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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 to 2028, 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	18.40	182.00	365.00	565,40
2024	1.17	9.87	-	-
2025	3.80	12.85	-	-
2026	1.70	8.10	-	-
2027	1.26	7.70	28.80	-
2028	0.96	7.00	42.40	-

This information is used as input data for the calculations and these values are assumed to be accurate. I note that these input values have increased substantially compared to my previous report, and that these new results are therefore substantially higher even though I used the exact same method. Notably, the total emission values for Tyrving increased by 52%, making the climate impact assessments 52% higher. Likewise, the total emission values for Breidablikk increased by 70%, making the climate impact assessments 70% higher. This caused the climate impact assessments for the 3 fields combined to be 17% higher. Overall, the difference in results between this report and my previous report (dated 15/07/2025) stem solely from the change in emission values that I used as input. Here below I provide my answers to these four questions.

Question 1 – Global-aggregate additional lifetime exposure to heatwaves for the 2010-2020 birth cohorts

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	11300	111900	224500	347700
2019	10900	108700	218100	337900
2018	10600	105600	211900	328300
2017	10300	102700	206000	319100
2016	10000	99700	200000	309900
2015	9700	96800	194200	300800
2014	9400	93800	188200	291500
2013	9100	90800	182200	282200
2012	8800	87300	175200	271300
2011	8400	83800	168200	260600
2010	8100	80500	161500	250300
2010-2020	**106600**	**1061600**	**2130000**	**3299600**

The results[2] imply, for example, that

- 111 900 children born in the year 2020 are expected to face one additional heatwave in their lifetime due to the total emissions of Breidablikk.
- 328 300 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.
- 3 299 600 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.

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[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).

Question 2 – Global-aggregate additional lifetime exposure to other climate extremes for the 2010-2020 birth cohorts

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	300	3600	7200	11200
2019	300	3400	6900	10700
2018	300	3300	6600	10300
2017	300	3100	6400	9900
2016	300	3000	6100	9500
2015	300	2900	5900	9200
2014	200	2800	5700	8800
2013	200	2700	5500	8600
2012	200	2600	5200	8100
2011	200	2400	4900	7700
2010	200	2300	4700	7300
2010-2020	**2800**	**32100**	**65100**	**101300**

	Number of children facing an additional **crop failure** due to the **total** emissions of			
Birth year	**Tyrving**	**Breidablikk**	**Yggdrasil**	**Combined**
2020	300	3000	6000	9400
2019	200	2900	5900	9200
2018	200	2800	5800	8900
2017	200	2800	5600	8700
2016	200	2700	5500	8500
2015	200	2700	5400	8400
2014	200	2600	5300	8200
2013	200	2500	5100	8000
2012	200	2500	5000	7700
2011	200	2400	4800	7500
2010	200	2300	4700	7300
2010-2020	**2300**	**29200**	**59100**	**91800**

	Number of children facing an additional **wildfire** due to the **total** emissions of			
Birth year	**Tyrving**	**Breidablikk**	**Yggdrasil**	**Combined**
2020	100	1100	2300	3600
2019	100	1100	2200	3500
2018	100	1100	2200	3400
2017	100	1000	2100	3300
2016	100	1000	2100	3300
2015	100	1000	2000	3200
2014	100	1000	2000	3100
2013	100	900	1900	3000
2012	0	900	1900	2900
2011	0	900	1800	2800
2010	0	800	1800	2700
2010-2020	**800**	**10800**	**22300**	**34800**

	Number of children facing an additional **tropical cyclone** due to the **total** emissions of			
Birth year	**Tyrving**	**Breidablikk**	**Yggdrasil**	**Combined**
2020	100	1100	2200	3400

2019	100	1000	2100	3300
2018	100	1000	2100	3200
2017	100	1000	2000	3200
2016	100	1000	2000	3100
2015	100	900	1900	3000
2014	0	900	1900	3000
2013	0	900	1800	2900
2012	0	900	1800	2800
2011	0	800	1700	2600
2010	0	800	1600	2500
2010-2020	**600**	**10300**	**21100**	**33000**

	Number of children facing an additional **river flood** due to the **total** emissions of			
Birth year	**Tyrving**	**Breidablikk**	**Yggdrasil**	**Combined**
2020	0	800	1600	2500
2019	0	700	1500	2400
2018	0	700	1500	2300
2017	0	700	1400	2200
2016	0	700	1400	2100
2015	0	600	1300	2000
2014	0	600	1300	2000
2013	0	600	1200	1900
2012	0	600	1200	1800
2011	0	500	1100	1700
2010	0	500	1100	1700
2010-2020	**0**	**7000**	**14600**	**22600**

The results imply, for example, that

- 101 300 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.
- 91 800 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.
- 34 800 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.
- 33 000 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 Tyrving, Breidablikk, and Yggdrasil combined.
- 22 600 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.

Question 3 – Global-aggregate additional heat-related mortality

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 (assuming a high-emissions scenario).

	Number of **heat-related deaths until 2100** due to the **total** emissions of			
	Tyrving	**Breidablikk**	**Yggdrasil**	**Combined**
Additional heat-related deaths until 2100 - high-emissions scenario	4100	41000	82300	127500

The results[3] imply that, under the assumption of a high-emissions scenario

- 4 100 heat-related deaths are expected worldwide until 2100 due to the total emissions of Tyrving.
- 41 000 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.
- 127 500 heat-related deaths are expected worldwide until 2100 due to the total emissions of Tyrving, Breidablikk, and Yggdrasil combined.

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

Question 4 – Global-aggregate and regional glacier volume loss

The following table provides the glacier mass loss in m³ 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 m³ due to the **total** emissions of			
Region	**Tyrving**	**Breidablikk**	**Yggdrasil**	**Combined**
Arctic Canada South	5192000	51361000	103006000	159560000
Western Canada & US	858000	8492000	17032000	26383000
Scandinavia	255000	2531000	5077000	7865000
Russian Arctic	19836000	196208000	393494000	609539000
Iceland	6324000	62553000	125451000	194329000
Greenland Periphery	20517000	202942000	407000000	630460000
Central Europe	153000	1513000	3035000	4701000
North Asia	156000	1552000	3113000	4823000
South Asia East	1003000	9927000	19909000	30841000
Svalbard & Jan Mayen	14182000	140284000	281338000	435805000
Southern Andes	5896000	58327000	116974000	181198000
Alaska	29242000	289249000	580088000	898580000
Sub & Antarctic Islands	63306000	626186000	1255814000.00000	1945308000.00000
Arctic Canada North	53678000	530947000	1064811000.00000	1649436000.00000
Low Latitudes	186000	1842000	3695000	5724000
Caucasus & Middle East	108000	1071000	2149000	3329000
New Zealand	138000	1368000	2744000	4250000
Central Asia	7481000	74003000	148414000	229899000
South Asia West	7604000	75214000	150842000	233660000
Global	**247483000**	**2447937000**	**4909325000**	**7604746000**

The results imply, for example, that
- Scandinavian glaciers will lose 255 000 m³ due to the total emissions of Tyrving.
- Scandinavian glaciers will lose 2 531 000 m³ due to the total emissions of Breidablikk.
- Scandinavian glaciers will lose 5 077 000 m³ due to the total emissions of Yggdrasil.
- Scandinavian glaciers will lose 7 865 000 m³ due to the total emissions of Tyrving, Breidablikk, and Yggdrasil combined.
- Glaciers worldwide will lose 7 604 746 000 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.

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

Question 5 – results from questions 1-4 for annual instead of total emissions

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	Tyrving 2028	Breidab. 2024	Breidab. 2025	Breidab. 2026	Breidab. 2027	Breidab. 2028	Yggdrasil 2027	Yggdrasil 2028
2020	700	2300	1000	700	500	6000	7900	4900	4700	4300	17700	26000
2019	600	2200	1000	700	500	5900	7600	4800	4600	4100	17200	25300
2018	600	2200	900	700	500	5700	7400	4700	4400	4000	16700	24600
2017	600	2100	900	700	500	5500	7200	4500	4300	3900	16200	23900
2016	600	2000	900	600	500	5400	7000	4400	4200	3800	15700	23200
2015	600	2000	900	600	500	5200	6800	4300	4000	3700	15300	22500
2014	600	1900	800	600	400	5000	6600	4100	3900	3600	14800	21800
2013	500	1800	800	600	400	4900	6400	4000	3800	3400	14300	21100
2012	500	1800	800	600	400	4700	6100	3800	3600	3300	13800	20300
2011	500	1700	700	500	400	4500	5900	3700	3500	3200	13200	19500
2010	500	1600	700	500	400	4300	5600	3500	3400	3000	12700	18700
2010-2020	**6300**	**21600**	**9400**	**6800**	**5000**	**57100**	**74500**	**46700**	**44400**	**40300**	**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	Tyrving 2028	Breidab. 2024	Breidab. 2025	Breidab. 2026	Breidab. 2027	Breidab. 2028	Yggdrasil 2027	Yggdrasil 2028
2020	0	0	0	0	0	100	200	100	100	100	500	800
2019	0	0	0	0	0	100	200	100	100	100	500	800
2018	0	0	0	0	0	100	200	100	100	100	500	700
2017	0	0	0	0	0	100	200	100	100	100	500	700
2016	0	0	0	0	0	100	200	100	100	100	400	700
2015	0	0	0	0	0	100	200	100	100	100	400	600
2014	0	0	0	0	0	100	200	100	100	100	400	600
2013	0	0	0	0	0	100	100	100	100	100	400	600
2012	0	0	0	0	0	100	100	100	100	100	400	600
2011	0	0	0	0	0	100	100	100	100	0	300	500
2010	0	0	0	0	0	100	100	100	0	0	300	500
2010-2020	**0**	**0**	**0**	**0**	**0**	**1100**	**1800**	**1100**	**1000**	**900**	**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	Tyrving 2028	Breidab. 2024	Breidab. 2025	Breidab. 2026	Breidab. 2027	Breidab. 2028	Yggdrasil 2027	Yggdrasil 2028
2020	0	0	0	0	0	100	200	100	100	100	400	700
2019	0	0	0	0	0	100	200	100	100	100	400	600
2018	0	0	0	0	0	100	200	100	100	100	400	600
2017	0	0	0	0	0	100	100	100	100	100	400	600
2016	0	0	0	0	0	100	100	100	100	100	400	600
2015	0	0	0	0	0	100	100	100	100	100	400	600
2014	0	0	0	0	0	100	100	100	100	100	400	600
2013	0	0	0	0	0	100	100	100	100	0	400	600

2012	0	0	0	0	0	100	100	100	100	0	300	500
2011	0	0	0	0	0	100	100	100	100	0	300	500
2010	0	0	0	0	0	100	100	100	100	0	300	500
2010-2020	**0**	**0**	**0**	**0**	**0**	**1100**	**1400**	**1100**	**1100**	**700**	**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	Tyrving 2028	Breidab. 2024	Breidab. 2025	Breidab. 2026	Breidab. 2027	Breidab. 2028	Yggdrasil 2027	Yggdrasil 2028
2020	0	0	0	0	0	0	0	0	0	0	100	200
2019	0	0	0	0	0	0	0	0	0	0	100	200
2018	0	0	0	0	0	0	0	0	0	0	100	200
2017	0	0	0	0	0	0	0	0	0	0	100	200
2016	0	0	0	0	0	0	0	0	0	0	100	200
2015	0	0	0	0	0	0	0	0	0	0	100	200
2014	0	0	0	0	0	0	0	0	0	0	100	200
2013	0	0	0	0	0	0	0	0	0	0	100	200
2012	0	0	0	0	0	0	0	0	0	0	100	200
2011	0	0	0	0	0	0	0	0	0	0	100	200
2010	0	0	0	0	0	0	0	0	0	0	100	200
2010-2020	**0**	**0**	**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	Tyrving 2028	Breidab. 2024	Breidab. 2025	Breidab. 2026	Breidab. 2027	Breidab. 2028	Yggdrasil 2027	Yggdrasil 2028
2020	0	0	0	0	0	0	0	0	0	0	100	200
2019	0	0	0	0	0	0	0	0	0	0	100	200
2018	0	0	0	0	0	0	0	0	0	0	100	200
2017	0	0	0	0	0	0	0	0	0	0	100	200
2016	0	0	0	0	0	0	0	0	0	0	100	200
2015	0	0	0	0	0	0	0	0	0	0	100	200
2014	0	0	0	0	0	0	0	0	0	0	100	200
2013	0	0	0	0	0	0	0	0	0	0	100	200
2012	0	0	0	0	0	0	0	0	0	0	100	200
2011	0	0	0	0	0	0	0	0	0	0	100	200
2010	0	0	0	0	0	0	0	0	0	0	100	100
2010-2020	**0**	**0**	**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	Tyrving 2028	Breidab. 2024	Breidab. 2025	Breidab. 2026	Breidab. 2027	Breidab. 2028	Yggdrasil 2027	Yggdrasil 2028
2020	0	0	0	0	0	0	0	0	0	0	100	100
2019	0	0	0	0	0	0	0	0	0	0	100	100
2018	0	0	0	0	0	0	0	0	0	0	100	100
2017	0	0	0	0	0	0	0	0	0	0	100	100
2016	0	0	0	0	0	0	0	0	0	0	100	100
2015	0	0	0	0	0	0	0	0	0	0	100	100
2014	0	0	0	0	0	0	0	0	0	0	100	100
2013	0	0	0	0	0	0	0	0	0	0	0	100
2012	0	0	0	0	0	0	0	0	0	0	0	100
2011	0	0	0	0	0	0	0	0	0	0	0	100
2010	0	0	0	0	0	0	0	0	0	0	0	100
2010-2020	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**700**	**1100**

The results imply, for example, that

- 6 000 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.
- 4 600 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.
- 6 400 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.

Region	**Glacier mass loss** in m³ due to the **annual** emissions of					
	Tyrving 2024	**Tyrving 2025**	**Tyrving 2026**	**Tyrving 2027**	**Tyrving 2028**	**Breidablikk 2024**
Arctic Canada South	330000	1072000	479000	355000	270000	2785000
Western Canada & US	54000	177000	79000	58000	44000	460000
Scandinavia	16000	52000	23000	17000	13000	137000
Russian Arctic	1261000	4096000	1832000	1358000	1034000	10640000
Iceland	402000	1306000	584000	433000	329000	3392000
Greenland Periphery	1304000	4237000	1895000	1404000	1070000	11005000
Central Europe	9000	31000	14000	10000	7000	82000
North Asia	9000	32000	14000	10000	8000	84000
South Asia East	63000	207000	92000	68000	52000	538000
Svalbard & Jan Mayen	901000	2929000	1310000	971000	739000	7607000
Southern Andes	374000	1217000	544000	403000	307000	3163000
Alaska	1859000	6039000	2701000	2002000	1525000	15686000
Sub & Antarctic Islands	4025000	13074000	5848000	4335000	3302000	33958000
Arctic Canada North	3413000	11085000	4959000	3675000	2800000	28793000
Low Latitudes	11000	38000	17000	12000	9000	99000
Caucasus & Middle East	6000	22000	10000	7000	5000	58000
New Zealand	8000	28000	12000	9000	7000	74000
Central Asia	475000	1545000	691000	512000	390000	4013000
South Asia West	483000	1570000	702000	520000	396000	4078000
Global	**15736000**	**51110000**	**22865000**	**16947000**	**12912000**	**132753000**

Region	**Glacier mass loss** in m³ due to the **annual** emissions of					
	Breidablikk 2025	**Breidablikk 2026**	**Breidablikk 2027**	**Breidablikk 2028**	**Yggdrasil 2027**	**Yggdrasil 2028**
Arctic Canada South	3626000	2285000	2173000	1975000	8127000	11965000
Western Canada & US	599000	377000	359000	326000	1343000	1978000
Scandinavia	178000	112000	107000	97000	400000	589000
Russian Arctic	13853000	8732000	8301000	7546000	31048000	45710000
Iceland	4416000	2783000	2646000	2405000	9898000	14572000
Greenland Periphery	14328000	9032000	8586000	7805000	32114000	47278000
Central Europe	106000	67000	64000	58000	239000	352000
North Asia	109000	69000	65000	59000	245000	361000
South Asia East	700000	441000	420000	381000	1570000	2312000
Svalbard & Jan Mayen	9904000	6243000	5935000	5395000	22198000	32681000
Southern Andes	4118000	2595000	2467000	2243000	9229000	13588000
Alaska	20422000	12873000	12237000	11124000	45771000	67385000
Sub & Antarctic Islands	44211000	27868000	26492000	24084000	99088000	145880000
Arctic Canada North	37487000	23630000	22463000	20421000	84017000	123693000
Low Latitudes	130000	82000	77000	70000	291000	429000
Caucasus & Middle East	75000	47000	45000	41000	169000	249000
New Zealand	96000	60000	57000	52000	216000	318000
Central Asia	5224000	3293000	3130000	2846000	11710000	17240000
South Asia West	5310000	3347000	3182000	2892000	11902000	17522000
Global	**172835000**	**108946000**	**103566000**	**94151000**	**387365000**	**570288000**

The results imply, for example, that

- Scandinavian glaciers will lose 52 000 m³ due to the 2025 emissions of Tyrving.
- Scandinavian glaciers will lose 137 000 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 51 110 000 m³ due to the 2025 emissions of Tyrving.
- Glaciers worldwide will lose 132 753 000 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**	**Tyrving 2028**	**Breidab. 2024**	**Breidab. 2025**	**Breidab. 2026**	**Breidab. 2027**	**Breidab. 2028**	**Yggdrasil 2027**	**Yggdrasil 2028**
*Additional heat-related mortality**	200	800	300	200	200	2200	2800	1800	1700	1500	6400	9500

** Until 2100 under a high-emission scenario*

The results imply that, under the assumption of a high-emissions scenario

- 200 heat-related deaths are expected worldwide until 2100 due to the emissions of Tyrving in 2024.
- 800 heat-related deaths are expected worldwide until 2100 due to the emissions of Tyrving in 2025.
- 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.
- 200 heat-related deaths are expected worldwide until 2100 due to the emissions of Tyrving in 2028.
- 2200 heat-related deaths are expected worldwide until 2100 due to the emissions of Breidablikk in 2024.
- 2800 heat-related deaths are expected worldwide until 2100 due to the emissions of Breidablikk in 2025.
- 1800 heat-related deaths are expected worldwide until 2100 due to the emissions of Breidablikk in 2026.
- 1700 heat-related deaths are expected worldwide until 2100 due to the emissions of Breidablikk in 2027.
- 1500 heat-related deaths are expected worldwide until 2100 due to the emissions of Breidablikk in 2028.
- 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.

Question 6 – On the possibility of climate impact assessments

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 my 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, five to eight orders of magnitude above the threshold of detectable impacts identified by the Stanford University study.

[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.

Discussion and Methods

As also mentioned during my testimonies of 30 November 2023 and 2 September 2025, 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 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 derived under a high-emissions scenario (referred to as 'Baseline emissions scenario' in the original publication, leading to 4.1°C global warming above pre-industrial by 2100). 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.

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

Statutory declaration

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. Dr. Wim Thiery
Full Professor
Department of Water and Climate
Vrije Universiteit Brussel

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. In 2026, he became full professor (age 38). With over 1100 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 148 peer-reviewed scientific articles, including 28 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". Prof. Thiery is currently leading a 2-million-euro European research grant awarded by the European Research Council (ERC Consolidator Grant) on impact attribution. 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.