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Expert opinion related to case number 24-036810ASD-BORG/02

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In case number 24-036810ASD-BORG/02, I have been asked by 'Föreningen Greenpeace Norden' and 'Natur og Ungdom' 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 Tyrving, Breidablikk, and Yggdrasil, in isolation and all combined?
2. How many children born in 2010-2020 worldwide are expected to face one extra other climate extreme due to the emissions of Tyrving, Breidablikk, and Yggdrasil, in isolation and all combined?
3. How many heat-related deaths are expected worldwide until 2100 due to the emissions of Tyrving, Breidablikk, and Yggdrasil, in isolation and all combined?
4. Which glacier mass loss is expected regionally and globally due to the emissions of Tyrving, Breidablikk, and Yggdrasil, in isolation and all combined?
5. What are the answers to questions 1 to 4 if one considers the annual emissions of Tyrving and Breidablikk in 2024 and 2025, as well as the annual emissions of Yggdrasil in 2027 and 2028, instead of their total emissions?
6. Are climate impact assessments possible for individual fossil fuel projects?

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

Emissions ($MtCO_2eq$) used as input in the calculations

Time period	Tyrving	Breidablikk	Yggdrasil	Combined
Total	12.08	106.97	365	484.05
2024	0.435	10.14	-	-
2025	3.08	10.39	-	-
2026	1.697	8.66	-	-
2027	1.262	8.08	28.8	-
2028	-	-	42.4	-

I use this information as input data for the calculations and assume that these values are accurate. I note that these input values have slightly changed compared to my previous report, and that these new results are therefore slightly different even though I used the exact same method.

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 Tyrving, Breidablikk, Yggdrasil, and all three combined. 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.

	Number of children facing an additional **heatwave** due to the **total** emissions of			
Birth year	**Tyrving**	**Breidablikk**	**Yggdrasil**	**Combined**
2020	7400	65700	224500	297700
2019	7200	63900	218100	289300
2018	7000	62100	211900	281100
2017	6800	60300	206000	273200
2016	6600	58600	200000	265300
2015	6400	56900	194200	257500
2014	6200	55100	188200	249500
2013	6000	53400	182200	241600
2012	5700	51300	175200	232300
2011	5500	49300	168200	223100
2010	5300	47300	161500	214300
2010-2020	**70100**	**623900**	**2130000**	**2824900**

The results[2] imply, for example, that

- 65 700 children born in the year 2020 are expected to face one additional heatwave in their lifetime due to the total emissions of Breidablikk.
- 281 100 children born in the year 2018 are expected to face one additional heatwave in their lifetime due to the total emissions of Tyrving, Breidablikk, and Yggdrasil combined.
- 2 824 900 children born in the years 2010 to 2020 are expected to face one additional heatwave in their lifetime due to the total emissions of Tyrving, Breidablikk, and Yggdrasil combined.

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 Tyrving, Breidablikk, Yggdrasil, and all three combined. The definitions of all climate extremes and means of calculating their annual occurrence are provides in Thiery et al. (2021 *Science*).

	Number of children facing an additional **drought** due to the **total** emissions of			
Birth year	**Tyrving**	**Breidablikk**	**Yggdrasil**	**Combined**
2020	200	2100	7200	9600
2019	200	2000	6900	9200
2018	200	1900	6600	8800
2017	200	1800	6400	8400
2016	200	1800	6100	8200
2015	100	1700	5900	7900
2014	100	1600	5700	7600
2013	100	1600	5500	7300
2012	100	1500	5200	6900

[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].

[2] Note that these numbers slightly differ from the numbers communicated during my intervention as expert witness in first instance, because (i) the emission estimates I received as input were updated following new information about production, and (ii) I now use a more accurate number for the Transient Climate Response to Cumulative Emissions (TCRE): 0.45°C per 1000 Gt CO_2eq instead of 0.5°C per 1000 Gt CO_2eq (the latter number was used in first instance and is a rounding of the former).

2011	100	1400	4900	6600
2010	100	1300	4700	6200
2010-2020	**1600**	**18700**	**65100**	**86700**

Birth year	Number of children facing an additional **crop failure** due to the **total** emissions of			
Birth year	**Tyrving**	**Breidablikk**	**Yggdrasil**	**Combined**
2020	200	1700	6000	8000
2019	100	1700	5900	7800
2018	100	1700	5800	7700
2017	100	1600	5600	7500
2016	100	1600	5500	7300
2015	100	1500	5400	7200
2014	100	1500	5300	7000
2013	100	1500	5100	6800
2012	100	1400	5000	6600
2011	100	1400	4800	6400
2010	100	1300	4700	6300
2010-2020	**1200**	**16900**	**59100**	**78600**

	Number of children facing an additional **wildfire** due to the **total** emissions of			
Birth year	**Tyrving**	**Breidablikk**	**Yggdrasil**	**Combined**
2020	0	600	2300	3000
2019	0	600	2200	3000
2018	0	600	2200	2900
2017	0	600	2100	2900
2016	0	600	2100	2800
2015	0	600	2000	2700
2014	0	600	2000	2700
2013	0	500	1900	2600
2012	0	500	1900	2500
2011	0	500	1800	2400
2010	0	500	1800	2300
2010-2020	**0**	**6200**	**22300**	**29800**

Birth year	Number of children facing an additional **tropical cyclone** due to the **total** emissions of			
	Tyrving	**Breidablikk**	**Yggdrasil**	**Combined**
2020	0	600	2200	2900
2019	0	600	2100	2800
2018	0	600	2100	2800
2017	0	600	2000	2700
2016	0	500	2000	2600
2015	0	500	1900	2600
2014	0	500	1900	2500
2013	0	500	1800	2500
2012	0	500	1800	2300
2011	0	500	1700	2200
2010	0	400	1600	2200
2010-2020	**0**	**5800**	**21100**	**28100**

	Number of children facing an additional **river flood** due to the **total** emissions of			
Birth year	**Tyrving**	**Breidablikk**	**Yggdrasil**	**Combined**
2020	0	400	1600	2100
2019	0	400	1500	2000
2018	0	400	1500	2000
2017	0	400	1400	1900
2016	0	400	1400	1800
2015	0	300	1300	1700

2014	0	300	1300	1700
2013	0	300	1200	1600
2012	0	300	1200	1600
2011	0	300	1100	1500
2010	0	300	1100	1400
2010-2020	**0**	**3800**	**14600**	**19300**

The results imply, for example, that

- 86 700 children born in the years 2010 to 2020 are expected to face one additional drought in their lifetime due to the total emissions of Tyrving, Breidablikk, and Yggdrasil combined.
- 78 600 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 Tyrving, Breidablikk, and Yggdrasil combined.
- 29 800 children born in the years 2010 to 2020 are expected to face one additional wildfire in their lifetime due to the total emissions of Tyrving, Breidablikk, and Yggdrasil combined.
- 28 100 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 Tyrving, Breidablikk, and Yggdrasil combined.
- 19 300 children born in the years 2010 to 2020 are expected to face one additional river flood in their lifetime due to the total emissions of Tyrving, Breidablikk, and Yggdrasil combined.

Regarding question 3; The following table provides the number of heat-related deaths expected worldwide until 2100 due to the total emissions of Tyrving, Breidablikk, Yggdrasil, and all three combined.

	Number of **heat-related deaths until 2100** due to the **total** emissions of			
	Tyrving	**Breidablikk**	**Yggdrasil**	**Combined**
Additional heat-related deaths until 2100	2700	24100	82300	109100

The results[3] imply that

- 2 700 heat-related deaths are expected worldwide until 2100 due to the total emissions of Tyrving.
- 24 100 heat-related deaths are expected worldwide until 2100 due to the total emissions of Breidablikk.
- 82 300 heat-related deaths are expected worldwide until 2100 due to the total emissions of Yggdrasil.
- 109 100 heat-related deaths are expected worldwide until 2100 due to the total emissions of Tyrving, Breidablikk, and Yggdrasil combined.

Regarding question 4; The following table provides the glacier mass loss in m^3 at stabilisation expected per region[4] and globally due to the total emissions of Tyrving, Breidablikk, Yggdrasil, and all three combined.

	Glacier mass loss in m^3 due to the **total** emissions of			
Region	**Tyrving**	**Breidablikk**	**Yggdrasil**	**Combined**
Arctic Canada South	3484000	30858000	105295000	139638000
Western Canada & US	576000	5102000	17410000	23089000
Scandinavia	171000	1521000	5190000	6883000
Russian Arctic	13312000	117883000	402239000	533435000
Iceland	4244000	37582000	128239000	170066000
Greenland Periphery	13769000	121929000	416045000	551744000
Central Europe	102000	909000	3102000	4114000
North Asia	105000	932000	3182000	4220000

[3] Note that these numbers slightly differ from the numbers communicated during my intervention as expert witness in first instance, because the emission estimates I received as input were slightly different.

[4] Regions are here defined according to the Randolph Glacier Inventory version 6, the gold standard in the field of glacier research [link]

South Asia East	673000	5964000	20352000	26990000
Svalbard & Jan Mayen	9518000	84283000	287590000	381392000
Southern Andes	3957000	35043000	119573000	158574000
Alaska	19625000	173783000	592978000	786387000
Sub & Antarctic Islands	42485000	376218000	1283721000	1702425000
Arctic Canada North	36024000	318997000	1088473000	1443495000
Low Latitudes	125000	1107000	3777000	5009000
Caucasus & Middle East	72000	643000	2197000	2913000
New Zealand	92000	822000	2805000	3719000
Central Asia	5021000	44462000	151712000	201195000
South Asia West	5103000	45189000	154194000	204486000
Global	**166089000**	**1470741000**	**5018421000**	**6655251000**

The results imply, for example, that
- Scandinavian glaciers will lose 171 000 m³ due to the total emissions of Tyrving.
- Scandinavian glaciers will lose 1 521 000 m³ due to the total emissions of Breidablikk.
- Scandinavian glaciers will lose 5 190 000 m³ due to the total emissions of Yggdrasil.
- Scandinavian glaciers will lose 6 883 000 m³ due to the total emissions of Tyrving, Breidablikk, and Yggdrasil combined.
- Glaciers worldwide will lose 6 655 251 000 m³ due to the total emissions of Tyrving, Breidablikk, and Yggdrasil combined.

These results are based on a study[5] published in 2025 in *Science* in which Zekollari, Schuster and colleagues calculated the long-term equilibration of global glacier mass under different global warming levels. They found that the >200,000 glaciers around the globe (excluding the Greenland and Antarctic ice sheet) will globally lose 2.0% of their mass per tenth of a degree of warming occurring in the +1.5°C to +3.0°C warming range. More specifically, every +0.1°C in warming results in a loss of 2749Gt of ice, which is roughly equivalent to filling 900 million Olympic swimming pools with meltwater from glaciers. At the regional scale, the sensitivity varies between 0.8% to 3.4% mass loss per tenth of a degree warming (still in the +1.5°C to +3.0°C warming range; see Table S1 in Zekollari, Schuster et al., 2025). Note that these regional and global warming sensitivities used in this report are conservative for the current situation, since this sensitivity decreases towards higher warming levels as there is less ice left to melt (i.e., at the present-day warming level of +1.2°C for the period 2014-2023 vs. 1850-1900, the sensitivity is higher than 2.0% loss per 0.1°C warming; see Fig. 1b in Zekollari, Schuster et al., 2025). The sensitivity per region and globally is a consensus estimate derived from internationally coordinated simulations performed with 8 glacier evolution models, of which four run globally and four only in selected regions. These global glacier models were forced with 80 different climate scenarios representing long-term climate change and associated glacier stabilisation at different levels of global warming.

Regarding question 5; The following table provides the number of children born in a particular birth year worldwide expected to face one additional heatwave, drought, wildfire, tropical cyclone, crop failure, or river flood due to the emissions of Tyrving and Breidablikk in the calendar years 2024, 2025, 2026 and 2027, and Yggdrasil in the calendar years 2027 and 2028. Note that for each value of 0 in the tables below, the method in fact returned a number between 1 and 99, which was subsequently rounded downwards to 0.

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

Birth year	Tyrving 2024	Tyrving 2025	Tyrving 2026	Tyrving 2027	Breidablikk 2024	Breidablikk 2025	Breidablikk 2026	Breidablikk 2027	Yggdrasil 2027	Yggdrasil 2028
2020	200	1800	1000	700	6200	6300	5300	4900	17700	26000
2019	200	1800	1000	700	6000	6200	5100	4800	17200	25300

[5] Zekollari, H., Schuster, et al. (2025). Glacier preservation doubled by limiting warming to 1.5°C versus 2.7°C. ***Science***, 388(6750), 979-983. [pdf]

2018	200	1700	900	700	5800	6000	5000	4600	16700	24600
2017	200	1700	900	700	5700	5800	4800	4500	16200	23900
2016	200	1600	900	600	5500	5600	4700	4400	15700	23200
2015	200	1600	900	600	5300	5500	4600	4200	15300	22500
2014	200	1500	800	600	5200	5300	4400	4100	14800	21800
2013	200	1500	800	600	5000	5100	4300	4000	14300	21100
2012	200	1400	800	600	4800	4900	4100	3800	13800	20300
2011	200	1400	700	500	4600	4700	3900	3700	13200	19500
2010	100	1300	700	500	4400	4600	3800	3500	12700	18700
2010-2020	**2100**	**17300**	**9400**	**6800**	**58500**	**60000**	**50000**	**46500**	**167600**	**246900**

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

Birth year	**Tyrving 2024**	**Tyrving 2025**	**Tyrving 2026**	**Tyrving 2027**	**Breidablikk 2024**	**Breidablikk 2025**	**Breidablikk 2026**	**Breidablikk 2027**	**Yggdrasil 2027**	**Yggdrasil 2028**
2020	0	0	0	0	200	200	100	100	500	800
2019	0	0	0	0	100	100	100	100	500	800
2018	0	0	0	0	100	100	100	100	500	700
2017	0	0	0	0	100	100	100	100	500	700
2016	0	0	0	0	100	100	100	100	400	700
2015	0	0	0	0	100	100	100	100	400	600
2014	0	0	0	0	100	100	100	100	400	600
2013	0	0	0	0	100	100	100	100	400	600
2012	0	0	0	0	100	100	100	100	400	600
2011	0	0	0	0	100	100	100	100	300	500
2010	0	0	0	0	100	100	100	100	300	500
2010-2020	**0**	**0**	**0**	**0**	**1200**	**1200**	**1100**	**1100**	**4600**	**7100**

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

Birth year	**Tyrving 2024**	**Tyrving 2025**	**Tyrving 2026**	**Tyrving 2027**	**Breidablikk 2024**	**Breidablikk 2025**	**Breidablikk 2026**	**Breidablikk 2027**	**Yggdrasil 2027**	**Yggdrasil 2028**
2020	0	0	0	0	100	100	100	100	400	700
2019	0	0	0	0	100	100	100	100	400	600
2018	0	0	0	0	100	100	100	100	400	600
2017	0	0	0	0	100	100	100	100	400	600
2016	0	0	0	0	100	100	100	100	400	600
2015	0	0	0	0	100	100	100	100	400	600
2014	0	0	0	0	100	100	100	100	400	600
2013	0	0	0	0	100	100	100	100	400	600
2012	0	0	0	0	100	100	100	100	300	500
2011	0	0	0	0	100	100	100	100	300	500
2010	0	0	0	0	100	100	100	100	300	500
2010-2020	**0**	**0**	**0**	**0**	**1100**	**1100**	**1100**	**1100**	**4100**	**6400**

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

Birth year	**Tyrving 2024**	**Tyrving 2025**	**Tyrving 2026**	**Tyrving 2027**	**Breidablikk 2024**	**Breidablikk 2025**	**Breidablikk 2026**	**Breidablikk 2027**	**Yggdrasil 2027**	**Yggdrasil 2028**
2020	0	0	0	0	0	0	0	0	100	200
2019	0	0	0	0	0	0	0	0	100	200
2018	0	0	0	0	0	0	0	0	100	200
2017	0	0	0	0	0	0	0	0	100	200
2016	0	0	0	0	0	0	0	0	100	200
2015	0	0	0	0	0	0	0	0	100	200
2014	0	0	0	0	0	0	0	0	100	200
2013	0	0	0	0	0	0	0	0	100	200

2012	0	0	0	0	0	0	0	0	100	200
2011	0	0	0	0	0	0	0	0	100	200
2010	0	0	0	0	0	0	0	0	100	200
2010-2020	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**1100**	**2200**

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

Birth year	Tyrving 2024	Tyrving 2025	Tyrving 2026	Tyrving 2027	Breidablikk 2024	Breidablikk 2025	Breidablikk 2026	Breidablikk 2027	Yggdrasil 2027	Yggdrasil 2028
2020	0	0	0	0	0	0	0	0	100	200
2019	0	0	0	0	0	0	0	0	100	200
2018	0	0	0	0	0	0	0	0	100	200
2017	0	0	0	0	0	0	0	0	100	200
2016	0	0	0	0	0	0	0	0	100	200
2015	0	0	0	0	0	0	0	0	100	200
2014	0	0	0	0	0	0	0	0	100	200
2013	0	0	0	0	0	0	0	0	100	200
2012	0	0	0	0	0	0	0	0	100	200
2011	0	0	0	0	0	0	0	0	100	200
2010	0	0	0	0	0	0	0	0	100	100
2010-2020	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**1100**	**2100**

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

Birth year	Tyrving 2024	Tyrving 2025	Tyrving 2026	Tyrving 2027	Breidablikk 2024	Breidablikk 2025	Breidablikk 2026	Breidablikk 2027	Yggdrasil 2027	Yggdrasil 2028
2020	0	0	0	0	0	0	0	0	100	100
2019	0	0	0	0	0	0	0	0	100	100
2018	0	0	0	0	0	0	0	0	100	100
2017	0	0	0	0	0	0	0	0	100	100
2016	0	0	0	0	0	0	0	0	100	100
2015	0	0	0	0	0	0	0	0	100	100
2014	0	0	0	0	0	0	0	0	100	100
2013	0	0	0	0	0	0	0	0	0	100
2012	0	0	0	0	0	0	0	0	0	100
2011	0	0	0	0	0	0	0	0	0	100
2010	0	0	0	0	0	0	0	0	0	100
2010-2020	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**700**	**1100**

The results imply, for example, that

- 6 200 children born in the year 2020 are expected to face one additional heatwave in their lifetime due to the emissions of Breidablikk in the year 2024.
- 5 100 children born in the years 2010 to 2020 are expected to face one additional drought in their lifetime due to the emissions of Yggdrasil in the year 2027.
- 6 900 children born in the years 2010 to 2020 are expected to face one additional crop failure in their lifetime due to the emissions of Yggdrasil in the year 2028.

Glacier mass loss in m³ due to the **annual** emissions of

Region	Tyrving 2024	Tyrving 2025	Tyrving 2026	Tyrving 2027	Breidablikk 2024
Arctic Canada South	122000	869000	478000	356000	2861000
Western Canada & US	20000	143000	79000	58000	473000
Scandinavia	6000	42000	23000	17000	141000
Russian Arctic	468000	3320000	1829000	1360000	10931000
Iceland	149000	1058000	583000	433000	3485000

Greenland Periphery	485000	3434000	1892000	1407000	11306000
Central Europe	3000	25000	14000	10000	84000
North Asia	3000	26000	14000	10000	86000
South Asia East	23000	168000	92000	68000	553000
Svalbard & Jan Mayen	335000	2374000	1308000	972000	7815000
Southern Andes	139000	987000	543000	404000	3249000
Alaska	691000	4894000	2697000	2005000	16115000
Sub & Antarctic Islands	1496000	10597000	5838000	4342000	34887000
Arctic Canada North	1269000	8985000	4950000	3681000	29581000
Low Latitudes	4000	31000	17000	12000	102000
Caucasus & Middle East	2000	18000	9000	7000	59000
New Zealand	3000	23000	12000	9000	76000
Central Asia	176000	1252000	690000	513000	4123000
South Asia West	179000	1272000	701000	521000	4190000
Global	**5850000**	**41426000**	**22825000**	**16974000**	**136385000**

Region	**Glacier mass loss** in m³ due to the **annual** emissions of				
	Breidablikk 2025	**Breidablikk 2026**	**Breidablikk 2027**	**Yggdrasil 2027**	**Yggdrasil 2028**
Arctic Canada South	2932000	2443000	2280000	8127000	11965000
Western Canada & US	484000	404000	377000	1343000	1978000
Scandinavia	144000	120000	112000	400000	589000
Russian Arctic	11201000	9336000	8710000	31048000	45710000
Iceland	3571000	2976000	2777000	9898000	14572000
Greenland Periphery	11585000	9656000	9009000	32114000	47278000
Central Europe	86000	72000	67000	239000	352000
North Asia	88000	73000	68000	245000	361000
South Asia East	566000	472000	440000	1570000	2312000
Svalbard & Jan Mayen	8008000	6675000	6227000	22198000	32681000
Southern Andes	3329000	2775000	2589000	9229000	13588000
Alaska	16512000	13763000	12841000	45771000	67385000
Sub & Antarctic Islands	35747000	29795000	27799000	99088000	145880000
Arctic Canada North	30310000	25263000	23571000	84017000	123693000
Low Latitudes	105000	87000	81000	291000	429000
Caucasus & Middle East	61000	50000	47000	169000	249000
New Zealand	78000	65000	60000	216000	318000
Central Asia	4224000	3521000	3285000	11710000	17240000
South Asia West	4293000	3578000	3339000	11902000	17522000
Global	**139747000**	**116478000**	**108677000**	**387365000**	**570288000**

The results imply, for example, that

- Scandinavian glaciers will lose 42 000 m³ due to the 2025 emissions of Tyrving.
- Scandinavian glaciers will lose 141 000 m³ due to the 2024 emissions of Breidablikk.
- Scandinavian glaciers will lose 589 000 m³ due to the 2028 emissions of Yggdrasil.
- Glaciers worldwide will lose 41 426 000 m³ due to the 2025 emissions of Tyrving.
- Glaciers worldwide will lose 136 385 000 m³ due to the 2024 emissions of Breidablikk.
- Glaciers worldwide will lose 570 288 000 m³ due to the 2028 emissions of Yggdrasil.

	Number of **heat-related deaths until 2100** due to the **annual** emissions of									
	Tyrving 2024	**Tyrving 2025**	**Tyrving 2026**	**Tyrving 2027**	**Breidabli. 2024**	**Breidabli. 2025**	**Breidabli. 2026**	**Breidabli. 2027**	**Yggdrasil 2027**	**Yggdrasil 2028**
Additional heat-related mortality until 2100	0	600	300	200	2200	2300	1900	1800	6400	9500

The results imply that

- 98 heat-related deaths are expected worldwide until 2100 due to the emissions of Tyrving in 2024 (note that 98 was rounded down to 0 in the table).

- 694 heat-related deaths are expected worldwide until 2100 due to the emissions of Tyrving in 2025 (note that 694 was rounded down to 600 in the table).
- 300 heat-related deaths are expected worldwide until 2100 due to the emissions of Tyrving in 2026.
- 200 heat-related deaths are expected worldwide until 2100 due to the emissions of Tyrving in 2027.
- 2200 heat-related deaths are expected worldwide until 2100 due to the emissions of Breidablikk in 2024.
- 2300 heat-related deaths are expected worldwide until 2100 due to the emissions of Breidablikk in 2025.
- 1900 heat-related deaths are expected worldwide until 2100 due to the emissions of Breidablikk in 2026.
- 1800 heat-related deaths are expected worldwide until 2100 due to the emissions of Breidablikk in 2027.
- 6400 heat-related deaths are expected worldwide until 2100 due to the emissions of Yggdrasil in 2027.
- 9500 heat-related deaths are expected worldwide until 2100 due to the emissions of Yggdrasil in 2028.

Regarding question 6; In recent decades, climate science has evolved to a level at which climate impact assessments for individual fossil fuel projects have become possible. The *de facto* proof for this ability is the current report, in which such a risk assessment is actually performed (see our responses to questions 1-5). The risk assessment is based on a framework which I, a research professor in Climate Science, developed based on the laws of physics and chemistry, and using parameter values established in IPCC reports and leading international scientific journals (*Science, Nature, Nature Communications*).
Furthermore, I am aware of at least two independent scientific frameworks that allow for similar types of risk assessment. The first framework is developed at ETH Zurich, and allows to translate emissions to spatially-resolved warming and extreme hot year occurrences (Beusch et al., 2022)[6]. The second framework has been recently developed at Stanford University, and translates the emissions of 1 ton of CO_2 to a set of 16 climate change indicators (Semken et al., forthcoming)[7]. Note that the latter explicitly assesses the effects of a single ton of CO_2, whereas the current report assesses emissions on the order of 0.5 to 500 million tonnes of CO_2, that is, four to eight order of magnitude above the threshold of detectable impacts identified by the Stanford University study.

Discussion and Methods; As also mentioned during my testimony of 30 November 2023, 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 question 1 and 2: the total greenhouse gas emission estimates for Tyrving, Breidablikk and Yggdrasil (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 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*[8]). 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

[6] Beusch, L., et al. (2022). Responsibility of major emitters for country-level warming and extreme hot years. Communications Earth & Environment, 3(1), 7. [pdf]
[7] This framework is finalised and the paper will soon be submitted for publication to a scientific journal.
[8] Thiery, W., et al., op. cit.

experiencing one additional climate extreme. The final results were rounded to the nearest lower hundred for every individual birth cohort.

For question 3, the input values include: the total greenhouse gas emission estimates for Tyrving, Breidablikk and Yggdrasil (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*[9]). The results were obtained by multiplying the emission values with the mortality cost of carbon. The results were rounded to the nearest lower hundred.

For question 4, the input values include the total greenhouse gas emission estimates for Tyrving, Breidablikk and Yggdrasil (see first table), the transient climate response to cumulative emissions (TCRE; 0,45°C per 1000 Gt CO_2eq), and the sensitivity of equilibrium change in regional and global glacier mass to global mean temperature rise (derived from Zekollari et al., 2025 *Science*[10]). The results were obtained by first converting the glacier mass loss (Gt per tenth of a degree of warming) to glacier volume loss (m^2 per degree of warming) assuming a density value of 0,920 kg dm^{-3} (which renders out estimate conservative as we disregard the fraction of snow which has a lower density). Next, the respective emission values were multiplied with the TCRE to obtain the global warming linked to the emissions. Finally, this value was multiplied with the change in glacier volume loss per degree of warming for the respective regions and the world. The results were rounded to the nearest lower thousand.

For question 5, the input values include the same inputs as in the previous questions, except for the greenhouse gas emission estimates for Tyrving, Breidablikk and Yggdrasil, where we use annual instead of total values (see first table). The calculation were performed analogous to the ones of questions 1-4.

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
Associate Professor
Department of Water and Climate
Vrije Universiteit Brussel

[9] Bressler, R. D. (2021). The mortality cost of carbon. **Nature communications**, 12(1), 4467. [pdf]
[10] Thiery, W., et al., op. cit.

About the author

Prof. Dr. 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 1000 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. Overall, he (co-)authored 136 peer-reviewed scientific articles, including 27 in the flagship Science and Nature-Family journals. 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 Royal Flemish Academy of Belgium for Science and the Arts (KVAB - Class Natural Sciences). Since 2023, he is recognised by Stanford University as a member of the top 2% of scientists worldwide across all scientific disciplines.

Full CV can be found here.
Full publication list can be found here.