Novel graphs show extreme rainfall shortages

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Abstract: *I have used the record of monthly rainfalls from 1884 at Manilla, NSW to compile cumulative rainfall totals through a range of durations up to 360-months. Expressed as percentile values, these are classed as serious, severe, and extreme rainfall shortages. Two new kinds of graph show this information concisely and comprehensively, month by month. They reveal that the current drought has extreme, even record-breaking rainfall shortages. The third kind of graph shows the beginning and end of shortages. Extreme decade-long rainfall shortages occurred from 1910 to 1950, but not since.*

Key words: rainfall deficiency, driest-ever, Federation Drought, contour graph

Introduction

Since 1999, I have been keeping weather records at Manilla for my own projects and for newspaper reports. Manilla is north of Tamworth, NSW. Although this work is specific to Manilla, it is representative of the North-West Slopes and surrounding areas, currently in drought.

Based on the long record of the Manilla rain gauge, I have done analyses of rainfall, including the nature and progress of droughts. I found that I could describe droughts more comprehensively by using novel graphs that show rainfall shortage, which I have described in this paper. I publish these graphs on my blog "climatebysurly" so that farmers, graziers, and others in the district may be better informed. I explain every aspect of this work in my blog, as referenced below.

Analysis of rainfall at Manilla is vitiated by the failure to maintain an official rain gauge through the last four years. The rain gauge at Manilla Post Office, Station 055031 (Bureau of Meteorology 2016) was read continuously from 1884 to 26 March 2015. Since then, there has been an intermittent record, in part as Manilla (Museum) Station 055312 (Bureau of Meteorology 2018). Most readings since March 2015 are from my own rain gauge.

Methods

Cumulative rainfall totals for each month

Spreadsheet analysis. I prepare two tables using the spreadsheet application Excel (Speight 2019a). The rows in each table are serial months containing more than 1600 in total. The columns in each table are headed by the selected number of months, n, as specified below. In the first table, I cumulate the rainfall totals. First, I add each month's rainfall total to that of the previous month for a 2-month total. I add the month before that to get a 3-month total, and so on. For every month, I get n-month rainfall totals from n = 1 up to n = 360. However, I calculate for only the following 25 values of n:

n = 1, 2, 3, 4, 5, 6, 9, 12, 15, 18, 24, 30, 36, 42, 48, 60, 72, 84, 96, 108, 120, 144, 180, 240, 360.

For the second table, I convert values from the first table to percentile values. Each value in this table represents the frequency of occurrence in the historical record of that rainfall total. A 12-month rainfall value that falls at the 5th percentile (for example) is lower than all but 5% of all 12-month totals in the record from January 1884 to March 2019. Importantly, each time a record is broken, the whole percentile table needs to be revised.

Graphs of the severity of rainfall shortage

I classify the percentile ranks of rainfall shortage, using the Bureau of Meteorology convention of Rainfall Deficiency (Bureau of Meteorology 2015). That is, 'Serious Deficiency' between the 10th and the 5th percentile, and 'Severe Deficiency' below the 5th percentile. I replace 'Deficiency' by the simpler term 'Shortage'. I also classify as 'Extreme Shortage' those values that are below the 1st percentile.

I devised graphs of two types, *line graphs* (Speight 2019a) and *contour graphs* (Speight 2019b). In each *line graph* (Fig. 1) a heavy black line shows the rainfall status for a chosen month and a thinner line for the previous month. The x-axis is not a date or time axis but shows the duration of rainfall shortages that have been calculated for the chosen month. The y-axis shows the percentile value of rainfall totals. On the graph, horizontal fields are labelled 'Serious Shortage', 'Severe Shortage' and 'Extreme Shortage'. The 50th percentile line is labelled 'Normal Rainfall'.

In each *contour graph* (Fig. 2), the x-axis shows the dates of sequential months in a selected part of the record. The y-axis shows the duration of rainfall shortage, increasing from 1-month at the top to 36-months at the bottom. Severity of shortage is shown by labelled, coloured or stippled zones, such as 'Extreme Shortage'.

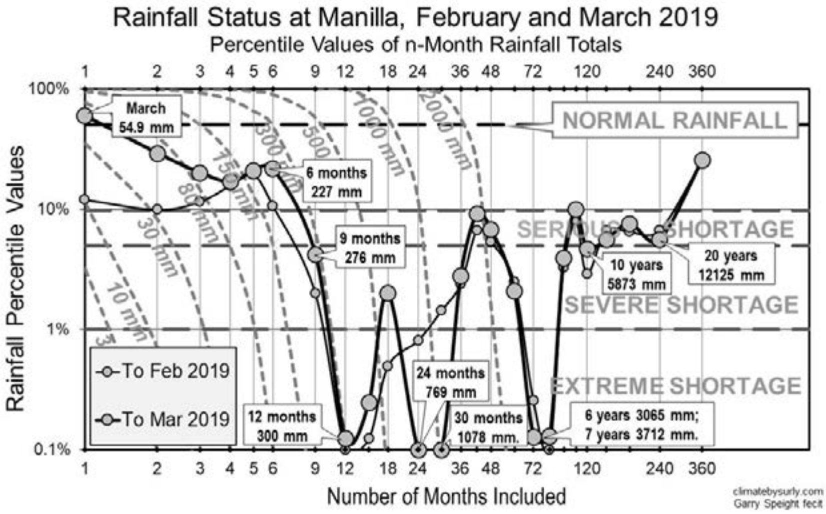

Figure 1. Line graphs showing rainfall status at February and March 2019. The x-axis is the duration of shortage and the y-axis is the percentile value. Labels show shortage percentile bands as 'Serious', 'Severe', or 'Extreme' as defined in the text.

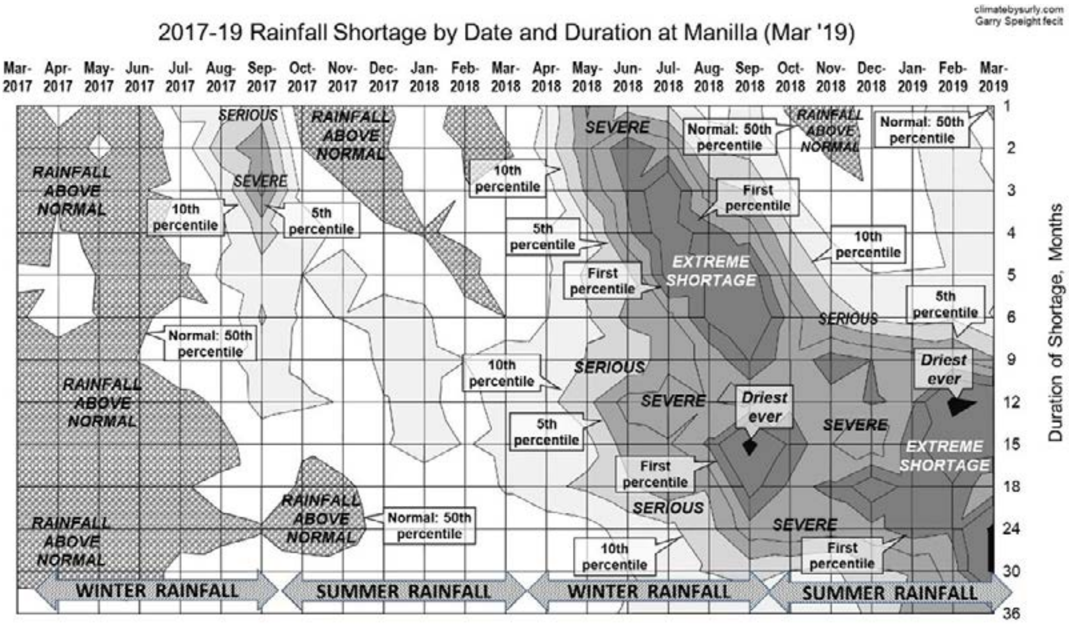

Figure 2. Contour graph showing the months from March 2017 to March 2019 on the x-axis, and duration of rainfall shortage on the y-axis. Severity of shortage is shown by layer tints and contours.

Identifying starting dates of shortages

Each tabulated rainfall shortage longer than 1-month must have begun earlier, but this is not explicit in the data or in the graphs described above. I developed further tables to extend each shortage back to the month when it began (Speight 2019c). I have new graphs to display the periods when rainfall shortages, as calculated for durations from 2 to 360-months, began and ended. Graphs may show the whole record (e.g. Fig. 3), or a part of the record in more detail (e.g. Fig. 4). Dashed lines labelled 'First Good Data' and 'Last Good Data' show the limits for determining true cumulative rainfall shortage. To the right of the second line, future observations may make values more extreme.

Discussion

In this paper, I do not attempt an analysis of droughts. Instead, I offer several graphs of rainfall shortages at Manilla as examples of their potential to throw light on the subject if used more generally.

Data traces for February and March 2019 (Fig. 1) both show six extreme shortages at or near record levels for durations between 12 and 84-months. That is despite the fact that rainfall totals from 1 to 6-months were not serious shortages. The contour graph (Fig. 2) extends the display back through 25-months (i.e.

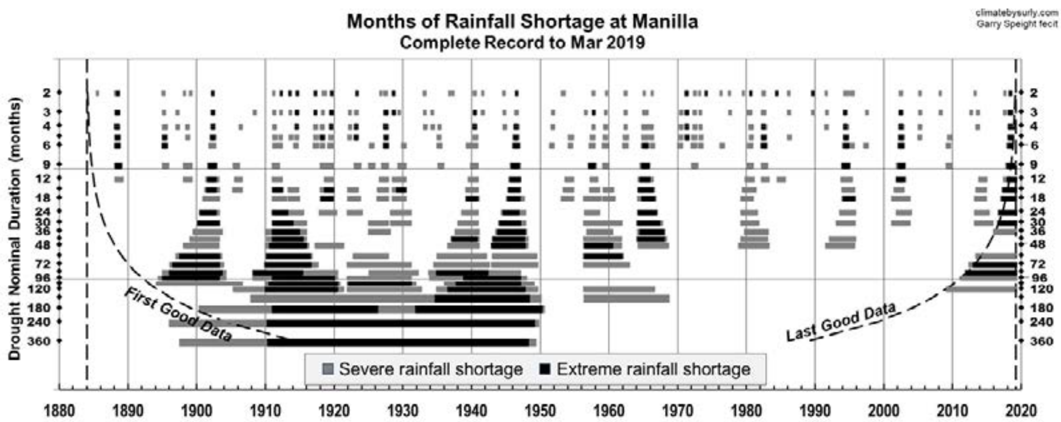

Figure 3. The complete record to March 2019 of severe and extreme rainfall shortage at Manilla. The y-axis is nominal duration from 2 to 360-months. Each period of shortage is plotted to show when it began and ended.

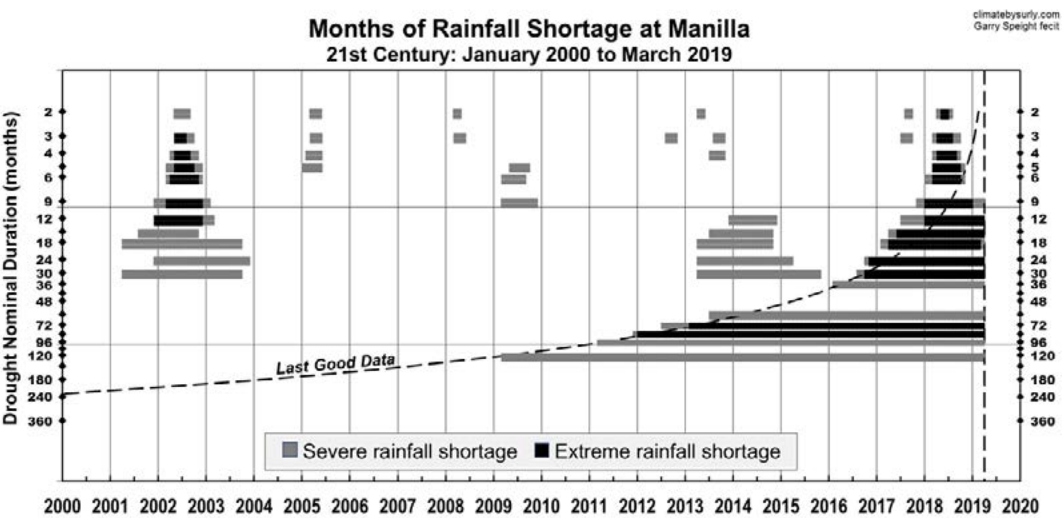

Figure 4. As Figure 3, with data plotted only from 2000 to date.

March 2017–March 2019) to show how rainfall shortages accumulated from month to month. The driest-ever 15-month total (400 mm) occurred in September 2018. The driest-ever 12-month total (271 mm) occurred in February 2019 as dry summer months succeeded very dry winter months.

In the complete history of Manilla's severe and extreme rainfall shortages (Fig. 3), the most striking feature is that decadal and longer extreme rainfall shortages occurred only between 1910 and 1950. This is not commonly known. Similarly, extreme shortages of 84-month (7-year) duration had been restricted to between 1895 and 1945, but we are currently experiencing them again now. This feature makes the drought of 2018 very like the Federation Drought of 1902.

The last 20 years of Manilla's severe and extreme rainfall shortages are shown in Figure 4. After the brief extreme rainfall shortage of 2002, the 15-year period from 2003 to 2017 was an unprecedented time without seasonal (i.e. <12-months) extreme rainfall shortages. Coping with water failure may have faded from memory. In retrospect, we can see that a 7-year (84-month) extreme shortage began in 2012 but could not be detected then (Speight 2019d).

Conclusions

These new graphs give context to the current drought on the North-West Slopes of NSW, revealing extreme rainfall shortages, some being of long duration, and records being broken. They provide food for thought.

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References

Bureau of Meteorology (2015) The convention on rainfall deficiency. (Commonwealth of Australia: Canberra) http://poama.bom.gov.au/climate/glossary/drought.shtml. Accessed 23 June 2015.

Bureau of Meteorology (2016) Daily Rainfall, Manilla Post Office, Station 055031. (Commonwealth of Australia: Canberra) http://www.bom.gov.au/jsp/ncc/cdio/weatherData/av?p_nccObsCode=136&p_display_type=dailyDataFile&p_startYear=&p_c=&p_stn_num=055031. Accessed 08 October 2016.

Bureau of Meteorology (2018) Daily Rainfall, Manilla (Museum), Station 055312. (Commonwealth of Australia: Canberra) http://www.bom.gov.au/jsp/ncc/cdio/weatherData/av?p_nccObsCode=136&p_display_type=dailyDataFile&p_startYear=&p_c=&p_stn_num=055312. Accessed 30 August 2018.

Speight JG (2019a) March rain leaves drought extreme. (Climate by Surly: Manilla) https://climatebysurly.com/2019/03/31/march-rain-leaves-drought-extreme/ Accessed 18 April 2019.

Speight JG (2019b) Rainfall shortage sequence 03/2019. (Climate by Surly: Manilla) https://climatebysurly.com/2019/04/09/rainfall-shortage-sequence-03-2019/ Accessed 18 April 2019.

Speight JG (2019c) Rainfall shortage history Manilla. (Climate by Surly: Manilla) https://climatebysurly.com/2019/04/15/rainfall-shortage-history-manilla/ Accessed 18 April 2019.

Speight JG (2019d) Rainfall shortage Jan 2000-Mar 2019. (Climate by Surly: Manilla) https://climatebysurly.com/2019/04/16/rainfall-shortage-jan-2000-mar-2019/ Accessed 18 April 2019.