Improved climate and weather maps

Anna Hepworth[1], Meredith Guthrie[1], and Fiona Evans[2] :[1] Department of Primary Industries and Regional Development, [2] Murdoch University

Key messages

- In 2018, the Department of Primary Industries and Regional Development (DPIRD) produced a wide range of climate and weather maps.
- New maps include rainfall decile maps using Bureau of Meteorology (BoM) weather data for the South West Land Division (SWLD). These maps differ from equivalent Bureau of Meteorology maps, as they use historical data from 1975 to 2017 rather than 1900 to 2017.
- Flexible selection of date range, reference years, and dataset(s) (BoM and/or DPIRD weather stations) has improved our ability map weather. For example
    - frost occurrence and severity maps for individual frost events,
    - plant available soil water maps now include ten soil type specific options; and
    - potential yield maps now include multiple evaporation, water use efficiency, and seasonal finish options.

Aims

Frost, heat stress, and dry seasons affect grain production in SWLD, which includes the grainbelt. Managing weather related risks and optimizing inputs in relation to expected conditions is a primary concern of all grain growers. DPIRD produce several tools to make weather dependent management decisions easier. In this paper, we discuss the increased range of mapping capability in relation to climate impacts. This includes, but is not limited to, frost severity and occurrence, heat stress, decile rainfall, potential yield and soil water.

Method

Weather maps are generated using data from 332 BoM and 175 DPIRD weather stations located in the SWLD. These stations have reliable medium to long-term data. Application Interface Programs (APIs) at DPIRD and Scientific Information for Land Owners (SILO) source the data. The SILO data set, maintained by Environment and Science, Queensland Government, https://silo.longpaddock.qld.gov.au/, is a Patched Point Dataset (PPD) that combines observations and interpolations to provide daily weather data.

The DPIRD APIs provide a number of summary options for both the DPIRD and SILO data sets, including rainfall deciles and cumulative rainfall. These, along with daily measures of rainfall and temperature (minimum, maximum), are interpreted and mapped using custom R packages to highlight spatial patterns across the SWLD. Point data was expanded, to cover the region of interest using kriging, a smoothing process that gives the best linear unbiased prediction of intermediate values in spatial data.

Rainfall to date

Rainfall anomaly from the historical median, rainfall as percentage of historical median, and anomaly as percentage of the historical median are calculated. The historical median, calculated from 1975 onwards, to reflect the SWLD climate shift in 1975 (IOCI, 2012). This is in comparison to the BoM, which uses 1900 onwards, and produces maps for calendar months only. Four proposed maps were displayed at the Dowerin Field days to obtain client and stakeholder feedback.

Temperature Thresholds

APIs were used to source daily minimum and maximum temperatures. Current differences in recording of minimum temperature observations were accounted for, by offsetting the DPIRD data by one day. Occurrence is the number of daily extremes more severe than the specified threshold; severity is the coldest temperature over the period of interest. Default threshold values are ≤2ºC for frost and ≥33ºC for heat stress; alternate thresholds are available.

Potential Yield

Potential yield, calculated using French and Schultz (1984), using November to March cumulative rainfall, daily growing season rainfall to date, and expected decile rainfall to 31st October sourced from the APIs. New maps allow for a range of water use efficiency (12 or 15kg/mm/ha), evaporation rate (90 or 110 mm), and expected decile rainfall for the remainder of the growing season (3, 5 or 7).

Soil Water

Using current rainfall data from 1 November of last year, plant available water is modelled using Ritchie two-layer fallow evaporation model (Ritchie, 1972). As well as averaged values, the new maps show variation across ten different soil types: clay, deep loamy duplex, deep sandy duplex, gravel, loamy earth, sand, sandy earth, shallow loamy duplex, shallow sandy duplex and shallow soil. The soil types have been characterised according to their water-holding capacity by Oliver and Robertson (2008).

Results

Rainfall to date maps

These maps provide the agriculture industry with a snapshot of the current season. As well as knowing absolute rainfall amounts, anomalies provide information on how the season is tracking with respect to the historical record. This can help in making decisions about the farming business.

Of the maps displayed the 2018 Dowerin Field Days (Figure 1), the most popular was a five-category rainfall decile map (53%), followed by difference from median in mm (22%), percent anomaly map (17%), and rainfall to date as percent of median (8%). The rainfall decile maps are available through the monthly DPIRD Seasonal Climate outlook newsletter.

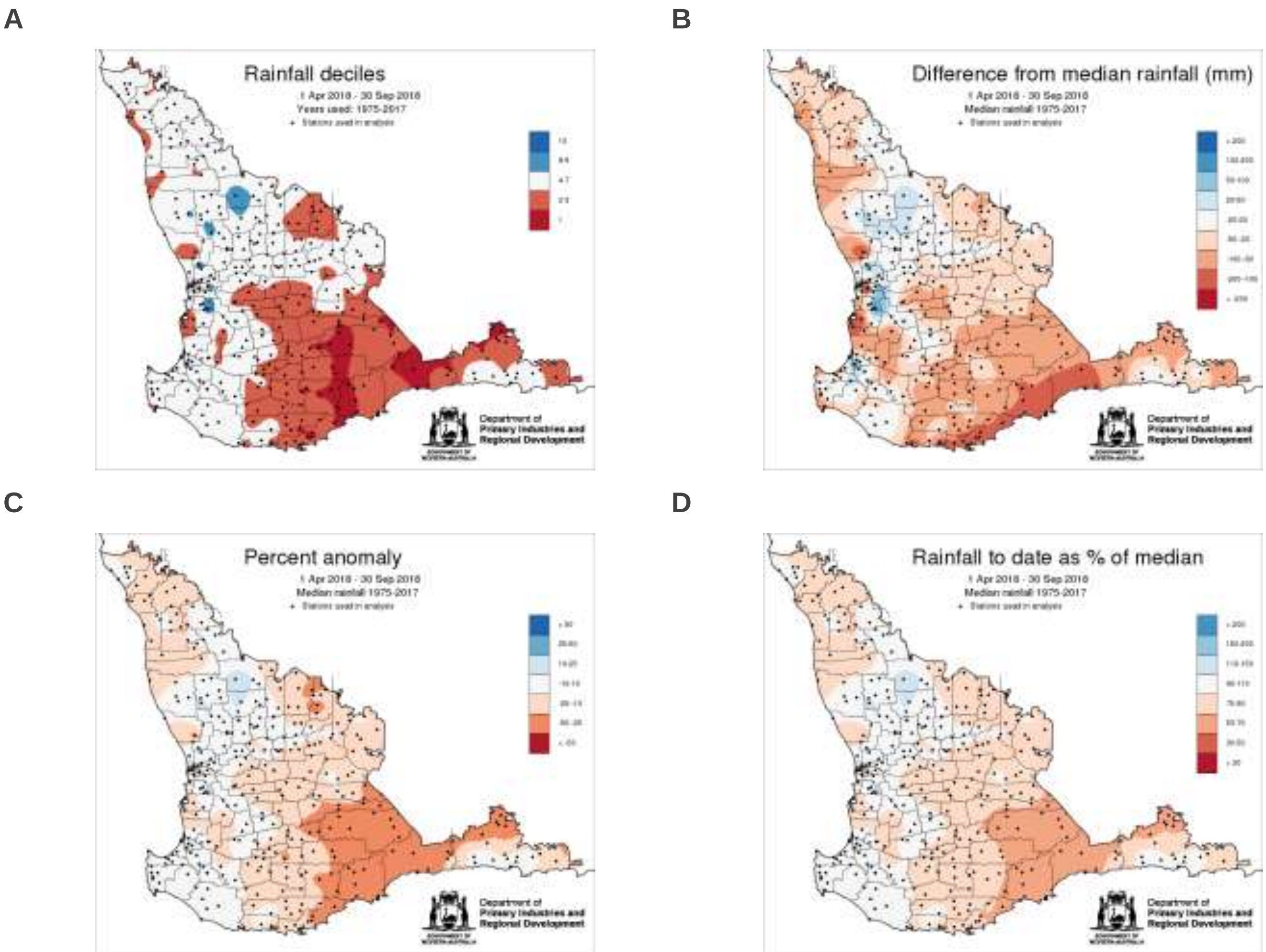

Figure 1. Rainfall anomaly maps produced by DPIRD based on rainfall to date a. Rainfall decile, b. Difference from median in mm, c. Percent anomaly, d Rainfall to date as percentage of historical median and d maps.

Temperature Thresholds

In addition to monthly summaries of frost occurrence and severity, daily frost events now can be produced (not shown). These included daily maps where an event lasted more than one calendar day, and summary maps for the whole event. Inclusion of the DPIRD stations in these maps improved understanding of how widespread each frost event was (see Figure 2). It is important to note that weather station temperatures can differ from on ground observations, as crop canopy temperatures are often colder in frost prone parts of the landscape than at the nearby weather station.

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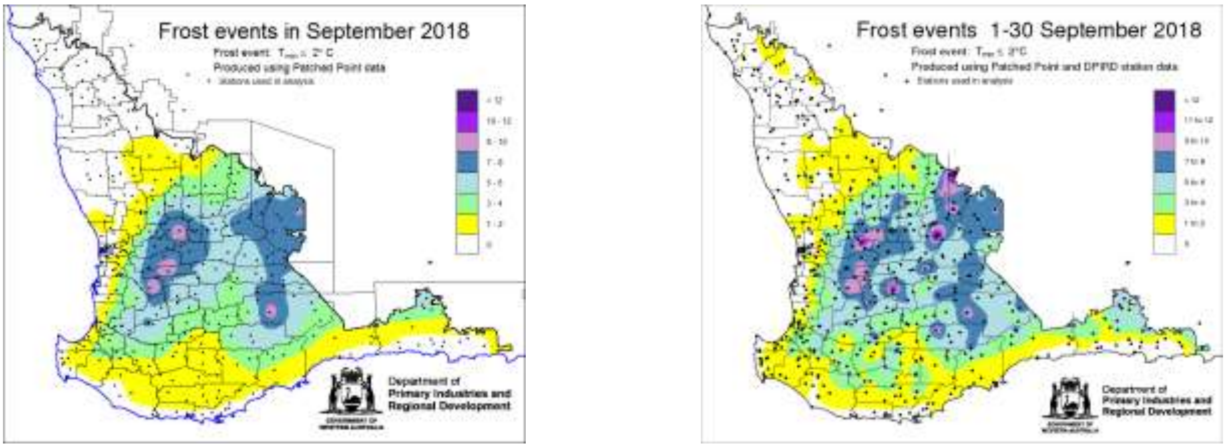

Figure 2 Frost occurrence (number of frost events) for September 2018 using (a) PPD stations and (b) PPD and DPIRD stations.

Potential Yield maps

The increased range of potential yield maps will allow users to more accurately match the French & Schulz equation to their farm. This is the first step in expanding this product to represent yields in crops other than wheat. Two examples are given in Figure 3; these show large differences in lower rainfall areas when water use efficiency and expected rainfall differ.

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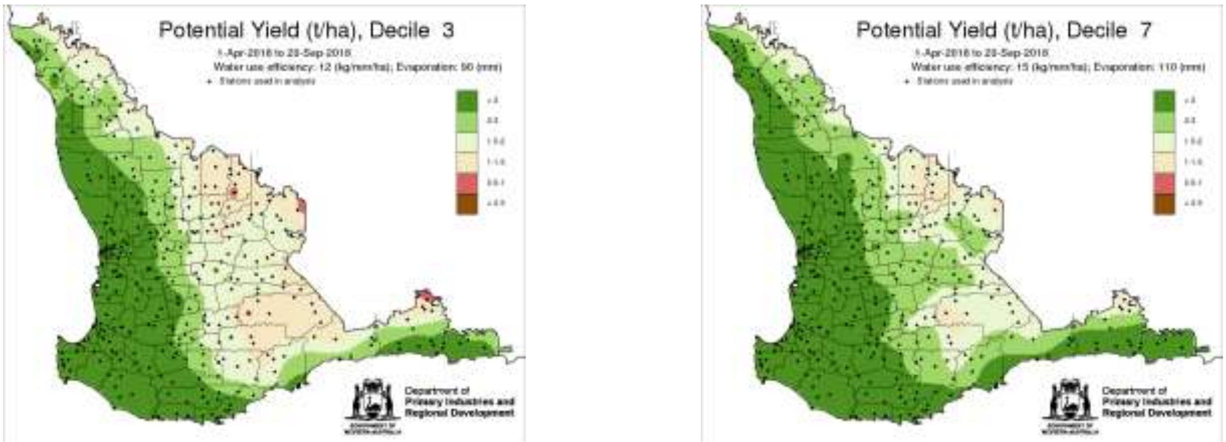

Figure 3 Two examples of the potential yield maps. Here, both have been set to have evaporation of 110, but differ in water use efficiency (WUE) and expected rainfall decile: (a) WUE = 12, decile 3 and (b) WUE = 15 and decile 7

Soil water maps

The differences in plant available soil water maps was highlighted when extreme soil types shallow soil (Figure 4b) and gravel (not shown) were compared with the other soil types and the mean (Figure 4a). Maps for all ten types, plus the mean, are therefore now available on the [DPIRD Seasonal Climate information page](#).

A B

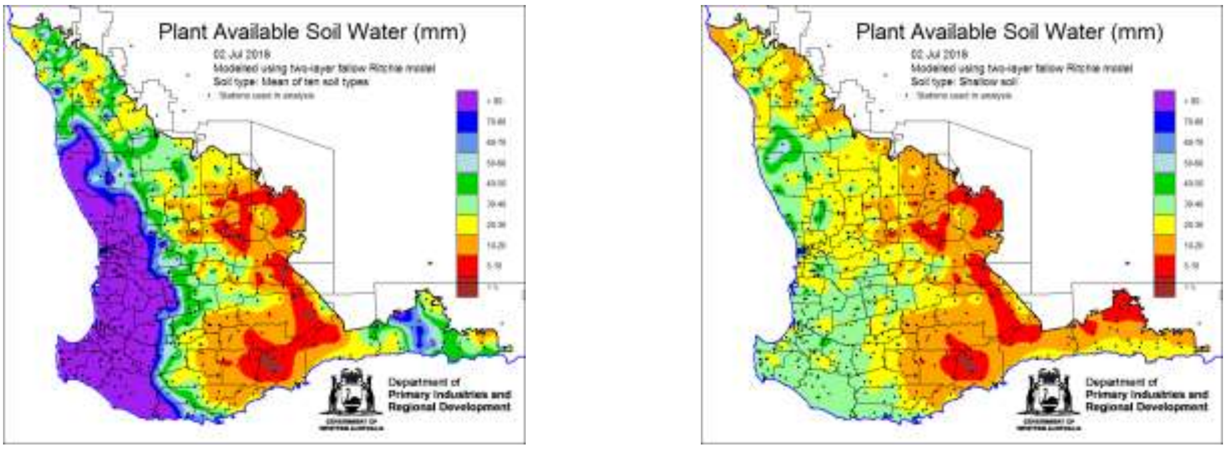

Figure 4 Two examples of the plant available soil water maps, for (a) the mean of the ten considered soil types and (b) shallow soil, showing how differences due to soil characteristics can be missed in the mean soil type map.

Conclusion

Previously, monthly provision of weather-based maps reduced their usefulness as management tools. Lack of historical context for rainfall reduced the degree to which current conditions were interpreted.

The weather API sources up-to-date weather data and flexible data summaries, increasing the number of maps produced. Spatial coverage has improved with the addition of 175 stations, improving understanding of current climate conditions, and their potential impact on the agriculture industry.

The rapid provision of maps has allowed for better communication of weather data and response times to short lived events. These maps informed the agricultural industry in dry seasons (2017, 2018) and in frost events (e.g. September 2018).

Future developments may include seasonal maps, mapping of summer rainfall, mapping of April sowing opportunities, and mapping of heat stress events.

Key words: Rainfall, weather API, potential yield, soil water, frost severity and occurrence

Paper reviewed by: Art Diggle, DPIRD

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