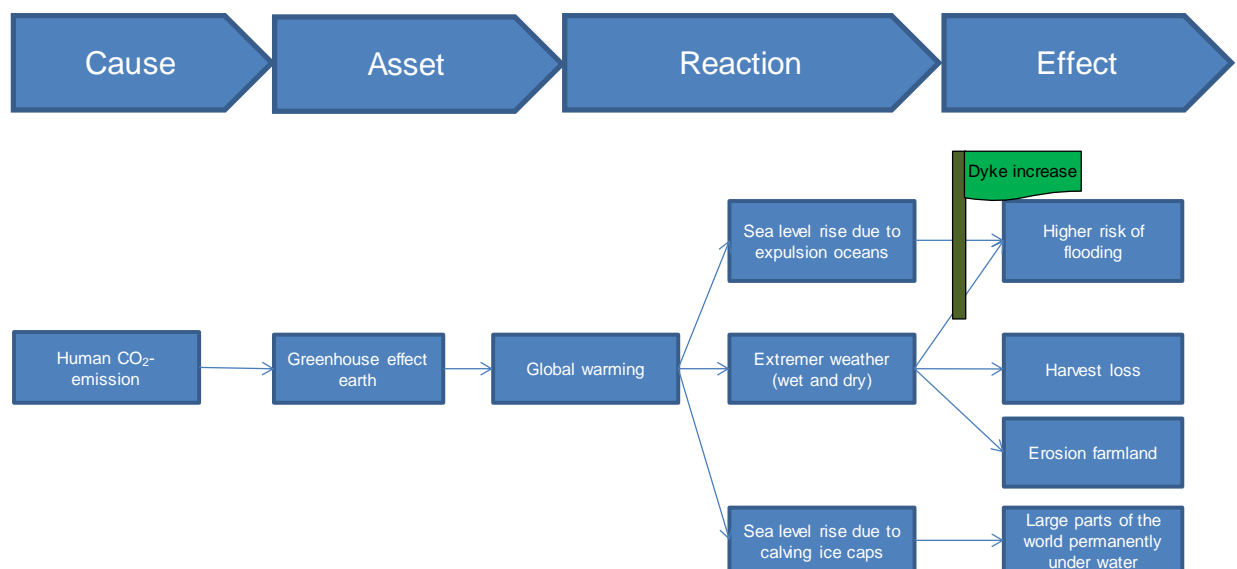


Regret regreter regretest

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20 April 2018

Last week, spring showed its best side, with temperatures well above 20 degrees¹. It is strange to see what the outside temperature does to a person. About a month ago we were still exposed to the eastern front offensive of arctic cold, now we are almost burned by the sun in the garden while we try to lit the barbecue. The solar panels run well, the heater can be switched off, if you wear less clothes you also have to wash less, and the best time is with a good book under the apple tree. You also do not have to fly far to see a little sun. So a higher temperature makes us all climate-friendly. Because we are still inside of a building thinking about sustainability (a computer screen can still be read badly in the sun) we feel an irresistible urge to quit and cut the primeval forest². Why are we doing so difficult about CO₂? Is not it nice that it is warmer? What is so bad about global warming? If you look at it absolutely (in Kelvin and not on that randomly chosen Celsius scale) then we talk about a change of less than 1%, so noise. How can it be a problem?



As we have understood, the problem consists of two parts. In the first place, a rising temperature will cause a rise in sea level. Many people (at least we do) have the impression that this is caused by the melting of the ice caps, but that is not the case at first³. The first phase of sea level rise is simply the expansion of the water that gets warmer. Water has a cubic coefficient of expansion of 0.21 e-3 per degree, or two ten thousandths. Because the water in the oceans can only expand upwards, this translates directly into the linear expansion coefficient. If the ocean is 10 km deep, then a degree of temperature rise gives a 2 meters higher sea level. Now the ocean is on average only slightly more than 4 km deep, so that gives a rough rise of 80 cm. This is also what the IPCC reports predict. Now there are some things where you can still doubt, for example whether the whole ocean is warming up, or whether there is a temperature gradient, or how long it takes for the ocean to really warm up⁴, but physics is undisputed. A warmer ocean gives a higher sea level. In the Netherlands we may not worry too much about 80 cm higher water. The delta works were calculated at a level of 5 meters above NAP,

¹ <https://www.nu.nl/binnenland/5229737/eerste-zomerse-dag-warmterecord-19-april-verbroken.html>

² <https://www.nu.nl/buitenland/5225861/europees-hof-bepaalt-polen-kappen-van-oerbos-moet-beeindigen.html>, so stop cutting

³ Smelting of Greenland results in a 6 meter rise, the south pole in 60 meters. However, the temperature at the South Pole is so low that 1 degree of warming does not yet give a melt of the ice cap. Greenland is more uncertain
<https://nl.wikipedia.org/wiki/Zeespiegelstijging>

⁴ For the people who want to calculate it, this is amazingly long. Even with a perfectly insulated earth where all solar irradiation is put in in the heating of the sea, you only reach a heating rate of half a degree per year. Because of the balance in which the earth more or less is, you can only use the surplus of the additional greenhouse effect for heating. The actual warming is therefore much slower. The disadvantage is that it will continue for a while if the earth itself is no longer heating up

and that would have to be 6 meters⁵. That is manageable, especially if you take into account the time course of 80 years⁶. The Netherlands is only a favorable exception. Roughly half of the world's population lives on the coast in an area where the risk of flooding increases. Inset salt water can ruin agricultural land. In many one cannot afford the costs of additional water defenses. 80 centimeters more will therefore be experienced as a serious problem.

The second part of the problem is that there will be more extreme weather. And we do not talk about the temperature records like last week (of which we say "yes please") but the violent summer storms. The mechanism is also well known. Because of a higher temperature, air can contain more water vapor. However creating water vapor takes a lot of energy (about 500 times more than heating up by 1 degree). That energy is released when the water condenses during cloud formation. More water vapor therefore results in more energy storage. If that is released it thunders and flashes a lot. In the Netherlands, the consequences may still be not that big. We have to cope with a few extra heavy thunderstorms. Well, some more trees can be blown, incidentally the hailstones will destroy greenhouses and harvests, in some places there may be water on the street, but the showers are local and short-term. More extreme heat waves can be annoying, but air conditioning can deal with it to some extent. Here, too, the Netherlands is a happy exception. Because of the flat land the water does not drain quickly, but in a hilly terrain an extra heavy rain can cause flash floods and cause accelerated erosion. This is completely the case if you consider the tropical storms. These can develop at a water temperature above 27° C⁷. If the oceans become warmer, this will occur more frequently, and the number or severity of the tropical storms will probably increase. In tropical storms you do not talk about local damage anymore, but about extensive areas, especially when looking at the accelerated erosion. The consequences once again reach the less prosperous people on the planet.

Summarizing, you can say that global warming will cause serious problems for a large number of people, and that only the prosperous part of them can yield the control measures. But it can get out of hand in the Netherlands too. The 80 cm by 1 degree is still manageable, but 3 meters at an increase of 4 degrees is already a lot trickier⁸. If you consider that rising sea levels can also accelerate the crumbling of the ice caps (the rising water lifts the glacier tongues, causing them to flow faster and more ice will be in the sea), a few meters can be added⁹. An increase of 10 meters would probably also be impossible to handle in the Netherlands¹⁰. So you have little choice but to tackle the source, reducing CO₂ emissions. The plans are now to go to zero, but you may even have reduce the CO₂ level in the air to get the temperature rise under control. Otherwise you get as much regret as our racing driver Max Verstappen in China.

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⁵ In addition, additional waves need to be taken into account, about 7 meters <https://nl.wikipedia.org/wiki/Deltahoogte>

⁶ The costs per year are in the order of billions, just as much as the testimony of Zuckerberg for senate yielded him.

⁷ <https://www.irishtimes.com/business/technology/facebook-shares-surge-as-us-senators-question-zuckerberg-1.3457565>

⁸ <https://www.knmi.nl/kennis-en-datacentrum/uitleg/tropische-cyclonen>

⁹ <http://documents.worldbank.org/curated/en/865571468149107611/Turn-down-the-heat-why-a-4-C-warmer-world-must-be-avoided>

¹⁰ <https://www.knmi.nl/over-het-knmi/nieuws/ijssmelt-antarctica-in-volgende-eeuw-rampzalig>

¹⁰ See for example <http://www.floodmap.net/?l=52.265342,6.039672&z=8&e=10>, at a 10 meter rise you talk about Arnhem by the sea