draw conclusions that will help them make decisions regarding their own everyday behaviour patterns.

The following sections of the OECD key competencies or sub-competencies of *Gestaltungskompetenz* are targeted:

- The ability to draw interdisciplinary conclusions and act on an interdisciplinary basis: interdisciplinary view of a subject, identifying problems and devising solutions. Pupils bring their scientific knowledge and apply it to a specific problem. They combine innovative technical knowledge and a planning strategy.
- The ability to plan and act with others (group work)
- The ability to motivate oneself to act (transfer phase)
- The ability to motivate others to act (transfer phase)
- The ability to plan and act independently (group work)

SUGGESTED APPROACH

Phase One – Rivers as a Lifeline

Worksheet 1:

As an introduction to the topic, organise a brainstorming session with pupils on the importance of rivers and how we use them. Pupils should gather all aspects of the importance of rivers for people. If the town or village the pupils live in happens to be on a river you could organise a field trip to the river and perhaps also poll passers-by on the uses of "their" river. You could also contact the relevant authorities. The results should be put together in group work, presented to the class as a whole, documented (for instance in the form of loose-leaf files, posters, wall newspapers) and compared with one another.

[1] Since Germany's low results in Pisa, the development of "*Gestaltungskompetenzen*" has been a very important topic. To explain "Gestaltungskompetenz" is by no means an easy task, as the concept includes many facets and layers. It is the ability to identify problems of sustainable and non-sustainable development and to apply knowledge about sustainable development. Furthermore, pupils should learn to draw conclusions from current analyses and forecast about ecological, economical, and social developments and their mutual dependence. Last but not least, they should be able to make, to understand and to implement decisions based on the analyses. www.managenergy.net/conference/pdfs/0505education.pdf

Phase Two – Going into more depth – Drinking water supply and wastewater disposal

Worksheet 2 (group work):
Pupils should be divided into groups of two or three and work on the exercises shown for Worksheet 2. It might make sense to give the groups different assignments, so that each group looks at different concepts. To help them find the information they need, you will have to provide them with school textbooks and information sheets. The other exercises should not be tackled until the pupils have presented their results for Exercise 1. The other results should be discussed and evaluated and perhaps documented in the form of a wall newspaper (or a loose-leaf file which the pupils should put together).

Phase 3 – The problems of flooding

Worksheet 3 (group work):
Pupils should get into small groups and do the exercises from Worksheet 3 together. It is important that you tell them where and how they can find the information they need. You could encourage the pupils to identify research options themselves before the group work session. (They could, for instance, contact relevant authorities such as environmental agencies, water and shipping authorities, identify relevant NGOs, use the Internet, visit the local library, etc.) Exercise 3 can be broken down such that each group explores and presents one specific flood protection method. The results of the group work should be documented and evaluated by the entire class. You should tell your pupils that in Germany, planning instruments exist which can be consulted on the premises of the relevant authority (identification of flooding zones, flood risk maps, etc.). You can find more information on what landscape planning, nature conservation and landscape preservation can do to prevent flooding, on the website of the German Federal Environment Agency (UBA).
www.umweltbundesamt.de > English > flooding

Phase Four – River engineering and renaturing

Worksheet 4, Information Sheet 1:
Worksheet 4 introduces pupils to the problems of technical interventions in rivers (culverting, channelisation, reinforcement, etc.) and the consequences of these. After you look at the problem "What does the river do for us?", you should ask pupils, "How have we changed the river?". The way we use rivers calls for numerous interventions in the river system, which has led for instance to changes in the natural flow of rivers and to obstacles to the flow. This has seriously impaired the function of rivers as an essential artery within the natural balance. The biodiversity found in a natural river is lost. To illustrate the problem clearly to pupils, it is a good idea to organise a field trip to a large stream or river at this point. Information Sheet 2 gives you an overview of the major characteristics of a river with a sound ecological status. It is important that the pupils record the findings of their field trip. They should make a note of everything they notice with regard to possible anthropogenic interventions in and around the river. They should then assess their observations, and consider whether the situation on the ground can be improved, and if so, how. The results should be assessed by the entire class. If possible, the class should present its results to a representative of the local government, the mayor, the authority responsible or a local NGO. It might even be possible to launch a joint renaturing project.

Worksheet 5 – Passability of running water:
The last worksheet will teach pupils that it is important to take a holistic view of running water in particular. Most indigenous river fish species in Europe migrate. In particular those species that migrate to spawn depend on being able to swim freely up and down rivers and on the networking of the river with related habitats. To preserve fish species it is thus important, along with clean water, to have a rich structure of water biotopes, which fish can access freely. The drop in fish stocks in rivers and streams is partly the result of some massive obstacles built in the path of the

river. Weirs and sluices, hydropower plants and locks prevent the free migration of fish. Since migrating fish cannot overcome these obstacles, effective ”ring roads“, such as fish ladders, must be built for the fish, in order to mitigate the consequences of the blockages. On the basis of these problems you can instigate an in-depth discussion of economic versus ecological imperatives. What is more important, for instance: The use of hydropower, which is after all a renewable energy source, or protecting fish in the rivers? As the example of the fish ladder shows, it need not necessarily be a question of ”either/or“. The various technical systems available to help fish pass obstacles make it possible to reconcile the economic and ecological considerations, although there is a price to be paid. It is, for instance, very expensive to backfit or modify hydropower plants. But if we aim to preserve fish stocks or reintroduce fish species, there is no alternative.

Go on a field trip to a local river so that pupils can investigate for themselves whether barriers exist that block the routes of migrating fish species, and if so in what form. They should consider the following questions: How far can fish swim unobstructed? Where do the fish spawn, or how could spawning grounds be recreated, and how do fish get there? Do locks and hydropower plants have effective fish ladders? Where are improvements needed? Contact local water authorities to obtain more information. Local angling clubs are often another good source of information on the problems, and will probably be happy to help you.

N.B./Further transfer:
It might be possible to put together all the materials gathered for the lesson unit and organise a small exhibition in the school, to coincide with a school open day or parents' evening, or to present the materials to the other classes. After all, your pupils are now experts in the field of ”living rivers“.

MATERIALS

- **Comic strip**
- **Worksheets 1 to 5**
- **Background information for teachers**
- **Information sheet 1: The EU Water Framework Directive**
- **Information sheets 2 and 3: What is a living river?**

ANSWERS TO THE WORKSHEET EXERCISES AND HELPFUL HINTS

Worksheet 1:

Exercise 2: Leisure/recreation, traffic and transport, water for drinking and other uses, wastewater, agriculture, quality of life
Exercise 3: Running water as a habitat for fish, other water creatures and plants, the river bank biotope, ecosystems, flood plains

Worksheet 2:

Exercise 2: Drinking water well – water treatment – water connections for industry and households – sewage pipes, treatment in sewage treatment plants – discharging the treated water into the river
Exercise 3: Under the provisions of the German Drinking Water Ordinance, the quality of drinking water must be such that it will have no negative consequences on the health of an individual drinking 2 – 3 litres of the water every day for a lifetime.
Grey water is the term used to describe water that has been used for bathing, showering and washing. Drinking water used in this way becomes grey water.
Raw water is untreated water, delivered to a purification plant to be made into drinking water.

Exercise 4: Use of power, chemicals (chorine, ozone, fluorine), maintenance costs, technical costs

N.B.:
At this stage you should point out the need to protect surface water and groundwater from pollutants. Since this topic is already dealt with in the relevant syllabuses and textbooks, we have not explored it again separately here.

Worksheet 3:

Exercise 1: On the right-hand map, the flood zone covers the whole area shown on the left-hand map as the river system with its lateral branches, old branches and abandoned river courses. You should not build on this area, because annual flooding can be expected there. The maps show that the meandering course of the river no longer exists. Neither do the oxbows and old branches of former times. These areas have now been built on. Pupils should realise that the risk of flooding affects the area which was still marked as river land on the 1825 map.

Exercise 2: Water authorities, local nature conservation authorities, environmental agencies
Exercise 3: When looking at what can be done to prevent flooding, pupils should realise that building dykes is not the only option. Ecological measures, such as establishing retention areas and renaturing should be mentioned, along with limiting the potential for damage in flooding zones.

The main reasons for flooding

1. People settle too close to the river, precisely in those places where the river would naturally burst its banks when water levels are particularly high.
2. River engineering is a particularly thorny issue, straightening the courses of streams and rivers, reinforcing banks and building embankments, and dredging the riverbed. This increases the rate of water flow and the flood wave flows downstream much more rapidly, thus increasing the risk of flooding for those settlements on the lower course of the river. We have merely substituted one problem for another.
3. Intensive settlement means that the surface of too much land in a river catchment area is sealed with asphalt and concrete. The soil becomes impermeable, and rainwater can no longer seep through it. Surface run-off is increased.
4. Major areas along the streams and rivers are farmed intensively. This compresses the soil and prevents water from seeping away.

Worksheet 4:

Exercise 1a: Left-hand picture; **1b:** Right-hand picture
Exercise 2: Additional arguments: e.g. settlements, sustainability, land use, restrictions on land use, drinking water, flora and fauna

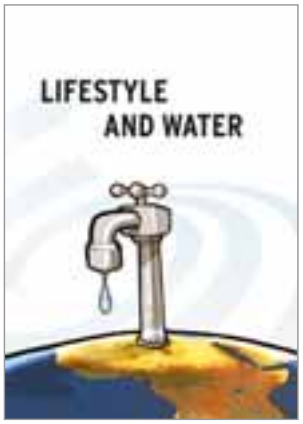
Worksheet 5:

Exercise 1: At the first hydropower plant and at the weir
Exercise 2: One possibility would be to build a ”ring road“ as you can see at the lock. Using the Internet links given, look at the various forms of fish ladders that can be built.

General information

www.bmu.de > English > Topics > Water
www.umweltbundesamt.de > English > Search: Water

BACKGROUND INFORMATION FOR TEACHERS



An adequate supply of water is a basic human need. Every individual uses several thousand litres of freshwater every day, directly (in the form of drinking water) and indirectly (the water used to produce food and industrial goods). The World Health Organisation (WHO) considers a daily per capita water consumption of 100 litres to be an absolute minimum requirement. While the quantity of water consumed directly is relatively low, significantly more is used to produce the food we eat. Irrigating one hectare of land in an arid region can use up to 10,000 cubic metres of water (i.e. 10 million litres) per annum. Agriculture is the largest consumer of water worldwide. In countries where a high percentage of cropland is irrigated, agriculture can account for more than 80 percent of total water consumption.

Currently about one third of the world's population lives in countries suffering a medium, high or very high level of water stress. By 2025, according to the figures of the International Water Management Institute, some 40 countries, with a total population of almost 2 billion, will be suffering serious water shortages. Rarely, however, do we think about how much water people in industrialised countries with their modern lifestyle consume indirectly. This is significantly higher than their direct consumption. With coffee, orange juice and many other agricultural products, they import ”virtual water“. Virtual water is a relatively new term, used to describe water used to manufacture or grow a product.

GOAL

The materials on the topic of ”Lifestyle and Water“ should be used independently by the pupils to acquire knowledge about ”The water of the Earth“ (Worksheet 1), ”How much water do we really need?“ (Worksheet 2), ”Is there enough water for everyone?“ (Worksheet 3), ”In the beginning there was the village ...“ (Worksheet 4), by using interactive media and materials as called for by the OECD competence levels. They should make use of the information contained in the worksheets and information sheets, interpret thematic maps and conduct their own online research to obtain additional information on the topics. The next step for them is to deliberate on their own lifestyle. They should be introduced to the still relatively little known notion that people in prosperous industrialised countries affect the water resources in developing countries by their virtual water imports (Worksheet 5). Pupils should review their own lifestyle on the basis of selected products (bananas, coffee, orange juice, for instance) to see how much they contribute to the consumption of virtual water from developing countries (Worksheets 6 and 7). In terms of scientific literacy, they thus learn to apply their newly acquired scientific knowledge to the field of lifestyle and water. They recognise scientific problems (and possible solutions) and can draw conclusions that will help them make decisions regarding their own everyday behaviour patterns (OECD competence field ”independent activities“).

POINTS OF CONTACT WITH THE SYLLABUS

- Water – a scarce commodity: How water is wasted in industry, agriculture and private households, the causes of water shortages, deforestation and erosion, sealing off the soil, over-grazing, exploiting groundwater resources
- Exhausting natural resources (air, water, soil, raw materials)
- Water – the basis for life and habitats
- Water, an unusual substance, importance for life and the environment
- National water consumption and the global water crisis
- Transnational problems in water supplies and water pollution

METHODS

Use proactive, interdisciplinary lessons. Pupils should acquire knowledge independently by working at various stations, and through individual, partner and group activities. They should produce short papers and presentations for the class. Organise group discussions and use scenario techniques.

Suitable for: Age 14 - 16

Subjects: biology, geography, mathematics, physics, social studies, ecology, political studies, economics, civics

CONTENTS

The four main characters introduce the topic. Pupils learn firstly about how water is distributed on Earth and what a tiny percentage of total water reserves is accounted for by accessible freshwater (Worksheet 1). They find out about drinking water and look at ”lifestyle and water“ around the globe, taking as their starting point the wide discrepancies in water consumption (Worksheet 2). Access to this valuable resource is extremely inequitable, for various reasons. In future it is to be expected that worldwide water shortages will become more acute (Worksheet 3). The problems caused by the lack of even basic sanitation in many countries, and the disastrous impacts thereof on human health are touched on in Worksheet 4. One important aspect of the global water situation is the importing of so-called ”virtual water“ by industrialised countries with the agricultural produce they import from developing countries already suffering water shortages. Worksheet 5 introduces pupils to this concept. They discover which agricultural products from developing countries are sold in Germany (Worksheet 6). They should keep a food record based on their own eating habits, to establish how much virtual water is imported from developing countries, which all too often have problems ensuring an adequate water supply for their own people (Worksheet 7). Thereafter pupils should go on to look at possible alternatives to the problems discussed. They should reflect on their own purchasing and consumption patterns and, if appropriate, look at how they could change these. They should also discuss the problems on the basis of fundamental values.

N.B.
The term ”water consumption“ is used frequently in the text. Strictly speaking we should use the terms ”water demand” or ”water use”, but since the relevant school textbooks and literature (especially online) use the term ”water consumption“, and pupils are more likely to be familiar with this term, we have decided to use it to facilitate understanding. We recommend that you explain the different terms and concepts in your lesson, perhaps as an introduction to the topic. Discuss with your pupils how the three terms are used, for instance by asking them whether water can in fact be consumed.

The two information sheets will give you and your pupils an insight into the topics ”The Global Water Situation“ and ”Virtual Water“.

LEARNING GOALS

Pupils should become familiar with and understand the problems involved in the enormous amount of water we use as a result of our lifestyle. They should devise ways of overcoming these problems. They should be introduced to important aspects of the issue, such as differing access to water from one country to another and virtual water imports. A critical look at their own lifestyle in terms of consumption should bring them to consider alternatives. At the end of the unit they should produce a pamphlet that gives advice on the topic of ”Lifestyle and Water“. It should provide information on the global water crisis and tips and recommendations regarding personal consumption patterns (see also the section on the transfer phase).

Learning goals in terms of *Gestaltungskompetenz*[1]/key competences as laid out by the OECD:
The following sections of the OECD key competencies or sub-competencies of *Gestaltungskompetenz* are targeted:

Interactive utilisation of media and tools:
- Building knowledge to integrate new perspectives, with an open mind,
  - Pupils find information independently using a variety of materials and media on the topic area ”Lifestyle and Water“,
  - Pupils present different points of view and forms of knowledge about global (non)-sustainable developments (virtual water, lifestyle) on the basis of the new perspectives they have come to know,
- The ability to acquire and handle interdisciplinary knowledge,
  - Pupils work on an interdisciplinary basis on a project. They apply scientific knowledge and principles to a specific problem. They link innovative technical knowledge and planning strategies,
- The ability to anticipate,
  - Pupils identify the symptoms of the global water crisis and recognise the consequences,
- Transferring and applying what has been learned,
  - Pupils design options for action and ideas in order to improve the situation.

[1] Since Germany’s low results in Pisa, the development of ”Gestaltungskompetenzen” has been a very important topic. To explain ”Gestaltungskompetenz” is by no means an easy task, as the concept includes many facets and layers. It is the ability to identify problems of sustainable and non-sustainable development and to apply knowledge about sustainable development. Furthermore, pupils should learn to draw conclusions from current analyses and forecast about ecological, economical, and social developments and their mutual dependence. Last but not least, they should be able to make, to understand and to implement decisions based on the analyses. www.managenergy.net/conference/pdfs/0505education.pdf

Interacting in heterogeneous groups:
- The ability to plan and act with others (group work),
- In group work, pupils can identify and analyse different points of view as well as dealing democratically with controversies arising in this context (discussion),
- Pupils learn to motivate others to play an active part (producing their pamphlet on "Water and Lifestyle" and presenting it to others).

Acting independently:
- Pupils reflect on their own guiding visions and those of others (Worksheets 6 and 7; own water consumption/ own consumer patterns)
- They acquire experience in independent planning and action (implementation of a sustainability project),
- They are able to empathise and demonstrate solidarity with the disadvantaged, the poor, the weak and the oppressed (recognise the situation in water-poor countries and the problems these nations face, develop an understanding).

SUGGESTED APPROACH

Introduction/ overview:
A comic strip on the topic of "Lifestyle and Water" with the familiar characters Viona, Manuel, Felix and Aysche.

Transfer phase:
Pupils collect and discuss their results in groups or with a partner. They should be given the following instructions: "Think together about the opportunities you have to reduce your consumption of virtual water. Draw up a list of your ideas. Which ideas do you think are good, and which are not so good? Think about how you could present your ideas to the class." (See Worksheet 7.) The results of this partner/group work session should be discussed by the class as a whole.

N.B.
We suggest that you get your pupils to produce a pamphlet with tips on how to change lifestyle and consumer patterns, which can be used by a wider audience. As they work on this guide, pupils will reflect on their work and focus again on what they have learned. A few points should be borne in mind: The aim is not to preach to the reader about the evils of consumption in general, but to point out the consequences of their actions. Pupils should then make an effort to propose creative solutions in their pamphlet. In this context it is also a good idea to identify future trends with your pupils using scenario techniques. You will find information on this method in the teaching materials on "Climate Change" available from the online Education Service of the Federal Environment Ministry (www.bmu.de/bildungsservice).

MATERIALS

- **Worksheets 1 to 7**
- **Information sheets 1 and 2**
- **Background information for teachers**
- **Stations pass**

ANSWERS TO THE WORKSHEET EXERCISES AND HELPFUL HINTS

Worksheet 1:

Exercise 1: Water with a very low salt content (lower than 1 g salt /kg water) is termed freshwater.

Exercise 2: The percentage is 0.3%.

Exercise 3: Freshwater is found in solid form as ice in glaciers and at the polar ice caps, as permanent ice and snow at high altitudes in mountains and occasionally at lower altitudes (in winter). Freshwater occurs in liquid form in surface bodies of water such as streams, rivers and lakes and as underground water (groundwater). It is also found in clouds and in precipitation (rain, snow, hailstones).

Exercise 4: Accessible groundwater reserves (which produce more than 70 percent of drinking water worldwide) and freshwater available in surface water; water falling as precipitation, ice and snow are rarely used.

Worksheet 2:

Exercise 1: The best overview of country data can be found in the CIA Factbook
https://www.cia.gov > World Factbook

Exercise 2: The presentation should be given as homework. Pupils should be given a week to complete it.

Worksheet 3:

Water scarcity and water shortages
A country is defined as suffering water shortages if it has fewer than 1,000 cubic metres of renewable freshwater per capita per annum at its disposal. This is the case, for instance in the Middle East and the Persian Gulf (Kuwait, the Gaza Strip and the United Arab Emirates) and in North Africa (Libya and Algeria). Saudi Arabia, for instance, had only 118 cubic metres of water per capita in 2002, making it one of the ten water-poorest countries on Earth. Yet 95% of the population of Saudi Arabia has access to drinking water, because the country is wealthy enough to offset water scarcity by drilling wells to tap groundwater aquifers, operating desalination plants which convert sea water into drinking water, and treating waste water. Ethiopia, by way of comparison, had reserves of 1,749 cubic metres water per capita in 2002, making it one of the countries that still have adequate reserves. The country lacks the infrastructure to tap and distribute the available water, however.

Exercise 1: USA, Haiti, France, Poland, Morocco, Algeria, Syria, Iraq, India, China (selection)

Exercise 2: Lack of precipitation, population growth, pollution of the environment, economic development, improper irrigation, water losses (e.g. as a result of obsolete pipes and irrigation plant), low level of public investment

Exercise 3: Current scientific knowledge points to climate change having the following impacts: There will be a further increase in global annual precipitation, especially at higher and middle latitudes and in most equatorial regions, while precipitation will drop in sub-tropical areas. There will be an increase in the intensity of precipitation, with more rain falling as relatively short but extremely strong downpours. The rising temperatures will also mean that a larger percentage of precipitation in higher latitudes will fall as rain rather than snow in winter. You will find more information in the materials on climate change provided by the online Education Service of the Federal Environment Ministry at www.bmu.de/bildungsservice.

War for water?
Water shortages are no longer a localized problem, but one that could lead to global conflict. Increasing numbers of reports like ”Water bomb ticking in the Middle East” or ”More wars about water resources feared in future” are appearing in the media. There is a vast amount of information on this topic in the Internet. Ask your pupils to use a search engine to look for items on the ”War for water”.

Worksheet 4:
Exercise 1: Elements of basic sanitation are promotion of hygiene, sanitary facilities in the home, waste water treatment.
Exercise 2:
a) true
b) false
c) false
d) true

Solar water disinfection
Swiss scientists have developed a method for disinfecting drinking water that is suitable for use in developing countries – SODIS, solar disinfection of drinking water. The method improves the microbiological quality of drinking water. The germs that cause diarrhoeal diseases are killed with UV-A radiation from the sun and by heating the water. For more information: www.sodis.ch

Information sheet 1 gives you and the class a good overall view on the topic of ”The global water situation.” Further information is available from the IHP/HWRP secretariat of the United Nations. http://ihp.bafg.de/servlet/is/8397 **> English > Information Service > Did you know?**

Worksheet 5:
Further detailed information on ”virtual water“ is to be found on information sheet 2.

Worksheet 6:
Exercise 1: Orange juice from Brazil and the USA, rice from the USA, Vietnam, Thailand, lemons from e.g. the Middle East, tea from India and Sri Lanka, soya (animal feed) from Brazil and Argentina, bananas from Colombia, Ecuador and Costa Rica, tropical fruit from African countries and Brazil, coffee from Colombia, Nicaragua etc. (selection)

Exercise 2: Nearly every supermarket has a wide range of produce originating in tropical and subtropical countries – usually available all year. In winter seasonal produce like fruit, potatoes and onions are imported from countries like Egypt (a country with water distribution problems).

Worksheet 7:
Exercise 1: sample calculation for one month, all figures are approximate!

150 g rice (450 litres), 2 kg bananas (2,000 litres), 200 g coffee (4,000 litres) or 200 g black tea (2,000 litres), 4 l orange juice (100 litres), 1,500 g meat = 1,125 g crushed soya (2,250 litres), 100 g lemons (100 litres), 150 g maize (200 litres), 500 g chocolate (1,250 litres), 1 kg tropical fruits (1,000 litres) adds up to – depending on consumption and lifestyle – some 13,000 to 15,000 litres of virtual water per month, or 160,000 to 180,000 litres per year.

Note

Experts agree that about 16,000 litres of water are expended to produce 1 kg of meat. Germany imports hardly any meat from southern countries. The sample calculation relates only to products from countries in the southern hemisphere (developing countries). Imports of soya, however, as part of animal feed, must be included in the balance. According to oral information supplied by Germany's animal feed association, the average soya content of animal feed is at least 25%, most comes from Argentina or Brazil and some from the USA. Around 3 kg of animal feed is needed to produce 1 kg of meat. That represents an average figure for domestic animals – from poultry (1:2) to pig fattening (1:3.5) and beef production (1:4).

Exercise 2: It takes up to 20,000 litres of water to produce 1 kg of cotton (see worksheet 5). A good quality T-shirt made of 100 percent cotton weighs about 250 grams. Even if you have only 10 in the cupboard, that represents 50,000 litres of virtual water. That figure does not include the water used to produce or dye etc. the T-shirt. The major cotton-producing countries are: China, USA, India, Pakistan, Brazil and Turkey.

Exercise 3: A small selection: Greater consumer awareness can be very helpful. People could buy fewer clothes, choosing better quality to last longer, opt for regional food in season, buy Fairtrade products etc. A very thought-provoking website treats some unusual aspects of the topic and can help the young people discuss the concept of "consumer awareness".

Exercise 4: Among the possibilities for reducing one's personal consumption of virtual water are: environmentally aware shopping, e.g. choosing regional products and products in season.

Note

Virtual water is not only a feature of agricultural produce! It takes 400,000 litres of virtual water to manufacture a car, for a computer 20,000 litres are used.

Have the class discuss the pros and cons of virtual water trading. Should countries with very limited supplies of water refrain from growing their own major foodstuffs, e.g. grains, and import them instead, in order to conserve resources? But how can poor countries pay for imports? There is currently heated debate on this topic in the professional community.

Use information sheet 2, "virtual water" for your discussions.

General information

www.bmu.de > English > Topics > Water
www.umweltbundesamt.de > English > Search: Water

The goal of modern learning is to shape society and one's own life in a well considered, soundly reasoned and self-determined manner working alongside others. This being so, schools must do more than teach pupils to merely react to the school's demands and to changes in later life. Teaching must enable them to acquire competencies, not only for coping with the future, but also for actively shaping the future. One fundamental aspect is therefore the acquisition of competencies that are not confined to managing and structuring everyday life in a self-determined fashion, but are also suitable for shaping life in the world of tomorrow.

So it is hardly surprising that topics like Renewable Energy Sources, Biological Diversity, Environment and Health, Water, Use of Natural Areas, or Waste and Recyclable Materials are commonly found as subjects in a modern syllabus or curriculum. These are important issues in everyday life today, and are of central importance for shaping a life worth living the world over. But is it sufficient merely to put these topics on the timetable? What kind of results do we expect as the outcome of such learning? To arrive at a clearer and more detailed picture, it makes sense to take a closer look at the competencies for shaping this future. According to a definition by F. E. Weinert, competencies are "the cognitive abilities and skills that individuals possess or can learn for solving specific problems, and the associated motivational, volitional and social readiness and abilities that enable them to use these solutions responsibly and successfully in a variety of situations." Thus competencies are primarily a matter of the ability to take action, not of abstract school knowledge. The ability to solve problems is seen here in close connection with standards, values, readiness to act and – of course – available knowledge. As the ability to take action, competencies are tied to specific objects, contents, knowledge and skills.

Competence-oriented education strategies are output-oriented, whereas conventional curricula and didactic approaches are input-oriented: the latter ask what topics the pupils should be studying. The output approach, by contrast, asks what problem-solving strategies, action concepts and abilities they should possess. Only on this basis is it possible to determine what needs to be learned. This can to some extent be made dependent on pupils' prior knowledge, motivation, local and individual everyday associations – and can thus enhance both the learner's interest in the subject and an acquisition of competence that is not confined to the mere accumulation of "dull knowledge" (Weinert). What abilities and skills, social and cultural reference points should children and adolescents possess to enable them to manage and shape their future? What knowledge should they share and have in common? These questions guide the search for teaching content when approaching the problem from the competence point of view. Looking at things from this angle, the list of possibilities is extremely long.

It is nevertheless possible to identify a few overarching educational objectives that help with the selection of what is to be learned. A study commissioned by the OECD mentions human rights, the goal of being able to practise living democracy, and the criteria for sustainable social, economic and environmental development. The pursuit of human rights, within a framework of democratic structures and in the interests of sustainable development, represents three overarching educational objectives which form guidelines for defining competencies. These statements are of no small importance. After all, the OECD is also responsible for the PISA studies; and in 2006 these surveyed pupils' competencies in the natural sciences.

The competencies that children and adolescents should possess if they are to be able to act in the interests of sustainable development are subsumed in Germany under the term Gestaltungskompetenz. Gestaltungskompetenz denotes the ability to identify problems of non-sustainable development

and apply knowledge about sustainable development. In other words, being able to draw conclusions about environmental, economic and social developments and their interdependence from analyses of the present and studies of the future, and to use them as a basis for taking, understanding and implementing decisions that permit the realisation of sustainable development processes.

This general description of Gestaltungskompetenz displays close relations to the definition of "scientific literacy" which underlies the PISA studies – including the 2006 study which investigated young peoples' competencies in the field of natural sciences. It reads as follows: "Scientific literacy is the capacity to use scientific knowledge, to identify questions and to draw evidence-based conclusions in order to understand and help make decisions about the natural world and the changes made to it through human activity." Both competence definitions are concerned with findings, knowledge, understanding phenomena and actions, and taking decisions that affect the environment. Above and beyond this, Gestaltungskompetenz focuses specifically on problem-solving skills and the ability to take proactive and future-oriented action.

In all, Gestaltungskompetenz comprises eight individual competencies. Placing them in the context of scientific and technical findings and problems, as presented in this large package of materials, results in the following picture:

1. The competence to think in a forward-looking way, to cope with uncertainty and with forecasts, expectations and designs for the future – for example, with regard to the future use of renewable energy sources – is the individual competence to look beyond the present. The crucial factor is being able to grasp the future as something that is open and capable of being shaped with the aid of innovative technologies, and to develop various action options from current situations on the basis of this attitude. Forward-looking thinking and acting makes it possible to consider potential future developments – such as climate change – and to discuss the opportunities and risks associated with present and future developments, even if these are unexpected. At the level of learning goals, this means:

- The pupils are familiar with various methods of future research into (non-) sustainable development (e.g. energy scenarios; species reduction forecasts). They are able to use the methods in group work. They can assess and describe the strengths and weaknesses of the methods.

- The pupils are able to select the various methods of future research appropriately for problem areas of environmental change and applications of environmental technology that have not yet been dealt with in lessons.

- The pupils can reproduce the main statements of various future scenarios and forecasts, for example on climate change, especially with regard to environmental risks, poverty and non-sustainable global economic developments. They are sufficiently familiar with associated action recommendations and strategies to be able to reproduce them in their threads of argument.
- On the basis of material and information sources provided on non-sustainable or problematical developments – e.g. with regard to landscape depletion due to housing-related measures – the pupils can work together on projects to design and visualise positive scenarios of technical, social, environmental and economic change, and can present them in verbal and pictorial form both logically and on the basis of value judgements and imaginative components.

2. The competence to work on an interdisciplinary basis. Problem areas of non-sustainable development and perspectives of viable future changes can no longer be coped with by a single technical discipline or using simple action strategies. They can only be handled by cooperation between multiple technical disciplines, different cultural traditions and aesthetic, cognitive and other approaches. The development of suitable abilities is indispensable for identifying and understanding system contexts and dealing appropriately with their complexity. Such abilities are fostered by problem-oriented interlinking of natural and social sciences, innovative technical knowledge and planning strategies, and imaginative thinking and innovative access facilities. This presupposes interdisciplinary, i.e. cross-subject, learning. This leads to the following learning goals:

- The pupils can describe complex situations with the aid of integrated analytical methods from the natural and social sciences.

- With the aid of creative methods, normative criteria, personal value judgements and research-oriented learning, the pupils can work on problematical non-sustainable development situations – e.g. biodiversity reduction – in a way that permits their transformation into models of sustainable development – e.g. as illustrated by biosphere reserves.

- When presented with problem situations – e.g. the threat to fresh water from inputs of environmental toxins – the pupils can analyse them to see which technical disciplines, information sources and actors need to be consulted to permit appropriate analysis and countermeasures.

3. The competence of cosmopolitan perception, transcultural communication and cooperation. *Gestaltungskompetenz* implies the ability to grasp and localise phenomena in their worldwide context of links and interactions. This competence focuses on perceptions that broaden contexts and horizons. Because a regional or national point of view is too narrow to permit orientation in a complex global society, perception and assessment horizons need to be expanded in the direction of a global approach. For example, a Central European view of freshwater reserves and use is totally different from the viewpoint of nations and peoples in arid or semi-arid regions. In terms of learning goals, this means:

- The pupils can describe relations between global climate change, resource consumption, pollutant inputs, economic ramifications and the social situation in developing countries on the one hand, and national pollutant inputs and resource consumption on the other.

- The pupils are able to familiarise themselves independently with other cultures' views and arguments regarding individual aspects of sustainability, and to assess and use these views and arguments in their own arguments, descriptions and assessments of situations. For example, what is the significance of exporting old cars and old clothes to Africa?

- They are also able to describe, with the aid of examples, the impacts that their own actions and those of their surroundings (school; region) have on resource consumption, pollutant inputs and equitable distribution at a supra-regional level and over long periods. To this they can apply a concept for calculating flows of materials.

- The pupils are familiar with methods of presentation and treatment that reflect different interests and problems from the viewpoint of various cultures and philosophies. What arguments do

developing countries put forward when they are called upon to invest in environmental technology or to reduce pollutant emissions? In this context the pupils can undertake a conscious change of perspective, identifying and assessing important points in the perspectives of different cultures, and using them in the interests of communication and understanding.

4. **Participation competence.** The ability to take part in shaping sustainable development processes is of fundamental importance for future-oriented education. There is a growing need to take part in decisions and a growing interest in helping to shape the world in which we live – at least in our culture: Involvement in decisions and self-determination at work, in civil society (and not just when it comes to planning leisure time) – are acquiring increasing importance for an emphatically independent way of life. This implies the following abilities:

- The pupils have the ability to draw up, together with their fellow pupils, teachers and non-school partners, joint sustainability objectives – for example, with regard to species protection or the use of renewable energy. They are able to stand up publicly with others in support of their joint objectives.

- The pupils can appreciate divergent positions of individuals, groups and nations on individual aspects of sustainability – e.g. regarding the designation of nature conservation areas and the protection of certain species. Together with their fellow pupils and other actors, they are able to turn conflicts and controversies into constructive suggestions for solutions.

- On the basis of practical activities, the pupils display the ability to engage regularly with others in environmental, economic or social fields of sustainability. This may relate to reducing energy and water consumption, advocating waste avoidance, or propagating gentle tourism or ideas for sustainable homes in the future.

5. Having planning and implementation competence means being able to assess action workflows with regard to the necessary resources and their availability from a sustainability point of view, to design cooperation networks, to allow for side-effects and possible surprise results, and to cater at the planning stage for their potential occurrence. Relevant learning options discuss feedback, delayed consequences and time lags of the kind familiar from the damage to the ozone layer or inputs of environmental toxins into water, and offer a corresponding repertoire of methods. Implementation competence comprises the actual interest in pushing action beyond the intention and planning stage – for example commitment to the installation of a photovoltaic system on the roof of the school. The pupils should therefore be able to do the following:

- The pupils can use sustainability criteria to estimate the resources (e.g. heat energy, water, office materials, cleaning and polishing agents) necessary for services, production or the ongoing operation of a facility (e.g. the school) and make optimisation proposals on this basis.

- Within planning processes, the pupils are able to cope with surprise effects, uncertainties and necessary modifications by reacting appropriately to such effects and situations and readjusting the planning processes – e.g. rising consumption as a result of dwindling commitment on the part of pupils, shortfall on savings targets due to cold winters.

- In this context the pupils are familiar with the phenomena of feedback, late consequences, and delayed occurrence of problem situations. For instance, they can name examples and can describe and critically assess forms of reaction and anticipation that are practised by the economic and political world in this context. The different reactions by various nations to climate change analyses provide a number of good examples.

- The pupils are in a position to implement a project successfully on the basis of their acquired planning competence. In this respect they undertake activities by developing planning processes into action concepts and taking them to the action stage either independently or in concert with others. Saving resources, propagating new heating technologies and using environmentally friendly materials provide numerous opportunities for action here.

- They are able to present the results of their sustainable planning processes to different external groups (parents, teachers, citizens in a pedestrian zone, younger pupils) in a manner appropriate to the individual groups.

6. **Capacity for empathy, sympathy and solidarity.** All sustainability concepts set out to achieve greater equity, which always involves a balancing transfer between rich and poor, advantaged and disadvantaged, and seeks to minimise or abolish oppression. This is not just a matter of morals. It also involves the will to exploit scientific and technological potential. This in particular has frequently not been the case in the past. Many new ideas for environmentally friendly technologies are not used because of short-term economic considerations or long-established habits. The ability to stand up for greater equity and the use of innovative potentials makes it necessary to develop a certain empathy, a kind of global "togetherness". Education for sustainable development therefore aims to develop individual and collective action and communication competence in a spirit of worldwide solidarity. It provides the motivation and empowerment to find viable joint solutions to joint problems and to make a considered stand for greater equity. This starts with collecting for a solar cooker that can be used by families in semi-arid areas with little fuel wood, and continues with support for whaling rules that conserve whale populations while acknowledging the traditional whale-catching rights of indigenous peoples. This includes the following examples:

- The pupils are able to express their empathy for animal protection, species-appropriate livestock farming, conservation of endangered species and ecosystems, and biological diversity.

- They can argue in favour of local and regional measures designed to combat non-sustainable developments – for example reduction of land take for settlement purposes – and for sustainable changes in socio-economic and natural living conditions, for instance by advocating greater use of wind energy, biosphere reserves and equitable water resources management in arid and semi-arid areas of the Earth. They can express their emotional attitudes to the relevant circumstances.
- The pupils can describe, both with rational arguments and with more emotive approaches, the situation of people who live in poverty, who lack adequate medical or other care, who are oppressed, or who have little or no access to education. Thanks to their knowledge of innovative technologies and sustainable management of resources, they are able to discuss action options for improving the situation.

- They are able to argue in favour of the interests of such people with the aid of international treaties and conventions, such as the Framework Convention on Climate Change or conventions on species protection, by reference to religious or ethical standards and values, and by making use of existing scientific and artistic works.

7. **The competence to motivate themselves and others.** Getting to grips with the concept of sustainability, breathing life into it and developing viable and satisfactory everyday lifestyles requires a high degree of motivation to change oneself and encourage others to do the same. Education for sustainable development sets out to develop the motivational drive we need if we want to lead a fulfilled and responsible life even under the complex conditions of an increasingly interdependent world. Being able to motivate oneself and others means knowing about action options. In other words knowing innovative environmental technologies, resource-conserving lifestyles, nature-friendly forms of mobility and economic activity, and being able to argue in favour of their use. What does this mean when translated into learning goals?

- The pupils can cite activities and learning progress from their work on sustainability issues, such as ”Renewable Energy Sources“, ”Biological Diversity“, ”Regional Utilisation and Threats“, which motivate them to put into practice and supplement the knowledge, problem-solving strategies and action concepts they have acquired.

- The pupils can demonstrate to others their commitment, problem-solving abilities and factual knowledge in relation to sustainable development processes and the identification of non-sustainable developments by informing them, say at exhibitions and other presentations, about the use of fuel cells, wind energy, solar technology and the implications of the growing consumption of oil for energy production.

- In the course of their learning, the pupils display increasing expectations about their own effectiveness with regard to the possibility of implementing strategies for sustainable development processes. This means, for example, that after working on Renewable Energy Sources for some time they should be more convinced than before that it is possible for them to make a contribution to the ”energy revolution“.

8. **The competence to engage in detached reflection about individual and cultural models.** Identifying and critically appraising one’s own interests and wishes, localising oneself in one’s own cultural context, or actually adopting a well considered stance in the debate on global equity calls for the competence to engage in detached reflection about individual and cultural models. This is partly a question of perceiving one’s own behaviour as culturally conditioned, and partly of getting to grips with social and societal models. For example, there are socially favoured lifestyles (the ideal of a detached house out in the country; air travel to one’s annual holiday destination; a car of one’s own; solarium-tanned skin) which are problematical from the point of view of health and sustainability. What kind of abilities and skills should pupils possess in connection with this individual competence?

- The pupils are able to give a structured description and assessment of their lifestyles and their local and family environments in the light of the perspective of people and living conditions in developing countries. This can for example be done by comparing land take for housing, differences in interest in repairable equipment, or misgivings about the use of environmentally harmful chemicals. Against this background, the pupils show their ability to describe the limits of their own lifestyles and the extent to which they can be generalised.

- The pupils are able to identify and describe the intentions associated with their lifestyles in terms of their consequences for the environment and for social equity. Suitable issues for this include topics from the complex "Water Consumption", and also reflections about leisure interests, clothing fashions, interest in the protection of animals and in mobile phones free from "electromagnetic smog".

- They are able to analyse their designs for the future – for example the kind of homes they want, their ideas about mobility, use of leisure time, travel destinations – from the point of view of social equity, consideration for the freedom of action of future generations and their potential environmental impacts, and can cite action options for reducing the resulting friction between sustainability and designs for the future.

It goes without saying that it cannot be the objective of every project or every lesson to teach al these individual competencies. They define the background against which the content should be chosen and discussed and the teaching methods selected. It will of course be necessary to specify the individual competencies in more detail, particularly in relation to the material taught. This is done in the following material under the heading of "Learning Goals".

Bibliography

- OECD (Ed.), DeSeCo Strategy Paper. An Overarching Frame of References for a Coherent Assessment and Research Program on Key Competencies.
www.statistik.admin.ch/stat_ch/ber15/deseco/deseco_strategy_paper_final.pdf

To help teachers use these materials on water in schools, we can provide general information about learning goals and the way the material fits into the existing syllabus, as well as pointers on educational standards in science. This will help teachers identify the contexts in which they can use the topics, project suggestions and worksheets. The teacher handouts for the two sets contain more helpful hints.

The importance of water for future generations and thus for today's young people is entirely uncontested. Water is the source of all life. The ancient Greeks saw it as one of the four elements from which the world was made. The development of the human race always has been and continues to be linked to the existence of water. Proximity to water has always been an important factor in the location of human settlements – primarily, but not only, because water is essential for drinking. The locations of modern urban settlements too are selected such as to ensure reliable water supplies. Seas, rivers and lakes are also transport routes. They are a source of food, generate power and create a special climate. Many pupils, and indeed adults, in Europe, however, have no particular awareness of the pivotal role that water plays in our lives. All too often we forget that it is by no means "normal" that good quality drinking water is always there, on tap, available round the clock.

Facts and figures:

- Over 1 billion people, or 18% of the world's population, have no access to safe drinking water, and over 2.4 billion people do not have adequate sanitation.
- 2.2 million people in developing countries, most of them children (6,000 a day), die every year from diseases associated with lack of access to safe drinking water, inadequate sanitation and poor hygiene.
- If current trends persist, by 2025 the demand for freshwater is expected to rise by 56%. That is more than is currently available. About 70% of current demand is accounted for by agriculture, while the remainder is used by households, municipalities and industry.

From: Annual report 2003 from the Commission to the Council and the European Parliament on the EC development policy and the implementation of external assistance in 2002 (available online at: http://www.pedz.uni-mannheim.de/daten/edz-h/az/03/com_2003_0527_en.pdf)

Learning goals (in brief)

One goal of these materials is to expand pupils' knowledge and understanding of how vital and valuable water is as a resource. Equally they are to be enabled to assess the problems involved in securing water resources. In Set 1 "Living Rivers", pupils should initially recognise the importance of water for human beings, and understand the complexity of providing safe drinking water. Set 2 takes them beyond the local dimension to introduce the global perspective. Under the motto "Lifestyle and the Global Water Crisis", pupils learn that safe drinking water is often in short supply in many countries of the Earth.

Alongside pupils' own water consumption, the focus is on the innovative approach involving "virtual water"*. Pupils should take a critical look at their own water consumption (for instance calculate their own monthly consumption of virtual water), which should then encourage them to think about alternatives (production of a guide to the global water crisis and consumer behaviour).

Pupils should be encouraged to work in pairs or in groups to help them deal in depth with this complex and complicated topic. You should provide for regular feedback to focus results and to ensure a discussion of the different positions which are bound to emerge within the class. As pupils are required to deal with views that are not their own, their abilities to play a cooperative role in socially heterogeneous groups will be strengthened.

Points of contact with the syllabus (in brief)

Water as a topic is firmly established in the syllabus for junior secondary level in several forms. It is found in particular in biology, where it is the focus of several units from "Water – a symbiosis" to "Water – a resource in short supply". The key topics of the syllabuses are water as a ecosystem, water pollution, water purification, water protection and water as a finite resource.

Set 1 can be used in particular for pupils age 13 to 15, in chemistry, geography and biology. The importance of water for our lives is underlined in topics such as "Water – the basis for life", "Water – its importance for life and the environment", and "Water for industrialised societies". Anthropogenic influence on water resources and the resulting ecological conflicts also feature on the syllabus (e.g. under water resources management, flooding). Set 1 thus links up well to the syllabuses which do not merely admonish pupils but which aim to encourage them to realise what they can do to change their own consumption patterns. "The goal should not be to identify and list environmental damage and destruction, but to get pupils to examine their own behaviour and adopt environmentally responsible behaviour patterns." (Syllabus for biology for junior secondary level, Federal State of Schleswig-Holstein, p.94).

The educational materials contained in Set 2 "Lifestyle and the Global Water Crisis" also link up best with the syllabus for pupils age 13 to 15 in biology and geography. Global water consumption and the results of water shortages are tackled in the syllabuses with topics such as national water consumption and global water crisis and "Water – a scarce commodity". Here too, pupils should take a long, hard, critical look at their own lifestyles.

"All topics which help us reinforce or encourage behaviour patterns involving responsible interaction with energy, the air, water, soil, the countryside, and flora and fauna can be used." (syllabus for biology for junior secondary level, Federal State of Schleswig-Holstein, p. 94) You will find more detailed information on link-ups to the syllabus under "Information for teachers", where each of the two sets is dealt with separately.

* Virtual water is a fairly new term in hydrology, where it is used to mean all the water used to produce a given product.

WHAT DO SYLLABUSES AND SCIENTIFIC EDUCATION STANDARDS FOR INTERMEDIATE SCHOOL CERTIFICATES SAY ABOUT "WATER"?

The scientific education standards of the KMK (standing conference of the ministers of education of the federal German states) make clear references to "Water", especially in Biology. The topic of "Water" is discussed in connection with the teaching of knowledge about ecosystems, and especially in relation to water uptake by plants. Examples of the use of water by human beings are also quoted when it comes to acquiring standardised competencies in Biology.

The standards for Chemistry make technical knowledge necessary when describing substance cycles in nature and technology. All natural sciences automatically show close connections with the topic of "Water" in the fields of knowledge discovery, communication and assessment. Accordingly, the material presented here builds on observation, systematisation, modelling, hypothesis formation, experimentation and the postulation of simple theories, and also on the acquisition of competencies designed to permit subject- and audience-specific communication and assessment of human use of water on the basis of scientific knowledge.

A special approach is necessary for Geography. The education standards for intermediate-level Geography drawn up by the DGG (German Society for Geography) provide many references to the subject of "Water". In general, the standards provide for acquisition of technical knowledge about the function and course of natural geographical processes. This can be done by working on bodies of water and ecosystems.

Pupils should also be able to explain "the impacts of area use and management (e.g. land clearance, water pollution, [...] water shortage)" and "explain in systemic terms the impacts of area use and management (e.g. [...] resource conflicts, marine pollution)".

Pupils should furthermore be able to "explain possible meaningful measures of an environmental, social and/or economic character for protecting areas [...] ". To this must be added skills in using spatial organisation systems, maps, geographical information sources, etc., which are to be taught in Geography and which are repeatedly available in this package of materials.

In the intermediate-level education standards for the Natural Sciences and Geography it is possible to identify seven key topics for the complex of "Water":

- Ecosystem Water
- Importance of water in physical geography
- Importance of water in human geography
- Use of water in the (agricultural) economy and in the household
- Water treatment
- Environmental pollution and destruction in relation to bodies of water
- Water conservation

Teaching pupils to know and assess the wide-ranging significance of the physical and human geography functions of water is the principal aim that this material sets out to achieve. The first task here is to explain, starting from the use of (tap) water that we take for granted, how complex the processes of water supply and wastewater disposal are, and also to understand how drinking water is produced and in what quality and quantity it is available (e.g. as surface water and groundwater).

However, the function of water, lakes and rivers is not confined to "providing" water as an indispensable food. Rivers, lakes and seas are transport routes and a focus of human settlement. They are of great climatic importance and have always been a magnet for economic uses (fisheries, agriculture etc.). Human intervention such as straightening, pollutant inputs etc. repeatedly prove to be factors which endanger and damage complex biocenoses that develop in and near water-dominated biotopes. For this reason it is also important, especially from a sustainability point of view, to deal with measures for renaturing rectified watercourses, sustainable use of water bodies and water as a resource, and also with flooding and other problems. This is possible with the material in Set 1. From age 12 to 14 onwards, the syllabuses for Geography and Biology and for interdisciplinary teaching display very close connections with this topic area.

In Set 2 the focus is on global aspects. Here there are close links with Geography from age 12 to 14 onwards. Knowing about and being able to assess the worldwide occurrence of freshwater and drinking water, and the various ways and quantities in which it is used in the household or in the industrial and agricultural sectors in individual countries around the world is of great importance for understanding the differences between industrialised and developing countries. Repeated reference to the pupils' own everyday situation (personal water consumption) demonstrates the great regional and local variations that exist worldwide when it comes to access to drinking water and basic sanitation. Moreover, from the perspective of viable future development it is essential to take a close look at future needs for fresh water, and especially drinking water, since factors such as population growth in Asia and parts of America and Africa, urban agglomerations, intensified agriculture, and industrialisation processes are creating an ever-increasing demand for fresh water of specific quality. Water shortages and water management are closely connected.

A special section is devoted to the topic of "virtual water". Discussion of this topic is of great importance from the point of view of sustainable consumption. How many people are aware how much water is needed to produce a kilo of rice or a litre of orange juice? Drawing attention to the water that has gone into products (i.e. the water necessary for their production) makes it clear that our daily consumption of drinking water usually accounts for no more than a small proportion of our daily water consumption. And when pupils know that a kilogram of (early) potatoes imported from Egypt needed 1,000 litres of water, which is very scarce there, to grow into an exportable product, they can judge what contribution they personally are making to water shortages in other countries.

The intermediate-level standards of the KMK for Chemistry, Biology and Physics are binding for all federal German states. Since they serve as the rules for future measurement of your pupils' performance, the following remarks set out to clarify how the material on "Water" is related to the educational standards. The intermediate-level KMK standards for "Biology" do not explicitly mention the topic of "Water". This is due to the general approach used in the wording of educational standards: they formulate competencies.

The content from which these can be acquired is not explicitly defined. However, the examples that illustrate what content can be used to achieve these competencies include numerous pointers to "Water", especially in Biology. In our context this is particularly true of the pointers to the importance of ecosystems: For example, pupils should learn to analyse the functions of organisms in the ecosystem, portray the substance cycle and energy flows in an ecosystem, outline the interactions between living beings and other spheres of the Earth, and describe the changes in an ecosystem over time. In the field of knowledge discovery, moreover, the pupils should be able to explain dynamic processes in ecosystems with the aid of model concepts and assess the information value of a model.

In this context, mention must also be made of the competence areas Communication and Assessment. The pupils should describe and explain originals or faithful illustrations with the aid of drawings or idealised pictures, and be able to present data on measurable parameters of systems. They should also learn to assess various measures and behaviour patterns relating to their own health care and social responsibility, and the impacts of human encroachment on an ecosystem. In the context of sustainability, the education standards for Biology also stipulate that pupils are to learn to assess influences on global cycles and material flows from the point of view of sustainable development, and discuss action options for environmentally sound and nature-friendly participation in the interests of sustainability.

The intermediate-level education standards for Physics do not display very strong links with the package of material. In the competence area ”Assessment“, however, the pupils are to compare and assess ”alternative technical solutions, taking account of physical, economic, social and environmental aspects“. For example, this applies to the question of the consequences of changes in the flow rate of straightened rivers (Set 1, Worksheet 3). In this context too, pupils acquire technical knowledge, and physical knowledge discovery processes are discussed (perceive, classify, explain, examine, construct models).

The education standards for Chemistry in the competence area ”technical knowledge“ play a role in that the pupils should learn to describe ”examples of substance cycles in nature and technology as a system of chemical reactions“. They should also grasp ”problems in real situations“, ”identify conflicts of interests“ (e.g. relating to fertiliser and pesticide inputs into water), consider ”possible solutions“ and discuss ”their consequences“.

WHAT COMPETENCES SHOULD PUPILS ACQUIRE AS THEY TACKLE THE TOPIC AREA "WATER"?

- Pupils become familiar with complex sets of circumstances relating to "Living Rivers" (for instance river courses as areas for human settlements and economic activities, rivers as food producers) and "The Global Water Crisis" (for instance, global water supplies, virtual water) on an interdisciplinary basis. They can recognise and describe the problems involved (for instance in Set 1: mutual influences between human beings and rivers, ecological conflicts; Set 2: water as a scarce resource, the consequences of virtual water imports), and can draw conclusions and produce their own assessments on the basis of the knowledge they have acquired.

- By adopting various perspectives (of the global water situation), pupils learn to present the various points of view relating to (non-)sustainable developments.

- On the basis of the information thus gained, pupils can assess different (non-sustainable) imperatives and patterns of action with respect to the global water crisis, and can thus make decisions affecting their own everyday activities (i.e. change their consumption patterns). In this context they can name and assess the approaches and concepts used in sustainable water resources management.

- Pupils are familiar with methods of forecasting appropriate to their own lives (scenario techniques) used to analyse the problems associated with future water supplies and the consequences thereof, and to anticipate possible sustainable developments in this field. Pupils should discuss and analyse their different points of view in groups and as a class and deal democratically with controversies arising. They should be enabled to deal constructively with differences of opinion and conflicts.

- They are able to present the results of their work and their findings with respect to the global water crisis to different external groups (for instance pupils from different classes, parents, the school website) in a way appropriate for the respective target group. In this context they should describe their individual and shared learning paths and outline how these can be used for further learning.

- Pupils identify and assess the background to, and the form and impacts of their own lifestyle and that of other people and societies on the living and working situation of other individuals and on the biosphere in terms of water.

- They can describe ways of life which ensure and encourage sustainable consumption of water, as well as the environmentally and socially sound utilisation of the resource.