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Expert report related to selected consequences of Neptun Deep emissions

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I have been asked by 'Greenpeace Romania' to address the following questions:

1. How many children born in 2010-2020 worldwide are expected to face one extra heatwave due to the emissions of Neptun Deep?
2. How many children born in 2010-2020 worldwide are expected to face one extra other climate extreme due to the emissions of Neptun Deep?
3. How do the results for people born in 2010-2020 compare to results for people born in the period 1960-1970?
4. How many heat-related deaths are expected worldwide until 2100 due to the emissions of Neptun Deep?

The following emission values were provided to me by 'Greenpeace Romania' (and were rounded to the nearest lower million):

	Emissions ($MtCO_2eq$) used as input in the calculations
Estimate	**Neptun Deep**
Best estimate	207

I use this information as input data for my calculations and assume that these values are accurate. In case these values would be corrected upward or downward, I could update my calculations accordingly.

Here below I provide my answers to these four questions.

Regarding question 1; The following table provides the global number of children born in a particular calendar year expected to face one additional heatwave due to the total emissions of Neptun Deep. A heatwave is defined here following Thiery et al. (2021 *Science*[1]) as a multi-day extreme heat event that is expected to occur only once per century in absence of climate change. The values for the birth cohorts

[1] Thiery, W., Lange, S., Rogelj, J., Schleussner, C.-F., Gudmundsson, L., Seneviratne, S.I., Frieler, K., Emanuel, K., Geiger, T., Bresch, D.N., Zhao, F., Willner, S.N., Büchner, M., Volkholz, J., Andrijevic, M., Bauer, N., Chang, J., Ciais, P., Dury, M., François, L., Grillakis, M., Gosling, S.N., Hanasaki, N., Hickler, T., Huber, V., Ito, A., Jägermeyr, J., Khabarov, N., Koutroulis, A., Liu, W., Lutz, W., Mengel, M., Müller, C., Ostberg, S., Reyer, C.P.O., Stacke, T., Wada, Y., Intergenerational inequities in exposure to climate extremes, ***Science***, 374(6564), 158-160. [pdf, Research highlight in Nature, Nature Climate Change, and The Lancet Planetary Health].

1960-1970 are added as a reference; from this the relative increase in human exposure between the 1960-1970 and the 2010-2020 birth cohorts is computed.

Number of children facing an additional **heatwave** due to the total emissions of

Birth year	Neptun Deep
2020	127000
2019	123000
2018	120000
2017	116000
2016	113000
2015	110000
2014	106000
2013	103000
2012	99000
2011	95000
2010	91000
2010-2020	**1203000**
1960-1970	**78000**
change (%)	1542

The results imply, for example, that

- 127 000 children born in the year 2020 are expected to face one additional heatwave in their lifetime due to the total emissions of Neptun Deep.
- 1 203 000 children born in the years 2010 to 2020 are expected to face one additional heatwave in their lifetime due to the total emissions of Neptun Deep. This is more than 15 times more people than the number of people born between 1960 and 1970 expected to face an extra heatwave due to these emissions.

Regarding question 2; The following tables provide the global number of children born in a particular calendar year expected to face one additional drought, crop failure, wildfire, tropical cyclone, or river flood due to the total emissions of Neptun Deep. The definitions of all climate extremes and means of calculating their annual occurrence are provided in Thiery et al. (2021 *Science*).

Number of children facing an additional **drought** due to the total emissions of

Birth year	Neptun Deep
2020	4000
2019	3000
2018	3000
2017	3000
2016	3000
2015	3000
2014	3000
2013	3000
2012	2000
2011	2000
2010	2000
2010-2020	**31000**
1960-1970	**0**
change (%)	Inf

Number of children facing an additional **crop failure** due to total emissions of

Birth year	Neptun Deep
2020	3000
2019	3000
2018	3000
2017	3000
2016	3000
2015	3000
2014	3000
2013	2000
2012	2000
2011	2000
2010	2000
2010-2020	**29000**
1960-1970	**0**
change (%)	Inf

Number of children facing an additional **wildfire** due to the total emissions of

Birth year	Neptun Deep
2020	1000
2019	1000
2018	1000
2017	1000
2016	1000
2015	1000
2014	1000
2013	1000
2012	1000
2011	1000
2010	1000
2010-2020	**11000**
1960-1970	**0**
change (%)	Inf

Number of children facing an additional **tropical cyclone** due to the total emissions of

Birth year	Neptun Deep
2020	1000
2019	1000
2018	1000
2017	1000
2016	1000
2015	1000

2014	1000
2013	1000
2012	1000
2011	0
2010	0
2010-2020	**9000**
1960-1970	**0**
change (%)	Inf

The results imply, for example, that

- 31 000 children born in the years 2010 to 2020 are expected to face one additional drought in their lifetime due to the total emissions of Neptun Deep.
- 29 000 children born in the years 2010 to 2020 are expected to face one additional crop failure in their lifetime due to the total emissions of Neptun Deep.
- 11 000 children born in the years 2010 to 2020 are expected to face one additional wildfire in their lifetime due to the total emissions of Neptun Deep.
- 9 000 children born in the years 2010 to 2020 are expected to face one additional tropical cyclone in their lifetime due to the total emissions of Neptun Deep.

Regarding question 3; The above tables provide the global number of children born in 2010-2020 expected to face one additional climate extreme due to the total emissions of Neptun Deep. The values for the birth cohorts 1960-1970 are added below as a reference; from this the relative increase between 1960-1970 and 2010-2020 is computed and shown in each table ('inf' stands for infinity and results from dividing a number by zero, 'NaN' stand for not a number and results from dividing zero by zero). The Figure below summarises these results.

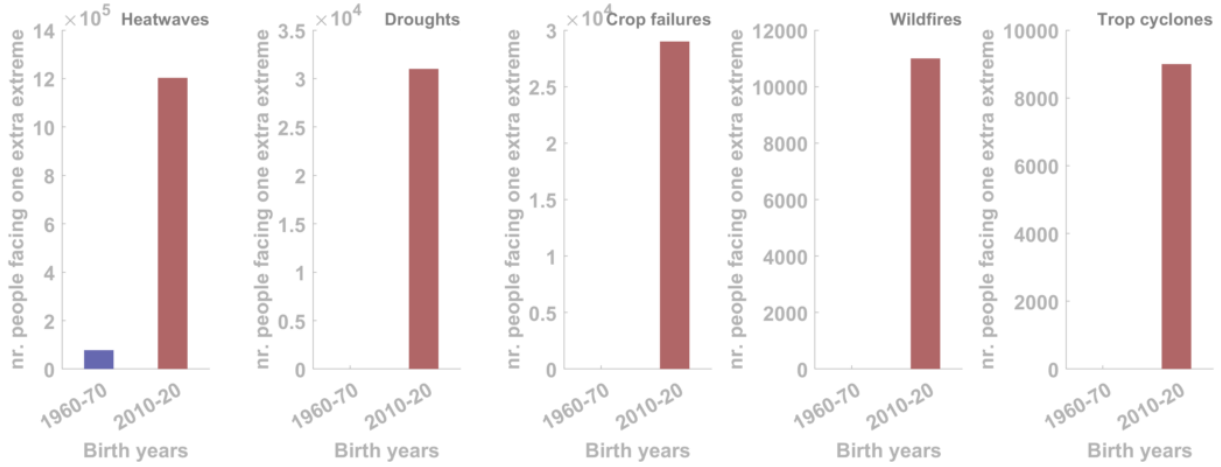

Figure 1: Number of people born in 1960-1970 (blue) and 2010-2020 (red) facing one additional climate extreme due to the total emissions of Neptun Deep. The bar heights indicate the best estimate shown in the above tables. Note the different y-axis ranges.

The results imply, for example, that

- 1 203 000 people born in the years 2010 to 2020 are expected to face one additional heatwave in their lifetime due to the total emissions of Neptun Deep, compared to 78 000 people born in the years 1960 to 1970. This is around 15 times more people.
- 31 000 people born in the years 2010 to 2020 are expected to face one additional drought in their lifetime due to the total emissions of Neptun Deep, compared to no people born in the years 1960 to 1970.

- 29 000 people born in the years 2010 to 2020 are expected to face one additional crop failure in their lifetime due to the total emissions of Neptun Deep, compared to no people born in the years 1960 to 1970.
- 11 000 people born in the years 2010 to 2020 are expected to face one additional wildfire in their lifetime due to the total emissions of Neptun Deep, compared to no people born in the years 1960 to 1970.
- 9 000 people born in the years 2010 to 2020 are expected to face one additional tropical cyclone in their lifetime due to the total emissions of Neptun Deep, compared to no people born in the years 1960 to 1970.

From these results, it can be concluded that recent birth cohorts are disproportionally affected by any current and future emissions. This is the combined effect of two factors: the younger cohorts are larger (that is, more people were born in the recent period), and the younger cohorts will spend a larger part of their life under a climate affected by future global warming. We here ignore the fact that young generations tend to live in places disproportionally affected by rising climate extremes. This makes that we likely underestimate the burden on young generations.

Regarding question 4; The following table provides the global number of heat-related deaths expected until 2100 due to the total emissions of Neptun Deep.

	Number of heat-related deaths until 2100 due to the total emissions of **Neptun Deep**
Additional heat-related deaths until 2100	46000

The results imply that

- 46 000 heat-related deaths are expected worldwide until 2100 due to the total emissions of Neptun Deep.

The numbers shown here represent the *best estimate*, that is, the central number expected given the employed scientific information. The actual number could be lower, but could equally well be higher, depending on the imprecision of the numbers that were used as input in the calculations. These input values include, for questions 1-3: the total greenhouse gas emission estimate for Neptun Deep (see first table), the transient climate response to cumulative emissions (TCRE; 0,45°C per 1000 Gt CO_2eq), the birth cohort size for 2010-2020 and 1960-1970 birth cohorts (obtained from the Wittgenstein Center), the sensitivity of lifetime heatwave, drought, crop failure, wildfire, and tropical cyclone exposure to global mean temperature rise (derived from Thiery et al., 2021 *Science*[2]).

The results were obtained by first multiplying the respective emission values with the TCRE to obtain the global warming linked to the emissions. This value was then multiplied with the change in lifetime extreme event exposure per degree of global warming for the respective climate extremes, to obtain the number of climate extremes additionally experienced by the average birth cohort member. Finally, this value was multiplied with the cohort size for the respective birth years to obtain the number of members from a birth cohort experiencing one additional climate extreme. The final results were rounded to the nearest lower thousand for every individual birth cohort and values below zero were set to zero (the latter occurred only for droughts for the 1960-1970 birth cohort). For question 4, the input values include: the total greenhouse gas emission estimate for Neptun Deep (see first table) and the mortality cost of carbon (1 extra heat-related death until 2100 per 4434 t CO_2eq; Bressler, 2021 *Nature Communications*[3]). The

[2] Thiery, W., et al., op. cit.

[3] Bressler, R. D. (2021). The mortality cost of carbon. **Nature communications**, 12(1), 4467. [pdf]

results were obtained by multiplying the emission values with the mortality cost of carbon. The results were rounded to the nearest lower thousand.

I hereby confirm that I have made these calculations in full scientific independence, and that I have not received any remuneration for this report.

Sincerely yours,

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Wim Thiery is a climate scientist focused on modelling extreme events in a changing climate. After obtaining MScs at KU Leuven in Philosophy (2008) and Terrestrial Ecosystems and Global Change (2011), he was an FWO PhD fellow investigating the interaction between climate and the African Great Lakes with a regional climate model (2011–2015). From 2015 to 2018, he was a Postdoctoral Fellow at ETH Zurich, where he investigated the historical and future impacts of irrigation on climate extremes at the global scale. In 2017 (age 29), he was appointed as research professor at the Vrije Universiteit Brussel, where he established the BCLIMATE Group. With over 950 media contributions since 2014, he is one of Belgium's leading climate science communicators. During his research, he undertook research exchanges to Montréal, Berlin, and Zurich, and conducted field campaigns to Uganda, Rwanda, and DR Congo to install automatic weather stations on Lake Kivu and Lake Victoria. Thiery is contributing author of the IPCC Special Report on Climate Change and Land (2019) and the Sixth Assessment Report (2021). His expertise includes climate change, climate extremes, regional and global climate modelling, global-scale climate impact modelling, impact attribution, land-atmosphere interactions, land management, storm early warnings, and energy meteorology. In 2017, Forbes magazine elected him as a member of the "Forbes 30 under 30 Europe", bringing together "the brightest young entrepreneurs, innovators and game changers in Europe". In 2023, he received one of the Arne Richter Awards for Outstanding Early Career Scientists from the European Geosciences Union. This is *de facto* the highest scientific recognition an early career researcher in climate science can receive in Europe. In 2024, he received the Scientific Award Climate Research, awarded by the Research Foundation – Flanders (FWO). In 2024, he received the price Laureate of the Class Natural Sciences of the Royal Flemish Academy of Belgium for Science and the Arts (KVAB).

Full CV can be found here: https://sites.google.com/site/wimthiery/cv
Full publication list can be found here: https://sites.google.com/site/wimthiery/publications