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Expert Report related to case number
J nr. 2025 – 16966

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In case number *J nr. 2025 – 16966*, we have been asked by 'Greenpeace Denmark' to address the following questions:

1. How many children born worldwide in 2016-2025 are projected to experience one additional heat wave, drought, crop failure, tropical cyclone, river flood and wildfire, respectively, due to the greenhouse gas emissions from the Hejre field?

2. How many children born in any country in 2016-2025 are projected to experience one additional heatwave, due to the greenhouse gas emissions from the Hejre field?

3. How many people born worldwide in 1951-1960 will be exposed globally to one additional heatwave, drought, crop failure, tropical cyclone, river flood and wildfire, respectively, due to the greenhouse gas emissions from the Hejre field, and how do these results compare to the results of question 1?

4. What is the committed steady-state glacier volume loss worldwide and for 19 different glacier regions due to the greenhouse gas emissions from the Hejre field?

5. Are climate impact assessments possible for individual fossil fuel projects?

The following emission values were provided to us by Greenpeace Denmark, and correspond to the scope 3 emissions associated with the exploitation of the Hejre Field:

Emissions (tCO_{2eq}) used as input in the calculations

Downstream Scope 3	*P90 (Low)*	*P50 (Mid)*	*P10 (High)*
Total	24 129 000	35 392 000	47 522 000

We use this information as input data for the calculations and assume that these values are accurate. Here below we provide our answers to these five questions.

Question 1 – Global-aggregate additional lifetime exposure to climate extremes for the 2016-2025 birth cohorts

The results for questions 1-3 are derived from four scientific studies conducted in the research team of the authors of this report: Thiery et al. (2021, *Science*)[1], Grant et al. (2025, *Nature*)[2], Pietroiusti et al. (forthcoming)[3], Laridon et al. (forthcoming)[4].

The following table presents the number of children born in a given calendar year worldwide who are expected to experience one additional heatwave over their lifetime because of emissions from the Hejre Field. A heatwave is defined here following Thiery et al. (2021 *Science*[5]) as a multi-day extreme heat event that is expected to occur, on average, only once per century in absence of anthropogenic climate change.

Number of children born worldwide between 2016 and 2025 expected to experience an additional heat wave over their lifetime due to emissions from the Hejre Field

Birth Cohorts	*Low Estimate*	*Best estimate*	*High Estimate*
2025	9 447	19 657	36 231
2024	9 962	19 132	34 422
2023	9 644	18 783	33 695
2022	9 321	18 125	33 222
2021	9 446	17 914	32 021
2020	9 240	17 571	33 020
2019	9 320	17 396	32 409
2018	8 996	17 303	32 466
2017	8 634	17 215	31 510
2016	8 270	15 899	29 609
Global	**92 280**	**178 995**	**328 605**

Table 1: Estimated additional number of children born worldwide between 2016 and 2025 who are expected to experience one extra heat wave over their lifetime due to emissions from the Hejre Field. *For each hazard, the best estimate (median of the simulation ensemble) as well as the low and high estimates (5th and 95th percentiles of the simulation ensemble) are provided.*

[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., (2021) Intergenerational inequities in exposure to climate extremes, ***Science***, 374(6564), 158-160. [pdf, Research highlights in Nature, Nature Climate Change, and The Lancet Planetary Health]. *(This study introduces the lifetime extreme event exposure framework)*

[2] Grant, L., Vanderkelen, I., Gudmundsson, L., Fischer, E., Seneviratne, S. I., and Thiery, W., (2025) Global emergence of unprecedented lifetime exposure to climate extremes, ***Nature***, 641, 374–379, 2021. [pdf, Research highlights in Nature News and Views; Nature Editorial; Nature News]. (*This study updates the global warming pathways feeding into the lifetime extreme event exposure framework to the latest generation)*

[3] Pietroiusti, R., Hetzer, J., Turco, M., Prudencio Montano, S., Laridon, A., Lejeune, Q., Prapotny, D., Thiery, W., Increasing lifetime exposure to extreme fire weather under climate change in Portugal and Europe, in review. *(This study updates the demographic data feeding into the lifetime extreme event exposure framework to the latest generation)*

[4] Laridon, A., Pietroiusti, R., Rogelj, J., Schleussner, C.-F., Smith, C.J., Menke, I., Nauels, A., Schuster, L., Zekollari, H., Thiery, W., A framework for systematically assessing climate change impacts from individual fossil fuel projects, in preparation. *(This study updates the climate and impact model simulations feeding into the lifetime extreme exposure framework to the latest generation, and extends the framework to apply it to individual fossil fuel projects)*

[5] Thiery, W., et al. (2021) ***Science*** op. cit. [pdf].

The results imply, for example, that

- 19 657 children born in the year 2025 are expected to face one additional heat wave in their lifetime due to the emissions of the Hejre Field (best estimate).
- 36 231 children born in the year 2025 are expected to face one additional heat wave in their lifetime due to the emissions of the Hejre Field (high estimate).
- 9 447 children born in the year 2025 are expected to face one additional heat wave in their lifetime due to the emissions of the Hejre Field (low estimate).
- 15 899 children born in the year 2016 are expected to face one additional heat wave in their lifetime due to the emissions of the Hejre Field (best estimate).
- From all children worldwide who are younger than 10 years old in 2025, 178 995 are expected to experience one additional heat wave over their lifetime due to emissions from the Hejre Field (best estimate), with 92 280 (low estimate) and 328 605 (high estimate).

For all results presented in this report, we provide the best estimate as well as the spread around it. This spread – referred to in the scientific literature as the uncertainty range – is characterised by a low estimate and a high estimate, corresponding to the 5th and 95th percentiles of the empirical output distribution respectively. The spread encapsulates numerical estimates of (i) imprecision in the emission estimates of the Hejre Field project, (ii) imprecision in global mean temperature response to emissions, (iii) imprecision in local climate extreme occurrence under global warming – accounted for by using an ensemble of multiple Earth system models and multiple biophysical impact models – and (iv) imprecision in demographic projections for different regions and countries. By combining these different sources of imprecision into one single spread, our scientific method allows for a robust quantification of possible outcomes, providing a best estimate as well as low and high estimates. Under the assumption that the input distributions adequately characterise the true uncertainty of each parameter, there is a 5% probability that the true value falls below the low estimate, and a 5% probability that the true value exceeds the high estimate – meaning there is a 90% probability that the true value lies within the reported range (that is, between the Low and High Estimate). These probabilities reflect the degree of confidence one can place in the result: a 90% probability means that, given the available scientific knowledge encoded in the input distributions, 9 out of 10 realisations of the underlying uncertainties would yield a value within this range. Importantly, the presence of a spread should therefore not be interpreted as an absence of knowledge, but rather as a transparent and rigorous quantification of what is known: the reported range reflects the boundaries of scientific understanding as currently encoded in the literature, and the best estimate remains a robust and well-constrained result within that range.

For example, our best estimate is that 178,995 children born between 2016 and 2025 will be exposed to one additional heatwave during their lifetime due to the emissions associated with the Hejre field. We further find that there is a 95% probability that at least 92,280 children born between 2016 and 2025 will be exposed to one additional heatwave during their lifetime due to the emissions associated with the Hejre field. We also find that there is only 5% probability that more than 328,605 children will face an additional heatwave. There is therefore a 90% probability that the true number of affected children lies between 92,280 and 328,605 children.

In a next step, we extend this analysis to five other climate extremes. 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 the Hejre Field. The definitions of all climate extremes and means of calculating their annual occurrence are provides in Thiery et al. (2021 *Science*[6]).

[6] Thiery, W., et al. (2021) ***Science*** op. cit. [pdf].

Number of children born worldwide between 2016 and 2025 expected to experience an additional crop failure over their lifetime due to emissions from the Hejre Field

Birth Cohorts	*Low Estimate*	*Best estimate*	*High Estimate*
2025	213	487	1 647
2024	209	469	1 503
2023	214	454	1 488
2022	200	437	1 447
2021	195	423	1 417
2020	189	416	1 351
2019	184	406	1 334
2018	181	397	1 306
2017	173	388	1 277
2016	164	349	1 138
Global	**1 922**	**4 226**	**13 908**

Table 2: Estimated additional number of children born worldwide between 2016 and 2025 who are expected to experience one extra crop failure over their lifetime due to emissions from the Hejre Field. *For each hazard, the best estimate (median of the simulation ensemble) as well as the low and high estimates (5th and 95th percentiles of the simulation ensemble) are provided.*

Number of children born worldwide between 2016 and 2025 expected to experience an additional drought over their lifetime due to emissions from the Hejre Field

Birth Cohorts	*Low Estimate*	*Best estimate*	*High Estimate*
2025	37	299	6 407
2024	36	298	5 999
2023	35	287	5 865
2022	35	282	5 781
2021	34	274	5 733
2020	34	271	5 708
2019	33	266	5 653
2018	33	262	5 631
2017	31	258	5 527
2016	30	236	5 196
Global	**338**	**2 733**	**57 500**

Table 3: Estimated additional number of children born worldwide between 2016 and 2025 who are expected to experience one extra drought over their lifetime due to emissions from the Hejre Field. *For each hazard, the best estimate (median of the simulation ensemble) as well as the low and high estimates (5th and 95th percentiles of the simulation ensemble) are provided.*

Number of children born worldwide between 2016 and 2025 expected to experience an additional wildfire over their lifetime due to emissions from the Hejre Field

Birth Cohorts	*Low Estimate*	*Best estimate*	*High Estimate*
2025	0	174	923
2024	0	171	872
2023	0	168	837
2022	0	165	815
2021	0	163	791
2020	0	162	770
2019	0	160	752
2018	0	158	719
2017	0	155	707
2016	0	145	639
Global	**0**	**1 621**	**7 825**

Table 5: Estimated additional number of children born worldwide between 2016 and 2025 who are expected to experience one extra wildfire over their lifetime due to emissions from the Hejre Field. *For each hazard, the best estimate (median of the simulation ensemble) as well as the low and high estimates (5th and 95th percentiles of the simulation ensemble) are provided.*

Number of children born worldwide between 2016 and 2025 expected to experience an additional river flood over their lifetime due to emissions from the Hejre Field

Birth Cohorts	*Low Estimate*	*Best estimate*	*High Estimate*
2025	14	153	482
2024	13	149	447
2023	12	145	435
2022	11	136	417
2021	10	130	397
2020	9	127	390
2019	8	122	382
2018	7	117	382
2017	6	109	363
2016	3	99	330
Global	**93**	**1 287**	**4 025**

Table 4: Estimated additional number of children born worldwide between 2016 and 2025 who are expected to experience one extra river flood over their lifetime due to emissions from the Hejre Field. *For each hazard, the best estimate (median of the simulation ensemble) as well as the low and high estimates (5th and 95th percentiles of the simulation ensemble) are provided.*

Number of children born worldwide between 2016 and 2025 expected to experience an additional tropical cyclone over their lifetime due to emissions from the Hejre Field

Birth Cohorts	*Low Estimate*	*Best estimate*	*High Estimate*
2025	0	100	951
2024	0	97	894
2023	0	95	870
2022	0	92	858
2021	0	91	848
2020	0	93	848
2019	0	95	845
2018	0	94	836
2017	0	92	833
2016	0	83	759
Global	**0**	**932**	**8 542**

*Table 6: **Estimated additional number of children born worldwide between 2016 and 2025 who are expected to experience one extra tropical cyclone over their lifetime due to emissions from the Hejre Field.** For each hazard, the best estimate (median of the simulation ensemble) as well as the low and high estimates (5th and 95th percentiles of the simulation ensemble) are provided.*

The results, shown as bar plots in Figure 1 for the cumulative data of the 2016–2025 birth cohorts worldwide, indicate that

- 4 226 children born in the years 2016 to 2025 are expected to face one additional crop failure in their lifetime due to the emissions of the Hejre Field (best estimate).
- 2 733 children born in the years 2016 to 2025 are expected to face one additional drought in their lifetime due to the emissions of the Hejre Field (best estimate).
- 1 621 children born in the years 2016 to 2025 are expected to face one additional wildfire in their lifetime due to the emissions of the Hejre Field (best estimate).
- 1 287 children born in the years 2016 to 2025 are expected to face one additional river flood in their lifetime due to the emissions of the Hejre Field (best estimate).
- 932 children born in the years 2016 to 2025 are expected to face one additional tropical cyclone in their lifetime due to the emissions of the Hejre Field (best estimate).

The best estimates and associated spread per climate extreme are visualised in Figure 1.

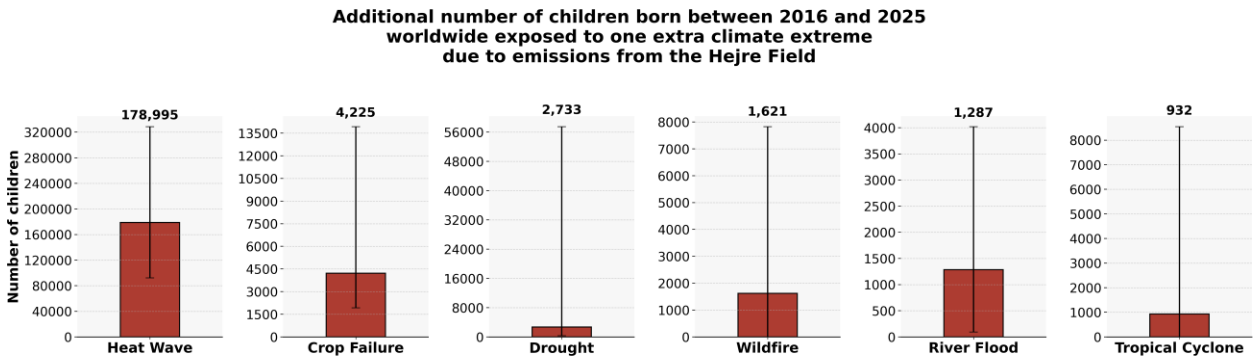

*Figure 1: **Estimated additional number of children born worldwide between 2016 and 2025 who are expected to experience one extra climate extreme over their lifetime due to emissions from the Hejre Field.** For each hazard, the best estimate (simulation ensemble median) is represented by the height of the bar, while the low and high estimates are indicated by the horizontal error bars. The value of the best estimate is also shown above each subplot. Extremes are ordered in descending order of their best estimate of the total number of children affected within the 2016-2025 birth cohort. Note the different y-axis ranges for the different panels.*

Question 2 – Country-scale additional lifetime exposure to heat waves for the 2016-2025 birth cohorts

The previous question addressed the global-aggregated additional exposure of the 2016-2025 birth cohorts to a range of climate extremes. In response to question 2, we break down this estimate to the country scale, focusing on heat waves.

Figure 2 shows the spatial distribution across countries of the 2016–2025 birth cohorts most affected by an additional heatwave over their lifetime due to emissions from the Hejre Field. In descending order, the most impacted countries are India (best estimate: 35 664 children), China (best estimate: 14 881 children), and Pakistan (best estimate: 9 169 children), followed by Nigeria (best estimate: 7 485 children) and Indonesia (best estimate: 6 301 children).

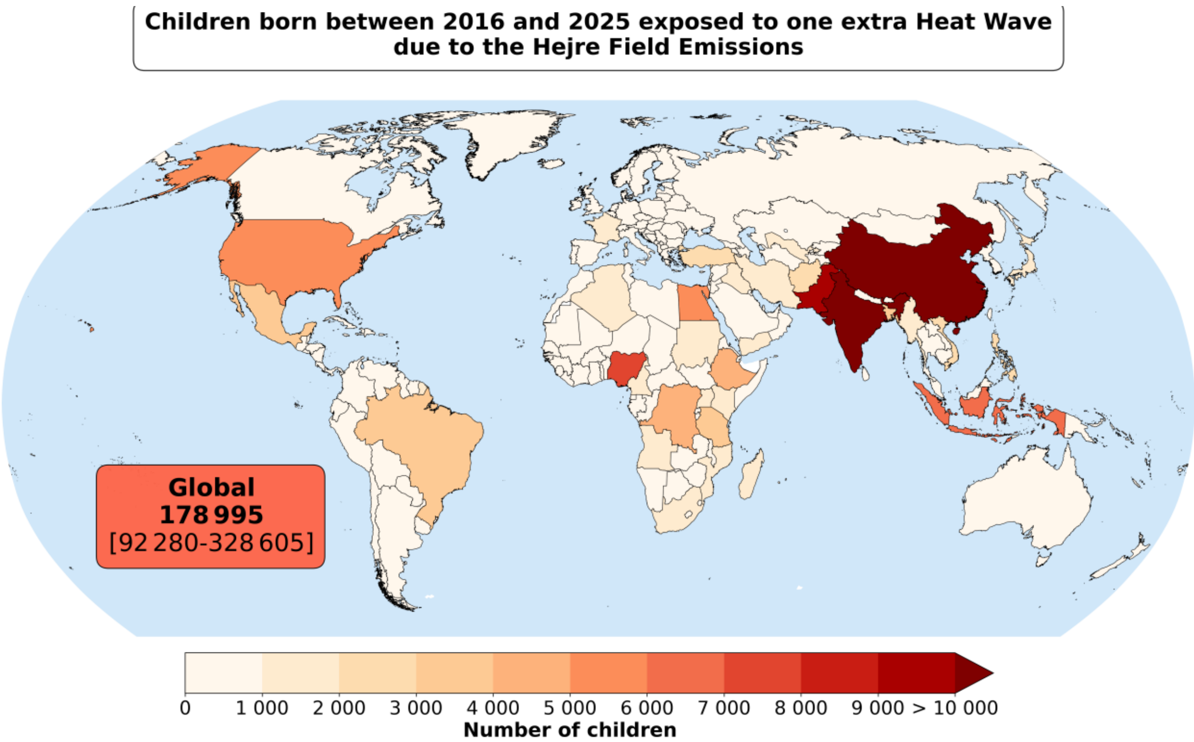

Figure 2: Map of the additional number of children born between 2016 and 2025 exposed to an extra heat wave over their lifetime due to the emissions of the Hejre Field. *Global totals are shown in the bottom-left corner. The value in bold represents the best estimate of the simulation ensemble, and the values in brackets indicate the low and high estimates.*

These results indicate that primarily countries in Asia and Africa are the most affected, while young generations in Europe experience relatively lower exposure numbers. Still, our best estimate reports additional exposure for young generations in each country in Europe. For example, 35 children born between 2016 and 2025 in Denmark are expected to face one additional heatwave in their lifetime due to the emissions associated with the Hejre field.

Table 7 provides, for these five most affected countries, the best estimate as well as the low and high estimates, along with the sum of these three values. The relative percentage, giving the share of impacts in these five countries compared to all countries, is indicated in parentheses. Our best estimate is that 41% of children born between 2016–2025 who are expected to experience an additional heatwave over their lifetime due to Hejre Field emissions are in these five countries in Asia and Africa.

Number of children born between 2016 and 2025 in the five most affected countries expected to experience an additional heat wave due to emissions from the Hejre Field

Countries	*Low Estimate*	*Best estimate*	*High Estimate*
India	18 145	35 664	69 878
China	6 222	14 881	38 122
Pakistan	5 099	9 169	16 440
Nigeria	2 051	7 485	15 762
Indonesia	3 012	6 301	10 412
Sum Top 5 Countries	**34 529 (37%)**	**73 500 (41%)**	**150 614 (48%)**

Table 7: Estimated additional number of children born between 2016 and 2025 in the five most affected countries expected to experience one additional heat wave during their lifetime due to emissions from the Hejre Field. *For each hazard, the best estimate (median of the simulation ensemble) as well as the low and high estimates (5th and 95th percentiles of the simulation ensemble) are provided.*

Table 8 shows the distribution by birth year within the 2016–2025 generation of children born in the most affected country, India, who are expected to experience an additional heatwave over their lifetime due to Hejre Field emissions. For example, 3 978 children born in 2025 in India are projected to experience one extra heatwave during their lifetime (best estimate), with 1 953 as the low estimate and 7 966 as the high estimate.

Number of children born in India between 2016 and 2025 expected to experience an additional heat wave over their lifetime due to emissions from the Hejre Field

Birth Cohorts	*Low Estimate*	*Best estimate*	*High Estimate*
2025	1 953	3 978	7 966
2024	1 969	3 876	7 692
2023	1 962	3 776	7 379
2022	1 871	3 700	6 993
2021	1 881	3 547	7 012
2020	1 823	3 554	6 872
2019	1 785	3 513	6 861
2018	1 744	3 449	6 685
2017	1 671	3 361	6 633
2016	1 486	2 910	5 785
Global	**18 145**	**35 664**	**69 878**

Table 8: Estimated additional number of children born in India between 2016 and 2025 who are expected to experience one extra heat wave over their lifetime due to emissions from the Hejre Field. *For each hazard, the best estimate (median of the simulation ensemble) as well as the low and high estimates (5th and 95th percentiles of the simulation ensemble) are provided.*

The concentration of additional exposure in Global South countries is due to two factors. The first is physics: climate warming is expected to have stronger effects in these regions. The second is demography: these countries host the youngest and largest populations. The combination of these two factors means that young generations in the Global South that will be disproportionally affected by any additional climate warming arising from ongoing and new fossil fuel projects.

Question 3 – Intergenerational differences in additional lifetime exposure to climate extremes

The previous questions focused on the additional exposure of the 2016-2025 birth cohorts to a range of climate extremes. In response to question 3, we compare these results against those obtained for the 1951-1960 birth cohorts, the oldest cohorts for which there is global-scale demographic data available. Table 9 shows the number of people born worldwide between 1951 and 1960 who are expected to experience one additional climate extreme over their lifetime due to Hejre Field emissions.

Number of people born between 1951 and 1960 worldwide expected to experience an additional climate extreme due to emissions from the Hejre Field

Climate Extreme	*Low Estimate*	*Best estimate*	*High Estimate*
Heat Wave	139	343	736
Crop Failure	0	0	0
Drought	0	0	213
Wildfire	0	0	12
River Flood	0	0	0
Tropical Cyclone	0	3	17

Table 9: Estimated additional number of people born between 1951 and 1960 worldwide expected to experience one additional climate extreme during their lifetime due to emissions from the Hejre Field. *For each hazard, the best estimate (median of the simulation ensemble) as well as the low and high estimates (5th and 95th percentiles of the simulation ensemble) are provided.*

The results imply, for example, that
- 343 people born between 1951 and 1960 are projected to experience one extra heatwave during their lifetime (best estimate)
- 0 people born between 1951 and 1960 are projected to experience an additional crop failure, drought, wildfire or river flood, respectively (best estimate)

Figure 3 compares the number of people affected between these two generations, each consisting of 10 birth years. The results indicate that, based on the best estimates,

- Worldwide, the 2016–2025 generation is projected to be 521 times more exposed to an additional heatwave over their lifetime than the 1951–1960 generation due to Hejre Field emissions.
- Worldwide, the 2016–2025 generation is effectively infinitely more exposed to an additional crop failure than the 1951–1960 generation, as the latter is not expected to experience any crop failure due to these emissions.
- Worldwide, the 2016–2025 generation is effectively infinitely more exposed to an additional drought than the 1951–1960 generation, as the latter is not expected to experience any drought due to these emissions.
- Worldwide, the 2016–2025 generation is effectively infinitely more exposed to an additional wildfire than the 1951–1960 generation, as the latter is not expected to experience any wildfire due to these emissions.
- Worldwide, the 2016–2025 generation is effectively infinitely more exposed to an additional river flood than the 1951–1960 generation, as the latter is not expected to experience any river flood due to these emissions.
- Worldwide, the 2016–2025 generation is projected to be 310 times more exposed to an additional tropical cyclone over their lifetime than the 1951–1960 generation due to Hejre Field emissions.

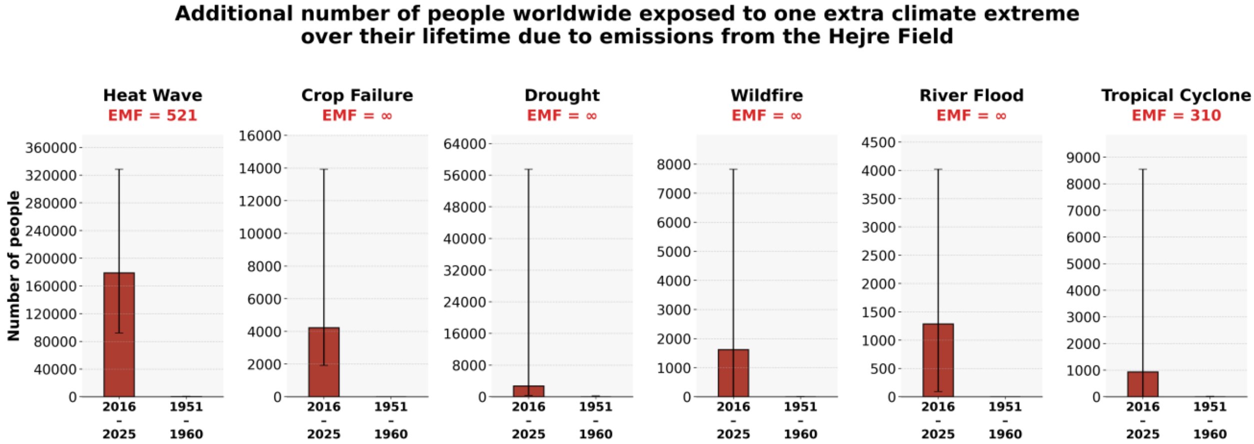

Figure 3: Estimated additional number of people born between 1951-1960 and children born between 2016-2025 worldwide expected to experience one additional climate extreme during their lifetime due to emissions from the Hejre Field. *For each hazard, the best estimate (median of the simulation ensemble) as well as the low and high estimates are provided with the vertical bars. EMF stands for Exposure Multiplication Factor and is defined for each extreme as the ratio of the best estimate for the 2016–2025 birth cohorts to the best estimate for the 1951–1960 birth cohorts worldwide. An infinite value is defined for the hazard where the exposure for the 1951–1960 birth cohort worldwide is equal to zero.*

These results highlight that younger generations will be disproportionally affected by emissions associated with the Hejre Field. The main reason for this intergenerational inequality is that younger generations would live a larger part of their lives in a climate rendered more hostile due to the Hejre Field emissions. A secondary effect is that their life expectancy is higher than that of previous generations, such as their grandparents, which further extends the period during which they will experience the effects of these emissions. However, a previous analysis of drivers showed that the increased life expectancy effect has only a small contribution to the overall increase in exposure across generations[7].

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[7] Thiery, W., et al. (2021) ***Science*** op. cit. [pdf].

Question 4 – Committed steady-state glacier volume loss

The previous questions focused on the additional human exposure to a range of climate extremes. In response to question 4, we turn to quantifying long-term committed changes in glacier volume.

Table 10 provides the glacier mass loss in m³ at stabilisation expected per region[8] and globally due to the total emissions of the Hejre Field.

Committed Steady-State Glacier Volume Loss in m³
due to the emissions of the Hejre Field

Glacier Region	*Low Estimate*	*Best estimate*	*High Estimate*
1 - Alaska	18 934 000	45 772 000	72 751 000
2 - Western Canada & US	274 000	1 433 000	3 147 000
3 - Arctic Canada North	42 703 200	79 996 000	135 499 000
4 - Arctic Canada South	2 130 000	5 496 000	11 130 000
5 - Greenland Periphery	19 566 000	34 821 000	51 024 000
6 – Iceland	2 948 000	6 738 000	10 872 000
7 – Svalbard	7 835 000	16 724 000	32 446 000
8 – Scandinavia	121 000	325 000	562 000
9 – Russian Arctic	16 615 000	34 055 000	57 512 000
10 – North Asia	102 000	214 000	419 000
11 – Central Europe	91 000	211 000	337 000
12 – Caucasus & Middle East	114 000	222 000	339 000
13 – Central Asia	6 138 000	13 091 000	21 830 000
14 – South Asia West	4 342 000	10 718 000	18 601 000
15 – South Asia East	980 000	1 953 000	3 819 000
16 – Low Latitudes	212 000	372 000	593 000
17 – Southern Andes	5 608 000	11 077 000	30 130 000
18 – New Zealand	185 000	337 000	505 000
19 – Sub & Antarctic Islands	51 732 000	158 346 000	295 743 000
Global	**156 325 000**	**448 582 000**	**715 504 000**

Table 10: Committed steady-state glacier volume loss for 19 glacier regions and the global total due to emissions from the Hejre Field. All values are expressed in m³. *For each region, the best estimate (median of the simulation ensemble) as well as the low and high estimates (5th and 95th percentiles of the simulation ensemble) are provided.*

The results imply, for example, that

- Scandinavian glaciers will lose 121 000 m³ due to the emissions of the Hejre Field (low estimate).
- Scandinavian glaciers will lose 325 000 m³ due to the emissions of the Hejre Field (best estimate).
- Scandinavian glaciers will lose 562 000 m³ due to the emissions of the Hejre Field (high estimate).
- Glaciers worldwide will lose 448 582 000 m³ due to the emissions of the Hejre Field (best estimate).

These results are based on a study[9] 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

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

[9] 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]

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.

Figure 9 shows the map representation of these 19 regions, displaying the best estimate of the committed steady-state glacier volume loss due to the emissions from the Hejre Field.

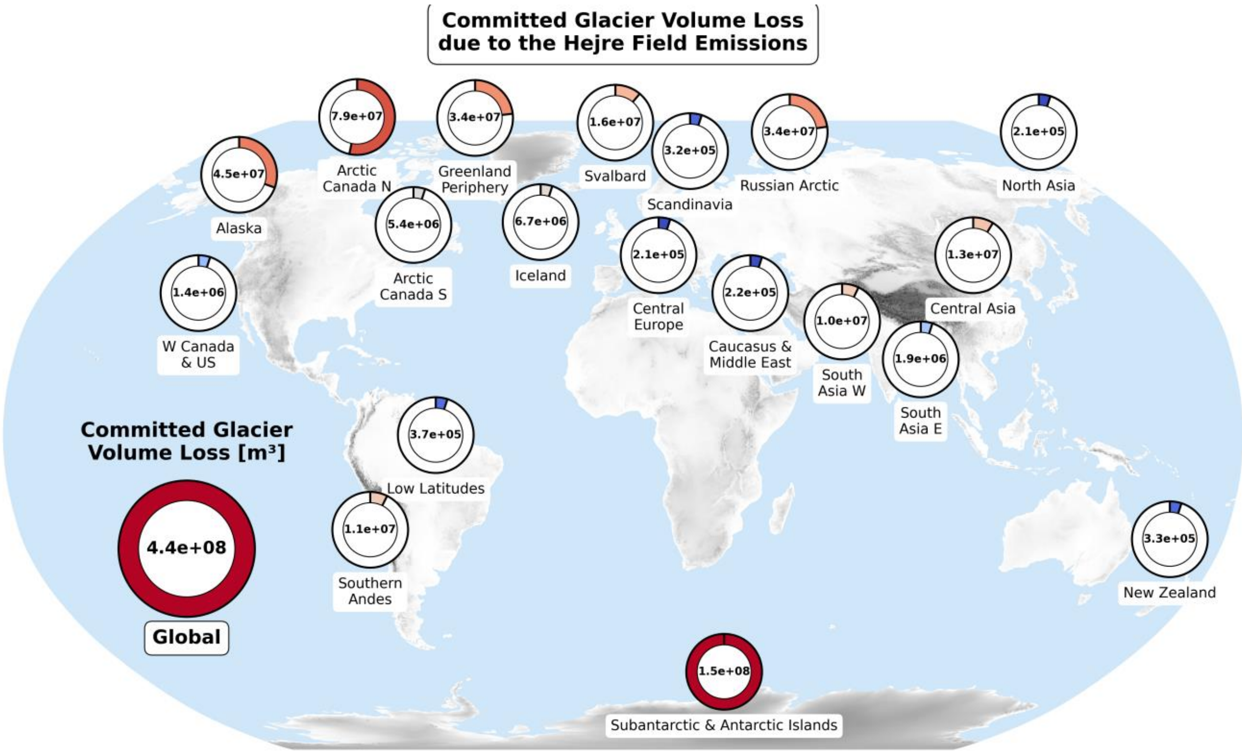

Figure 9: Committed steady-state glacier volume loss for 19 glacier regions due to the emissions of the Hejre Field. All values are expressed in m³. *The progress bar and the associated colour in each of the 19 regional circles represents the proportion of regional glacier volume loss relative to the committed steady-state glacier volume loss for the most impacted region (Subantarctic & Antarctic Islands). The committed steady state glacier volume loss at the global scale is shown in the lower-left corner of the figure.*

Question 5 – On the scientific ability to estimate impacts from individual fossil fuel projects

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 performed and presented (see our responses to questions 1-4). The risk assessment is based on a framework which we, a research professor and doctoral researcher in Climate Science, developed based on the laws of physics and chemistry, and using parameter values established in a recent IPCC report[10] and three very recent publications in the World's leading international scientific journals (*Science* and *Nature*)[11].

Furthermore, we are aware of at least three independent scientific frameworks that allow for similar types of risk assessment:

1. 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)[12].
2. The second framework is developed by a team of Australian scholars and quantifies the impacts of an individual fossil fuel project using an approach analogous to ours for selected regional impact indicators like heat-related mortality in Europe and Great Barrier Reef coral loss (Abram et al., 2025)[13].
3. The third 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)[14]. Note that the latter explicitly quantifies the effects of a single ton of CO_2, whereas the current report assesses emissions on the order of 24 to 47 million tonnes of CO_2, that is, seven orders of magnitude above the threshold of detectable impacts identified by the Stanford University study.

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[10] IPCC (2021), Summary for Policymakers. In: Climate Change 2021: The Physical Science Basis. Contribution of Working Group I to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change [Masson-Delmotte, V., P. Zhai, A. Pirani, S.L. Connors, C. Péan, S. Berger, N. Caud, Y. Chen, L. Goldfarb, M.I. Gomis, M. Huang, K. Leitzell, E. Lonnoy, J.B.R. Matthews, T.K. Maycock, T. Waterfield, O. Yelekçi, R. Yu, and B. Zhou (eds.)]. [pdf]

[11] Thiery, W., et al. (2021) ***Science***, op. cit. [pdf];
Grant, L., et al. (2025) ***Nature***, op. cit. [pdf]
Zekollari, H., Schuster, L. et al. (2025) ***Science***, op. cit. [pdf]

[12] Beusch, L., Nauels, A., Gudmundsson, L., Gütschow, J., Schleussner, C.F. and Seneviratne, S.I. (2022). Responsibility of major emitters for country-level warming and extreme hot years. Communications Earth & Environment, 3(1), 7. [pdf]

[13] Abram, N.J., Maher, N., Perkins-Kirkpatrick, S., Falster, G.M., Hughes, T.P., Meissner, K.J., Slater, L.J., King, A.D., Pitman, A.J., Moon, G. and Morgan, W. (2025). Quantifying the regional to global climate impacts of individual fossil fuel projects to inform decision-making. *npj Climate Action*, 4(1), 92. [pdf]

[14] This framework is under review in a scientific journal.

Methods

Input values into the calculation include, for question 1, 2 and 3: the low, mid, and high greenhouse gas emission estimates for the Hejre Field (see first table), the transient climate response to cumulative emissions (TCRE; 0,45°C per 1000 Gt CO_2eq with a standard deviation of 0.1094°C per 1000 GtCO_2eq as reported by the IPCC[15]), the best estimate and spread of the birth cohort size for 2016-2025 and 1951-1960 birth cohorts (obtained from the United Nations World Population Prospect 2024), climate impacts simulations from the ISIMIP database. The climate impacts simulations for heat waves, wildfires and droughts comes from ISIMIP3b and the climate impacts simulations for crop failures, tropical cyclones and river floods comes from the ISIMIP2b as in Thiery et al., 2021 *Science*[16]. The data and parameter estimates used in the model are thus grounded in the best available science.

In short, the results were obtained by multiplying the estimate of the emission values with the TCRE estimate to obtain an estimate of global warming linked to the emissions. This value was then multiplied with the estimate of 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 estimate of the cohort size for the respective birth years to obtain the number of members from a birth cohort experiencing one additional climate extreme.

To robustly probe the probable values of each of these variables, we employ a Latin Hypercube Sampling approach. To this end, at each stage of the model — emissions, TCRE, climate impact projections, and demography — we derive a probability density or mass function for each variable based on the best assessment of its likely range of values. We first fit a Gaussian distribution to the emissions of the Herje field, using the reported median as the distribution mean and the low and high estimates (10th and 90th percentiles) to estimate the standard deviation, assuming the distribution is symmetric about the median (as consistent with the Gaussian hypothesis). The assumption of a Gaussian distribution was verified through a symmetry test of the reported 10th and 90th percentile values, which confirmed that the distribution can be considered as symmetric about the median. We furthermore assumed that the TCRE follows a normal distribution, consistent with the symmetric likely range reported in IPCC AR6 WG1 (p. 749), from which the mean and standard deviation are derived. We retrieve a probability mass function for each hazard and locations based on the exposure slopes given by each individual climate impact simulations within the ISIMIP2b and ISIMIP3b ensemble[17]. Lastly, we model a Gaussian distribution based on the mean and standard deviation given by the United World Population Prospect 2024 birth cohort size data. A symmetry test was again performed to assess the validity of assuming a Gaussian distribution for the high and low estimates provided by the United Nations World Population Prospects 2024 birth cohort size dataset.

The Latin Hypercube Sampling method provides an efficient means of sampling values from each of these four distributions to obtain an empirical distribution of the expected additional exposure, from which the best estimate (the median), low (5th percentile) and high estimate (95th percentile) can be derived. The resulting range should therefore be interpreted as a measure of the combined parametric spread across all four stages of the model – reflecting simultaneously the imprecision in emission estimates, in the global temperature response to emissions, in the local climate extreme occurrence under warming, and in demographic projections. Because Latin Hypercube Sampling propagates the full input distributions rather than point estimates, the 5th–95th percentile interval admits a direct probabilistic interpretation: under the assumption that the input distributions adequately characterise the true uncertainty of each parameter, there is a 90% probability that the true value lies within the reported range. As noted above, the distributions assigned to each input parameter are grounded in the best available science, supporting

[15] IPCC (2021), op. cit. [pdf]
[16] Thiery, W., et al. (2021) ***Science***, op. cit. [pdf]
[17] Thiery, W., et al. (2021) ***Science***, op. cit. [pdf]; Laridon, A., et al. (forthcoming).

the validity of this assumption. Lastly, to ensure the stability and reliability of the results, convergence tests were performed to verify that the empirical output distribution stabilises as the number of Latin Hypercube Sampling iterations increases, confirming that the reported estimates are not sensitive to the specific random draws used in the sampling procedure.

We specify that the exposure numbers presented in this report do not imply that the additional climate extremes are experienced by *separate* individuals. It may very well be that an individual child born between 2016 and 2025 will experience two (or more) additional heatwaves in their lifetime due to the Hejre field emissions, in which case we aggregate this in the total estimate to facilitate presentation of an integral number. We can illustrate this with a hypothetical example: if 100 people are reported to face one additional climate extreme, it could be that (i) 100 *separate* individuals will face 1 additional heatwave, or (ii) 50 *separate* individuals will face 2 additional heatwaves, or (iii) 60 *separate* individuals will face 1 additional heatwave while 20 *separate* individuals will face 2 additional heatwaves, and so on.

For question 4, the same method with the Latin Hypercube Sampling as described above for question 1 to 3 is used. The same model for the emission and the TCRE is used. To quantify the steady-state committed glacier volume loss for 19 different glacier regions we used the study of Zekollari et al., 2025 Science[18]. This study provides the sensitivity of committed steady-state glacier loss for 19 different glacier regions and the global glacier mass to global mean temperature rise. For each glacier region, we first translate the projected steady-state committed glacier mass loss percentage into an absolute mass loss by applying it to the 2020 glacier mass estimate for that region (also given by Zekollari et al., 2025 Science[19]). We then convert this mass loss into a volume loss using an ice density of 917 kg m^{-3} (equivalent to 1.09×10^9 m^3 Gt^{-1}). This estimate is slightly conservative, as glaciers are not composed solely of pure ice but also contain snow and firn in their upper layers, which have lower densities. The standard conversion factor proposed by Huss et al. 2013[20], which accounts for this mixed composition, yields a bulk density of 850 kg m^{-3} — approximately 8% lower than pure ice density — and would therefore produce a ~8% larger volume estimate for the same mass loss. Our use of pure ice density thus leads to a modest underestimation of committed glacier volume loss. As for questions 1–3, the uncertainty range was derived from the Latin Hypercube Sampling procedure. To introduce an additional conservative assumption, all results were rounded down to the nearest thousand.

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[18] Zekollari, H., Schuster, et al. (2025) ***Science***, op. cit. [pdf]
[19] Zekollari, H., Schuster, et al. (2025) ***Science***, op. cit. [pdf]
[20] Huss, M. (2013) Density assumptions for converting geodetic glacier volume change to mass change, *The Cryosphere*, 7, 877–887. [pdf]

Statutory declaration

We hereby confirm that we have made these calculations in full scientific independence, and that we have not received any remuneration for this work, nor for any previous work related to this case.

Sincerely yours,

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About the authors

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.

Amaury Laridon is a climate scientist whose research focuses on climate change impacts and Earth system tipping points, with a particular emphasis on the attribution of climate impacts to fossil fuel projects. He obtained a Bachelor of Science in Physics (2018–2021) at UCLouvain, followed by a University Certificate in Philosophy (2021–2022) focusing on the philosophy of science, and a Master of Science in Physics (2022–2024), specialising in climate physics, also at UCLouvain. His MSc thesis developed a tipping element emulator for the Atlantic Meridional Overturning Circulation (AMOC) and the Greenland Ice Sheet, integrated into a reduced-complexity climate model. Amaury is currently pursuing a PhD under Prof. W. Thiery at Vrije Universiteit Brussel, co-supervised by Prof. M. Crucifix at UCLouvain. His doctoral project aims to produce original climate projections for the 22nd century, assessing the impacts of continued global warming and the potential transgression of major Earth system tipping points, including the AMOC and the Amazon rainforest. In the first year of his PhD, he published his first peer-reviewed article in Open Research Europe, building on his MSc research, and initiated the Source2Suffering project to strengthen a framework for attributing climate impacts to emissions from specific fossil fuel projects. In addition, Amaury was nominated by BELSPO as an author to the forthcoming JPI Climate and JPI Ocean report AMOC in Focus. He is actively engaged in science communication at the interface between research and climate activism, through conferences, courses, science festivals, and summer schools, and has authored two articles in a journal of critical social analysis.

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