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Expert opinion related to case number 34068/21

Brussels, 12/08/2024

In case number 34068/21, I have been asked by 'Greenpeace Nordic' and 'Young Friends Of The Earth Norway' 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 Barents Sea South (minimum, median, maximum), Barents Sea South East (minimum, median, maximum), as well as an early scenario of Barents Sea South East (low, high)?
2. How many children born in 2010-2020 worldwide are expected to face one extra other climate extreme due to the emissions of Barents Sea South (minimum, median, maximum), Barents Sea South East (minimum, median, maximum), as well as an early scenario of Barents Sea South East (low, high)?
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 Barents Sea South (minimum, median, maximum), Barents Sea South East (minimum, median, maximum), as well as an early scenario of Barents Sea South East (low, high)?

The following emission values were provided to me by 'Greenpeace Nordic':

	Emissions ($MtCO_2eq$) used as input in the calculations	
Estimate	**Barents Sea South**	**Barents Sea South East**
Minimum	2880	132
Median	5184	722
Maximum	6336	1627
Low scenario	-	106,9
High scenario	-	388,0

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 number of children born in a particular calendar year worldwide expected to face one additional heatwave due to the total emissions of Barents Sea South (minimum, median, maximum), Barents Sea South East (minimum, median, maximum), as well as an early scenario of Barents Sea South East (low, high). A heatwave is defined here following Thiery et al. (2021 Science1) 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 1960-1970 are added as a reference; from this the relative increase between 1960-1970 and 2010-2020 is computed.

	Number of children facing an additional **heatwave** due to the total emissions of							
	Barents Sea South			**Barents Sea South East**			**Scenario**	
Birth year	**Min**	**Median**	**Max**	**Min**	**Median**	**Max**	**Low**	**High**
2020	1771000	3188000	3897000	81000	444000	1000000	65000	238000
2019	1721000	3098000	3787000	78000	431000	972000	63000	231000
2018	1672000	3010000	3679000	76000	419000	944000	62000	225000
2017	1625000	2925000	3576000	74000	407000	918000	60000	218000
2016	1578000	2841000	3473000	72000	395000	891000	58000	212000
2015	1532000	2758000	3371000	70000	384000	865000	56000	206000
2014	1484000	2672000	3266000	68000	372000	838000	55000	200000
2013	1437000	2587000	3163000	65000	360000	812000	53000	193000
2012	1382000	2488000	3041000	63000	346000	780000	51000	186000
2011	1327000	2389000	2920000	60000	332000	749000	49000	178000
2010	1275000	2295000	2805000	58000	319000	720000	47000	171000
2010-2020	**16804000**	**30251000**	**36978000**	**765000**	**4209000**	**9489000**	**619000**	**2258000**
1960-1970	**1139000**	**2056000**	**2515000**	**47000**	**280000**	**641000**	**37000**	**149000**
change (%)	1475	1471	1470	1628	1503	1480	1673	1515

The results imply, for example, that

- 3 188 000 children born in the year 2020 are expected to face one additional heatwave in their lifetime due to the total emissions (median estimate) of Barents Sea South.
- 944 000 children born in the year 2018 are expected to face one additional heatwave in their lifetime due to the total emissions (maximum estimate) of Barents Sea South East.
- 2 056 000 people born in the years 1960 to 1970 are expected to face one additional heatwave in their lifetime due to the total emissions (median estimate) of Barents Sea South.
- 30 251 000 children born in the years 2010 to 2020 are expected to face one additional heatwave in their lifetime due to the total emissions (median estimate) of Barents Sea South. This is over 14 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 number of children born in a particular calendar year worldwide expected to face one additional drought, crop failure, wildfire, tropical cyclone, or river flood due to the total emissions of Barents Sea South (minimum, median, maximum), Barents Sea South East (minimum, median, maximum), as well as an early scenario of Barents Sea South East (low, high). The definitions of all climate extremes and means of calculating their annual occurrence are provides in Thiery et al. (2021 Science).

[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].

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

	Barents Sea South			Barents Sea South East			Scenario	
Birth year	**Min**	**Median**	**Max**	**Min**	**Median**	**Max**	**Low**	**High**
2020	57000	102000	125000	2000	14000	32000	2000	7000
2019	54000	98000	120000	2000	13000	31000	2000	7000
2018	52000	94000	115000	2000	13000	29000	1000	7000
2017	50000	90000	111000	2000	12000	28000	1000	6000
2016	48000	87000	107000	2000	12000	27000	1000	6000
2015	47000	84000	103000	2000	11000	26000	1000	6000
2014	45000	81000	99000	2000	11000	25000	1000	6000
2013	44000	79000	96000	2000	11000	24000	1000	5000
2012	41000	74000	91000	1000	10000	23000	1000	5000
2011	39000	70000	86000	1000	9000	22000	1000	5000
2010	37000	67000	81000	1000	9000	21000	1000	5000
2010-2020	**514000**	**926000**	**1134000**	**19000**	**125000**	**288000**	**13000**	**65000**
1960-1970	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
change (%)	Inf	Inf	Inf	Inf	Inf	Inf	Inf	Inf

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

	Barents Sea South			Barents Sea South East			Scenario	
Birth year	**Min**	**Median**	**Max**	**Min**	**Median**	**Max**	**Low**	**High**
2020	47000	86000	105000	2000	12000	27000	1000	6000
2019	46000	84000	103000	2000	11000	26000	1000	6000
2018	45000	82000	100000	2000	11000	25000	1000	6000
2017	44000	80000	98000	2000	11000	25000	1000	6000
2016	43000	78000	96000	2000	10000	24000	1000	5000
2015	42000	77000	94000	1000	10000	24000	1000	5000
2014	41000	75000	92000	1000	10000	23000	1000	5000
2013	40000	73000	89000	1000	10000	23000	1000	5000
2012	39000	71000	87000	1000	9000	22000	1000	5000
2011	38000	69000	84000	1000	9000	21000	1000	5000
2010	37000	67000	82000	1000	9000	21000	1000	5000
2010-2020	**462000**	**842000**	**1030000**	**16000**	**112000**	**261000**	**11000**	**59000**
1960-1970	**38000**	**73000**	**91000**	**0**	**6000**	**19000**	**0**	**0**
change (%)	1216	1153	1132	Inf	1867	1374	Inf	Inf

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

	Barents Sea South			Barents Sea South East			Scenario	
Birth year	**Min**	**Median**	**Max**	**Min**	**Median**	**Max**	**Low**	**High**
2020	18000	33000	40000	0	4000	10000	0	2000
2019	18000	32000	39000	0	4000	10000	0	2000
2018	17000	31000	38000	0	4000	9000	0	2000
2017	17000	31000	37000	0	4000	9000	0	2000
2016	16000	30000	37000	0	4000	9000	0	2000
2015	16000	29000	36000	0	4000	9000	0	2000
2014	16000	29000	35000	0	4000	9000	0	2000
2013	15000	28000	34000	0	3000	8000	0	2000
2012	15000	27000	33000	0	3000	8000	0	2000
2011	14000	26000	32000	0	3000	8000	0	1000
2010	14000	25000	31000	0	3000	8000	0	1000
2010-2020	**176000**	**321000**	**392000**	**0**	**40000**	**97000**	**0**	**20000**
1960-1970	**44000**	**79000**	**98000**	**0**	**11000**	**22000**	**0**	**0**
change (%)	400	406	400	NaN	364	441	NaN	Inf

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

	Barents Sea South			Barents Sea South East			Scenario	
Birth year	**Min**	**Median**	**Max**	**Min**	**Median**	**Max**	**Low**	**High**
2020	17000	31000	38000	0	4000	9000	0	2000
2019	17000	30000	37000	0	4000	9000	0	2000
2018	16000	30000	36000	0	4000	9000	0	2000
2017	16000	29000	35000	0	4000	9000	0	2000
2016	15000	28000	35000	0	4000	9000	0	2000
2015	15000	28000	34000	0	3000	8000	0	2000
2014	15000	27000	33000	0	3000	8000	0	2000
2013	14000	26000	32000	0	3000	8000	0	2000
2012	14000	25000	31000	0	3000	8000	0	1000
2011	13000	24000	30000	0	3000	7000	0	1000
2010	13000	23000	28000	0	3000	7000	0	1000
2010-2020	**165000**	**301000**	**369000**	**0**	**38000**	**91000**	**0**	**19000**
1960-1970	**14000**	**29000**	**37000**	**0**	**0**	**6000**	**0**	**0**
change (%)	1179	1038	997	NaN	Inf	1517	NaN	Inf

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

	Barents Sea South			Barents Sea South East			Scenario	
Birth year	**Min**	**Median**	**Max**	**Min**	**Median**	**Max**	**Low**	**High**
2020	12000	23000	28000	0	3000	7000	0	1000
2019	12000	22000	27000	0	3000	7000	0	1000
2018	11000	21000	26000	0	3000	6000	0	1000
2017	11000	20000	25000	0	2000	6000	0	1000
2016	11000	19000	24000	0	2000	6000	0	1000
2015	10000	19000	23000	0	2000	6000	0	1000
2014	10000	18000	22000	0	2000	5000	0	1000
2013	9000	17000	21000	0	2000	5000	0	1000
2012	9000	17000	20000	0	2000	5000	0	1000
2011	9000	16000	20000	0	2000	5000	0	1000
2010	8000	15000	19000	0	2000	4000	0	1000
2010-2020	**112000**	**207000**	**255000**	**0**	**25000**	**62000**	**0**	**11000**
1960-1970	**2000**	**5000**	**7000**	**0**	**0**	**0**	**0**	**0**
change (%)	5600	4140	3643	NaN	Inf	Inf	NaN	Inf

The results imply, for example, that

- 926 000 children born in the years 2010 to 2020 are expected to face one additional drought in their lifetime due to the total emissions (median estimate) of Barents Sea South.
- 842 000 children born in the years 2010 to 2020 are expected to face one additional crop failure in their lifetime due to the total emissions (median estimate) of Barents Sea South.
- 321 000 children born in the years 2010 to 2020 are expected to face one additional wildfire in their lifetime due to the total emissions (median estimate) of Barents Sea South.
- 301 000 children born in the years 2010 to 2020 are expected to face one additional tropical cyclone in their lifetime due to the total emissions (median estimate) of Barents Sea South.
- 207 000 children born in the years 2010 to 2020 are expected to face one additional river flood in their lifetime due to the total emissions (median estimate) of Barents Sea South.

Regarding question 3; The above tables provide the number of children born in 2010-2020 worldwide expected to face one additional climate extreme due to the various emissions. 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.

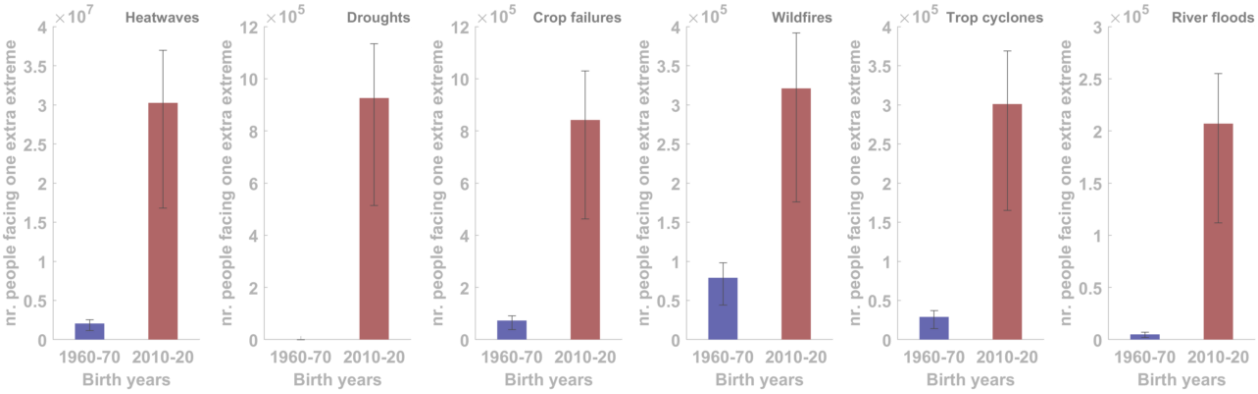

Figure 1: Number of people born in 1960-1970 (blue) and 2010-2020 (red) facing one additional climate extreme due to the total emissions of Barents Sea South. The bar heights indicate the Median value shown in the above tables. The error bars indicate the Min and Max values shown in the above tables. Note the different y-axis ranges.

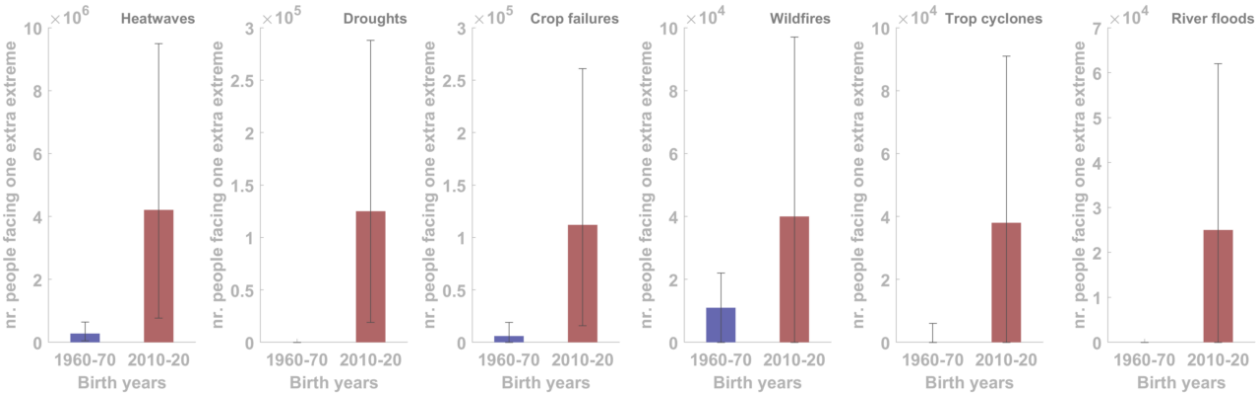

Figure 2: Same as Figure 1, but for Barents Sea South East.

The results imply, for example, that

- 30 251 000 people born in the years 2010 to 2020 are expected to face one additional heatwave in their lifetime due to the total emissions (median estimate) of Barents Sea South, compared to 2 056 000 people born in the years 1960 to 1970. This is around 14 times more people.
- 842 000 people born in the years 2010 to 2020 are expected to face one additional crop failure in their lifetime due to the total emissions (median estimate) of Barents Sea South, compared to 73 000 people born in the years 1960 to 1970. This is around 11 times more people.
- 321 000 people born in the years 2010 to 2020 are expected to face one additional wildfire in their lifetime due to the total emissions (median estimate) of Barents Sea South, compared to 79 000 people born in the years 1960 to 1970. This is around 4 times more people.
- 301 000 people born in the years 2010 to 2020 are expected to face one additional tropical cyclone in their lifetime due to the total emissions (median estimate) of Barents Sea South, compared to 29 000 people born in the years 1960 to 1970. This is around 10 times more people.
- 207 000 people born in the years 2010 to 2020 are expected to face one additional river flood in their lifetime due to the total emissions (median estimate) of Barents Sea South, compared to 5 000 people born in the years 1960 to 1970. This is around 41 times more people.

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 potentially underestimate the burden on young generations.

Regarding question 4; The following table provides the number of heat-related deaths expected worldwide until 2100 due to the total emissions of Barents Sea South (minimum, median, maximum), Barents Sea South East (minimum, median, maximum), as well as an early scenario of Barents Sea South East (low, high).

	Number of heat-related deaths until 2100 due to the total emissions of							
	Barents Sea South			**Barents Sea South East**			**Scenario**	
	Min	**Median**	**Max**	**Min**	**Median**	**Max**	**Low**	**High**
Additional heat-related deaths until 2100	649000	1169000	1428000	29000	162000	366000	24000	87000

The results imply, for example, that

- 649 000 heat-related deaths are expected worldwide until 2100 due to the total emissions (minimum estimate) of Barents Sea South.
- 1 169 000 heat-related deaths are expected worldwide until 2100 due to the total emissions (median estimate) of Barents Sea South.
- 1 428 000 heat-related deaths are expected worldwide until 2100 due to the total emissions (maximum estimate) of Barents Sea South.
- 29 000 heat-related deaths are expected worldwide until 2100 due to the total emissions (minimum estimate) of Barents Sea South East.
- 162 000 heat-related deaths are expected worldwide until 2100 due to the total emissions (median estimate) of Barents Sea South East.
- 366 000 heat-related deaths are expected worldwide until 2100 due to the total emissions (maximum estimate) of Barents Sea South East.

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 estimates for Barents Sea South (minimum, median, maximum), Barents Sea South East (minimum, median, maximum), as well as an early scenario of Barents Sea South East (low, high) (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 birth cohorts (obtained from the Wittgenstein Center), the sensitivity of lifetime heatwave, drought, crop failure, wildfire, tropical cyclone, and river flood 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 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 and values below zero were set to zero. For question 4, the input values include: the total greenhouse gas emission estimates for Barents Sea South (minimum,

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

median, maximum), Barents Sea South East (minimum, median, maximum), as well as an early scenario of Barents Sea South East (low, high) (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 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 work, nor for any previous work related to this case.

Sincerely yours,

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

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).

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