From:	Ian Gordon
To:	Justine Stansen
Cc:	Ariane Wilkinson [redacted]
Subject:	Hazelwood report for Thursday, Ian Gordon
Date:	Wednesday, 14 October 2015 9:52:32 AM
Attachments:	image003.jpg image004.gif image005.png Ian Gordon report Hazelwood Mine Fire Inquiry 15-10-14.docx

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Dear Justine –

I received a forwarded request from you for a report containing my views of Associate Professor Barnett's latest conclusions. The report is attached. It is briefer than I would have preferred, due to the time constraints. I hope it is helpful.

Regards,

Ian

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Commentary on Associate Professor Barnett's recent reports, Hazelwood Mine Fire

Professor Ian Gordon PhD, AStat, Director
Statistical Consulting Centre
The University of Melbourne

14 October 2015

Preliminaries

1. This report addresses a request from the Hazelwood Mine Fire Inquiry to provide my views on the conclusions reached by Associate Professor Barnett, in a number of reports provided to me recently. This request was conveyed to me by lawyers representing Environmental Justice Australia, in an email from Ms Justine Stansen, dated 13 October, addressed to them and forwarded to me, the relevant part of which reads as follows:

   "I confirm that the Board would be grateful if Professor Gordon could provide a short report in relation to the fourth report of Associate Professor Barnett dated 25 September 2015 and any other matter you think would be useful to the Board. The Board is interested in your opinion as to whether you agree or disagree with the methodology used and conclusions reached by Associate Professor Barnett. It would be grateful if your report could be provided as soon as possible."

   (I assume that "you" in this message refers to me.)

2. I was provided with the following documents to examine for the purposes of meeting this request.

   1. A report by Associate Professor Barnett dated September 2015 and with the file name "Death.Analysis.3.pdf". I refer to this as [Barnett 3A].
   2. Some comments by Professor Armstrong on this document, in an email dated September 18, 2015. [Armstrong 1]
   3. A report by Associate Professor Barnett dated 25 September 2015, also with the file name "Death.Analysis.3.pdf", addressing Professor Armstrong's points from the September 18 email. [Barnett 3B]
   4. Some comments by Professor Armstrong on this document, in an email dated October 8, 2015. [Armstrong 2]
   5. A report by Associate Professor Barnett dated 9 October 2015, with the file name "Death.Analysis.5.pdf", addressing Professor Armstrong's points from his October 8 email. [Barnett 5]

6. A report by Associate Professor Barnett dated 7 October 2015, with the file name "Death.Analysis.4.pdf", addressing questions put to him by representatives of GDF Suez. [Barnett 4]
7. Some comments from Dr Flander in an email dated today (13 October) regarding Associate Professor Barnett's report dated 25 September.

3. I assume that in general terms the readers of this report are familiar with the Hazelwood mine fire and the recent hearings of the Inquiry in Morwell.

4. Given the timing of the request (yesterday) and of the provision of documents, I have not been in a position to spend much time on this commentary and it is therefore necessarily brief. In particular, there are more analyses that I would have preferred to have done in order to inform my opinion. However, I have done some analyses, described below.

Commentary

5. I now comment on a number of issues in Barnett 3B. As a general overall consideration, in usual scientific contexts, Associate Professor Barnett and I could resolve at least some and perhaps all of the issues discussed below, by discussion and further work.

6. Barnett 3B uses deaths from across the whole year. This is a difference from most of the analyses discussed at Morwell.

7. Barnett 3B confines the period of interest for the outcome to the actual period of the fire. This has the desirable effect of excluding the first 8 days of February 2014, which were prior to the mine fire. It also excludes any period after the mine fire ended. As I discussed at Morwell, and as is implicit in analyses done by Dr Flander, it may be useful to consider a longer period of potential impact of the mine fire, on the grounds of potential lingering effects of the exposure.

8. Barnett 3B says that the number of deaths analysed is 3414. I examined the files provided to me of daily deaths, extracted those with usual postcode of residence equal to either 3825, 3840, 3844 or 3844, and obtained 3462 deaths. I am not sure of the reason for the discrepancy of 48 deaths (a little over 1%).

9. I obtained the daily maximum temperature data from the Bureau of Meteorology Station number 85280; these seem to be the same data as used in Barnett 3B.

10. I am a little unclear about the Australian Bureau of Statistics (ABS) data on population by postcode over time that are used in Barnett 3B. The ABS has progressively used postcodes as a geographical areas less and less, and I do not know of good population data that are available at the postcode level over time. I found "Community Profiles" for postcode areas for the 2011 census, which are

at one point in time. Ostensibly, the statistical model in Barnett 3B allows for a different population for each postcode for every day. If the postcode populations are changing over time in the data used in Barnett 3B, it would be useful to know how; more generally, it would be helpful to know more about the source of the postcode-specific population data: sourced from a website? Obtained directly from the ABS?

11. The period of the fire was 9 February 2014 to 26 March 2014. This is a total of 46 days (inclusive). In a couple of places at least, Barnett 3B uses the figure of 45 days (e.g. the top and bottom of page 2). I am not sure why.

12. The use, nature and implications of the natural splines for trend and temperature could be explored more, in my view. There is some discussion of this in Barnett 4. I am not sure if, for example, the estimated spline for temperature is as expected, since it seems to show a reduction in risk for hotter temperatures.

13. Barnett 3B uses day of the week in the model. I would be very surprised if this was necessary or useful for any bias adjustment of the fire effect, since this variable is close to balanced for the fire and "not fire" period. In fact, his Table 5 shows that this is the case: it makes almost no difference.

14. In Barnett 3B, the model specified does not match the table of results, in terms of the explanatory variables whose estimates are reported.

15. I have done some modelling of the data that does not go as far as attempting to replicate exactly the model fitted in Barnett 3B; for one thing, I am not sure I have the population data discussed there. I have not used natural splines. My modelling gave some results (e.g. for day of the week) that were very close to those obtained in Barnett 3B. Others were different; without discussion between Associate Professor Barnett and me, and further work, I am not in a position to say why they are different. It could be due to data differences, or model differences, or both.

16. I am surprised by the size of the relative risk for the fire period in Table 2 of Barnett 3B, namely, 1.32. This is because in previous corresponding analyses, for February and March 2014, it was generally about one third to one half as large, on the log scale, which is the relevant scale for considering the estimates in a linear way. For example, the natural logarithm of this relative risk is ln(1.324) = 0.281; in Associate Professor Barnett's December 2014 report, the corresponding estimate was a relative risk of 1.103, and ln(1.103) = 0.098. This latter relative risk was adjusted for temperature, albeit in a different way to that used in Barnett 3B. Other estimates of relative risk, for example, the one for Feb to June, discussed extensively by Professor Armstrong and me at the Morwell hearings, was 1.20, and ln(1.20) = 0.182.

17. Professor Armstrong asked about this, and, in response, Table 5 of Barnett 3B provides estimates of relative risk for the fire period with and without other

explanatory variables. This shows that omitting temperature does reduce the relative risk somewhat. The change is greater than for the omission of other variables. It is not clear to me why the effect is in that direction, but, more importantly, it shows that the relative risk result for the fire period does depend on the way in which temperature has been modelled. To arrive at a firm conclusion about this, I would need more time and the opportunity to explore exactly the same data that Associate Professor Barnett has used.

18. Barnett 5 addresses another issue of Professor Armstrong's, namely, whether (in Barnett 3A and Barnett 3B) varying fire risks in the four postcodes were obscured by the use of a single, overall relative risk. This is addressed in Tables 2 and 3 of Barnett 5.

19. Firstly, I agree with Associate Professor Barnett's conclusion that there is little evidence for a postcode-specific effect, and that conclusion was also implicit in virtually all of the discussion at Morwell, which was about analyses of combined data. In any of the analyses I looked at, the statistical test of effect modification (of the fire effect) by postcode was not at all significant; the P-values were large.

20. In Table 2 of Barnett 5, I believe the difference in degrees of freedom should be 3, not 2, for the extra interaction term of fire (2 levels) × postcode (4 levels).

21. The relative risk estimates, assuming a varying effect of the fire, are given in Table 3 of Barnett 5. I am surprise by the proximity of these values to each other. When I include an interaction between the fire effect and postcode, I obtain relative risks that are more varied. So did Associate Professor Barnett, in his December 2014 report. I am unable to say what accounts for the relatively slight variation in Table 3 of Barnett 5; my view is that, relatively speaking, these relative risks should be affected rather directly by the rates of deaths in the postcodes, and those postcode-specific death rates vary more than is reported here.

22. My own analysis, which is not as complex as Associate Professor Barnett's and does not use the same data, gave an overall relative risk of 1.17, slightly higher than Associate Professor Barnett's original relative risk of 1.11 for February and March 2014 in Table 2 of his September 2014. I do not have the time to document this fully, but the analysis used a time trend, day of the week, cosine and sine seasonal terms, a crude adjustment for temperature, and overall differences between postcodes.

23. As mentioned above, to resolve issues further would require collaboration and exchange of data and computer code; this would either produce a position of entire agreement, or complete clarity about the cause of the lack of agreement. Without the opportunity for such a process, I have the reservations indicated here, and my position about the results is therefore not currently changed from the evidence I have previously given.