SUSTAINABLE DEVELOPMENT AND CLIMATE CHANGE EDUCATION

TEACHING GUIDE

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I. GENERAL INTRODUCTION ON ENVIRONMENTAL EDUCATION

We know that the environment cannot be reduced to "ecological" issues - a branch of biology - or to nature. We humans are part of it and changes in our connection to nature mean that we have gradually transformed it and think of it as an area for action to be managed, harnessed, exploited or protected.

Our direct or indirect actions on nature can thus have collateral effects and consequences that we cannot foresee. Despite our abilities, the tools and the ethics that we have inherited from our ancestors have become inadequate in the face of an environmental crisis that is without precedent in our history. A contemporary philosopher, Hans Jonas, determinedly described the ethical crisis linked to the deep uncertainties that we face: "*never before have human beings had so much power with so little guidance in using it*". In other words, we inherit technologies do not all come with an 'instruction manual' that is sufficiently reliable to prevent consequences that are harmful to our planet.

In the face of these issues, the Brazilian coordination team of the *International Conference of Children and Youth "Let's Take Care of the Planet"* is reasserting the objectives of environmental education, whether it be in terms of values, know-how or behaviours. To achieve these objectives, this education is based on processes of continuous learning, encouraging respect for the diversity of living organisms and, within that, for human cultural diversity. It also aims to strengthen social resistance in the face of the destructive relationships that humans can form with their environment and with other humans.
Therefore, it is only with critical and participative environmental education actions, tackling cross-cutting and interdisciplinary subjects, that we can encourage a responsible attitude in young people with regard to the global socio-environmental challenges that we must face.

II. GLOBAL ISSUES[1] AND INTERDEPENDENCIES

The changes that are confronting modern societies affect many areas, both economic and geopolitical, and sociocultural and environmental. The globalisation of trade and its consequences are challenging the political and economic systems of the past, but also social and family relationships, and our connection to religious figures. Through their interaction, these changes are reaching a scale such that they can be described as "global".

Concerning the environment, in the strict sense of the term, the impact of human activities is of course significant at the local level (urbanisation, air and water pollution, changes in land use, in cultural practices, etc.), but it also has global consequences, particularly on climate. These human activities also affect other aspects that are not strictly climatic, such as biodiversity (disappearance of certain living species), the exhaustion of natural resources, the acid-base balance of the seas and the transformation of coastal regions.

In fact, the climate and the seas are in the process of changing under the influence of substantial anthropogenic[2] greenhouse gas emissions[3] and under the influence of other changes (e.g. urbanisation and land use). Climate change encompasses rising temperatures (in other words, global warming), but also changes in other meteorological (e.g. changing wind and precipitation patterns) and oceanic parameters (rising sea level, acidification of the seas, changing sea currents etc.). These changes will also have an impact on biodiversity, but, here too, with regional variations.

While we are beginning to measure certain impacts of these recent changes (shrinking glaciers, drying up of water reserves, coastal zone flooding etc. but also their consequences on the movement of populations living in flood or desert zones, the opening up of new sea lanes in glacial zones etc.), their scale and their impact are still unknown because we know neither by how many degrees the Earth's temperature will continue to rise, nor if there are turning points beyond which the situation may undergo irreparable change.

[1] Source:http://www.insu.cnrs.fr/a1368,recherches-liees-aux-impacts-changement-global.html

[2] In geography and in ecology, "anthropisation" is the transformation of spaces, landscapes or natural environments through human action.

[3] see the text box on greenhouse gases on the following page

III. CLIMATE CHANGE EXAMINED

Climate is defined as a description of the meteorological averages and extremes in a limited area. Climate is naturally variable with the seasons and years.
This variability is normal and is due to the fluctuations of various natural factors: sea currents, volcanic eruptions, solar radiation and other components of the climate system that are still not fully understood. Furthermore, our climate has extremes (e.g. heavy rainfall, droughts, hail, tornadoes and hurricanes), which can have considerable impacts on regions of the world. But, for some decades, indicators and studies have shown a variation that is in no way natural in the strict sense of the term: the climate is warming on a global level... and this phenomenon has sped up in just one century. What is causing this and what could the consequences be? That is what we will try to answer in the pages that follow.

THE GREENHOUSE EFFECT:
The greenhouse effect is a natural phenomenon that is essential to life on Earth and which ensures an average temperature of approximately +15°C. Without the greenhouse effect it would be -18°C.
The Earth receives the majority of its energy from the Sun (mainly in the form of visible light): part of it is directly reflected, another part is absorbed and a final part is radiated by our planet in the form of infrared. This radiation is in part cut off by the greenhouse gases in the earth's atmosphere while the rest escapes into space.
Water vapour, methane, carbon dioxide and nitrous oxide, which **are the main greenhouse gases (GHGs)** thereby contribute to trapping the reflected energy, increasing the Earth's average temperature. Clouds play an important role in the greenhouse effect: low clouds essentially act like a parasol that reflects a large part of the rays Sun's towards space. The reflective power, or albedo, of dense low-altitude clouds, is thus very high, in the order of 80%.
Global temperatures (measured 2 m above ground in shelter) are: +15.1°C on average (polar regions: -20°C, temperate regions: +11°C, equatorial regions: +26°C).
On Mars, where there is no greenhouse effect, the average temperature is -50°C. On Venus, where the atmosphere has a very high carbon dioxide content, the average temperature is +420°C. We can therefore understand that the greenhouse gas concentrations on Earth have enabled the emergence of the forms of life that we know and that they are very sensitive to temperature.
You can see a diagram at:
http://lewebpedagogique.com/202svt2009/2009/10/06/cours-du-mardi-06-octobre-2009/

1. What kind of climate change do we mean?

Changes to the environment through human action are well known today (deforestation, soil and water pollution, greenhouse gas emissions etc.), but their consequences on major natural systems, including climate, are difficult to foresee and quantify on environmental, social and economic levels. The work carried out by the Intergovernmental Panel on Climate Change (IPCC - see text box) is among the leading references on climate and climate change. It gives us precious indications on the current changes in climate and their causes, but also proposes avenues for research on their consequences and the probability of their occurrence.

THE INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE (IPCC)

The IPPC, created in 1988 at the request of the G7, is overseen by two UN bodies: the World Meteorological Organization (WMO) and the United Nations Environment Programme (UNEP). It was mandated to regularly review the state of knowledge on climate change. It has already published four assessment reports. The first three led to the signature of the United Nations Convention of Climate Change at the Rio summit (1992) and to the adoption of the Kyoto Protocol five years later. The fourth, published in 2007, provided a framework for the negotiations of the Copenhagen summit in December 2009, on the follow-up to the Kyoto Protocol (which expires on 31 December 2012).

Definitions of climate change

Climate change in IPCC usage refers to a change in the state of the climate that can be identified (e.g. using statistical tests) by changes in the mean and/or the variability of its properties. Furthermore, this must persist for an extended period, typically decades or longer and may be due either to natural variability or to human activity.

THE 4TH IPCC REPORT:

Warming of the climate system is unequivocal. The report shows that discernable human influence extends beyond average temperature to other aspects of climate. Globally, an increase in average air sea temperatures, widespread melting of snow and ice, a rising average sea level and a disruption of certain natural systems is already evident.

2. The causes of climate change[4]

Variations in atmospheric concentrations of greenhouse gases (GHGs) and aerosols[5], those in volcanic activity and solar radiation, and changes in the Earth's land cover have an impact on the climate system. But since industrial times, GHGs due to human activities have had a greater impact because of their unprecedented growth (there has been an increase of 70% between 1970 and 2004) and the climatic research gathered by the IPCC up to 2007 showed that there is a correlation between this increase and climate change.

The IPPC therefore showed in its conclusions that:

- Global atmospheric concentrations of carbon dioxide (CO_2), methane (CH_4) and nitrous oxide (N_2O) have increased markedly as a result of human activities since 1750 and now far exceed pre-industrial values determined from ice cores spanning the last 800,000 years.
- Of the GHGs, carbon dioxide is the most important anthropogenic GHG. Its annual emissions grew by about 80% between 1970 and 2004.
- Atmospheric concentrations of CO_2 (379 ppm) and CH_4 (1174 ppb) in 2005 exceed by far the natural range over the last 800,000 years.

These increases have several causes:

- Global increases in CO_2 concentrations are due primarily to fossil fuel use by humans with land-use change providing another significant but smaller contribution;

[4] The information in parts 2. and 3. is drawn from: **IPPC- Climate Change 2007: Synthesis Report – Summary for Policymakers.**

[5] Aerosol is the collection of very small particles suspended in air. These particles can me liquids (fog) or solid (smoke). Source: http://www.b-harmony.com/savoir/eau/eau_glossaire.htm

- It is very likely that the observed increase in CH_4 concentration is predominantly due to agriculture and fossil fuel use. CH4 growth rates have declined since the early 1990s, consistent with total emissions (sum of anthropogenic and natural sources) being nearly constant during this period;
- The increase in N_2O concentration is primarily due to agriculture.

The IPCC therefore has "***very high confidence that the net effect of human activities since 1750 has been one of warming and that it is very likely due to the observed increase in anthropogenic GHG concentrations***", because if one confined oneself only to natural causes during the past 50 years (impact of volcanic activity and fluctuations in solar radiation), the climate would likely have cooled. Observed global warming and its changes are simulated only by models that include anthropogenic forcings. On the other hand, difficulties remain in simulating and attributing observed temperature changes at smaller than continental scales.

3. The impact of human activities on other aspects of climate:

❖ Temperature rise

- Between 1995 and 2007, eleven of the last twelve years rank among the warmest years in the instrumental record of global surface temperature (since 1850). The value established for 1906–2005 is an average of +0.74 °C. Average Northern Hemisphere temperatures during the second half of the 20th century were very likely higher than during any other period of the same duration in the last 500 years and probably in at least the past 1300 years.
- The increase in temperatures is greater at higher northern latitudes.
- Land regions have warmed faster than the oceans.

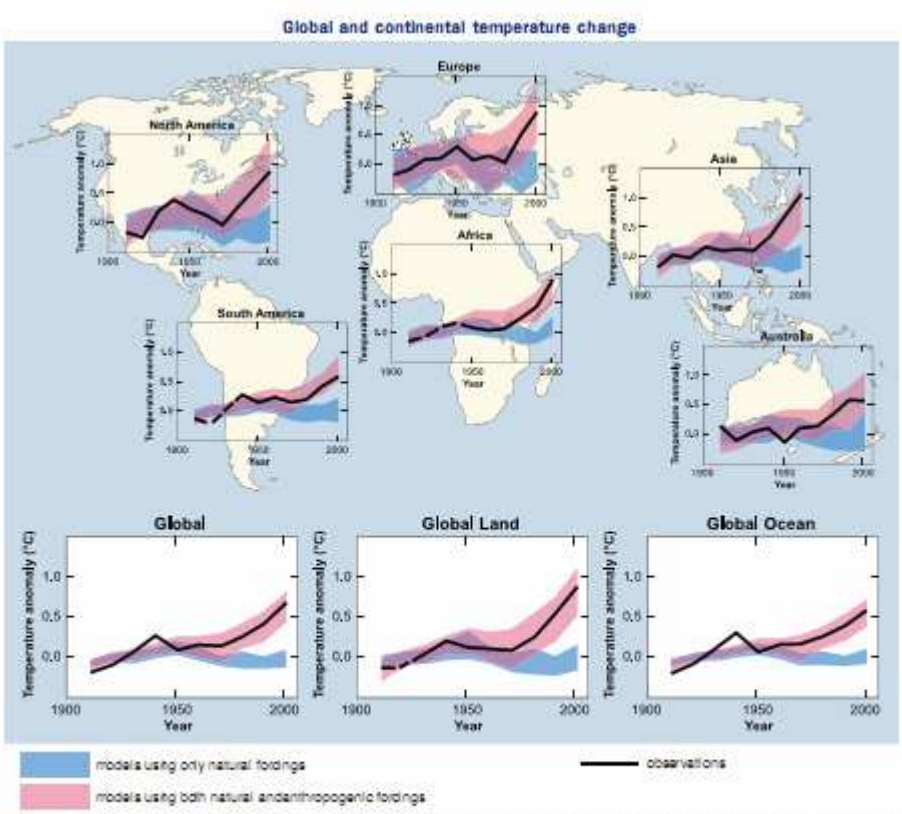


Figure SPM.4. Comparison of observed continental- and global-scale changes in surface temperature with results simulated by climate models using either natural or both natural and anthropogenic forcings. Decadal averages of observations are shown for the period 1906-2005 (black line) plotted against the centre of the decade and relative to the corresponding average for the period 1901-1950. Lines are dashed where spatial coverage is less than 50%. Blue shaded bands show the 5 to 95% range for 19 simulations from five climate models using only the natural forcings due to solar activity and volcanoes. Red shaded bands show the 5 to 95% range for 58 simulations from 14 climate models using both natural and anthropogenic forcings. (Figure 2.5)

Source: IPPC- Climate Change 2007: Synthesis Report – Summary for Policymakers - page 6. Comparison of observed continental- and global-scale changes in surface temperature with results simulated by climate models using either natural or both natural and anthropogenic forcings. Decadal averages of observations are shown for the period 1906-2005 (black line) plotted against the centre of the decade and relative to the corresponding average for the period 1901-1950. Lines are dashed where spatial coverage is less than 50%. Blue shaded bands show the 5 to 95% range for 19 simulations from 5 climate models using only the natural forcings due to solar activity and volcanoes. Red shaded bands show the 5 to 95% range for 58 simulations from 14 climate models using both natural and anthropogenic forcings.

❖ Regional increase in precipitation

- From 1900 to 2005, precipitation increased significantly in eastern parts of North and South America, northern Europe and northern and central Asia but declined in the Sahel, the Mediterranean, southern African and parts of southern Asia.

❖ Seal level rise

Seal level rise is consistent with warming. Global average sea level has risen since 1961 at an average rate of 1.8 mm/year since 1961 and since 1993 at 3.1 mm/year since 1993 (approximately 17 cm during the course of the 20th century), with contributions from thermal expansion, melting glaciers and ice caps, and the polar ice sheets. However whether the faster rate for 1993 to 2003 reflects decadal variation or an increase in the longer-term trend is unclear.

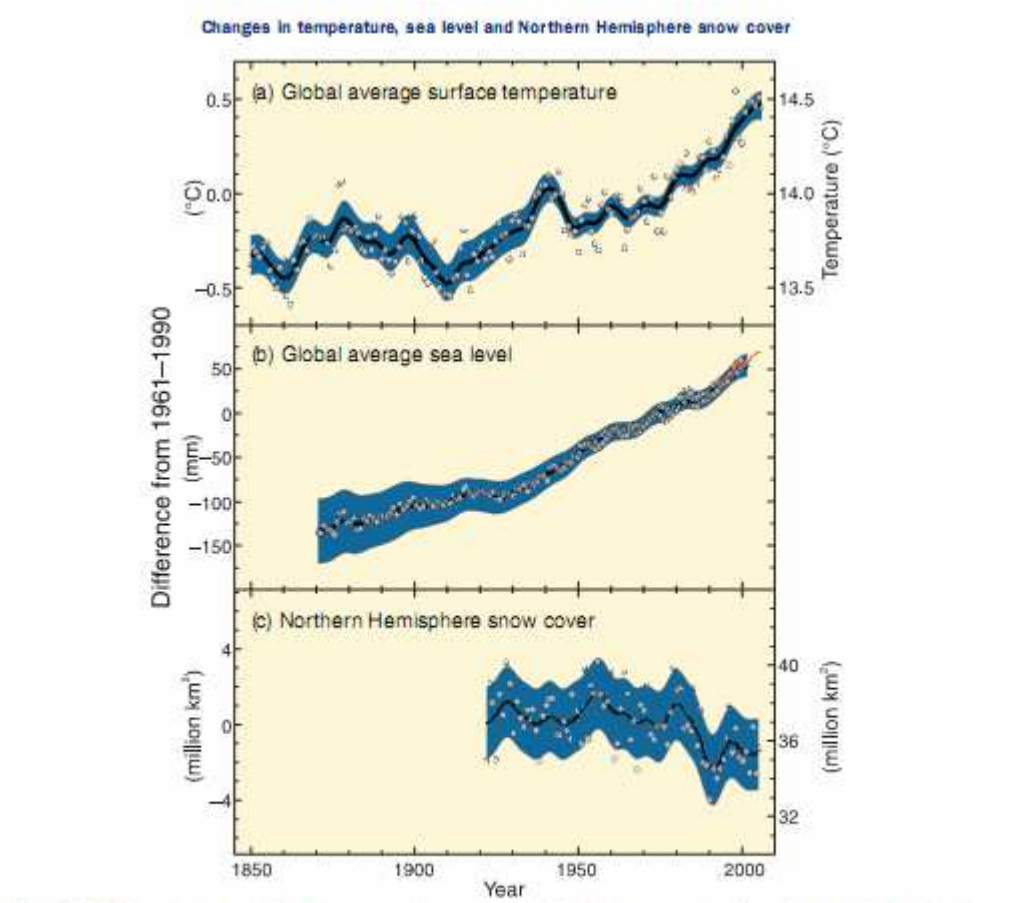


Figure SPM.1. Observed changes in (a) global average surface temperature; (b) global average sea level from tide gauge (blue) and satellite (red) data and (c) Northern Hemisphere snow cover for March-April. All differences are relative to corresponding averages for the period 1961-1990. Smoothed curves represent decadal averaged values while circles show yearly values. The shaded areas are the uncertainty intervals estimated from a comprehensive analysis of known uncertainties (a and b) and from the time series (c). {Figure 1.1}

Source: IPPC- Climate Change 2007: Synthesis Report – Summary for Policymakers - page 3. Observed changes in (a) global average surface temperature; (b) global average sea level from tide gauge (blue) and satellite (red) data and (c) Northern Hemisphere snow cover for March-April. All differences are relative to corresponding averages for the period 1961-1990. Smoothed curves represent decadal averaged values while circles show yearly values. The shaded areas are the uncertainty intervals estimated from a comprehensive analysis of known uncertainties (a and b) and from the time series (c). {Figure 1.1}

❖ Melting of snow and ice

- Observed decreases in snow and ice extent are also consistent with warming. Satellite data since 1978 show that glaciers and snow cover today occupy a reduced area in both hemispheres.
- Some hydrological systems have also been affected through increased runoff and earlier spring peak discharge in many glacier- and snow-fed rivers and through effects on thermal structure and water quality of warming rivers and lakes.

❖ Extreme climatic events

There is observational evidence of an increase in intense tropical cyclone activity in the North Atlantic since about 1970, with limited evidence of increases elsewhere.
For the time being no other extreme phenomena can be attributed to climate change.

❖ Effect on natural systems

- Observational evidence from all continents and most oceans shows that many natural systems are being affected by regional climate changes, particularly temperature increases.
- In terrestrial ecosystems, earlier timing of spring events and poleward and upward shifts in plant and animal ranges are with very likely linked to recent warming.
- In some marine and freshwater systems, shifts in ranges and changes in algal, plankton and fish abundance are very likely associate with rising water temperatures, as well as related changes in ice cover, salinity, oxygen levels and circulation, and acidity in the specific case of the seas.
- The growth of CO2 emissions and nitrogen and sulphur discharges related to human activities increase the acidity of the seas, which upsets their balance.

TO SUM UP:
In addition to increasing average temperatures, human activities have:
- very likely contributed to sea level rise during the latter half of the 20th century;
- likely contributed to changes in wind patterns, affecting extra-tropical storm tracks and temperature patterns;
- likely increased temperatures of extreme hot nights, cold nights and cold days;
- more likely than not increased the risk of heat waves, the area affected by drought since the 1970s and the frequency of heavy precipitation events;
- likely had a discernable influence on observed changes in many physical and biological systems.

4. The disputed causes of global warming

Some counter-arguments made by so-called "sceptic" scientists because they are a minority on the international scene, call into question in particular the link between global warming and human activity. They therefore often speak in support of the natural nature of this phenomenon. Among the most frequently given arguments are[6]:

- The activity of the Sun has intensified in recent years
- The Earth experienced climate change long before our era
- The evidence drawn from computer models is not sufficiently reliable and is based on a series of hypotheses
- There is an overestimation of the negative impacts of global warming and silence on the positive impacts (some region of the world could for example benefit from a rise in temperatures, in particular to increase agricultural yields)
- The main challenge concerns the following scientific argument: an increase in CO_2 emissions leads to global warming. For the sceptics, the phenomenon is the other way round: it is natural global warming that leads to a greater concentration of CO_2 in the atmosphere and not the opposite. Humans are therefore not the source of the problem but will suffer its consequences.

[6] Arguments drawn from the study by Paul Bricout "Le réchauffement climatique – étude critique du scepticisme", downloadable in pdf format on the Greenpeace site at the following address: http://www.greenpeace.org/luxembourg/press/reports/le-rechauffement-climatique; and from another site in English: http://www.skepticalscience.com/

However, these counter-arguments do not explain everything and in particular the rapidity with which the warming of the planet is occurring.

On the other hand, and in the words of Marc Jamous (Scientific Supervisor at the LSCE-IPSL), "*a scientist will not say that he or she is absolutely sure about a phenomenon […] instead he or she will say that it is likely or very likely or very highly likely. It is currently said that it is highly likely that there is global warming on the surface of the planet, including the seas, and that it is highly likely that this warming is due to human activities.*"

5. The Climate Convention and the Kyoto Protocol[7]

The United Nations Framework Convention on Climate Change (UNFCCC) came into being in 1992 in order to prevent any dangerous disruption of climate. It is the basis of global cooperation on climate, but does not set a quantitative target for the reduction of emissions, countries simply had to produce an annual report of their greenhouse gas emissions (GHG).
In order to strengthen this Convention, the Kyoto Protocol was signed in 1997 entering into force in 2005 after bitter negotiations. Today, 184 countries of both the North and the South have ratified it, but only 38 industrialised countries have an obligation to reduce their GHGs by 5.2% between 2008 and 2012, compared to the 1990 level. This global target was then divided up by country. The Kyoto Protocol provides for penalties if a country does not achieve its reduction target (except for the United States, the only industrialised country that did not ratify it).
There are therefore two avenues for negotiation: one under the UNFCCC and the other under the Kyoto Protocol.

Copenhagen COP-MOP: what is it?
In the jargon of the climate negotiations, the annual meeting in which the countries discuss action to tackle climate change is called the COP-MOP for *Conference of the Parties* - *Meeting of the Parties* - meaning Conference of the Parties to the UNFCCC and Meeting of the Parties to the Kyoto Protocol. The last COP-MOP took place in Copenhagen (Denmark) between 7 and 18 December 2009. There are also intermediate sessions during the year, which are more technical and which should allow the experts to make progress on certain subjects before the political meetings of the COP-MOP.
The first application period of the Kyoto Protocol ends in 2012. The objective of the Copenhagen COP-MOP, in December 2009, was to reach an agreement between all of the countries on the second commitment period: what GHG emission reduction targets and for which countries? What mechanisms should be used to reach these targets?
It was a crucial challenge since we must reduce our greenhouse gas emission very quickly in order to avoid devastating impacts.

What were the key issues of the Copenhagen summit? [8]

The aim of Copenhagen was to reach an international agreement on climate change. Consideration of a few key points, on which there were negotiations.

[7] Extract from the CAR's (Climate Action Network) booklet "Changements climatiques, cap vers Copenhague"
[8] See: http://www.copenhague.developpement-durable.gouv.fr

What level of global ambition in 2050? Based on the scientific assessments of the IPCC's experts, many countries, including those of the European Union, consider that in order to limit the risks to the planet, it is necessary to limit temperature rise to 2°C above the average temperature dating back to the industrial revolution. This requires the stabilisation of global greenhouse gas (GHG) emissions compared to their 1990 level by 2020 at the latest, before reducing them by at least half by 2050. Not all countries agree on these objectives in particular because of their interpretation of the scientific data that has led to these conclusions.
What distribution of effort? To achieve the global objective of reducing emissions by at least 50% by 2050, a new distribution of effort also appears necessary and should take into account:
- the country's share of responsibility in global GHG emissions;
- the country's ability to finance efforts to reduce their GHG emissions.

A measurement and verification system also appears necessary in order to know the effort of developing countries to reduce their emissions, as well as that of developing countries regarding financing and technology transfer.

Disappointing outcomes on the issues[9]

The last two days of the Conference were critical to reaching a "Copenhagen Accord", but this remains vague and very insufficient. While it does assert the need to contain warming to + 2°C compared to the beginning of the industrial era, **the final text comprises no quantitative commitments for the reduction of greenhouse gas emissions** by 2020 or 2050 and **no obligations on assistance for adaptation for the poorest countries**, which are therefore the most at risk. Consequently, according to confidential analysis by the secretariat of the of the United Nations Framework Convention the current emission reduction commitments are insufficient and will lead to global warming of a least 3 degrees...

Furthermore, **no timetable was planned for the signature of a treaty next year**: Copenhagen therefore represents a step backwards compared to Kyoto.

The United Nations Conference "takes note" of the Copenhagen Accord, without endorsing it. A list will set out the countries that are in favour of and opposed to this accord.

In the end, each country will do what it wants to, with however an agreement on the communication (on a voluntary basis only), every two years, of the actions conducted to reduce greenhouse gases.

The one positive point: the unprecedented mobilisation of civil society and the general public, despite the subject, which appears very abstract and complicated.

[9] Source: http://www.notre-planete.info/actualites/actu_2220_Copenhague_climat_echec.php

IV. How to incorporate this subject into an environmental and sustainable development education project

1. Understand in order to act

Teaching work conducted within educational structures should enable an understanding of climate change through experimentation (knowledge area) but also the practising of public debate and the ability to defend, negotiate, to come to an agreement on ideas share by the whole group (life skills area). This will also be a means for each person to gain awareness of their responsibilities and, on the basis of these, to produce local actions and projects that are in line with the global issues identified by them (know-how areas).

2. Anchor projects in local issues

A good way of studying the climate change issue is to establish relationships with the local environment and to conduct research projects with the pupils. Carrying out research is above all a matter of attitude, reasoning and method. Research is not something only developed by sophisticated laboratories, universities or specialist centres. The various educational structures (middle school, high school, youth club and arts centre, etc.) are places for the development of knowledge, but also of know-how and of life skills.

3. Build collectively…

In a teaching project in sustainable development education, importance must be given to work in small groups. The members of the educational community must be present and collaborate in the project as much as possible, each according to their skill area, with their ideas, their knowledge and their uncertainties. Research work in groups on specific subjects will thereby place the pupils in the role of actors and give them the possibility of building knowledge by themselves.

4. … and with interdisciplinarity

Interdisciplinarity is a critical element. A theme such as climate change is actually very wide. It encompasses very different areas of research and needs to be looked at from different angles (purely scientific but also social, economic and cultural). At the beginning of each project, it is important to ask oneself: what is the role and the challenge of human societies in the face of a global problem such as this one? The economic and social sciences may for example be lagging behind on the globalisation of our societies and the impacts that it has had on a local and global level on the way we exploit resources, produce and consume.

The more your project comprises a number of different disciplines, the more comprehensive it will be and the more it will provide both an overall and specific understanding. Moreover, it will facilitate the objective of resolving a local problematic situation all the more.

5. Favour thematic inputs

Furthermore, if we looking more detail at the types of research that can be conducted by the pupils, a great number of themes can be linked together. Let us also remember that the coordination team of the International Conference has chosen "global socio-environmental change", which encompasses climate change, as the theme for the international conference in which the European delegates will participate. This theme cuts across the social, economic, cultural and environmental dimensions of current changes.

Here are a few examples of links between particular themes and climate change. We use here the major themes (earth, water, air, fire), which came out of the working method developed by the Brazilians.

❖ Water:

Include the water cycle (p.18)
Causes of global warming:
Water in vapour form is a GHG
Increase in evaporation leads to an increase in temperatures, which leads to an increase in evaporation etc.

Consequences of global warming:
Expansion and rise of the seas
Melting of ice
Acidification of the seas
Scarcity of drinking water resources
Drying up of major water reserves (lakes and inland seas)

Links to socio-economic issues
Population movement to access drinking water and water for livestock (migration, conflicts, overpopulation etc.)
Reflection on water management methods at the local, national and global level (public, private, community, project to make it a Global Public Good etc.)
Strikes and demonstrations because of the price of water in countries of the South
Economic disruption in certain mountainous regions linked to a drop in snowfall and the melting of glaciers

❖ Air:

Include the carbon cycle (p.17)

Causes of global warming:
Include the phenomenon of rising temperatures on the Earth's surface:
Greenhouse effect
CO_2 emissions (fossil energy combustion, transport, housing, agriculture, etc.) and aerosols
Increase in fossil energy transport

Consequences of global warming:
Changes in wind and precipitation patterns
Links between pollution and warming

Changes in gas exchanges between air, water and land

Links to socio-economic issues
Health issues related to pollution
Choice of policy on energy, transport, housing and agriculture
Globalisation of the economy / relocation of the economy

❖ Earth

Causes of global warming:
Intensive agricultural production methods
Deforestation
Urbanisation (concentration of CO_2 emissions)
Exploitation (overexploitation) of natural resources

Consequences of global warming on:
Agricultural production (unfavourable to some areas, favourable to others)
Biodiversity and natural habitats (change and disappearance, invasion and emergence)
Coastal zones (disappearance of some due to rising seas)
Certain fragile areas (desertification, flooding etc.)

Links to socio-economic issues
Rises in food prices
Famine, malnutrition
Dwellings (densification of urban areas, changing and disappearance of living areas)
*Compare examples of policy choices on agricultural production (*Intensive agriculture intensive / local organic agriculture)*, modes of transport, methods of the use of natural resources* (protection of biodiversity / patenting of life)

❖ Fire (energy):

See the carbon cycle p.17

Causes of global warming:
Exploitation and use of fossil energy

Consequences of global warming on:
Same as for the other themes

Links to socio-economic issues
Exhaustion of fossil energy resources
Rise in the price of fossil energy
Compare the energy policies in different countries

❖ the alternatives and solutions:

- renewable energy: what resources enable the generation of clean energy and the reduction of carbon in the atmosphere?
- responsible consumption (consumption of organic and/or local products, fair trade)
- reduction of waste production and recycling,
- reduction of energy consumption
- sustainable housing
- transport that is an alternative to the use of fossil fuel combustion vehicles and personal vehicles
- etc.

For a project to be relevant, it is very important to start from a local issue identified by the pupils and from this to widen it to the global context into which it fits. Another very important aspect is the production by the young people of "educommunication"[10] tools through which they may communicate their project and its outcomes.

[10] "Educommunication" is a term used by the organisers of the Brasilia International Conference. They believe it is a way of linking education and communication, and to defend the right of individuals to produce information and communication.

V. ANNEXES

ANNEX 1. THE CARBON CYCLE

Carbon is a chemical element present on Earth since its formation. It can take various forms: gaseous form, such as carbon dioxide (or carbon acid gas – CO_2), on of the gases of which the atmosphere is formed[11]; liquid form, such as the carbonic acid present in water; or sedimentary form, such as oil and coal. The different states of carbon are closely linked in the form of a cycle and on four levels: the atmosphere (air), the biosphere (living), the hydrosphere (oceans, seas, lakes) and the lithosphere (sediments and rocks).
The land and marine carbon cycle is carried out through three phenomena: photosynthesis[12], respiration and decomposition.

Photosynthesis: it is a process through which chlorophyllian plants (green plants, algae and bacteria), in the presence of light, produce their food, producing their energy reserves and synthesising organic matter. The chlorophyll captures light energy and uses it to form carbohydrates (sugars) from carbon dioxide and water. This reaction also produces oxygen, which is released into the atmosphere. It is through this process that a large share of the carbon is absorbed by the natural world. It thus becomes an organic carbon[13].

Respiration[14]: Conversely, living organisms (animals, plants and micro-organisms) use the oxygen present in the atmosphere to burn nutrients and obtain the energy necessary for their growth, their mobility and to provide all of their vital functions. It is the phenomenon of respiration. This reaction produces CO_2, which is released into the atmosphere and reused in photosynthesis, thus forming a continual cycle.

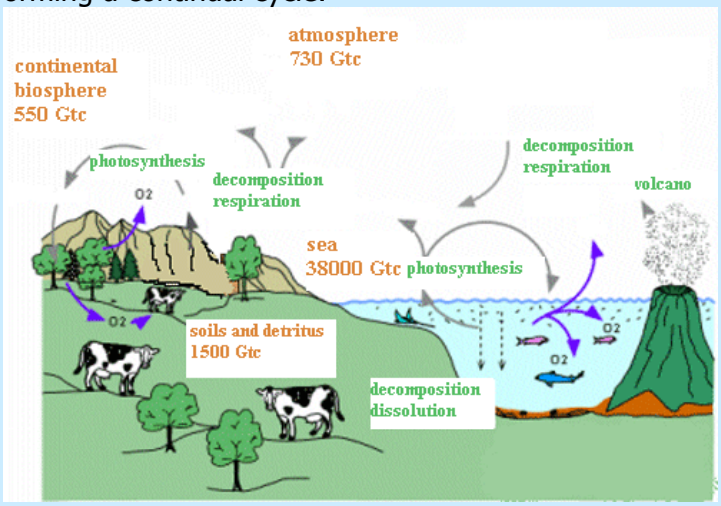


Image source: http://www.cnrs.fr/cw/dossiers/dosclim/motscles/Images/cycleC.html

Decomposition: Some carbon is found in soils and is carried by the roots of plants, the leaves fallen from trees, the excrement and the carcasses of living organisms. These dead organisms are digested by micro-organisms: the decomposers. The latter, mostly bacteria and fungi, destroy organic matter and transform into basic elements which return to the soil (e.g. nitrogen, proteins) or to the atmosphere (carbon in the form of CO_2) and again become available to plants.
Source: CNRS – *cycle du carbone*

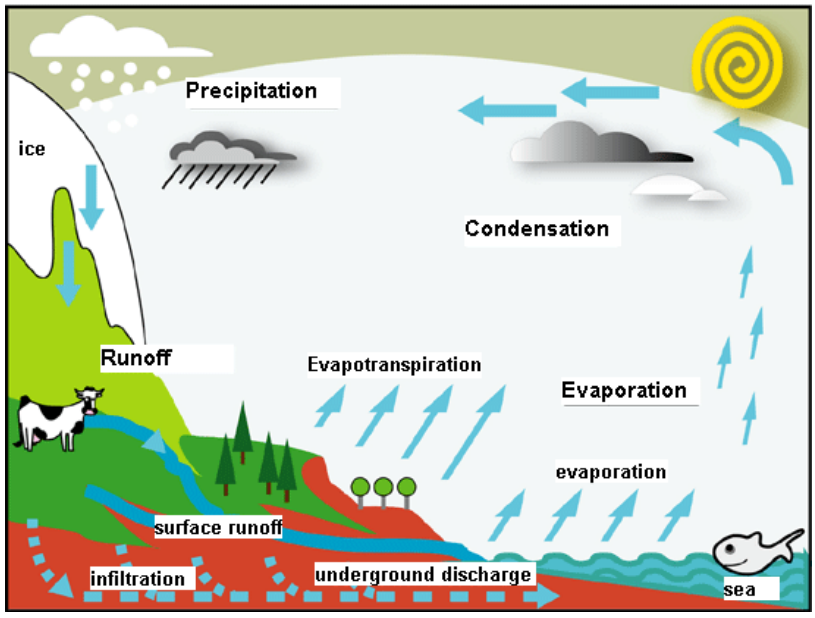
[11] See text box on greenhouse gases p.6
[12] See the definition and the animation that accompanies it at: http://cycleducarbone.ipsl.jussieu.fr/content/view/11/6
[13] Inorganic carbon is found in non-living compounds, such as for example the carbon in the atmosphere or limestone.
[14] Opposite process to photosynthesis: consumption of oxygen (oxidation of sugars) and release of carbon dioxide and water into the atmosphere. http://cycleducarbone.ipsl.jussieu.fr/content/view/11/6

This phenomenon is also at the origin of the formation of hydrocarbons. Dead organic matter slowly escapes into the soil, until it reaches sedimentary rocks. It is a very slow process (several million years), which enables the formation of hydrocarbons: coal, petrol and gas.

The same cycle (photosynthesis, respiration and decomposition) is found in the seas (which occupy 70% of the globe's surface), except that the actors that ensure photosynthesis are phytoplankton and zooplankton[15].

ANNEX 2. THE WATER CYCLE

The Earth has contained the same quantity since its origin. Organised in a system, water is a unique resource. In continuous movement, it circulates between four large reservoirs: the hydrosphere (seas and oceans), inland water bodies (surface and underground), the atmosphere and the biosphere. This forms what is called the hydrological cycle or water cycle. It is an essential cycle of life, during which water goes through different physical phases (solid, liquid, gaseous). The driver of this thermal mechanism is the energy of the Sun.



In fact, solar energy causes the evaporation[16] of water (in the seas, streams, lacks, rivers), but also the transpiration of the soil and plants (otherwise known as evapotranspiration). As the water vapour penetrates the atmosphere, the fine droplets of water expand and form clouds. This is condensation[17]. The more the water condenses, the more it forms large drops, which finally fall back to the surface of the Earth as rain, snow or hail (depending on the ambient temperature). This is precipitation. While the majority evaporates again, the rest infiltrates the soil, absorbed by the roots of plants or feeding the water table and aquifers[18]. This water becomes "ground water".

Image source: *http://www.cnrs.fr/cw/dossiers/doseau/decouv/cycle/cycleEau.html*
When the soil is saturated, the water runs off the soil to rivers and then towards the seas. In cold regions, the water turns into ice.

[15] Phytoplankton and zooplankton belong to the plankton family (very small living organisms that live suspended in water). The phytoplankton is a plant organism whereas the zooplankton is an animal organism, which feeds on phytoplankton. www.futura-sciences.com

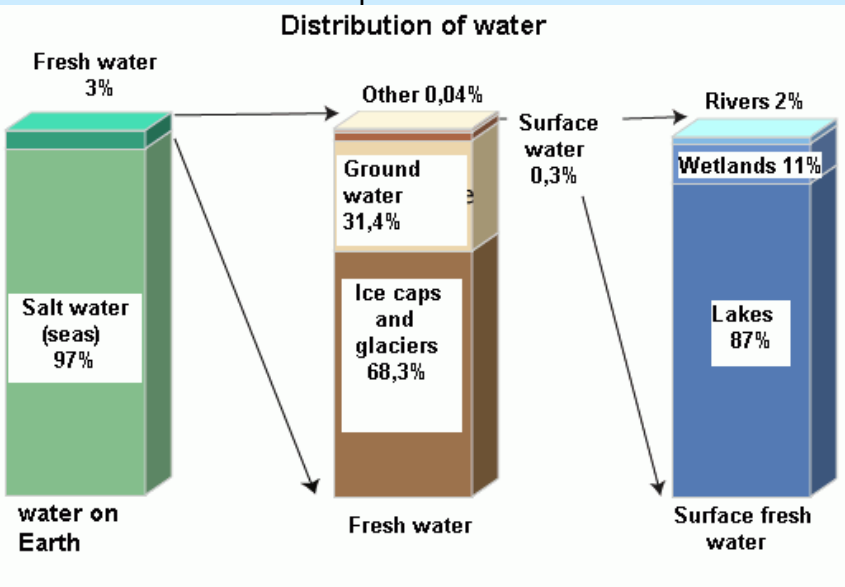
[16] Process by which liquid water turns into gas or vapour. *USGS (U.S. Geological Survey)*, http://ga.water.usgs.gov/edu/watercyclefrench.html#evaporation

[17] Opposite process to evaporation, it is the transformation of vapour into liquid.

[18] Geological formation temporarily or permanently containing movable water, made up of permeable rocks and able to release it naturally and/or through extraction. *Futura Science* site, http://www.futura-sciences.com/fr/definition/t/terre-1/d/aquifere_1030

On average over the year and over the whole of the Earth, it is estimated that 65% of the precipitation that falls to the ground evaporates, 24% runs off and 11% infiltrates[19]. The quantity of water in the hydrosphere remains stable and it can be considered that any loss of water in one or other of the parts that we have just seen (atmospheric or land) is compensated by a gain in the other part.

97% of the quantity of water present on Earth is found in the seas and oceans (salt water) and the remaining 3% is fresh water. Within this 3%, only 0.3% is available as surface water. This is what remains for human and animal consumption.



Source: http://ga.water.usgs.gov/edu/watercyclefrench.html

Pollution can affect water quality, but its use can change the quantities present in the four large reservoirs. For example, the quantity of water can fall in a region's rivers and lakes when it is intensively and inappropriately used or when its tributaries and coastal forests are destroyed.
When the quantity of water in a given area is disturbed, this can affect the local water cycle and alter the local climatic conditions. For example, flooded soil feeds back into precipitation through a more substantial convergence of moisture due to the increased evaporation of water vapour.

Water is a greenhouse gas that is essential to the planet because it contributes to the creation of the temperature and moisture necessary for the formation and maintenance of life. Water vapour retains more heat in the atmosphere when it is present in greater quantity. It is a vicious circle since the heat in turn generates more vapour in the air, which leads to more precipitation, etc. However, the link between global warming and disturbance of the water cycle is not yet proven. In fact, there is considerable natural variability in precipitation, it is difficult to model[20] certain observed trends and there uncertainties regarding the impacts of the different anthropogenic forcings[21].

[19] Figures taken from the site of the CNRS (Centre National de la Recherche Scientifique), *Dossier scientifique: L'eau*, "Le cycle de l'eau", http://www.cnrs.fr/cw/dossiers/doseau/decouv/cycle/cycleEau.html

[20] "A climate model is a numerical representation of the Earth system using many lines of computer code. This representation of the Earth system is based on the state of our knowledge of the physical, chemical and biological properties of the different elements, their interaction and of the feedback processes." CNRS definition, *Dictionnaire des mots-clés*, http://www.cnrs.fr/cw/dossiers/dosclim/motscles/motscl1.html

[21] "Les impacts des changements climatiques sur le cycle hydrologique" by Hervé Douville, Jean-Claude Andre and Ghislain de Marsily, http://www.cnrm.meteo.fr/gmgec/news/Annales.Mines-Impacts.Eaux.Climat_2007.pdf

ANNEX 3. INTERNET RESOURCES FOR TEACHERS AND PUPILS IN ENVIRONMENTAL AND SUSTAINABLE DEVELOPMENT EDUCATION, AND ON CLIMATE CHANGE

Useful links for your educational projects

http://www.carboeurope.org/education/index.php?lang=en
CarboSchools, a European project on scientific learning of the carbon cycle in schools. A partnership between researchers and secondary school teachers on the global changes.

http://ec.europa.eu/environment/climat/campaign/index_en.htm
European Website on the climate changes: among others, several quiz games to test their knowledge, PowerPoint presentations, resources of different types to be used at school or at home…

http://www.worldwildlife.org/climate/curriculum/item5944.html
WWF – Climate Curriculum for Teachers

http://www.youtube.com/watch?v=kvUsSMa0nQU
Video on YouTube: The other CO2 problem (Plymouth Marine Laboratory and a school).

http://www.curiosphere.tv/spheres/developpement-durable
More than 100 videos on sustainable development, documentaries, humour, in French or in English.

Understanding Climate changes and Sustainable development issues:

http://www.cite-sciences.fr/english/ala_cite/expo/tempo/planete/climax/index_climax.php
Climax, simulation expo on the climate changes (from 2005) - information on climate changes, film, online games, experts answers on several questions.

http://www.manicore.com/anglais/index.shtml
Jean-Marc Jancovici website. He is a consultant engineer, expert on climate change and greenhouse gases. An excellent website that will answer all your questions!

http://www.thew2o.net/events/oceans/oa.php
World Ocean Observatory – Ocean acidification

http://www.ncdc.noaa.gov/paleo/globalwarming/what.html
NOAA - Global Warming and Green house effect

http://hyperphysics.phy-astr.gsu.edu/hbase/thermo/grnhse.html
HyperPhysics – Green House Effect (University Georgia, US)

http://earthguide.ucsd.edu/earthguide/diagrams/energybalance/index.html
EarthGuide - Global Energy Balance, diagram (Sripps Intitution of Oceanography)

http://www.educypedia.be/education/environmentwarming.htm
Educypedia - many references on climate change

http://www.ipcc.ch/pdf/assessment-report/ar4/wg1/ar4-wg1-spm.pdf
Summary of the 4th IPCC report (Intergovernmental Panel on Climate Change), providing all the official data on climate changes (2007 report).

http://www.carboeurope.org/education/carboschools_booklet_HD.pdf
"What we know, what we don't know. How we try to better understand global change", an educational guide created by CarboSchools on scientific aspects of the climate changes.

Contacts

European internet platform :
http://www.mondepluriel.org/psdlp/

Official International Conference website :
http://portal.mec.gov.br/brasil2010/en/

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