Estimating CO2 production and climate deaths from WCM's proposed coal production figures

By Henry Adams. March 2019. Results first, then explanatory notes:

In summary, I've come up with the following results via calculations on Excel:
(These assume WCM predictions of coal extraction rates are realistic estimates – which they may not be(?)).

GHG EMISSIONS

1. CO2 emissions from combustion of WCM coal is likely to reach a peak from year five of **8 million tonnes of CO2 per annum**, and if this is continued over the 50 years this would total around **400 million tonnes CO2**.

2. These figures don't include combustion emissions of other GHGs, nor do they include 'upstream emissions' of GHGs - which are significant, not just on a Cumbria scale but also on a national scale. Emissions from all stages of life-cycle together are likely to be nearer **9mtCO2pa** and **500 million tonnes over 50 years**.
Please refer to Laurie Michaelis's assessment of likely emissions on-site at Whitehaven. LM is an IPCC contributor with many years of specifically relevant professional experience.

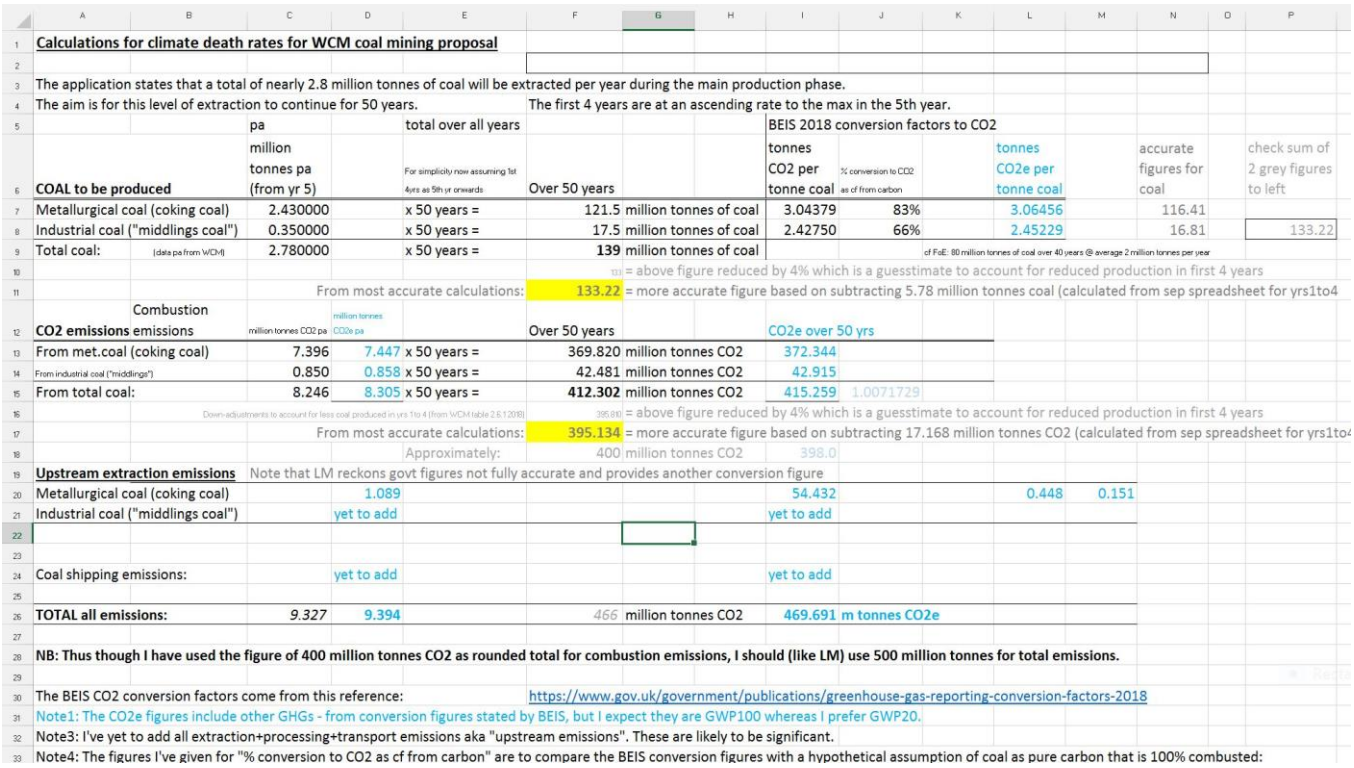
CLIMATE DEATHS

Again – please refer to the assessment by Laurie Michaelis on this in preference to mine.
e.g. via this link https://keepcumbriancoalinthehole.wordpress.com/2018/03/02/quaker-charity-and-ipcc-author-blast-coal-mine-plan/ or his more recent work.

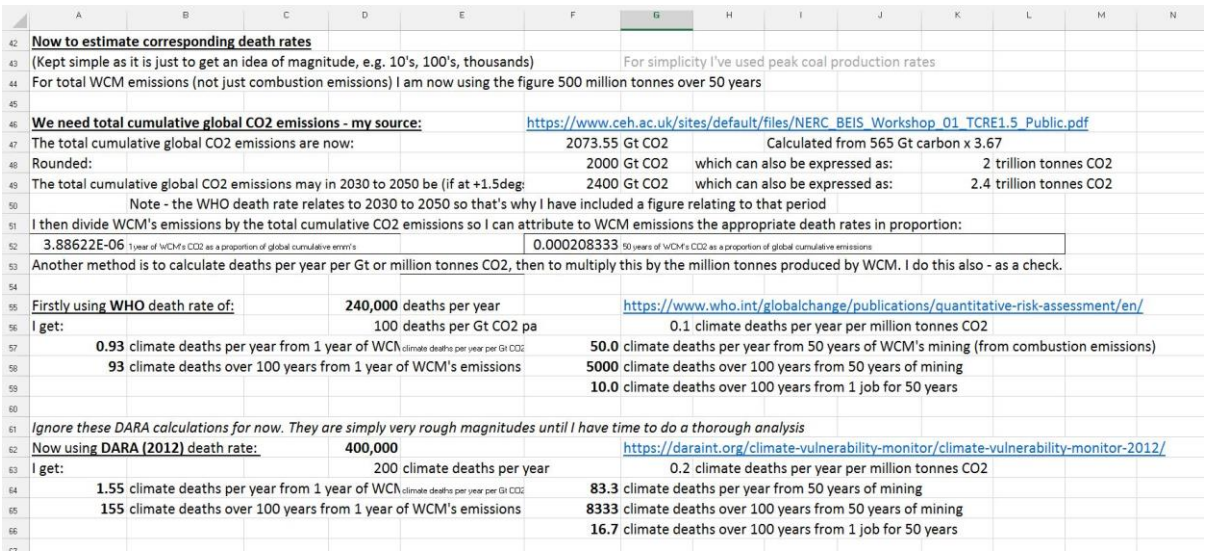
My assessment is mainly because climate deaths is something I have wanted to increase awareness on for several years, and I have been wanting to learn this topic by doing it. But please give higher focus to what LM has written.

3. - I have so far only considered climate deaths from a subset of the possible health impacts:
WHO: "The assessment takes into account a subset of the possible health impacts, and assumes continued economic growth and health progress. Even under these conditions, it concludes that **climate change is expected to cause approximately 250 000 additional deaths per year between 2030 and 2050**; 38 000 due to heat exposure in elderly people, 48 000 due to diarrhoea, 60 000 due to malaria, and 95 000 due to childhood undernutrition.
DARA: ...
4. I have assumed *[yet to complete this write-up]*

Spreadsheet screengrabs etc are on next page vvvvvvvvvvvvvvvvv



Calculations for climate death rates for WCM coal mining proposal																
The application states that a total of nearly 2.8 million tonnes of coal will be extracted per year during the main production phase.																
The aim is for this level of extraction to continue for 50 years.					The first 4 years are at an ascending rate to the max in the 5th year.											
		pa		total over all years				BEIS 2018 conversion factors to CO2								
COAL to be produced		million tonnes pa (from yr 5)		For simplicity now assuming 1st 4yrs as 5th yr onwards	Over 50 years			tonnes CO2 per tonne coal	% conversion to CO2 as cf from carbon		tonnes CO2e per tonne coal			accurate figures for coal	check sum of 2 grey figures to left	
Metallurgical coal (coking coal)		2.430000		x 50 years =	121.5	million tonnes of coal		3.04379	83%		3.06456			116.41		
Industrial coal ("middlings coal")		0.350000		x 50 years =	17.5	million tonnes of coal		2.42750	66%		2.45229			16.81		133.22
Total coal:	(data pa from WCM)	2.780000		x 50 years =	**139**	million tonnes of coal					cf FoE: 80 million tonnes of coal over 40 years @ average 2 million tonnes per year					
					111	= above figure reduced by 4% which is a guesstimate to account for reduced production in first 4 years										
				From most accurate calculations:	133.22	= more accurate figure based on subtracting 5.78 million tonnes coal (calculated from sep spreadsheet for yrs1to4										
CO2 emissions	Combustion emissions	million tonnes CO2 pa	million tonnes CO2e pa		Over 50 years			CO2e over 50 yrs								
From met.coal (coking coal)		7.396	7.447	x 50 years =	369.820	million tonnes CO2		372.344								
From industrial coal ("middlings")		0.850	0.858	x 50 years =	42.481	million tonnes CO2		42.915								
From total coal:		8.246	8.305	x 50 years =	**412.302**	million tonnes CO2		415.259	1.0071729							
Down-adjustments to account for less coal produced in yrs 1to 4 (from WCM table 2.6.1 2018)					395.840	= above figure reduced by 4% which is a guesstimate to account for reduced production in first 4 years										
				From most accurate calculations:	395.134	= more accurate figure based on subtracting 17.168 million tonnes CO2 (calculated from sep spreadsheet for yrs1to4										
				Approximately:	400	million tonnes CO2		398.0								
Upstream extraction emissions		Note that LM reckons govt figures not fully accurate and provides another conversion figure														
Metallurgical coal (coking coal)			1.089					54.432			0.448	0.151				
Industrial coal ("middlings coal")			yet to add					yet to add								
Coal shipping emissions:			yet to add					yet to add								
TOTAL all emissions:		*9.327*	9.394		*466*	million tonnes CO2		469.691	m tonnes CO2e							
NB: Thus though I have used the figure of 400 million tonnes CO2 as rounded total for combustion emissions, I should (like LM) use 500 million tonnes for total emissions.																
The BEIS CO2 conversion factors come from this reference:					https://www.gov.uk/government/publications/greenhouse-gas-reporting-conversion-factors-2018											
Note1: The CO2e figures include other GHGs - from conversion figures stated by BEIS, but I expect they are GWP100 whereas I prefer GWP20.																
Note3: I've yet to add all extraction+processing+transport emissions aka "upstream emissions". These are likely to be significant.																
Note4: The figures I've given for "% conversion to CO2 as cf from carbon" are to compare the BEIS conversion figures with a hypothetical assumption of coal as pure carbon that is 100% combusted:																



Now to estimate corresponding death rates							
(Kept simple as it is just to get an idea of magnitude, e.g. 10's, 100's, thousands)				For simplicity I've used peak coal production rates			
For total WCM emissions (not just combustion emissions) I am now using the figure 500 million tonnes over 50 years							
We need total cumulative global CO2 emissions - my source:			https://www.ceh.ac.uk/sites/default/files/NERC_BEIS_Workshop_01_TCRE1.5_Public.pdf				
The total cumulative global CO2 emissions are now:		2073.55	Gt CO2	Calculated from 565 Gt carbon x 3.67			
Rounded:		2000	Gt CO2	which can also be expressed as:	2	trillion tonnes CO2	
The total cumulative global CO2 emissions may in 2030 to 2050 be (if at +1.5deg:		2400	Gt CO2	which can also be expressed as:	2.4	trillion tonnes CO2	
Note - the WHO death rate relates to 2030 to 2050 so that's why I have included a figure relating to that period							
I then divide WCM's emissions by the total cumulative CO2 emissions so I can attribute to WCM emissions the appropriate death rates in proportion:							
3.88622E-06 1 year of WCM's CO2 as a proportion of global cumulative emm's		0.000208333	50 years of WCM's CO2 as a proportion of global cumulative emissions				
Another method is to calculate deaths per year per Gt or million tonnes CO2, then to multiply this by the million tonnes produced by WCM. I do this also - as a check.							
Firstly using **WHO** death rate of:	**240,000**	deaths per year		https://www.who.int/globalchange/publications/quantitative-risk-assessment/en/			
I get:	100	deaths per Gt CO2 pa		0.1	climate deaths per year per million tonnes CO2		
0.93 climate deaths per year from 1 year of WCM	climate deaths per year per Gt CO2		**50.0**	climate deaths per year from 50 years of WCM's mining (from combustion emissions)			
93 climate deaths over 100 years from 1 year of WCM's emissions			**5000**	climate deaths over 100 years from 50 years of mining			
			10.0	climate deaths over 100 years from 1 job for 50 years			
Ignore these DARA calculations for now. They are simply very rough magnitudes until I have time to do a thorough analysis							
Now using **DARA (2012)** death rate:	**400,000**			https://daraint.org/climate-vulnerability-monitor/climate-vulnerability-monitor-2012/			
I get:	200	climate deaths per year		0.2	climate deaths per year per million tonnes CO2		
1.55 climate deaths per year from 1 year of WCM	climate deaths per year per Gt CO2		**83.3**	climate deaths per year from 50 years of mining			
155 climate deaths over 100 years from 1 year of WCM's emissions			**8333**	climate deaths over 100 years from 50 years of mining			
			16.7	climate deaths over 100 years from 1 job for 50 years			

"The WCM planning submission clearly sets out and responds to all of the questions raised by external parties over the last three years and provides clear scientific evidence based responses to all of these points, clearly demonstrating that there are no risks or significant impacts from the scheme."
https://www.newsandstar.co.uk/news/17453859.anti-mine-campaigners-hope-polar-bear-protest-puts-a-freeze-on-plans/

– Does WCM regard consequent climate deaths as trivial because they are not in the UK?

The following text below is mostly notes – yet to fully write up.

Coal production estimates

"The application states that a total of nearly 2.8 million tonnes of coal will be extracted per year during the main production phase – and the aim is for this level of extraction to continue for 50 years."

The application states that a total of nearly 2.8 million tonnes of coal will be extracted per year during the main production phase.
The aim is for this level of extraction to continue for 50 years.

FoE: for cf.

The application talks of a production life-span of 20-50 years, and a peak of 2.8 million tonnes a year. Assuming a 40 year life (following construction), and an average of 2 million tonnes a year, that is total production of 80 million tonnes, which will emit around 175 million tonnes of carbon dioxide.
[175/80 = 2.1875 tonnes CO2 per tonne of coal]

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WCM revised 6june17 – from pdf of application form:
"Metallurgical Coal: 2,430,000 Tonnes Per Annum
Industrial Coal: 350,000 Tonnes Per Annum"
over a permission period of "50 years"
[Total: 2,780,000 Tpa of which mc=87.41%, ic=12.59%]
WCM Planning Statement pdf 2018
Excavation rates will build over a 5 year period to reach a maximum coal output of approximately 2.8 million tonnes per annum" [A table from their 2018 report:]

2.6.1 The following table provides annual production from the mine

Table 1 – Annual Production

Production	Year 1	Year 2	Year 3	Year 4	Year 5
Met Coal	410,000	770,000	1,390,000	2,060,000	2,430,000
Industrial Coal	70,000	130,000	210,000	300,000	350,000
Refuse	50,000	90,000	110,000	160,000	150,000

Conversion of tonnes of coal to tonnes of CO2 (or CO2e)
Combustion emissions
(i.e. excluding other life-cycle emissions such as extraction & transport emissions)

The simplistic way is to (i) assume all the coal is pure carbon and (ii) all the coal fully combusts to CO2. Neither of these assumptions in reality are accurate, but they provide a useful hypothetical maximum conversion figure, based on atomic weights of C and O being 12 and 16 respectively. Thus C + O2 = CO2 means 1 tonne of Carbon combusts to (12+(2*16))/12 tonnes CO2 = 3.6667 tonnes CO2.

This figure is useful also as a yardstick to compare conversion factors and get an idea of the % conversion:

Conversion factors as supplied by government (BEIS)

Source: https://www.gov.uk/government/publications/greenhouse-gas-reporting-conversion-factors-2018 - from which I have copied here a screen-grab from the Excel spreadsheet ('Condensed set' not the 'Full set')

See chart below. Although WCM intend to produce mostly coking coal and partly thermal coal, initially I'll use just the coking coal factors for simplicity – because I am only wishing to calculate orders of magnitude of death rates:

	3064.56 kg CO2e	or	3043.79 kg CO2	per tonne coking coal
=			3.044 tonnes CO2	per tonne coking coal

Equivalent to a conversion % of (3.04379/3.6667)% = 83.01245% **83%**

(Note I've omitted to add the extra c.1% from other GHG combustion products)

(Laurie Michaelis uses the rounded figure of 3100kg per tonne from 2017 BEIS figures.)

UK Government GHG Conversion Factors for Company Reporting

Fuels

Index

		kWh (Gross CV)	0.26255	0.25877	0.00011	0.00367

Activity	Fuel	Unit	kg CO_2e	kg CO_2	kg CH_4	kg N_2O
Solid fuels	Coal (industrial)	tonnes	2,452.29	2,427.50	6.73	18.06
		kWh (Net CV)	0.34191	0.33846	0.00094	0.00252
		kWh (Gross CV)	0.32482	0.32153	0.00089	0.00239
	Coal (electricity generation)	tonnes	2,261.32	2,247.66	0.62	13.04
		kWh (Net CV)	0.32750	0.32552	0.00009	0.00189
		kWh (Gross CV)	0.31112	0.30924	0.00009	0.00179
	Coal (domestic)	tonnes	2,881.65	2,630.61	214.41	36.63
		kWh (Net CV)	0.36288	0.33127	0.02700	0.00461
		kWh (Gross CV)	0.34473	0.31470	0.02565	0.00438
	Coking coal	tonnes	3,064.56	3,043.79	7.45	13.32
		kWh (Net CV)	0.36483	0.36236	0.00089	0.00159
		kWh (Gross CV)	0.34659	0.34424	0.00084	0.00151
	Petroleum coke	tonnes	3,396.50	3,386.49	2.92	7.08
		kWh (Net CV)	0.35993	0.35887	0.00031	0.00075
		kWh (Gross CV)	0.34193	0.34092	0.00029	0.00071
	Coal (electricity generation - home produced coal only)	tonnes	2,261.32	2,247.66	0.62	13.04
		kWh (Net CV)	0.34028	0.33822	0.00009	0.00196
		kWh (Gross CV)	0.32326	0.32131	0.00009	0.00186

Source: [(BEIS) **Greenhouse gas reporting: conversion factors 2018**]

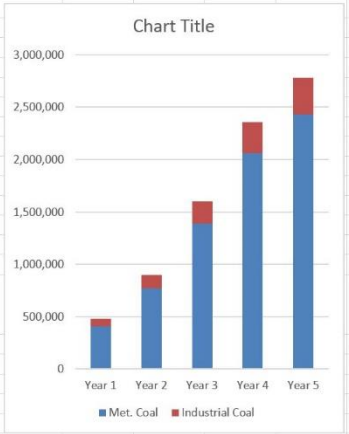
WCM production and emissions in years 1 to 4 and 5

Production	(tonnes)	Year 1	Year 2	Year 3	Year 4	Year 5	Year 5 onwards
Met. Coal	(coking coal)	410,000	770,000	1,390,000	2,060,000	2,430,000	2,430,000
Industrial Coal	("middlings	70,000	130,000	210,000	300,000	350,000	350,000
Total Coal		480,000	900,000	1,600,000	2,360,000	2,780,000	
Cumulative total coal:		480,000	1,380,000	2,980,000	5,340,000		
Figure to subtract in other sheet:					5,780,000		
					5.780		
Cumulative met.coal:		410,000	1,180,000	2,570,000	4,630,000	9,720,000	
Figure to subtract in other sheet:					5,090,000		
					5.090		
Result of same calcs for industrial coal:					690,000		
					0.690		

BEIS 2018 conversion factors to CO2

CO2 emissions	tonnes CO2 per tonne coal	Year 1	Year 2	Year 3	Year 4	Year 5
Met. Coal	3.04379	1247954	2343718	4230868	6270207.4	7396409.7
Industrial Coal	2.42750	169,925	315,575	509,775	728,250	849,625
Total emissions		1,417,879	2,659,293	4,740,643	6,998,457	8,246,035
Cumulative emmisions:		1,417,879	4,077,172	8,817,815	**15,816,273**	24,062,307
Cum.emms if all 4 years at peak:					32,984,139	
ratio of above 2 figures as %:					0.479511464	0.480
Approx:					a half	or
					As I guesstimated before the above calcs!	

This means that total emissions from yrs1to4 from above, plus full emissions yrs5to50, are roughly the same as:
48 years of full emissions.
So to down-adjust total 50yr emissions based on 50yrs of full emissions, all I need do is:
Subtract 2 years of full emissions, or e.g.:
Because 2 years is 4% of duration of 50 years, I could adjust by reducing by 4% or multiplying by 96%
But that's lazy. Better to be more accurate:
Reduce by: 17,167,866 tonnes CO2 17.16787 million tonnes CO2
=F12-F11 17.168



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Calculation of climate deaths, climate-related deaths, climate-caused deaths

NB: Read Laurie Michaelis on this in preference to my analysis.
Though I come up with similar magnitude of results for linear estimate.

I have used 2 sources so far for estimates of climate deaths per annum: WHO (2014) and DARA (2012)
NB: These do not provide estimates of *all* climate-related deaths or climate-caused deaths but just those in specific categories.
Thus my calculations are under-estimates of total climate-related deaths – probably by a long way – but I hope are a useful start in getting a rough idea of minimum estimates by orders of magnitude.

I'm not the first to estimate climate deaths from WCM's coal production proposals, nor the first (of a number) to estimate CO2 emissions from WCM's proposals. I strongly recommend you also read Laurie Michaelis's words on climate deaths from WCM proposals, as he has much more experience in climate change research and analysis than I have.

WHO (2014)
Quantitative risk assessment of the effects of climate change on selected causes of death, 2030s and 2050s - Authors: WHO **Publication details**
Editors: Simon Hales, Sari Kovats, Simon Lloyd, Diarmid Campbell-Lendrum
Publication date: 2014 https://www.who.int/globalchange/publications/quantitative-risk-assessment/en/
I quote from the above web-page:

Download
Quantitative risk assessment of the effects of climate change on selected causes of death, 2030s and 2050s
Overview
WHO releases a quantitative assessment of the health impacts of climate change. This constitutes an update and a further development of the assessment that was first published by WHO for the year 2000, now with a wider range of health impacts, and projections for future years.
The assessment takes into account a subset of the possible health impacts, and assumes continued economic growth and health progress. Even under these conditions, it concludes that climate change is expected to cause approximately 250 000 additional deaths per year between 2030 and 2050; 38 000 due to heat exposure in elderly people, 48 000 due to diarrhoea, 60 000 due to malaria, and 95 000 due to childhood undernutrition. Results indicate that the burden of disease from climate change in the future will continue to fall mainly on children in developing countries, but that other population groups will be increasingly affected.

DARA (2012)
https://daraint.org/climate-vulnerability-monitor/climate-vulnerability-monitor-2012/