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EduS4EL © - Worksheet

Temperatures - Sea level height - Melting of polar ice
Are there connections?

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Source: https://www.pexels.com/de-de/foto/szenische-ansicht-des-gefrorenen-sees-gegen-blauen-himmel-314839/

Global warming and climate change - Germany experienced an exceptional weather year in 2022. The 2018 temperature record of 10.5 degrees Celsius was at least set. There was a new record for sunshine duration. With a precipitation deficit of about 15 percent, the past twelve months were very dry in this country. The trend in the annual mean temperature also saw a further increase with the warm year of 2022: since 1881, it has now become 1.7 degrees warmer in Germany. In the previous year, this value was still 1.6 degrees.

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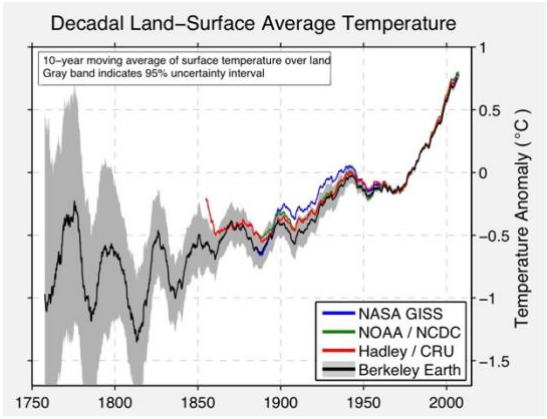
In Europe, the summer of 2022 was the hottest since weather data has been recorded[1] . In tandem with global warming, extreme weather events are increasing in all regions of the world - including here in Germany.
The forecasts for the future sound no less threatening: deserts are spreading, glaciers are melting and areas are being flooded. In the meantime, the dangers of climate change have been recognised and efforts are being made worldwide to protect the climate. But how did climate change come about in the first place? And are the efforts to combat global warming sufficient?

Here are some key facts:
(More details at: https://www.klimafakten.de/en , or https://climate.copernicus.eu/)

Over the past centuries, the **surface temperature** on Earth has risen significantly. Blue, green and red in the graph below are the data sets of the established research institutes (Goddard Institute of Nasa, National Climate Data Center of the US government and Hadley Center/CRU in Great Britain). Nasa, the US government's National Climate Data Centre and the Hadley Centre/CRU in the UK) - the black line shows the results of the Berkeley Earth Project.



1. The past decade (2010-2019) was the **warmest decade** since 1850: the average temperature from 2010 to 2019 was probably higher than at any time in a decade since measurements began, according to the World Meteorological Organisation (WMO).
2. Another indicator of long-term climate change is the **frequency distribution of temperature extremes.** The five warmest years since weather records began in1880 were all in the last five years, with 2019 being the second warmest year.
3. **Ocean temperatures** are at least as relevant as air **temperatures** - because the oceans can absorb many times more heat than the energy storage capacity of the atmosphere. The uppermost ocean layers (up to 700m depth) have warmed significantly in recent decades. For more than a decade, it has been consistently above the long-term average (1981 to 2010).
4. **Permafrost areas - ground that is frozen all year round - are** shrinking worldwide.
5. Global warming can also be seen in the **melting mountain glaciers**: they have been losing mass worldwide for years.
6. Around the North Pole, warming is about twice as fast as the global average. In recent decades, the **extent of Arctic sea ice has** declined dramatically The ice is not only becoming less, but also thinner. The melting ice is causing **sea levels to rise**, threatening to flood many inhabited areas of the earth.

[1] https://climate.copernicus.eu/copernicus-summer-2022-europes-hottest-record

Sunny, hot and dry: Germany experienced an "exceptional weather year" in 2022, as the German Weather Service announced in its annual weather balance[2] . "The long-term warming has continued in the past year," explains meteorologist Tim Staeger from the *ARD weather centre*. "Meanwhile, the temperature level in this country has risen by 1.7 degrees compared to pre-industrial times." The year 2022, together with 2018, is the warmest since systematic measurements began in 1881. On average, it was 10.5 degrees warm in Germany.[3]

What are the connections between rising temperatures, melting ice in the Arctic and rising sea levels?

Further background information

https://www.ardalpha.de/wissen/umwelt/klima/klimawandel/meeresspiegel-steigt-klimawandel-meer-eis-eisschmelze-pole-100.html
http://psc.apl.uw.edu/research/projects/arctic-sea-ice-volume-anomaly/

List of variables

To investigate whether there is a relationship between sea level, average land and sea temperature (land_ocean_temp) and ice volume (polar_ice) in the Arctic, we compiled three data sets:

Data set sea level[4]

Variable name	Possible characteristics	Explanation
Date	From 1880-01-16 until 2009-12-17	Date of the measurement
gmsl (global mean sea level)	Values between -184 and 85	Sea level height, global mean sea level Data are given as changes from 1 January 1993 and are 2-month averages measured in mm.
method	Coastal tide gauge records or satellite	Records of coastal tide gauges[5] or Satellite measurements[6]

[2] https://www.dwd.de/DE/presse/pressemitteilungen/DE/2022/20221230_deutschlandwetter_jahr2022_news.html
[3] https://www.tagesschau.de/wissen/klima/wetterbilanz-dwd-klima-2022-101.html
[4] https://sealevel.nasa.gov/understanding-sea-level/key-indicators/global-mean-sea-level/
[5] http://www.cmar.csiro.au/sealevel/downloads/church_white_gmsl_2011.zip
[6] http://sealevel.colorado.edu/files/2018_rel1/sl_ns_global.txt

	observation	

Data set land_ocean_temp[7]

This dataset contains information on the global land-ocean mean temperature measured by weather stations and ships around the world for each year from 1880 to the present (Source: NASA GISTEMP Team, 2020[8]).

Variable name	Possible characteristics	Explanation
Date	From 1880-01-01 to 2019-01-01	Date of measurement (day is always 1 January)
Ann-mean	Values from -0.47 to 0.99	The data represent so-called temperature anomalies or deviations, which indicate how much warmer or colder it is at a particular place and time. Normal here means the average over the 30-year period 1951-1980 for that location and time of year.

Data set polar_ice[9]

Variable name	Possible characteristics	Explanation
Year	From 1979 to 2021	Year of measurement (day is always 1 January)
extent	Values between 3.57 to 7.67	Arctic ice area measured in millions of square kilometres, each as of 1 January

For data exploration we work with the software Common Online Data Analysis Platform CODAP.

CODAP is a free educational software for data analysis. This web-based data science tool is designed as a platform for developers and an application for students in grades 6-14.

Discover and analyse:

[7] https://data.giss.nasa.gov/gistemp/tabledata_v4/GLB.Ts+dSST.csv
[8] NASA GISTEMP Team (2020). GISS Surface Temperature Analysis (GISTEMP), version 4.
[9] https://nsidc.org/data/g02135/versions/3

Now it is up to you to explore the data. By clicking on the following link, you can view and analyse the data using the CODAP programme,

https://codap.concord.org/app/static/dg/en/cert/#shared=https%3A%2F%2Fcfm-shared.concord.org%2F4ZSKtEUzP97hWHzgF98m%2Ffile.json

Tasks:

1. Imagine you live in Greenland. Maybe you live from fishing. You have heard about climate change. What impact do you think rising temperatures and shrinking ice cover in your country will have on the way you and your descendants live?

2. Which statements related to the context and background are not clear to you? Which unfamiliar technical terms are used?

Our guiding question here is: What are the connections between rising temperatures, melting ice in the Arctic and rising sea levels? Try to come to conclusions through appropriate graphical representations and statistical calculations.

3. Create a graph that shows the temporal course of the relative height of the sea level from 1880 to 2020. Select "Connect lines" in the graph menu. Describe in words what you see.
4. Create a similar graph showing the mean land-ocean temperature from 1880 to 2020. Comment!
5. Display both graphs from 1) and 2) one below the other, with the same width of the graph window. Select the symbol "colour brush" in one of the two graphic windows, click on "transparent" and change the colour of the graph. Now drag the transparent graph window over the other graph window so that the two time axes are aligned. You should now see both lines in one graph. Comment on what you see.
6. When you look very carefully at your graph for sea level height (task 3) you notice that the data up until December of 2009 were recorded by the coastal tide gauge records, and the sea level was surveyed with satellite methods between Dec 1992 to January 2018. Hence there is an overlap of 17 years from Dec 1992 to December 2009, when both methods were used to record the global mean sea level (gmsl). Do the two different methods come to measurements that are close to each other or do they differ much?
7. Now create a graph that shows the course of the Arctic ice sheet over time between 1980 and 2020. Describe what you see.
8. Place the graph from 4.) below the graph created in 3.) and scale it so that the years of the two (actually three) graphs between 1980 and 2020 are below each other.