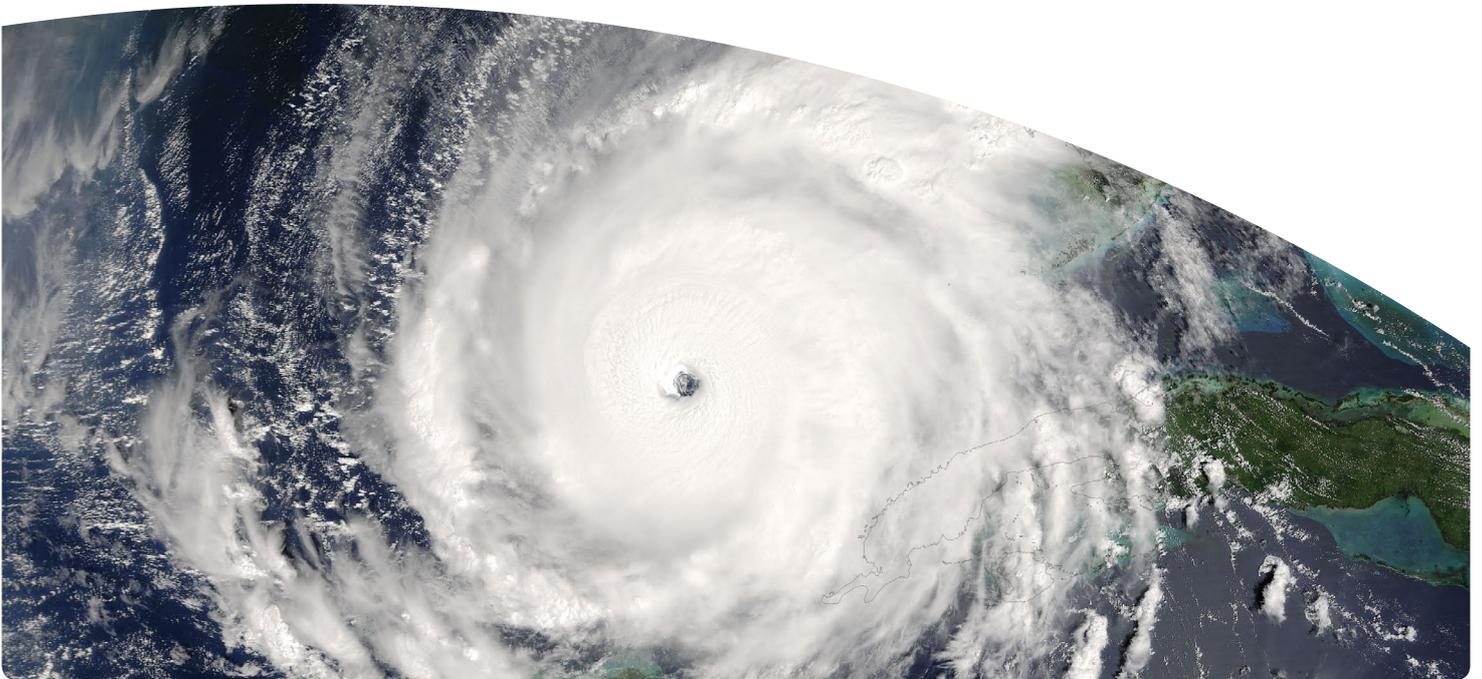


WORKSHEETS ON CLIMATE CHANGE

Global climate change

General issues



Global climate change

General issues

The relatively stable climate in the Holocene period brought about the living conditions for humanity to create civilisation on planet Earth. The human-made greenhouse effect is a characteristic of the Anthropocene period, whose onset is currently the subject of discussion, though generally dated to around the year 1800. Anthropogenic climate change is one of the most significant threats to the global environment and an impediment to development. It is above all the lifestyles and economies of the industrialised countries, which are increasingly being adopted by the better-off members of society in emerging and developing countries, which are responsible. However, those most likely to be affected by it are the developing countries, particularly the poorest members of society. More than just about any other phenomenon of our time, the human-made greenhouse effect and its consequences are exemplary of the challenges facing the globalised world. Reports about weather catastrophes (e.g. the European “summer of the century” in 2003, floods in India and Bangladesh in 2007, Typhoon Haiyan which hit the Philippines particularly hard in 2013), warnings from climate researchers, annual climate conferences and broad-based political-public discussion at the highest levels of government (e.g. the 2007 G8 Summit in Heiligendamm) all indicate a high level of public interest in the issue of climate change. This reached a new peak in 2013 with the publication of the Fifth Assessment Report of the Intergovernmental Panel on Climate Change (IPCC).

This report provides the scientific certainty that humans are the main cause of climate change (95% probability). It shows that in this century we may see a significantly higher increase in sea level than previously predicted while also highlighting the problem of ocean acidification, with the oceans absorbing much of the carbon dioxide (CO₂) emitted by human activity. At the same time, IPCC scientists have also demonstrated that, with ambitious climate protection measures, there is a chance we can still avoid a dangerous climate change, i.e. a rise in the average global temperature of over 2 °C. How humanity responds to this challenge in the coming years is vital to the issue of whether living conditions will change to a dangerous degree.

Use in the classroom

This teaching unit focuses on the causes and effects of climate change in general, and the issue of culprits and victims in particular. This basic module should allow the pupils to gain the basic knowledge for the following modules, which are conceived as case studies. A current extreme weather incident would be a good starting point for this series of lessons, if possible using the example of a concrete, local action or conflict scenario with which the pupils are directly or indirectly engaged. Options could include current heat or drought events in the pupil's country, where possible presented with the assistance of audio-visual aids. Thereafter the origins of the natural greenhouse effect should be developed using material **M 1**. By repeating important climatic terminology and examining the radiation balance of the Earth, pupils become familiar with the Earth's current temperature as well as the effect of natural temperature fluctuations. Information on the basic functions and possible consequences of the anthropogenic greenhouse effect builds on this knowledge. In units **M 2–M 5**, pupils discover the greenhouse effect and learn the extent to which the natural greenhouse effect is being increased by anthropogenic influence. Solid scientific findings on the natural and anthropogenic greenhouse effect as well as hitherto unexplained aspects can be derived from analysis of the key results of climate research and current discussion. This should allow pupils

to recognise that scientific uncertainty in some areas can no longer serve as an excuse for inaction. An approach to the topic of climate change and climate protection which takes these problems into account requires facts on the origins of sources of greenhouse gas emissions. **M 6–M 10** consequently examine the sources and causes of the anthropogenic greenhouse effect which to date have largely been found in industrialised countries but which are increasingly apparent in emerging countries. **M 11–M 20** look at the possible impact of climate change, with the most vulnerable sections of the population in developing countries being most at risk. As this is largely derived from the results of scientific scenarios, the message here is that most consequences are still subject to influence and thus avoidable. In developing countries, particularly, there is an urgent requirement for adaptation to consequences which can no longer be avoided. These modules lend themselves to a work-sharing approach in small groups (e.g. by developing a wall newspaper) with a concluding presentation. **M 21–M 25** are concerned with the issue of solutions. The range of possible solutions indicate above all that humanity still has the power to limit the negative impacts of climate change. There's no call for fatalism. Finally, the materials on offer provide an opportunity for discussion about possible solutions and the actions which would be required to achieve them.

Further reading:

Archer, D. and S. Rahmstorf (2009): *The Climate Crisis: An Introductory Guide to Climate Change*. Cambridge University Press, Cambridge.

Burck, J. et al. (2013): *The Climate Change Performance Index. Results 2014*. Germanwatch, Bonn.
<http://germanwatch.org/en/7677> (Accessed 10.02.2014).

Kreft, S. and D. Eckstein (2013): *Global Climate Risk Index 2014*. Germanwatch, Bonn.
<http://germanwatch.org/de/7659>. (Accessed 27.01.2014).

IPCC (2013): *Summary for Policymakers*. In: 9, 20, 2013 *The Physical Science Basis. Contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change* [Stocker, T.F., D. Qin, G.-K. Plattner, M. Tignor, S. K. Allen, J. Boschung, A. Nauels, Y. Xia, V. Bex and P.M. Midgley (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA.
<http://www.climate2013.org/spm> (Accessed 24.01.2014).

The World Bank (2012): *Turn Down the Heat. Why a 4°C Warmer World Must be Avoided*. International Bank for Reconstruction and Development / The World Bank, Washington.
http://climatechange.worldbank.org/sites/default/files/Turn_Down_the_heat_Why_a_4_degree_centrigrade_warmer_world_must_be_avoided.pdf (Accessed 18.02.2014).

Germanwatch

Following the motto “Observing, Analysing, Acting”, Germanwatch has been actively promoting global equity and the preservation of livelihoods since 1991. In doing so, we focus on the politics and economics of the North and their worldwide consequences. The situation of marginalised people in the South is the starting point of our work. Together with our members and supporters as well as with other actors in civil society, we intend to represent a strong lobby for sustainable development.

We attempt to approach our goals by advocating for the prevention of dangerous climate change, food security, and compliance of companies with human rights.

Germanwatch is funded by membership fees, donations, grants from the “Stiftung Zukunftsfähigkeit” (Foundation for Sustainability) as well as grants from various other public and private donors.

You can also help achieve the goals of Germanwatch by becoming a member or by donating to:

Bank fuer Sozialwirtschaft AG
BIC/Swift: BFSWDE33BER
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The publisher is responsible for the content of this publication.

Within the series of *Worksheets on Climate Change* the following publications are available in English:

- Global climate change – General issues
- The melting glaciers – Glacial lake outburst floods in Nepal and Switzerland
- Sea level rise – Consequences for coastal and lowland areas: Bangladesh and the Netherlands
- Going under! The threat of rising sea levels for the small island nation of Tuvalu
- The threat to tropical rainforests and international climate protection
- Climate change and food security – Trends and key challenges
- Extreme events and climate change – Insurances for developing countries

See: www.germanwatch.org/en/worksheets

All worksheets are also available in German.



Observing. Analysing. Acting.
For Global Equity and the Preservation of Livelihoods.

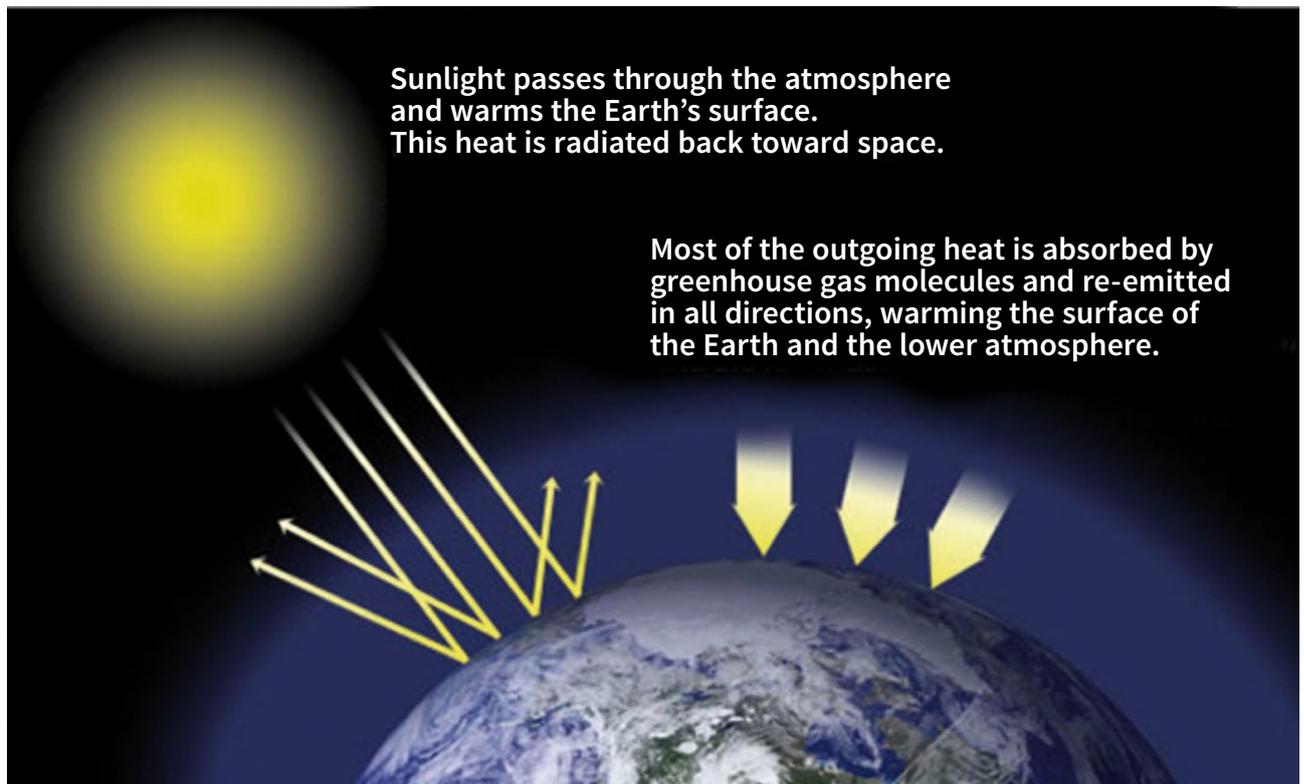
M 1

The natural greenhouse effect

The atmosphere processes radiation from the sun or from the Earth just like the glass walls of a greenhouse for plants: it allows most of the short-wave solar radiation to pass through, but largely absorbs long-wave terrestrial radiation. This heats the air in the greenhouse. However, if sunrays were reflected unhindered into space as heat rays, the Earth would become an uninhabitable ice desert with none of the oceans, seas and rivers which it now has.

The global mean temperature would be $-18\text{ }^{\circ}\text{C}$ rather than $+15\text{ }^{\circ}\text{C}$. Two-thirds of this approximately $33\text{ }^{\circ}\text{C}$ difference in temperature brought about by the natural greenhouse effect is attributable to atmospheric vapour. The rest is made up of carbon dioxide (21%) and to a lesser extent trace gases and aerosols. Both the atmospheric concentration of greenhouse gases and the global mean temperature are subject to natural fluctuation.

(Source: Bauer, J. et al. (2001): Physische Geographie. Materialien für den Sekundarbereich II Geographie. Hannover, p. 81, significantly modified and supplemented.)



(Source: <http://climate.nasa.gov/causes>, accessed 31.01.2014)

EXERCISE

1. Describe the natural greenhouse effect using the illustration in **M 1**.
2. Summarise the potential causes of natural climatic fluctuations and compare them with each other (you can use the Internet and other sources for research).

M 2

Early recognition of the greenhouse effect

The first indication of a greenhouse effect in the atmosphere caused by humans was published by Swedish scientist Svante Arrhenius in 1896. He put forward the theory that the increase in industrial coal combustion could cause the atmospheric concentration of CO₂ to double.

The ensuing anthropogenic greenhouse effect would lead to a global warming of 4–6 °C. However, because Arrhenius couldn't substantiate his theory with measurements, his research attracted little public attention.

M 3

The anthropogenic greenhouse effect

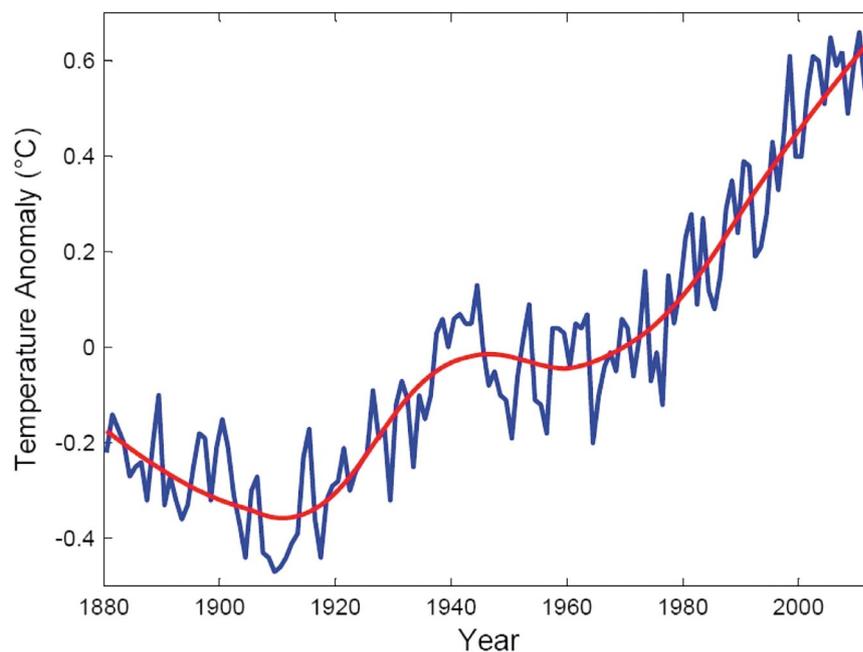
Today almost all scientists agree that the Earth's climate began to warm up a few decades ago, an outcome which can only be explained by human intervention. The main cause is the so-called anthropogenic greenhouse effect. The factors responsible are greenhouse gases, par-

ticularly carbon dioxide (CO₂), which since the Industrial Revolution has been pumped into the air in large quantities, additional to the naturally occurring concentration of greenhouse gases.

M 4

Indicators of climate change

Change in the global mean temperature (year values blue, smoothing red) based on NASA data.



(Source: Rahmstorf, S. (2013): Globale Temperatur 2012. In: Spektrum SciLog's, Klimalounge, based on NASA data. <http://www.scilog.de/wblogs/blog/klimalounge/klimadaten/2013-01-20/globale-temperatur-2012>, accessed 24.01.2014)

M 5

Climate-changing trace gases

According to the IPCC, the concentration of the greenhouse gases carbon dioxide, methane and nitrous oxide in our atmosphere is higher than at any point in the last 800,000 years.

(Source: <http://climate.nasa.gov/causes>, accessed 31.01.2014)

Trace gas	Anthropogenic origin	Current concentration (change since 1750, pre-industrial level) ¹	Annual concentration increase (average 2003–2012) ¹	Proportion of anthropogenic greenhouse effect (since 1750) ¹	Greenhouse potential per particle, CO ₂ = 1 (over 20 years) ²
Carbon dioxide (CO ₂)	Combustion of fossil fuels, forest clearance, soil erosion, wood combustion	393 ppm (141%)	2.02 ppm	64%	1
Methane (CH ₄)	Rice cultivation, livestock, natural gas seepage, combustion of biomass, landfill, use of fossil fuels	1819 ppb (260%)	3.7 ppb	18%	84
Nitrous oxide (N ₂ O)	Combustion of biomass and fossil fuels; use of fertiliser	325 ppb (120%)	0.8 ppb	6%	264

ppm: parts per million; ppb: parts per billion.

ppm/ppb is a relative value used to estimate, for example, the level of concentration of greenhouse gases in the atmosphere. An atmospheric concentration of 393 ppm means that a volume of 1 million air particles contains 393 particles of CO₂.

(Sources: ¹WMO (2013): Greenhouse Gas Bulletin. The State of Greenhouse Gases in the Atmosphere. Based on Global Observations through 2012;

²IPCC (2013): Climate Change 2013: The Physical Science Basis. Working Group 1 Contribution to the IPCC Fifth Assessment Report, Chapter 8)

EXERCISE

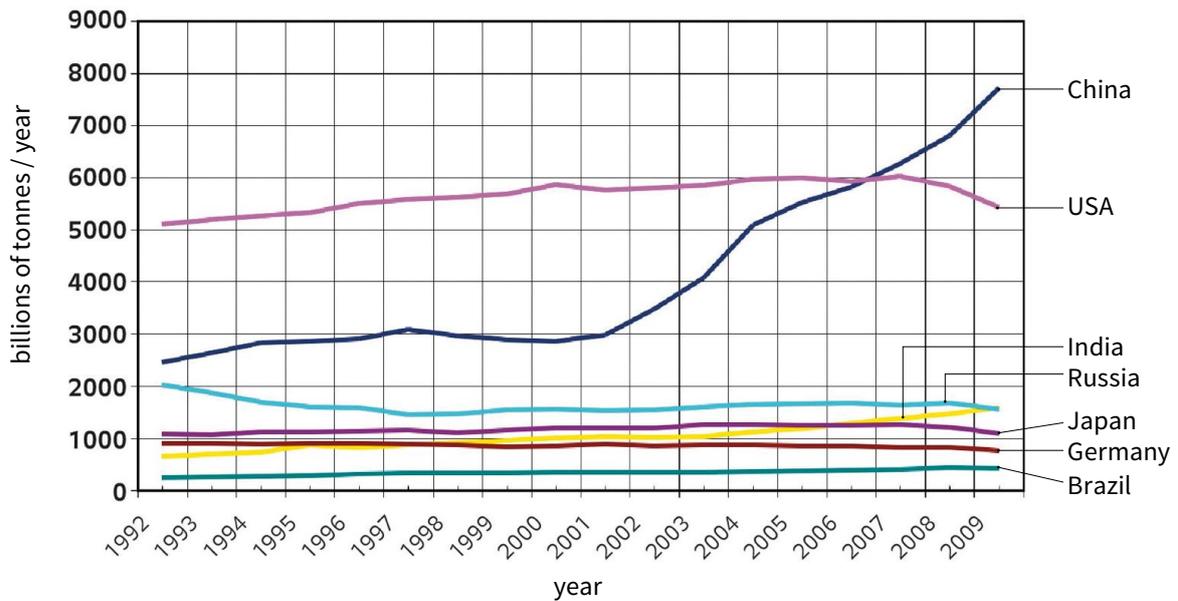
- Interpret the diagram **M 4** and relate it to **M 2 and M 3**. What conclusions can you draw from the curve trend since the Industrial Revolution?
- Compare and evaluate the trace gases in relation to their characteristics (origin, effect and trend) and their corresponding influence on the greenhouse effect (**M 5**).

Who is responsible for the anthropogenic greenhouse effect?

M 6

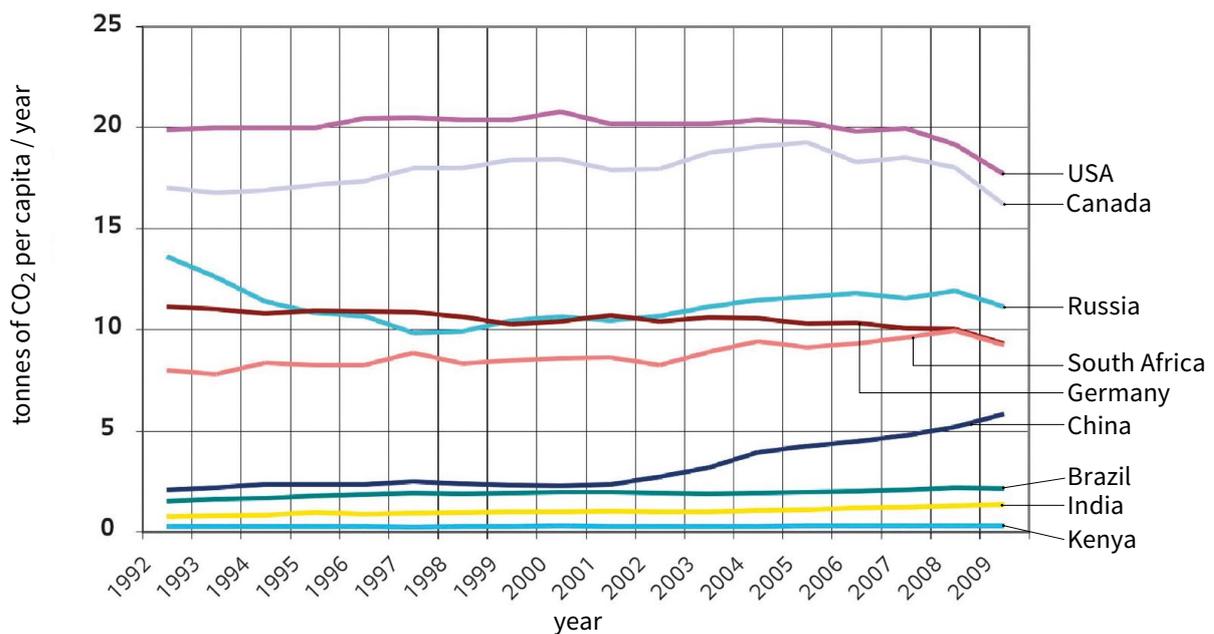
Development of energy-related CO₂ emissions 1992–2009

Development of energy-related CO₂ emissions 1992-2009



(Source: Germanwatch (2011): Globaler Klimawandel: Ursachen, Folgen, Handlungsmöglichkeiten. Germanwatch, Bonn, p. 43. <http://germanwatch.org/de/3428>, accessed 28.01.2014, based on data from U.S. Energy Information Administration, <http://www.eia.doe.gov>)

Development of energy-related CO₂ emissions per capita of nine selected countries between 1992 and 2009



(Source: Germanwatch (2011): Globaler Klimawandel: Ursachen, Folgen, Handlungsmöglichkeiten. Germanwatch, Bonn, p. 44. <http://germanwatch.org/de/3428>, accessed 28.01.2014, based on data from U.S. Energy Information Administration, www.eia.doe.gov)

M 7

The greenhouse gas culprits

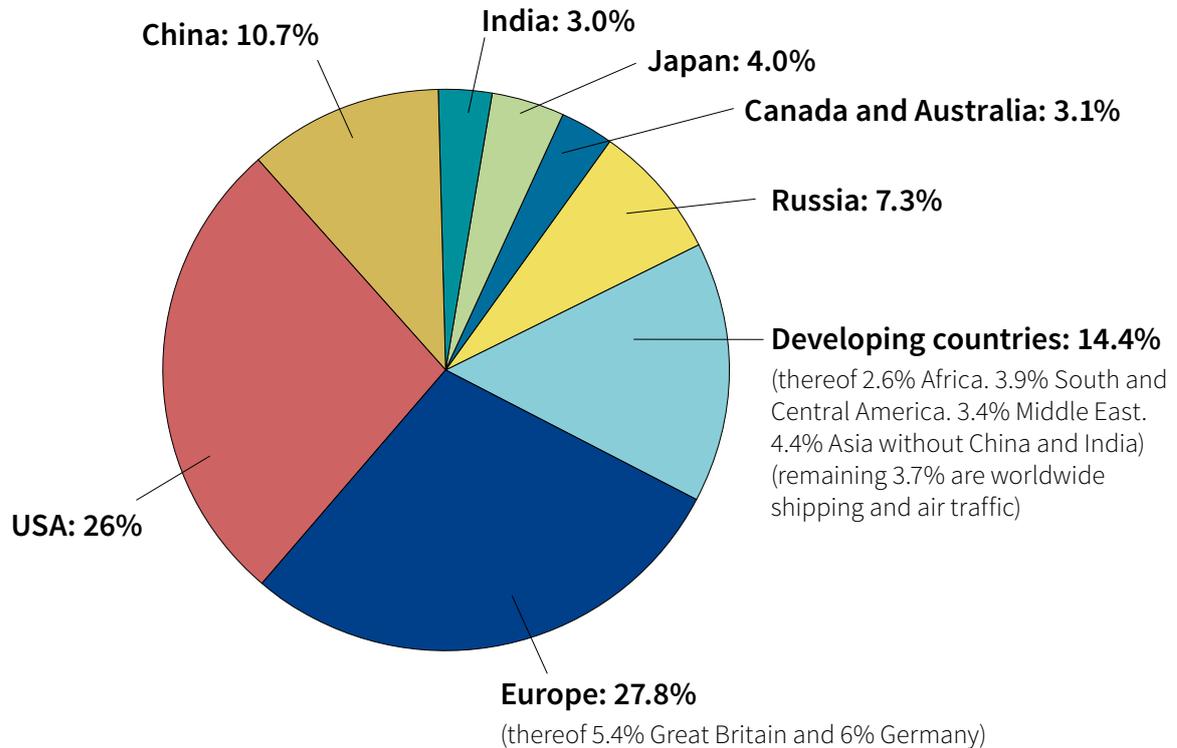
Energy-related CO₂ emissions* in 2011 (selected countries)

Country	Total in million tonnes CO ₂	Change between 1990 and 2011	Per inhabitant in tonnes CO ₂
China	7999.6	+251.2%	5.9
USA	5287.2	+8.6%	16.9
India	1745.1	+199.7%	1.4
Russia	1653.2	-24.1%	11.7
Japan	1186.0	+11.7%	9.3
Germany	747.6	-21.3%	9.1
Canada	529.8	+23.7%	15.4
Great Britain	443.0	-19.3%	7.1
Indonesia	425.9	+191.6%	1.8
Brazil	408.0	+112.1%	2.1
Australia	396.8	+52.6%	17.4
Italy	393.0	-1.1%	6.5
South Africa	367.6	+44.9%	7.3
France	328.3	-6.9%	5.0
Poland	300.0	-12.3%	7.8
Spain	270.3	+31.7%	5.9
Thailand	243.2	+202.4%	3.5
Argentina	183.6	+83.8%	4.5
Netherlands	174.5	+12.0%	10.4
Czech Republic	112.7	-27.4%	10.7
Greece	83.6	+19.3%	7.4
Austria	68.5	+21.4%	8.2
Finland	55.6	+2.2%	10.3
Bangladesh	54.1	+298.9%	0.4
Portugal	48.1	+22.4%	4.5
Hungary	47.4	-28.6%	4.7
Sweden	44.9	-14.9%	4.7
Denmark	41.7	-17.7%	7.4
Switzerland	39.9	-4.2%	5.1
Norway	38.1	+34.7%	7.6
Ireland	34.9	+14.6%	7.6
Luxembourg	10.4	+0.7%	20.8
Jamaica	7.6	+5.8%	2.8
Nepal	4.1	+359.1%	0.1

* “energy-related CO₂ emissions” means that the values don’t include other greenhouse gases such as methane or nitrous oxide, nor do they include CO₂ emissions which arise as a result of forest clearance or industrial processes. The data is based on the sectoral approach of the IEA.

(Source: International Energy Agency (2013): CO₂ Emissions From Fuel Combustion Highlights 2013, Paris.)

M 8

Cumulative energy-induced CO₂ emissions 1750–2012

(Source: Hansen et al. (2013): Assessing "Dangerous Climate Change": Required Reduction of Carbon Emissions to Protect Young People, Future Generations and Nature. <http://www.plos.org/wp-content/uploads/2013/05/pone-8-12-hansen.pdf>, accessed 24.01.2014)

EXERCISES

5. Explain the emission trends in the countries depicted (M 6).
6. In your opinion, who are the "climate culprits" who are most responsible for the greenhouse effect?
Discuss and back up your opinion with arguments (M 7)
7. Compare historic and present-day "greenhouse effect culprits" (M 7 and M 8).
Discuss which perspectives should be given more weight, and why.

M 9

Developing and industrialised countries – the same requirements?

Developing and industrialised countries – equal right to pollute?

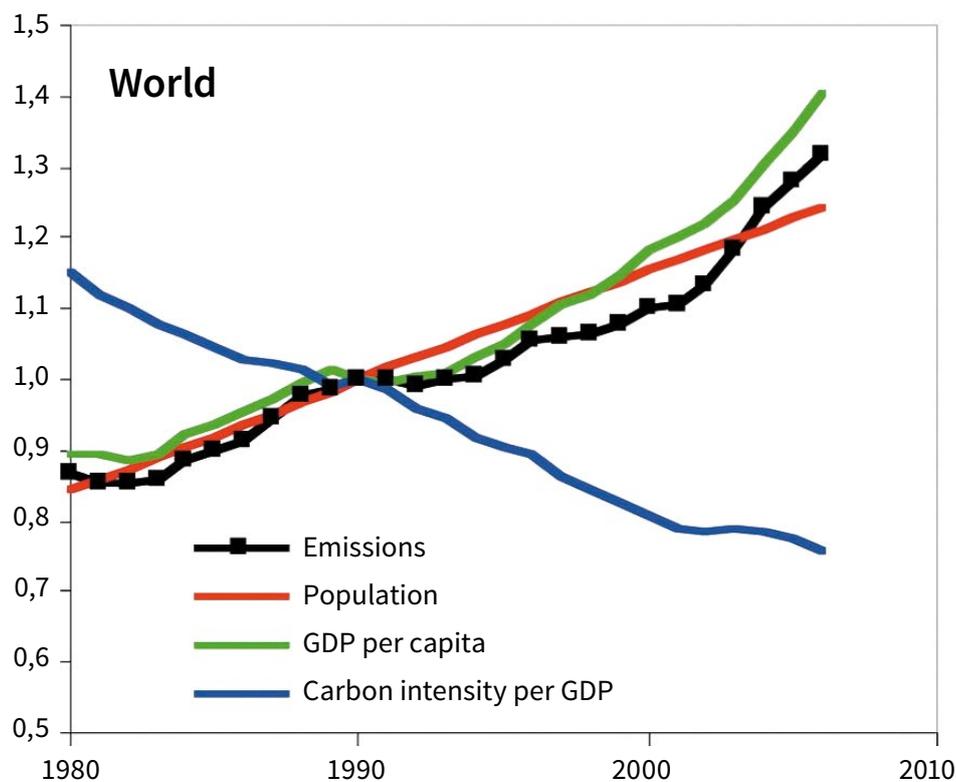
Developing countries are demanding the same right to economic development as industrialised countries have enjoyed for over 100 years, even when it comes to climate policy discussions. They reject demands from industrialised countries to adhere to cost-intensive environmental regulations. “Economic growth first” is the motto here: they feel that the responsibility for environmental policies rests with those historic “culprits”. China, for example, has recorded rapid growth and currently leads the world in CO₂ emissions. Coal-fuelled power stations are responsible for 80 percent of the country’s energy. However, China is also number one in the use of solar panels, wind energy and, since 2013, photovoltaic energy.

A further example of China’s state of development is the car industry, where growth has been increasing steadily since the country joined the World Trade Organization (WTO). The percentage of the Chinese population able to afford a car is increasing steadily. In 2011 more than 40,000 new cars were registered every day. The total number of cars has grown to more than double that of Germany, but bear in mind that China has a population 16 times larger than Germany’s.

The climatic effects of a further “boom” will be dramatic.

M 10

Worldwide development of emission factors



(Source: updated and simplified from Raupach, M. et al. (2007): Global and regional drivers of accelerating CO₂ emissions. In: PNAS. Vol. 104.)


 EXERCISES

8. Evaluate the development of CO₂ emissions in China and India (**M 6, M 7 and M 9**).

9. The first commitment period of the Kyoto Protocol until 2012 called for industrial countries to reduce emissions by 5.2%. One of the USA's arguments against signing the Kyoto Protocol was that the major emitters among the developing and emerging countries, such as China and India, were not yet obliged to reduce their greenhouse gases. Evaluate the American position (**M 6 to M 9**).

10. Analyse the factors which are responsible for the growth in emissions over the last 30 years (**M 10**), and to what degree. How do you assess the trend for the last ten years? Discuss the factors which might be decisive here.

11. Simulate a press conference (role play) in which the representatives of various interests, both producers and victims of carbon dioxide emissions, present their positions on the issue of reducing carbon dioxide emissions. Speakers should discuss the costs and consequences that preventing or accepting global climate change could have for the economy and for the affected countries.

Further suggestions

There are numerous CO₂ calculators available on the Internet which easily allow you to calculate your personal CO₂ balance. Try this website:

<http://www.carbonfootprint.com/calculator.aspx>

For air travel emissions:

<https://www.atmosfair.de/en/home>

Potential exercises

12. Analyse the relative relevance of individual causes of emissions (e.g. your energy consumption, the heating consumption of your home, etc.) which contribute to your total emission budget.

13. Compare your own total emission budget with the emissions per person of various countries.

The consequences – effects and victims of anthropogenic climate change

M 11**Headlines**

“Climate catastrophes – all lies?”

“Antarctica too warm for animals!”

“Glaciers melting, seas rising!”

“The sea level is rising! Will northern Germany sink into the sea?”

“The climate catastrophe is already here – cyclones, floods and droughts all on the increase!”

“Climate catastrophe imminent! Will Germany become a steppe?”

“Climate change worries insurers.”

M 12

The Fifth Assessment Report of the IPCC (2013)

The first part (WG1) of the IPCC's Fifth Assessment Report (AR5) presented clear-cut results to the global public in 2013:

The key statements of the AR5 on the phenomenon of climate change:

- In 2012 the global mean temperature was 0.85 °C higher than in 1880. The last three decades were each warmer than every other decade since temperature records began (1850).
- There is almost complete scientific certainty (95%) that anthropogenic greenhouse gas emissions are the primary factor in the rise of global temperatures. There is ongoing discussion about the exact scope and impacts which can be expected in different regions.
- The AR5 makes clear for the first time the massive impact of anthropogenic climate change on the world's oceans. Between 1971 and 1990 the oceans absorbed over 90% of the additional energy of the "greenhouse Earth". Moreover, the acidification of the seas caused by absorption of CO₂ represents a major problem. Around 30% of anthropogenic CO₂ emissions since industrialisation have been absorbed by the seas.
- The projections for various scenarios indicate a likely rise in temperature of 1.5 °C by the end of the 21st century compared to the average between 1850 and 1900. Other projections assume an increase of up to 4.8 °C compared to the global average temperature between 1986 and 2005.

Phenomenon and direction of trend	Assessment that changes occurred (typically since 1950 unless otherwise indicated)	Assessment of a human contribution to observed changes	Likelihood of further changes, based on scenarios for the late 21 st century
Warmer and/or fewer cold days and nights over most land areas	Very likely	Very likely	Virtually certain
Warmer and/or more frequent hot days and nights over most land areas	Very likely	Very likely (nights only)	Virtually certain
Warm spells/heat waves: Frequency and/or duration increases over most land areas	Medium confidence on a global scale Likely in large parts of Europe, Asia and Australia	Likely	Very likely
Heavy precipitation events. Increase in the frequency, intensity, and/or amount of heavy precipitation	Likely	More likely than not	Very likely
Increases in intensity and/or duration of drought	Low confidence on a global scale Likely changes in some regions (increase in the Mediterranean and West Africa, decrease in central North America and North West Australia)	More likely than not	Likely
Increases in intense tropical cyclone activity	Low confidence in long-term changes Virtually certain in North Atlantic since 1970	More likely than not	More likely than not (in the Western North Pacific and North Atlantic)
Increased incidence and/or magnitude of extreme high sea level	Likely	Likely	Very likely

(Source: IPCC (2013): Summary for Policymakers. In: Climate Change 2013: The Physical Science Basis. Contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change, p. 5 and 18)

M 13 Methodical approach to establishing climate projections

IPCC scenarios

Climate projections

Assumptions

- World population
- Economic growth
- Energy mix
- Energy costs

Emission and concentration

- Greenhouse gases
- Aerosols

Calculations

Climate change

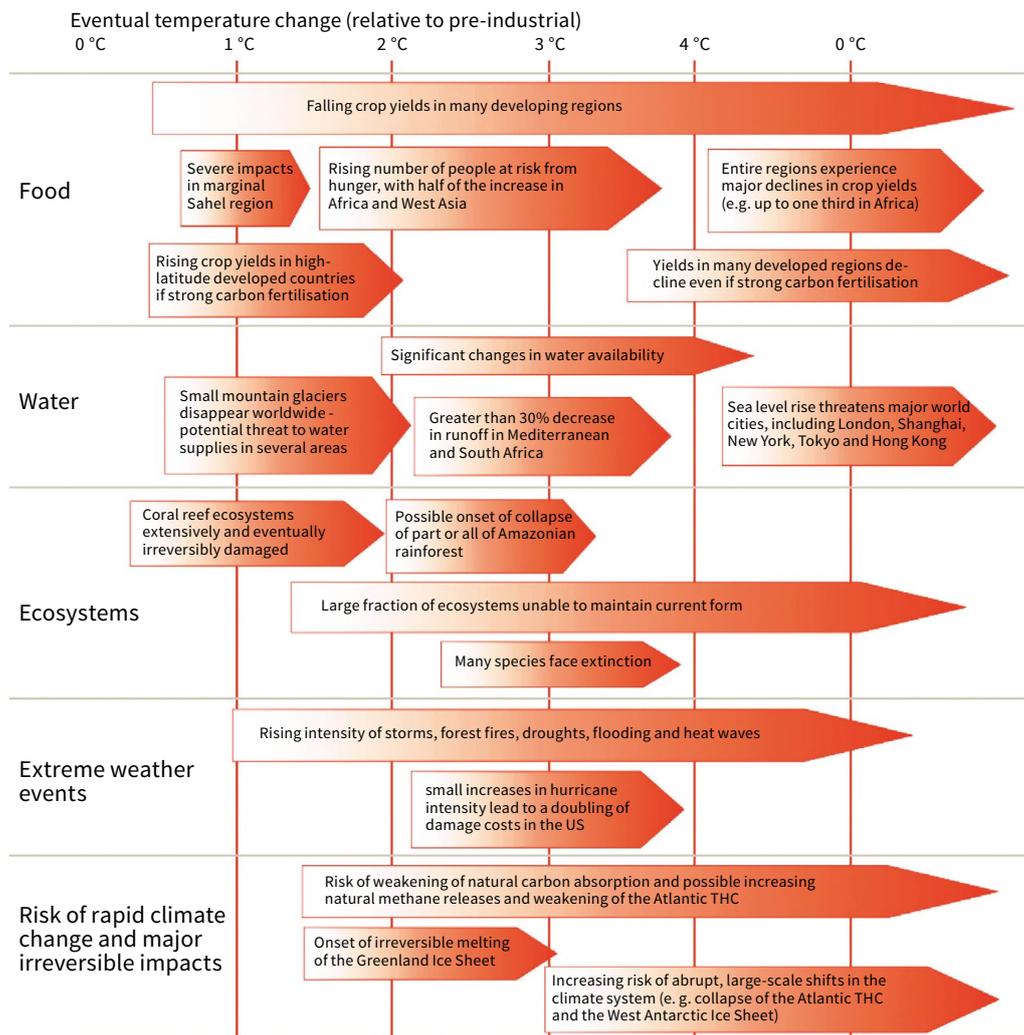
- Temperature
- Ocean currents
- Precipitation

Climate impact

- Sea level
- Extreme weather
- Health

(Source: IPCC (2001): Climate Change 2001 - The Scientific Basis, New York.)

M 14 The impact of climate change for people and the environment



(Source: WBGU (2007): Climate Change as Security Risk. Springer, Berlin, Heidelberg, New York, p. 164. <http://www.wbgu.de/en/flagship-reports/fr-2007-security/>, accessed 26.01.2014)

EXERCISES

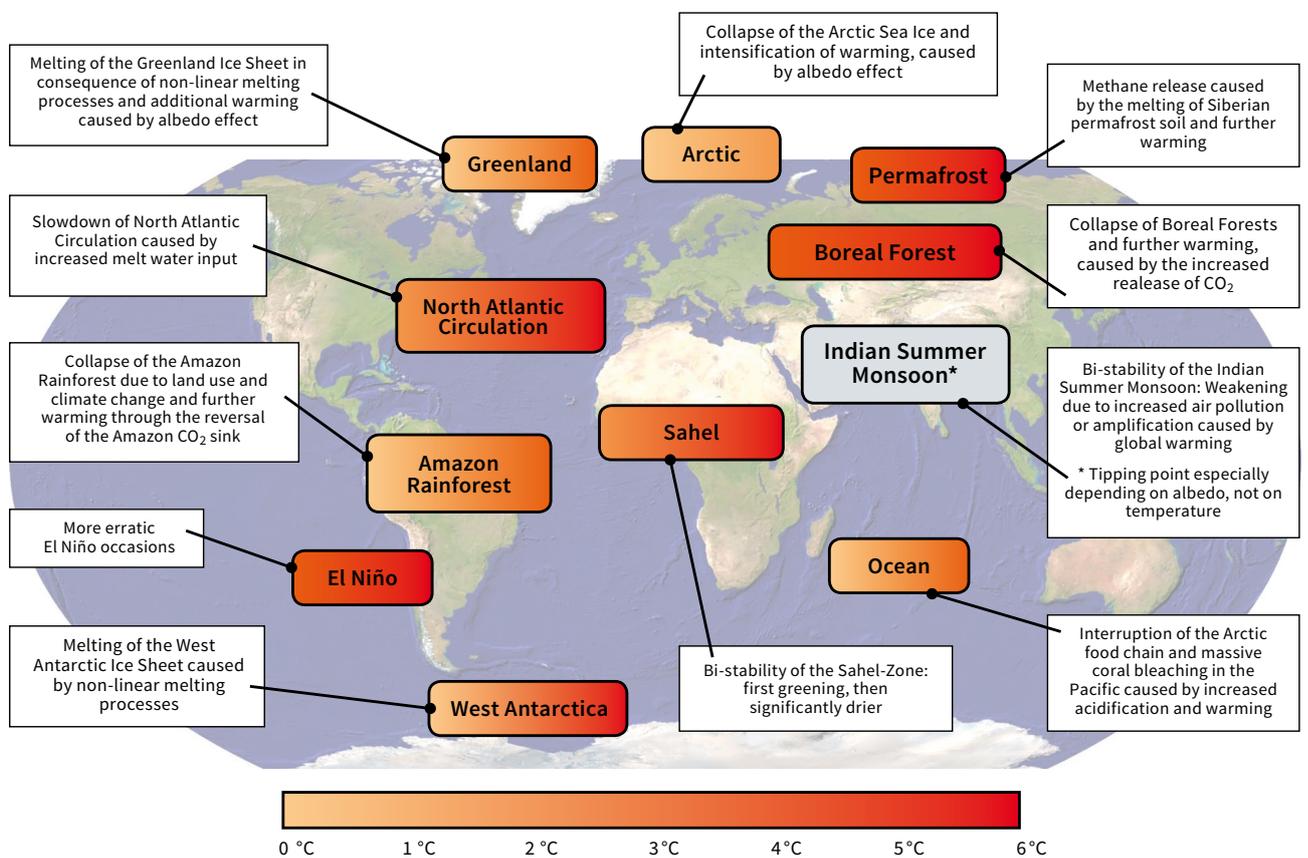
14. Provide a short response, ideally one sentence, to the statements in M 11.
15. Discuss the methods applied and potential problems in compiling climate projections (M 13).
16. Discuss the findings of the IPCC reports of 2013 and 2007 (if required see www.ipcc.ch) (M 12 and M 14).

M 15 Non-linear effects and tipping points in the climate system

“ In the event of high global warming, however, beyond 2-3 °C the risk of additional, qualitative changes occurring in the climate system increases. Such strongly non-linear responses by system components are often referred to as ‘tipping points’ in the climate system. This term is used to refer to the behaviour of the system when a critical threshold has been crossed, triggering runaway changes that are then very difficult to bring under control again. Broadscale parts of the Earth System capable of triggering such instability have been termed ‘tipping elements’. ”

(Source: WBGU (2007): Climate Change as Security Risk. Springer, Berlin, Heidelberg, New York, p. 72. <http://www.wbgu.de/en/flagship-reports/fr-2007-security/>, accessed 26.01.2014)

M 16 Tipping elements: Major risks for humans and nature

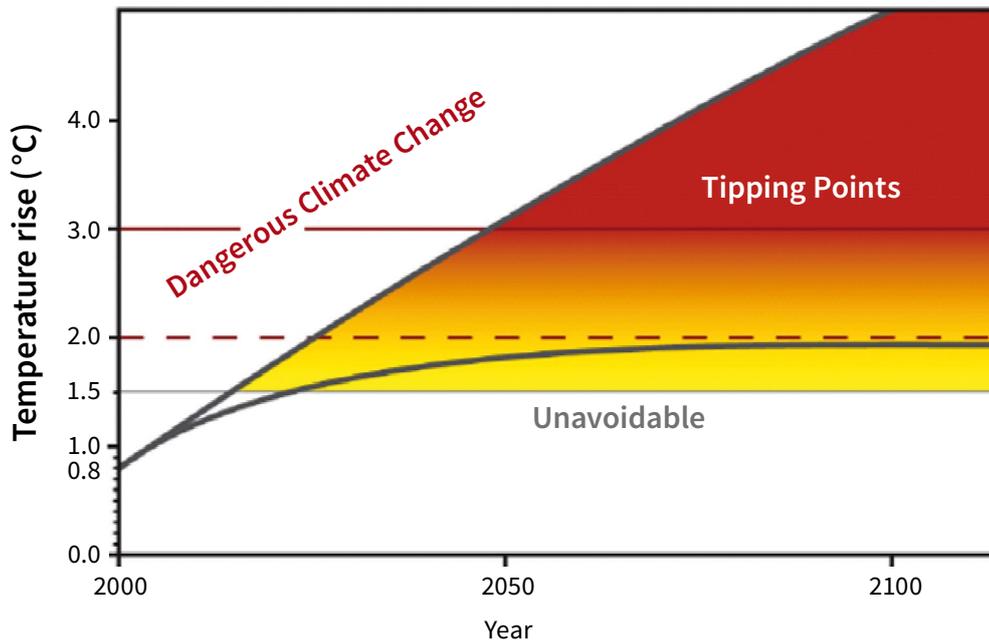


The colour scale indicates the point at which temperature increases cause such a system to destabilise.

(Source: Own diagram after Lenton, T.M. et al. (2008): Tipping Elements in the Earth's Climate System. In: PNAS. Vol. 105.)

M 17

Avoiding dangerous climate change



(Source: Bauer (2007): Fragile Staaten und Klimawandel: Neue Herausforderungen für internationale Politik und Entwicklungszusammenarbeit. Unpublished presentation)

EXERCISES

17. Express the positive and negative impacts of the greenhouse effect in the form of a table (M 14 and M 16).
18. Explain why many scientists, as well as the EU, are calling for the global temperature increase to be limited to 2 °C over the pre-industrial level.
19. Which consequences could an increase in global temperature have for you personally?

M 18

Climate change as a challenge for development cooperation

“ It is the developing countries who will suffer most from global warming – although they themselves have made the lowest contribution to it. And it is in turn the poorest of the poor who are most heavily affected by the increasing occurrences of droughts, floods and severe storms. [...] The countermeasures must come first and foremost from the countries whose climate-damaging greenhouse gases are responsible for climate change. And that means industrialised countries above all. But

it also means helping developing countries to adapt to the consequences of climate change and ensuring that they do not further contribute to the greenhouse effect. It’s about assistance in the use of renewable energies to help avoid further greenhouse emissions; it’s about protecting tropical forests, the “climate lungs” of the Earth; it’s about adapting agriculture to changing climate conditions – and it’s providing immediate protection for people, against heavy flooding, for instance. ”

(Source: own translation of BMZ Newsletter November 2007)

M 19

Adaptation despite scientific uncertainty

Measures for adaptation to climate change are highly dependent on concrete changes at the local or regional level. Global scenarios are not enough here. This is particularly true with respect to climate scenarios, as it is at the local and regional levels that there is most scientific uncertainty, due to insufficient spatial resolution in how these are mapped. Therefore, many countries see improved adaptation to current climatic conditions as a logical first

step. Measures such as improved catastrophe provisions against hurricanes in Central America certainly make sense whether climate change leads to a minor or major increase in severe hurricanes in the region. However, there must of course be more intensive research into the concrete local impact of climate change in order to develop long-term, successful adaptation strategies.

M 20

Fighting poverty and adapting to climate change – increasing resilience

Non-climatic stress factors increase vulnerability to climate change by decreasing resilience and reducing the capacity for adaptation through competition for resources. Coral reefs, for instance, are currently under strain from pollution of the seas, drainage of agricultural chemicals into the oceans as well as increasing water temperatures and ocean acidification. Vulnerable regions are confronted with multiple stress factors which negatively impact their stress and vulnerability as well as their capacity for

adaptation. These stress factors can result from current climate risks, poverty and unequal access to resources, or from food insecurity, trends in economic globalisation, conflicts and the incidence of diseases such as HIV/AIDS. Adaptive measures are rarely carried out solely in reaction to climate change. However, they could be integrated into such measures as water resource management, coastal preservation and risk minimisation strategies.

(Source: IPCC (2007): Klimaänderung 2007: Auswirkungen, Anpassung und Verwundbarkeiten, p.36)



EXERCISES

20. Explain why developing countries are particularly at risk from climate change (**M 18 and M 19**).
21. Explain why the field of “adaptation to climate change” is of increasing importance in development cooperation, and why it can’t be viewed in isolation from the struggle against poverty (**M 18-M 20**). Use the Internet to research the ways in which German development cooperation is transforming to adjust to this challenge (e.g. at www.bmz.de or www.giz.de). Where appropriate chose a different country.
22. In your opinion, what are the options available for adapting to the various impacts of climate change? What particular problems and obstacles do you see for developing countries?

Potential solutions

M 21

“*We are conducting an experiment with our climate which has got completely out of hand. We must do everything we can to slow it down – so that we leave a liveable world for our grandchildren.***”**

Dr. Gerhard Berz, Munich Re

“*We can still influence the severity of the sentence – the extent of the damage. It's worth fighting for every degree of temperature increase, even for every tenth of a degree.***”**

Prof. Dr Hans Joachim Schellnhuber, Director of the Potsdam Institute for Climate Impact Research (PIK) and Chairman of the German Advisory Council on Global Change (WBGU)

M 22

Towards global energy transition

In order to prevent dangerous, large-scale climate change, global warming should be restricted to 2 °C above the pre-industrial level. Furthermore, 4/5 of currently available fossil fuel resources should remain in the ground; however, a large proportion of them are already on companies' order books. To keep this upper limit of 2 °C, anthropogenic greenhouse gas emissions must be at least halved by 2050 compared to the 1990 levels. In the long term, the average emissions per head of population on Earth should be less than two tonnes per year. In Germany the level of emissions per head averages nine tonnes per year. For industrialised countries this would entail a reduction of at least 80% by 2050. In the rapidly developing emerging

countries such as China and India an urgent decoupling of economic growth and emissions increase is required.

Environmental organisations called 2014 on the EU:

1. *to reduce the production of greenhouse gas emissions in the EU by at least 55% by 2030 (in comparison with the base year 1990)*
2. *to include a 45% proportion of renewable energies in the gross final consumption of energy by 2030*
3. *to reduce final energy consumption by 40% by 2030 (in comparison with the base year 2005)*

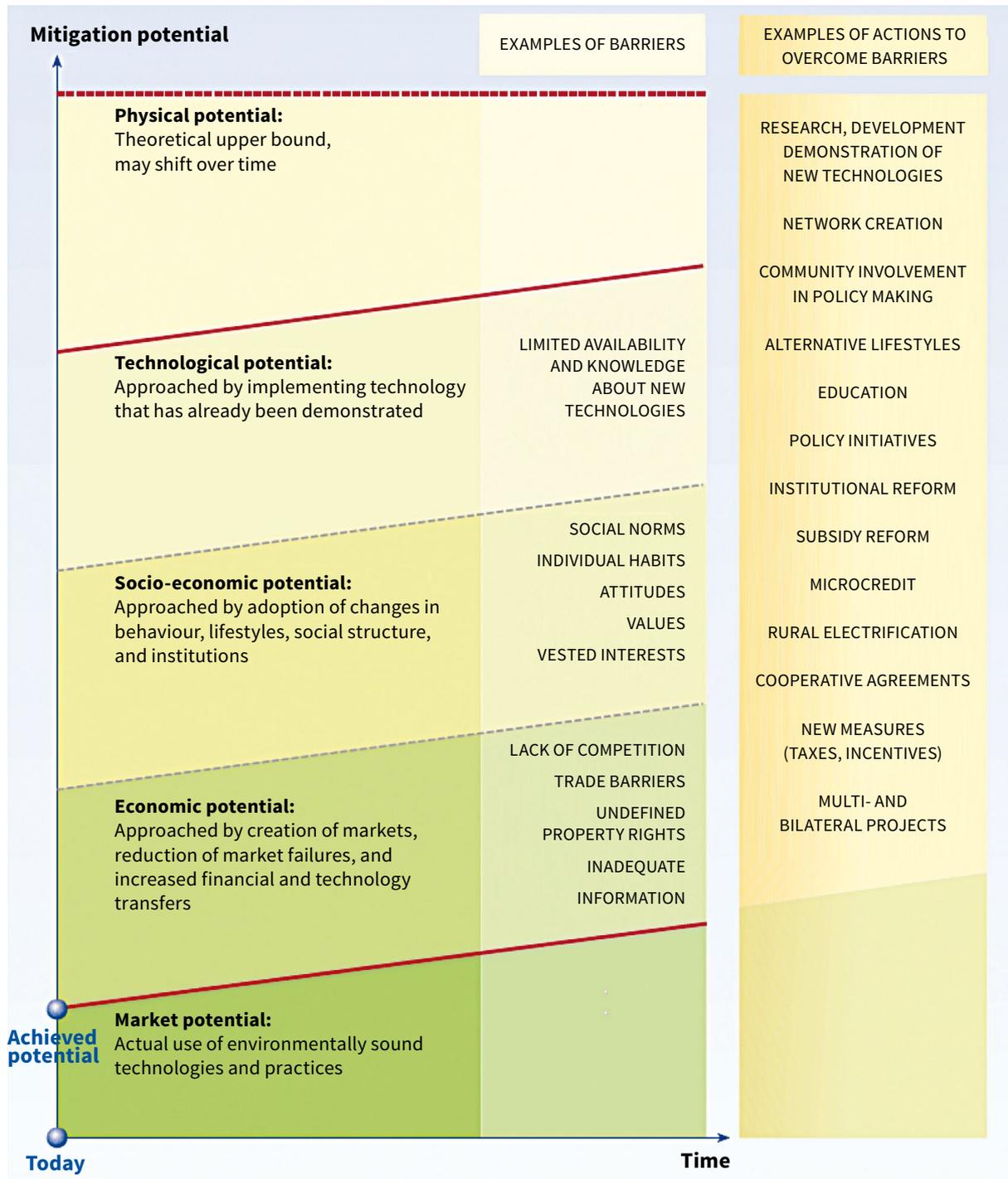
(Source: Germanwatch (2014): Verbände warnen vor Demontage der europäischen Klimapolitik. Umwelt- und Entwicklungsorganisationen fordern ambitionierte EU-Klimaziele für 2030. <http://germanwatch.org/de/7968>, accessed 24.01.2014)

Because developing and emerging countries are expected to double or quadruple their emissions in the same time period, if they do not play an active part in the energy transition, these countries must also make rapid changes to their energy production and usage. The focus of the energy transition, that is, the conversion of the energy

system towards a sustainable energy supply, should be based on the expansion of renewable energy sources, energy efficiency measures and energy saving. Because of considerable uncertainty around the tipping elements in the climate system, for example, the reduction objectives provided should be regarded as minimum requirements.

M 23

Concepts for reducing greenhouse gases



(Source: IPCC (2001): Climate Change 2001 - Synthesis Report, New York, p. 111)

EXERCISES

- Analyse opportunities for and obstacles to reducing anthropogenic greenhouse gas emissions (M 22 and M 23).
- Find out how the issue of climate protection is dealt with in your town or city, and present local projects and initiatives in the form of a short report.
- Consider and discuss what contribution you (or your school) can make in reducing emissions. Compile a list of personal climate protection measures which you can implement straight away, and review them in one (or half a) year. Factor in the varying impact levels of the measures. Form different work groups for this exercise.

M 24 The Kyoto Protocol

To concretise their obligations to protect the global climate, the signatory countries of the UN Framework Convention on Climate Change (UNFCCC) unanimously approved the Kyoto Protocol at their third conference in late 1997 in Kyoto, Japan. In the first phase, industrialised countries committed themselves to a verifiable total reduction in their greenhouse gas emissions of 5.2%.

The second commitment period of the Kyoto Protocol, which will last until 2020, is merely the hull of a once mighty vessel. It only covers around 15% of global emissions, with many significant emitters excluded. The EU, along with Norway, Switzerland and Australia, is taking part. Not so Russia, Japan and New Zealand. Canada left the Kyoto Protocol in 2011 and the USA never ratified it. The Kyoto architecture continues and so raises the question of which of its positive elements will find their way into future agreements.

(Source: adapted and supplemented from: Fischer-Weltalmanach (2003): p 1263)

M 25

“We can choose to believe that Superstorm Sandy, and the most severe drought in decades, and the worst wildfires some states have ever seen were all just a freak coincidence. Or we can choose to believe in the overwhelming judgment of science, and act before it’s too late.”

(B. Obama, President of the USA, 2013)

“I believe that the situation that we face [related to climate change], [...] is as dangerous as any of the sort of real crises that we talk about.

Today we had a hearing [...] on the subject of Syria, and we all know what’s happening with respect to Iran, and nuclear weapons and the possibility even of a war. Well, this issue [of climate change] actually is of as significant a level of importance, because it affects life itself on the planet.”

(J. Kerry, Secretary of State)

“At a time when governments throughout the world are struggling to boost growth, increase access to energy, and improve food security, it is essential that the full costs and benefits of climate policies are more clearly understood.”

(Nicolas Stern, British Economist, October 2013)

“The energy transition is finally underway, and no-one can return to the old structures! And I don’t know anyone who would seriously want to.”

(Professor Klaus Töpfer, former executive director of the United Nations Environment Programme (UNEP), in: Deutsche Umwelthilfe, 22 November 2013)

(Source: WBGU (2007): Climate Change as Security Risk. Springer, Berlin, Heidelberg, New York, p. 72. <http://www.wbgu.de/en/flagship-reports/fr-2007-security/>, accessed 26.01.2014)

M 26

Worldwide energy transition is achievable

Many people are currently looking towards Germany. Most countries are still not convinced that the German energy transition will succeed. However, worldwide energy transition is not only achievable, it is urgently required. As early as 2050, 77% of all energy worldwide could come from renewable sources. Currently the rate is just under 19%, with traditional biomass including wood and manure combustion representing 9.3%. While major investments will be required upfront, they will not exceed one percent of global gross domestic product. Moreover, these invest-

ments will pay off in 10 to 15 years, as renewable energies prove considerably cheaper in the long term. Renewable energies are already competitive today, but politicians need to do more to promote their use. The first signs of a transition can be seen in the fact that just under 120 countries have agreed on objectives for the expansion of renewable energies. More than half of them are developing countries. Along with China, the USA and Germany, significant growth in renewable energies has been seen above all in Spain, Italy, India and Japan.

(Source: REN 21 (2013): Renewables 2013: Global Status Report, Paris.)



26. Explain and discuss the ways in which CO₂ emissions could be reduced at global and local levels (M 22–M 24 and M 26).

27. Discuss the difficulties in establishing measures for reducing the anthropogenic greenhouse effect as well as their implementation (M 21–M 24 and M 26).

28. Comment on and evaluate the statements in M 25.
Where do you see the basic difficulties and discrepancies between “talk and action” summarised?