The forest, greenhouse gases and climate change

Students, teachers and scientists in interaction

- **Description of how to build a partnership between students, teachers and scientists**
- **Teaching material and laboratory**

Contents

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Preface

How climate change can affect humans and environment, our country and the world, has become a common concern. We hear news about the effects of changing climate, often very threatening news which alarms us. Researchers can provide answers, but the information we receive is contradictory, and it can be difficult to know what is a real threat and what the true situation is. The knowledge we have is not static; it evolves as new research is completed. In today's society, it is important for students to understand and sift the information they receive, in order to obtain the full picture. Then they can become members of society who take responsibility and make conscious choices.

With this booklet, we try to provide inspiration and ideas for your teaching about the climate issue, and to show how students themselves can identify forests and the role of soil in the balance of greenhouse gases, by using the same techniques as those used by researchers today. The booklet contains teaching materials and laboratory work, and you can also take advantage of the experience which cooperation between a university and a secondary school can provide. The material was designed in close cooperation between secondary school teachers and students from Platengymnasiet in Motala, Sweden, and researchers from the Swedish University of Agricultural Sciences (SLU) in Uppsala. During several years, students of an upper secondary school carried out research work on the theme of global warming, greenhouse gases, climate and forests.

Much information about different aspects of the greenhouse effect already exists, and teaching material to share can be retrieved from books, films or through the Internet. In this booklet, we give suggestions of where to find more inspiration, information, brief presentations on global warming, climate scenarios, teaching materials and other things. The focus of this project lies in the part played by the forest and natural ecosystems in the balance of greenhouse gases; and it is within this area that ideas and exercises that can be used in secondary schools are presented.

Cooperation between secondary school teachers from Platengymnasiet and researchers at SLU took place within the European project 'Teacher-Scientist-Partnership: a tool for professional development'. Collaboration between secondary schools and research institutes in this project has also been going on in Germany, the Netherlands and Italy. We have been inspired by other countries' activities, and have included some of them here. The project was funded by the Socrates programme and by Comenius 2.1 (Training of School Education Staff) and SLU.

The original language of the booklet is Swedish, and the content was chosen to fit Swedish conditions. The section on Suggestions for literature, films, teaching material and websites (pages 12-13) has not been translated into English, since most of the sources require skills in Swedish. Nevertheless, similar projects and work can be carried out in other countries, with minor or major adaptions to fit the local curriculum or, where laboratory work is concerned, different ecosystems. So feel free to be inspired by this booklet, and adapt it to your own conditions!

Uppsala, October 2009
Monika Strömgren
Coordinator for the 'Teacher-Scientist-Partnership: a tool for professional development' in Sweden.

Students and teachers from Platengymnasiet in Motala, Sweden measures soil respiration and take soil samples in the School forest.

SLU and Platengymnasiet - a pilot project

Here you can follow, step by step, how cooperation between the Swedish University of Agricultural Sciences (SLU) and Platengymnsiet in Motala, has developed.

Make contact with a collaboration partner at a suitable university/college
In our case, Monika Strömgren (doctor in ecology and environmental conservation), and Mats Olsson (professor in soil science of forest landscapes) at SLU contacted us at Platengymnasiet. We met both in Uppsala and at Platengymnasiet to discuss and plan our cooperation.

Start a school forest near the school
We use a forest area approximately 5 km north of the school, which was earlier used for the school's biology classes. First, we arranged a meeting with the landowner, Monika and Mats, to explain the nature of the study, to ask permission to carry it out, and to find suitable areas of forest. With the help of Mats and Monika, we chose a moist area of forest on peat and a drier area on more normal forest soil.

Informing students
At the same time, the 3rd years-to-be were choosing subject areas for their school projects. We took the opportunity to inform and inspire students to participate in our cooperative project. We highlighted the opportunities for working practically with measurements and calculations, for cooperating with scientists working with a 'real' study, and for going into more detail within the current issue of climate change. During the two years in which students had the opportunity to work with this, a total of 16 students carried out their projects within our EU-project.

Field trips to SLU in Uppsala
Students working within the cooperative project had close contact with Monika and Mats, to solve problems and ask questions their teachers could not answer. We organised one field trip each year for our students to the Department of soils and environment at SLU where, among other things, the students obtained help with the carbon analysis of soil samples, and gained insight into how researchers work with measurements of carbon dioxide. The students also had the opportunity to discuss their projects with Monika and Mats, and it is primarily since this trip that the students have had individual contact with Mats and Monika by telephone and e-mail. These contacts have increased in intensity as the students' deadline has approached.

Further education for teachers
Collaboration with SLU was also very educational for the teachers. Through our students' work, we gained deeper knowledge about methods of data collection, calculation models and the role of the soil/forest system in the carbon cycle. Monika and Mats contributed knowledge

Hilmer Olai and Johan Björling measure soil respiration in the school forest, 2007.

Professor Mats Olsson and Anton Valek, student at Platongymnasiet, discuss the ongoing project.

and aspects which would otherwise have been difficult to obtain. The teachers also took part in further education, in the form of 'Markdagen' at SLU in Uppsala, to deepen and expand our knowledge within this field.

Integrating this into other classes
Several of the students devoted much time in developing methods for measuring carbon dioxide, also to biomass calculations and carbon-storage calculations. This work is used by us in other parts of the students' education in other classes, for example in field- and laboratory work. In Nk A- and Bi A-classes, we use our equipment for carbon dioxide measurement in various ways to demonstrate photosynthesis and respiration. In the optional class 'Environment studies', the students carry out fieldwork to enable them to calculate the forest's uptake vs. its emission of carbon dioxide, to estimate the forest's net uptake.

At Platengymnasiet we have also had a local course, within the individual option 'Environmental chemistry', in which we compared moist and dry forest through fieldwork and calculation, to discover whether the two forests are carbon dioxide traps or carbon dioxide sources. In this course, compared with 'Environmental studies', we focus more on the methods involved, and we also have more time, so we can deal with them more thoroughly. The course may possibly be converted into one or two chemistry C-courses.

In all courses, demonstrations, fieldwork and calculation are an excellent foundation for analysis and discussion of methods and results, which can be linked to the greenhouse effect and climate change.

Evaluation
An important tool for improving e.g., projects and cooperation, is regular evaluation, especially from the students. They have contributed many new ideas and suggestions for improvement.

Contact with foreign collaborators
Germany, Italy and the Netherlands are carrying out similar collaboration within this EU-project. This has meant that we have had the opportunity to meet teachers and scientists from these countries on some occasions. It has been inspiring to be part of research about climate change, and to see how other schools work with these issues. It has also given some of our students an opportunity to participate actively in the EU-project's final conference in Italy.

Continuation…
Even after the end of the EU-project and its economic support, our hope and ambition is to continue our collaboration with Monika and Mats at SLU. It is incredibly valuable to have a contact which we teachers can use when our own capacity and knowledge is insufficient.

Rune Davidsson and Lennart Wallstedt, teachers grades 10-12 at Platengymnasiet

The teachers also participated in further education. Here we are during the field excursion outside Uppsala.

Field trip to Norunda, a research forest where the carbon balance is followed second by second.

Learning targets and integration in curriculum

Goals for cooperation between school and university are that pupils should…

- Discover and better understand research and research methods.
- Make use of current research and research techniques.
- Acquire an understanding of nature's role in the greenhouse gas balance.
- Become thinking individuals, capable of making informed choices when necessary.

Examples of targets for courses where modules from the TSP project can be used:

Project work (SKOLFS 2000:162)*

Pupils should

- be able to choose a subject area, and within this delimit a task or problem,
- be able to select relevant materials, methods and tools,
- be able to document the progress of their work in a logbook, and regularly report the process,
- be able to discuss the progress of their work with the supervisor,
- be able to produce a final product which contains an independent solution to the task or problem chosen,
- be able to produce a written report of the project, describing the progress of the work from the initial idea to the final result,
- be able to assess, either in writing or verbally, their work process and results.

Natural sciences (Nk A, SKOLFS: 2000:9)*

Pupils should

- be able to make observations and carry out simple experiments, as well as analyse and interpret results,
- have developed their knowledge both of the structure and dynamics of the ecosystem, and of the importance of biological diversity,
- be able to describe both natural cycles and material and energy flows created by humans, as well as having an understanding of the laws of thermodynamics,
- be able to describe environmental problems on the basis of their chosen field of study, and actively participate in discussion of possibilities for influencing development,
- be aware of the importance of lifestyle choices for the environment, and for sustainable ecological development.

Biology A (SKOLFS: 2000:19)*

Pupils should

- be able to plan and carry out field studies and experimental investigations, interpret them, and present their work orally and in writing,
- have knowledge of the structure and dynamics of ecosystems.

Environmental Sciences (SKOLFS: 2000:85)*

Pupils should

- have knowledge of human impacts on ecosystems and ecosystem cycles,
- be capable of measuring significant chemical and physical parameters, of interpreting results and of describing the limitations of the methods,
- be able to explain the carrying capacity of ecosystems in relation to various environmental loads.

Environmental Chemistry (Local course 100 p)

The course is designed for students in the Science Programme who require a stronger environmental component in their education.

Pupils should

- be able to apply a practical and independent way of working through field and laboratory study,
- have developed their knowledge about current environmental issues.

'Environmental studies' student Andrea Filipovic estimating tree biomass in the School forest near Motala.

**Extract from SKOLFS in English can be found at homepage of the Swedish National Agency for Education (http://www.skolverket.se/sb/d/353)*

Comments from students

"I am so satisfied with my efforts. I have done my very best and learned an incredible amount. I have put my heart and soul into this ..."
Pupil from Platengymnasiet, 2008

The pupils' projects were evaluated each year. Here is a compilation of the views of the pupils.

What has been good?
It has been very interesting and rewarding to work on a highly topical subject, and to have a good combination of practical and theoretical approaches. Good and enjoyable to cooperate with SLU, and good to have access to researchers and their material. Very worthwhile to visit SLU and gain insight into research. Enjoyable and exciting to draw conclusions based on measurements, and to solve problems. Fine to have tried science 'for real'. Nice to be out in nature. Good contact with teachers, and positive with close cooperation within the group. Good to learn something new.

How do you think the project work was influenced by collaboration with researchers from SLU?
Only positively. It became more enjoyable and more exciting. It felt more realistic and scientific. We could not have progressed as far as we did without this cooperation. The scientists could help us more with methods than our teachers could. It gave many new ideas for projects which might otherwise not have come up. Good to have someone to ask questions when the literature and the teachers could not help.

Could you recommend another student to do a similar project?
Absolutely. Of course. It's fun and a challenge, which would be silly to miss. You can take part in a real project. It is both practical and theoretical. Cooperation with the scientists was rewarding. You can learn a lot of new things. A contribution to research. Problem-solving. Questions of climate are topical. However, you need to be interested in the environment.

Has the project's work on forests and climate change influenced your view of:
a) ... the enhanced greenhouse effect and climate change?
It has given more insight into the role of forests and the impact of forestry practices. It has given an insight into the great effect of forest, and the role of the soil. About carbon sinks. Have obtained more detailed and practical knowledge. How important it is to find future methods to stop warming. I think more about the environment now, for example, about using cars less.

b) ... research?
That research is not always boring, but a bit more fun. That it needs to go faster and needs more money. Have become more interested in research. That it actually gives answers to questions about how the forest functions. That there is so much to do research on. Better insight into research, at a high level. How research actually works. What depth of knowledge is required. That one has to be very precise and develop a good method.

Are you satisfied with your role in the project work, and did you get the results you expected?
I am satisfied with my efforts. I am very satisfied. I think that the result was not quite what I had expected. It was a bit more difficult and time-consuming than I thought. It ended up being better than expected. The result was as expected, but gave a deeper insight. One student wrote as the final comment: 'I am so satisfied with my efforts. I have done my very best and learned an incredible amount. I have put my heart and soul into this ...'


Students visiting a research lab at department of Soil and Environment, SLU Uppsala.

Idea bank — to engage students in climate research

In this idea bank, you can find themes and issues for different projects. Methods for field and laboratory work are given under the section 'Demonstration experiments and laboratory work'.

Is your forest a carbon sink?
How much carbon dioxide can a forest assimilate during one year? How much carbon dioxide is emitted from the soil? The trees bind carbon dioxide into their biomass. How much they bind can be determined by measuring tree growth. Carbon dioxide from the soil can be measured with a soil respiration chamber and a gas analyser.

The forest in the year 2100
In what state will the forest in your county or region be in the year 2010? How is the climate expected to change this? How would this change affect the living organisms in the forest, such as berry bushes, trees, animals, growth rate or the carbon balance? The project can be carried out as a literature survey, or experimentally, whereby the impact of temperature and water availability on photosynthesis and respiration is studied.

What is 'climate-smart' forest management?
A forest takes up and emits carbon dioxide continuously in a balance that depends on weather and light conditions. How is this balance affected by management measures (scarification, water regulation, choice of tree species, etc.)? Should the forest be managed, or should it be left untouched for free growth? Is it advisable to maintain big carbon stocks in forests? For these questions it is possible to arrange projects where comparisons are made between deciduous and coniferous forests, drained and undrained.

Carbon stock in agricultural soils
How is the stock of carbon/humus in farmland affected by different management measures? For example, tilled arable land for cereal production could be compared with pasture that is only occasionally tilled, or a non tillage system.

To estimate carbon stock in living biomass and soil
How large is the carbon stock in the soil and in living biomass? In the laboratory guidelines (only in Swedish), advice is given on how the carbon stock in trees, ground vegetation and soil can be assessed. One can compare different ecosystems and land that is managed in various ways.

Carbon dioxide flux from soil
Is there any difference in microbial activity (respiration) between different ecosystems or management measures (fertilization, ploughing, liming and ash application)? How does soil respiration vary (roots–soil) during a growing season? How do temperature and moisture affect this? Are there differences between management strategies? How can differences be explained (length of growing season, amount of roots, humus content, temperature, moisture)?

Carbon dioxide measurement in air
How does the CO_2 concentration vary in the air at your school? Set up a climate station and let your CO_2 sensor work continuously. Then analyze and interpret the results. Is there an impact from traffic or from plant photosynthesis during days with good light conditions? Through the School CO_2 web (http://www.carboeurope.org/education/schoolweb.php), comparisons can be made with results from other schools in Europe. Data can also be downloaded from experiments in Europe, if you don't want to make your own measurements.

SoilInfo — a web-based resource
Information on forest soil conditions in Sweden is available in the Forest Soil Inventory database (http://www-markinfo.slu.se). This is used *e.g.* for reporting changes in forest carbon pools, according to the Kyoto protocol. The database is available to anyone. In addition to information on carbon concentration at different soil depths in different regions, there are data on pH, N content, base saturation, cation exchange capacity and much more.

To study a school forest
The projects could be carried out in any forest (or any other type of ecosystem), but it is advantageous if projects are carried out in a specially selected 'school forest'. This gives an opportunity for classes, teams or individuals to return to the same forest for various investigations. It is then easier to obtain background information (e.g. landuse history, climate,) and to follow environmental changes over time, in order to give a more comprehensive picture of the forest. It is also possible to arrange a climate station in the forest, to study the climatic conditions and to relate them to the measured data.

Other issues
The projects could also be carried out, to provide a wider view of the climate issue:

- What do we mean by the concept 'greenhouse-gas effect'?
- What activities contribute to greenhouse-gas emissions in Sweden and globally?
- How is the climate changing?
- How does a changed climate affect different ecosystems, food production and society?
- What measures can be undertaken to mitigate climate change
- What actions are being undertaken in Sweden to diminish emissions of greenhouse gases?
- What are the implications of the Kyoto agreement, and how are the climate negotiations between countries proceeding?

Demonstration experiments and laboratory studies

Here are some examples of demonstration experiments and laboratory studies. A step-by-step guide that can be used directly in teaching can be found in the CD at the back of the booklet. The guides were developed in collaboration between students, teachers and researchers.

Carbon dioxide measurements in the classroom
Biology, ecology and environmental education contain many theoretical concepts and models. Students often need help to understand both simple and more complex interactions. Simple experiments and demonstrations can provide a better understanding, and encourage pupils to ask their own questions, which contribute to the student's knowledge.

By measuring CO_2, several biological and environmental processes can easily be visualized.

Examples of processes that can be demonstrated are: Photosynthesis, respiration, carbon sequestration, soil respiration, decomposition, recycling

Other issues to be examined:

- How is the photosynthesis affected by the light intensity, temperature, or plant material?
- How is the respiration affected by water content, temperature or substrate?

The experiments are suitable as demonstration experiments. Deepening and enlargement of the experiments can be done as student laboratory work or project work.

Trees as carbon sinks
The amount of CO_2 a tree assimilates during a year is estimated in this laboratory exercise. The carbon uptake for an entire forest can also be estimated by measuring tree height and the diameter of some trees, and estimating the density of the stand.

Purpose
To be able to perform field measurements and calculation of biomass and to obtain a better understanding of photosynthesis and the carbon cycle.

Duration
Field work ca 1–2 h. Analysis and discussion of the results 1–2 h.

Carbon sequestration in a forest
In this project, you should calculate how much CO_2 the forest emits by respiration and takes up by photosynthesis, to be able to calculate the net uptake of carbon in each forest. The guide in the CD is designed to be used in a Norway spruce stand. It may be suitable to compare two different forests, *e.g.* a forest on wet peatland with one on naturally drained mineral soil.

The laboratory exercise exists in two versions, one of them simplified with fewer calculations, which should require less time and knowledge of mathematics.

Purpose
To gain a detailed knowledge of the forest's role in carbon cycling and of the conduct of measurements and calculations of CO_2, and to be able to interpret the results and to understand the reliability of measurement methods as well as their limitations.

Duration
Fieldwork 2–3 h per occasion. One occasion is sufficient if respiration measurements have previously been made in the same area, otherwise at least three occasions are required. Carbon dioxide measurements and measurements of tree diameter, tree height, can be done at the same time. Classroom work with the Excel program and calculations 2–3 h, and 1 h for analysis and discussion of the results.

To estimate the carbon stock in soil
In this laboratory exercise, you should calculate how much carbon is stored in the soil. It can be appropriate to compare, e.g. a forest on a wet peatland with one on a naturally drained mineral soil.

Purpose
To gain a detailed knowledge of the soil's role in carbon cycling and to be able to conduct sampling and calculation of carbon stocks; the interpretation of results, and an understanding of the reliability of measurement methods and their limitations.

Duration
Fieldwork ca 2 h. Analytical work with soil samples and calculations ca 2–3 h and 1 h for the analysis and discussion of the results.

Photosynthesis study in the classroom.

Measuring Carbon dioxide

To be able to measure the concentration of carbon dioxide in the air, a carbon dioxide analyser is needed. With this as a base, you can later make additions to measure respiration or photosynthesis yourself. The following are three examples of analysis equipment in the lower price-ranges, which are also easy to use. In the pilot project at Motala, the PPsystems EGM-4 was used.

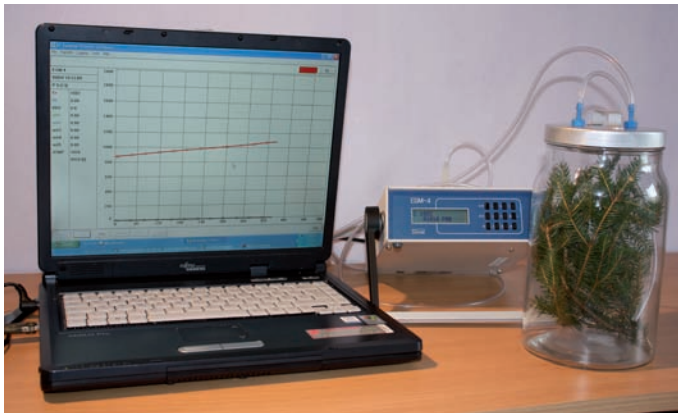
EGM-4 from PPsystems

EGM-4 is a low-maintenance gas analyser with which is relatively easy to use. The analyser has a built-in pump and the air is circulated. For further reading about the instrument, visit the manufacturer's homepage (http://www.ppsystems.com). Salesman in Sweden: Toragon AB, Umeå (www.toragon.se)

Good to know:

- A hydrophobic filter is useful for preventing dirt and water from entering the analyser. (It is cheaper to change a filter than to send the whole apparatus abroad for repair.)
- The internal battery should last four hours, but only in good conditions. To be on the safe side, you can either buy a EGM-4 with an internal battery with extra capacity, or install an external 12V battery, e.g. a motor-cycle battery.
- A humidity sensor can be installed in the instrument. The carbon dioxide analyser cannot distinguish between water-vapour and carbon dioxide. With the humidity sensor the carbon dioxide concentration can be corrected for the moisture in the air. In most measurements of respiration and photosynthesis, the correction does not affect the end result appreciably.
- A soil-temperature sensor can also be installed and temperature is logged separately. This can be convenient, but considerably cheaper thermometers can be found elsewhere.
- Cuvettes can also be obtained to fit the carbon dioxide meter. They may appear unduly expensive, and it is relatively easy to build something yourself, by using a large glass jar when you want to measure photosynthesis or a drainpipe with a lid when you want to measure respiration (see laboratory guide about carbon dioxide measurements in the classroom).

Price: about 35 000 SEK(4300 USD)



A carbon dioxide analyser from PPsystems is used here with a home-made photosynthesis cuvette. The measurements are simultaneously displayed on a computer.

GMP343 from Vaisala

This analyser from Vaisala is also easily used and sturdier than the EGM-4. It exists in a version with diffusion, and a version in which the air can be circulated. In the latter you need a small pump to circulate the air. Remember that an external pump will affect the pressure within the measuring cell. Therefore, choose a pump that does not have too high an airflow rate. The analyser can be directly connected to a computer or a measuring indicator (MI70). Read more about the analyser on Vaisala's homepage (www.vaisala.se).

Even here, the measured value of humidity and air-pressure is affected. Before the measurement can take place, the values for these must be entered into the measuring indicator, so that a corrected value of the concentration of carbon dioxide will appear automatically. There are also other sensors for humidity, temperature, etc., that can simultaneously be connected to the measuring indicator.

If a pump is used with this analyser, it should be fitted with a hydrophobic filter to prevent dirt and water from entering the measuring cell.

Price: 23 000 SEK (GMP343) and 7 900 SEK (MI70)

GM70 from Vaisala

This version of carbon dioxide analyser is cheaper and not as accurate as the above. There are two versions, the one where air reaches the sensor by diffusion, the other through circulation with a pump. The measuring indicator (MI70) is required to collect measurement data.

Price: 8 200 SEK (GM70) and 7 900 SEK (MI70)

Carbon dioxide analysers from Vaisala. The picture to the left shows measurement by diffusion, while in that on the right, air is passed through the sensor. The picture to the right shows a simpler analyser (GM70) connected to a pump and a measuring indicator (MI70). Photo: Vaisala.

Examples of projects

Here are titles of various project works that have been carried out during the project in Motala. Some of the projects can be found in their complete form (Swe) in the CD at the end of the booklet.

Linus Svensson (2008) Carbon Dioxide – Its relationship with the weather.

Ida Wernström (2008) The forest's net flow of carbon dioxide - sink or source?

Hilmer Olai (2008) Analysis of carbon storage in the soil in Kolmetorp.

Johan Björling (2008) The effect of forest soils on the climate.

Camilla Carlsson and Hannan Gawriye (2008) The annual growth in the Kolmetorp forest. The amount of carbon stored in the biomass in a year.

Oscar Düring and Christopher Pettersson (2008) The role of forest in the greenhouse drama. Can the forest be the villain?

Linda Karlsson and Kristina Karlsson (2008) Which forest emits most carbon dioxide: broadleaved or coniferous forest?

Anton Valek, Jakob Wodlin, Moa Asplind and Oscar Lindell (2009) The net carbon flux of the forest.

Robert Larsson and Martin Waern (2009), Soil respiration in cultivated fields and grazing areas.

Background knowledge- the role of the forest in the balance of greenhouse gases

The research programme LUSTRA has published three booklets about the forest's role in the balance of greenhouse gases, in the series 'Carbon, climate and the forest'. The information booklets can be downloaded from LUSTRA's homepage (http://www.mistra.org/lustraweb) or ordered from 'Utbudet' (http://www.utbudet.com).

Part 1. This is how it works

Del 2. How forestry practices have an effect

Del 3. Forested peatlands

PowerPoint: Climate change – How the forest can mitigate

A PowerPoint presentation on carbon, climate, and the forest is included in the accompanying CD (In Swedish). It contains notes for the lecturer.

MOTALA · VADSTENA

Annons Motala: kl 8.30–12.30 och 13.30–16.30 tel 0141-23 95 00, fax 0141-23 95 05 mejl: annons@corren.se

Om tidningen uteblir, ring 0141-543 60 må–fre 7–10, lö 8–10

Linköping B2 | Mjölby B8 | Motala Vadstena B12 | Kinda B14 | Åtvidaberg B15

Elever på Platen får resa till Italien

MOTALA

I ett år har elever på Platengymnasiet mätt koldioxidhalten i skogs- och jordbruksmark. Nästa torsdag åker de till Italien för att dela med sig av sina resultat.

Som projektarbete har sex elever valt att delta i ett EU-projekt där forskare, elever och lärare från fyra länder arbetar med att mäta koldioxid i mark och luft. Fyra av eleverna på Platengymnasiet har gjort mätningar i skogen och två har gjort mätningar på åker- och betesmark.

– Vi har undersökt om skogen släpper ut mer koldioxid än vad den tar upp, säger Jakob Wodlin som är med i skogsgruppen.

Projektet ska ge deltagarna en bättre förståelse för den förstärkta växthuseffekten. Eleverna har fått fundera över hur man kan förebygga problemet genom att ändra bruknings-metoderna för skog- och

tiga på att lösa också, säger Rune Davidsson, en av två

Sedan förra sommaren har de arbetat med att mäta skogs- och jordbruksmarkens utsläpp och upptagning av koldioxid.

BILD: JEPPE GUSTAFSSON

During the school year 2008/09, six students at Platengymnasiet made their school projects within the cooperation between the school and SLU. In April they participated in a EU-conference in Italy and presented their results. Clip from the newspaper Östgöta Correspondenten 18 April 2009.

Suggestions for literature, films, material for education and homepages

This is a brief compilation of literature, to show where you can find material for education which deals with the issue of climate change. There is a lot of information; this list summarises the most important information. For a more detailed list, visit the Campaign against climate change's homepage (http://www.klimatkampen.se). This part has not been translated into English since most sources require knowledge in Swedish language.

Litteratur

Makten över klimatet. Christian Azar. Albert Bonniers förlag, 2008. ISBN 978-91-85555-06-2.

Meteorologernas väderbok. Claes Bernes och Pär Holmgren. Förlag Medströms Bokförlag AB, 2006. ISBN 13 9789173290005

En varmare värld. Växthuseffekten och klimatets förändringar. Claes Bernes. Naturvårdsverket, 2003. ISBN 9789162012281

En ännu varmare värld. Claes Bernes. Naturvårdsverket, 2007. ISBN 978-91-620-1261-8.

Filmer

En obekväm sanning
En dokumentär av Al Gore, f d vicepresident i USA, som förklarar växthuseeffekten och dess konsekvenser för samhälle och ekosystem.

The Day After Tomorrow
En science-fiction film där den globala uppvärmningen utlöser en ny istid.

Planeten
Glaciärer som smälter, ett jordsystem som håller på att rubbas utöver sina normala gränser och en miljö som inte mår bra. Stämmer det att vi människor är orsaken bakom dessa förändringar? Kan vi påverka vår framtid? Planeten är en dokumentär-serie av SVT från 2006 som går att se på webb-TV. (http://svt.se/planeten)

Foto: Mats Gerntz, SLU

Undervisningsmateriel

Keep cool
Ett spel för upp till sex aktörer som representerar olika länder. För att vinna ska aktörerna ta hänsyn både till deras egna länders ekonomiska intressen och världens klimat. Spelet finns på tyska och engelska. Utges av Spieltrieb, i Tyskland. http://www.spieltriebgbr.de

Många av hemsidorna innehåller även material som går att använda i undervisningssyfte.

Hemsidor

CarboSchools
Här finns dokument om klimatförändringen och miljön, ideér på hur man startar ett samarbete mellan forskare och lärare, samt förslag på aktiviteter för skolelever i olika åldrar.
http://www.carboschools.org

Energimyndigheten
Här finns information om hur Sverige arbetar för att minska växthusgasutsläppen från energisektorn.
http://www.energimyndigheten.se

EU:s klimatkampanj
EU:s hemsida om klimatförändringen och hur du kan påverka den. Här finns material för skolor, mm
http://ec.europa.eu/environment/climat/campaign/

FN:s klimatpanel
FN:s klimatpanel (IPCC) består av ett stort antal framstående klimatforskare från många olika länder. Deras uppgift är att förse politiker och samhällsplanerare med bästa möjliga sammanställning av befintlig kunskap.
http://www.ipcc.ch

Klimatkampen
Klimatkampen är en tävling där gymnasieelever ska komma på effektiva sätt att på lokal nivå minska växthuseffekten. Bakom tävlingen finns ett projekt, som drivs av IVL Svenska Miljöinsititutet, där lärare, elever och sakkunniga arbetar med nya sätt att lära kring hållbar utveckling. På Klimatkampens hemsida finns aktuella tips om undervisningsmaterial, litteratur, andra hemsidor etc.
http://www.klimatkampen.se

KUNSKAP DIREKT
Ett kunskapssystem om skogsbruk och skogsskötsel som tagits fram av SkogForsk. Här kan man lära sig mycket om skog och hur man uppskattar höjd, stamvolym mm.
http://www.skogforsk.se/kunskapdirekt

LUSTRA
Ett forskningsprogram om hur skogen och skogsskötsel inverkar på växthusgaskoncentrationen i luften
http://www.mistra.org/lustraweb

MarkInfo
Här kan man få fram kartor över pH, och koncentrationer av olika näringsämnen i skogsmarken i Sverige.
http://www-markinfo.slu.se/

Naturvårdsverket
Naturvårdsverket har ett aktivt arbete med hela klimatfrågan. Här finns tips om litteratur och färdiga OH-presentationer färdiga att använda. Här kan man även anmäla sig till deras klimatnyhetsbrev ”Klimataktuellt” som skickas ut via e-mail.
http://www.naturvardsverket.se

Regeringen
På regeringens hemsida kan man läsa mer om Sveriges klimatpolitik.
http://www.regeringen.se

Skogen i Skolan
Skogen i Skolan är ett samverkansprogram mellan skolan och skogliga intressenter. Här finns undervisningsmateriel och många länkar.
http://www.skogeniskolan.se/

Skogsstyrelsen
Skogsstyrelsen är myndigheten som behandlar frågor om skog. Här finns information om svenskt skogsbruk, Sveriges och världens skogar.
http://www.skogsstyrelsen.se

SkogsSverige
Skogsnäringens portal på Internet med länkar till andra skogsrelaterade sidor.
http://www.skogssverige.se

SMHI
SMHI gör prognoser om hur klimatet ska förändras i Sverige.
http://www.smhi.se

SNF
Svenska Naturskyddsföreningen har information om klimatfrågor och även skolmateriel.
http://www.snf.se

Med länk till deras skolmateriel ”Klimatresan”:
http://www.snf.se/verksamhet/klimat/klimatresan.htm

Elever från Platengymnasiet diskuterar sina projektarbeten med Monika Strömgren, forskare på SLU i Uppsala.

Teachers and scientists in partnership

Do you want to start a cooperative project between your school and a university? Within SLU, there is research that deals with many of our Swedish climate goals. Feel free to contact the information department at SLU (rekrytering@slu.se or 018-67 10 00 within Swden) to get help with starting cooperation with a researcher.

In 'Teacher – Scientist Partnership guide' there are tips on what to think about to get a project going. The guide was written by teachers and researchers in Europe, who have experience of cooperative projects. The guide is included in the CD, but can also be downloaded in its complete form at CarboSchool's homepage http://www.carboschools.org. Here is an excerpt from some of the guide's twelve short steps to a successful collaboration:

- Teachers & Scientists need to have commitment & desire to make the project work
- Activities should be driven by teacher needs
- Expect teacher to make first contact
- Plan activities jointly, ahead of working with pupils, ideally within informal settings (e.g. over coffee or in the pub)
- Try to make frequent contact (direct/indirect), particularly initially
- Grow into your partnership: small goals, smart experiences

"Contact with researchers has been invaluable for the development of new practical methods for environmental education."
Lennart Wallstedt, teacher at Platengymnasiet

"It has been fantastic to cooperate with teachers and students. Their enthusiasm and commitment is contagious..."
Monika Strömgren, researcher at SLU

"The students are our future! We have to reach out to them."
Mats Olsson, professor at SLU

"If both are giving something to the partnership, they should both get something out of it..."
Maxine Woods, teacher & Phil Smith, researcher

"Cooperation with SLU has been an excellent teacher education. I have gained insight into current research and inspiration for new teaching methods."
Rune Davidsson, teacher at Platengymnasiet

CD

The forest, greenhouse gases and climate change

- Students, teachers and scientists in interaction

This is working material on climate change, greenhouse gases and the forest. It contains information and material which can be used in teaching, but also information on how a partnership can be built between upper secondary schools and universities.

Analyses and laboratory work are similar to those used by scientists, but are designed to be used in upper secondary schools in individual projects, group projects or as a part of ordinary courses in biology or courses in environmental sciences or natural sciences.

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Motala kommun

SLU