Rural Funds Group (ASX: RFF)

Discussion Paper

Climatic Diversification

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Rural Funds Group ARSN 112 951 578
Responsible Entity: Rural Funds Management Limited ACN 077 492 838 AFSL 226701

Introduction

RFF leases its agricultural properties to experienced and capable lessees who assume the agricultural operational risks. Although RFF does not carry direct agricultural operational risk, extreme or prolonged climatic events, such as drought or flood, may affect its lessees' ability to pay rent.

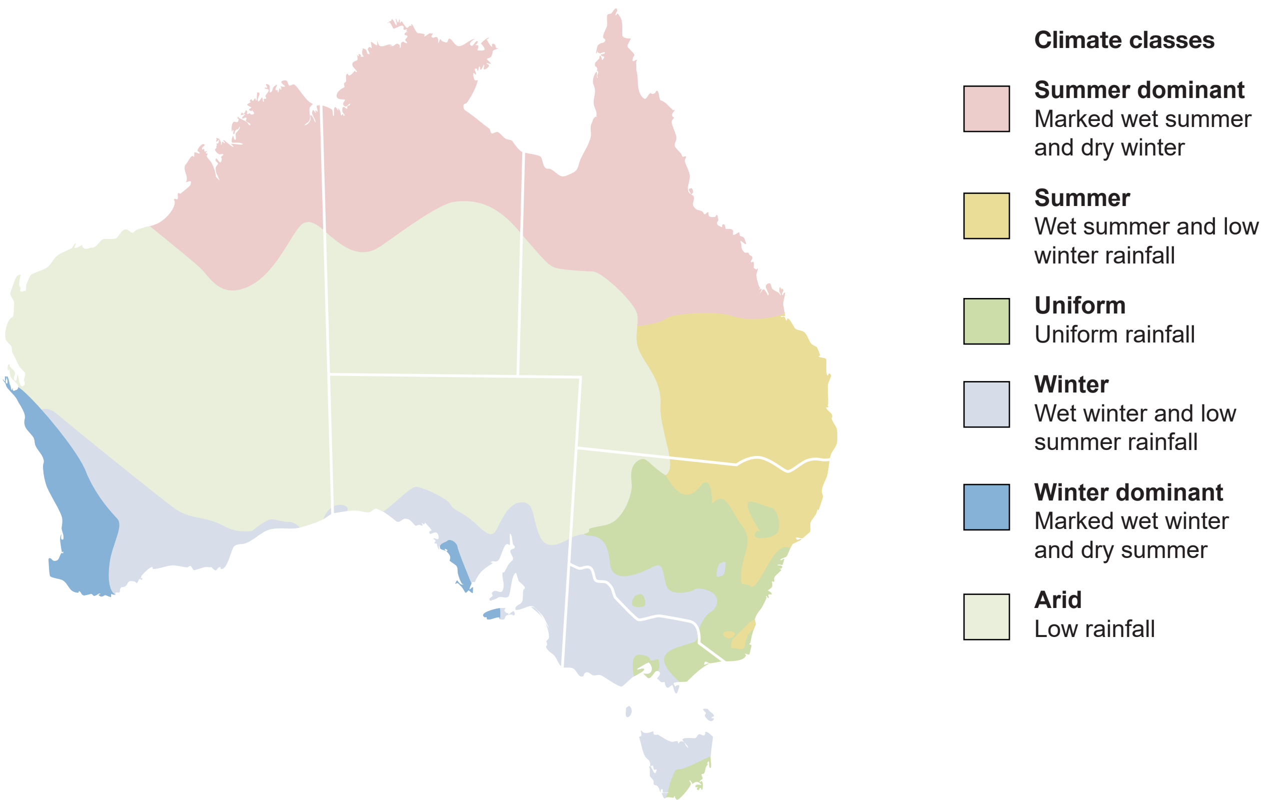
The likelihood of multiple lessees experiencing extreme conditions at the same point in time is reduced by acquiring new assets in geographically dispersed areas.

As an additional benefit, climatic diversification into new agricultural regions will introduce new commodities with different seasonal production and commodity price cycles.

The findings of previous studies conducted internally by Rural Funds Management (RFM) in 2009 and 2012 support climatic diversification of the RFF portfolio.

This discussion paper builds on RFM's previous studies. It initially outlines the diversity of rainfall conditions across Australia with certain areas affected by summer or winter dominant rainfall. Secondly, it discusses the varying degree to which rainfall zones are affected by large scale events such as El Niño. Thirdly, data is used to show that there is reduced correlation of rainfall variability in geographically dispersed locations. Finally, the benefits of diversifying the RFF agricultural property portfolio across the Australian continent are summarised.

Figure 1 - Major seasonal rainfall zones of Australia[1]



[1] Bureau of Meteorology (BOM) 'Major seasonal rainfall zones of Australia' Based on median annual rainfall and seasonal incidence determined from the ratio of the median rainfall November to April and May to October. Based on 100-year period from 1900-1999 (zones are indicative, positions may shift slightly with newer data)

Section 1:
Relationships between Australian weather regions

This section outlines four aspects of the Australian climate, observed by RFM, which are important considerations when discussing climatic diversification of the RFF property portfolio:

Seasonal differences – There are contrasting seasonal variations in rainfall between geographically dispersed rainfall zones, with winter dominant rainfall occurring in the south and summer dominant rainfall occurring in the north.

Recurring, large scale weather patterns – Large scale remote drivers of weather, such as El Niño, have varying levels of impact on rainfall in geographically dispersed areas.

Correlation analysis – RFM has analysed historic rainfall data and found there is generally a low correlation in rainfall variability across geographically dispersed rainfall zones.

Climate Change – While the exact impacts of climate change cannot be accurately predicted, some researchers predict that weather extremes such as drought and floods may increase in frequency and severity.

1.1 Seasonal differences

Australia is a vast continent spanning approximately 4,000km east to west[2] that includes tropical, subtropical and temperate climate zones[3]. It can be broken up into large zones defined by their seasonal rainfall patterns.

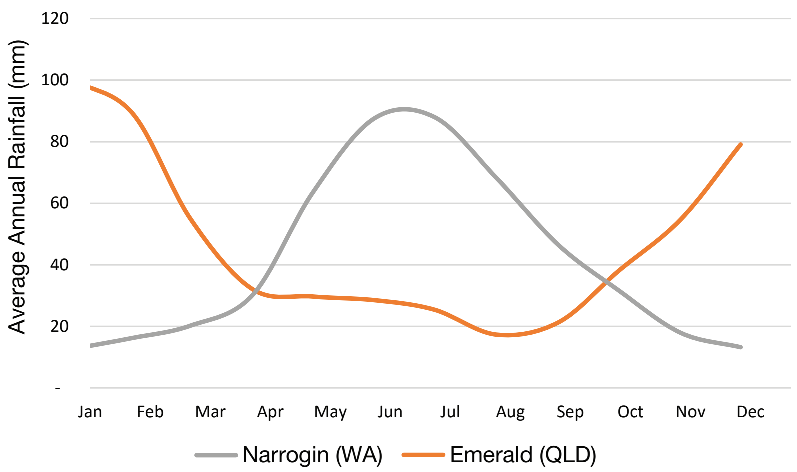
Figure 1 presents different weather zones categorised by rainfall distribution in the winter and summer months. While areas of southeastern Australia have reasonably consistent rainfall throughout the year, other areas demonstrate a high bias towards either winter rainfall, such as the region around Perth, or summer rainfall, such as the tropical region of Cape York.

This contrast is demonstrated by Figure 2 which compares rainfall in a southwestern location, Narrogin, a wheat growing region in South West Western Australia (WA), and a northern location, Emerald, a cotton and horticulture region in Central Queensland. This contrast is due to their exposure to different prevailing climatic forces, in particular large scale 'remote drivers'[4] which are outlined in the next section.

As climatically dispersed regions are more, or less, influenced by different remote drivers, rain is prevalent at different times of the year. As an aside, a slight increase in summer rainfall has been recorded over the last 100 year period, particularly in areas that already had more summer dominant rain[5].

The summer or winter dominance of rainfall is a determinant of the agricultural commodities found in each region. This aspect, being commodity diversification, is discussed later in this paper.

Figure 2 - Comparison between Narrogin (South West WA) and Emerald (Central Queensland)[6]



[2] Commonwealth of Australia (Geoscience Australia) (2016) 'Continental Extremities'
[3] Dr Greg McKeon (2006) CRC for Greenhouse Accounting, Queensland Department of Natural Resources and Water, prepared for the 2006 Australian State of the Environment Committee
[4] Risbey et al (2009) 'On the remote drivers of Rainfall Variability in Australia'
[5] BOM (2016) 'Australian climate variability & change - Trend Maps'
[6] BOM (2016) Monthly Rainfall Data

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1.2 Recurring, large scale weather patterns (remote drivers)

Australia is affected by large scale weather systems known as 'remote drivers'[7], which are further described in Figure 3. These forces relate to large scale processes in the oceans and atmosphere around Australia, such as cyclical changes in sea water temperatures and air pressures due to the uneven heating of the Earth's surface by the sun[8]. Variations and movements in these remote drivers have a strong impact on rainfall in their areas of influence.

The El Niño Southern Oscillation (ENSO) is a predominant driver of eastern climatic conditions producing the El Niño and La Niña weather events. El Niño occurs every four to seven years and typically lasts for 12 to 18 months. It is often associated with reduced rainfall over southeastern and northern Australia with the harshest effects usually felt in the winter and spring months of an El Niño year.

North western, central and southern Australia are affected by the Indian Ocean Dipole (IOD). Similar to ENSO, the IOD is an ocean and atmospheric phenomenon in the equatorial Indian Ocean to the west of Australia, which sees the western and eastern sea surfaces alternate between warmer and colder temperatures. Cooler water in the eastern Indian Ocean (known as a positive event) may produce less rainfall over central and southern Australia[9].

Figure 3 - Schematic representation of rainfall variability remote drivers in the Australian region[10]

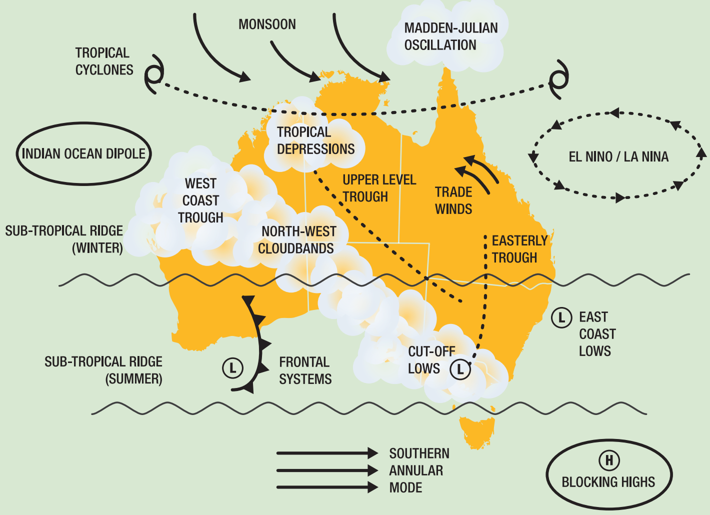
The Indian Ocean Dipole (IOD) is similar to ENSO as an ocean and atmospheric phenomenon in the equatorial Indian Ocean to the west of Australia, which sees the western and eastern sea surface temperatures alternatively become warmer and colder. Cooler water in the eastern Indian Ocean (known as a positive event) may produce less rainfall over central and southern Australia[9].

The Sub Tropical Ridge (STR) is a band of atmospheric high pressure which migrates between 30°N and 30°S of the equator. Its location is associated with dry and stable conditions and has the greatest affect over central Australia. It is the driving force behind a lot of northern Australia's weather particularly its dry winter[8].

The Southern Annular Mode (SAM) also known as the Antarctic Oscillation (AAO), describes the north–south movement of the westerly wind belt that circles Antarctica. Changes in the SAM can affect rainfall in southern Australia[8].

The Madden-Julian Oscillation (MJO) is the major fluctuation in tropical weather on weekly to monthly timescales and a major driver of the northern Australian monsoon from December through to March. It has its greatest effect on the tropical areas of Australia during summer[12].

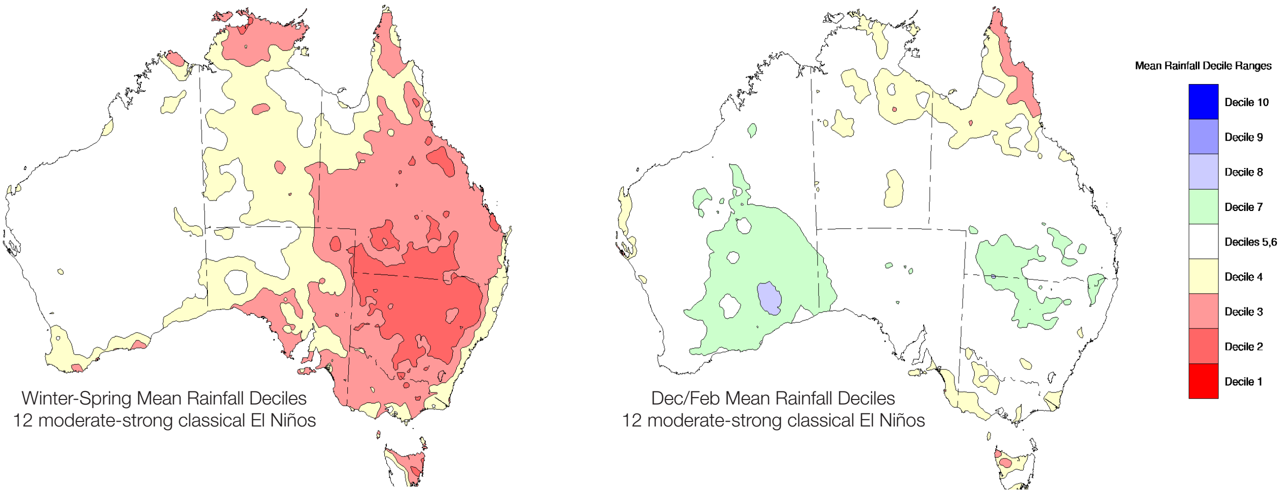
The Trade Winds are east to southeasterly winds which blow across much of the southern hemisphere tropics, affecting tropical to subtropical areas of Australia. They collect moisture as they travel over the Pacific Ocean before proceeding across the subtropical regions of the east coast, resulting in increased rainfall. The winds, after drying out, continue inland across the north of Australia resulting in drier conditions[13].



ENSO is a cycle of changes in the winds and ocean temperatures of the Pacific Ocean. It is a natural part of the climate system caused by cooler and warmer water shifting across the Pacific Ocean and has been occurring for thousands of years. The phenomenon can produce the El Niño effect, which is typically associated with reduced rainfall in northern and eastern Australia, with less water vapour in the air as cooler waters prevail in the western Pacific and the Trade Winds weaken. Conversely, the La Niña effect is typically associated with wetter weather with more water vapour in the air as warmer waters prevail and the Trade Winds strengthen. ENSO can be monitored in the short term by the Southern Oscillation Index (SOI), a measure of sea level air pressure differences between Darwin and Tahiti[14].

[7] Risbey et al (2009) 'On the remote drivers of Rainfall Variability in Australia'
[8] Climate Kelpie (2008-2016) Grains Research & Development Corporation
[9] BOM (2016) 'The Indian Ocean Dipole'
[10] BOM (2010) 'Australian Climate Influences'
[11] BOM(2008) 'The Southern Annular Mode (SAM)'
[12] BOM (2008) 'Madden Julian Oscillation (MJO)'
[13] BOM (2008) 'Trade winds'
[14] BOM (2008) 'The three phases of the El Nino-Souther Oscillation (ENSO)

Figure 4 – Impact of El Niño during winter and summer months[15]



According to the Bureau of Meteorology, the winter-spring period noted in Figure 4 covers most of the dry season for northern Australia. In the dry season, zero monthly rainfall totals are quite common in some northern and central parts even in ordinary years, so it is not surprising that there is little or no consistent El Niño effect for this time of year across central and southern parts of the Northern Territory and adjacent parts of Western Australia.

The impacts of remote drivers may be more significant on some rainfall zones than others. Figure 4 shows the severity of twelve of the strongest El Niño events on record. The left hand map shows that rainfall from winter to spring was severely deficient in southeastern Australia. In contrast, the right hand map shows that in the summer months, December to February, some areas in northern New South Wales and Western Australia received slightly more rainfall than in most years, while the majority of Queensland experienced median summer rainfall.

These maps demonstrate that agriculture in southeastern Australia is more likely than northern Australia to experience lower overall rainfall during El Niño events. The impact of El Niño in northern Australia is less severe given that this region receives most of its rainfall in summer, by which time El Niño is typically receding. The varying impacts of remote drivers like El Niño are important when considering the location of new acquisitions to diversify the RFF portfolio.

1.3 Correlation analysis

Referring to BOM data, RFM has compared rainfall records in different locations across the Australian continent. A number of locations were chosen from each of the rainfall zones in Figure 1. Annual rainfall between 1900-2015 was analysed to see how each location's rainfall varied compared to the others.

Figure 5 demonstrates that the correlation between the annual rainfall in each of the zones was very low, with rainfall conditions appearing to be independent of each other across the geographically dispersed zones. If a particular zone experienced a higher than average year of rain, other regions may not have necessarily received the same benefits. Conversely, if a particular zone experienced a poor rainfall year, other zones may have received average or above average rainfall.

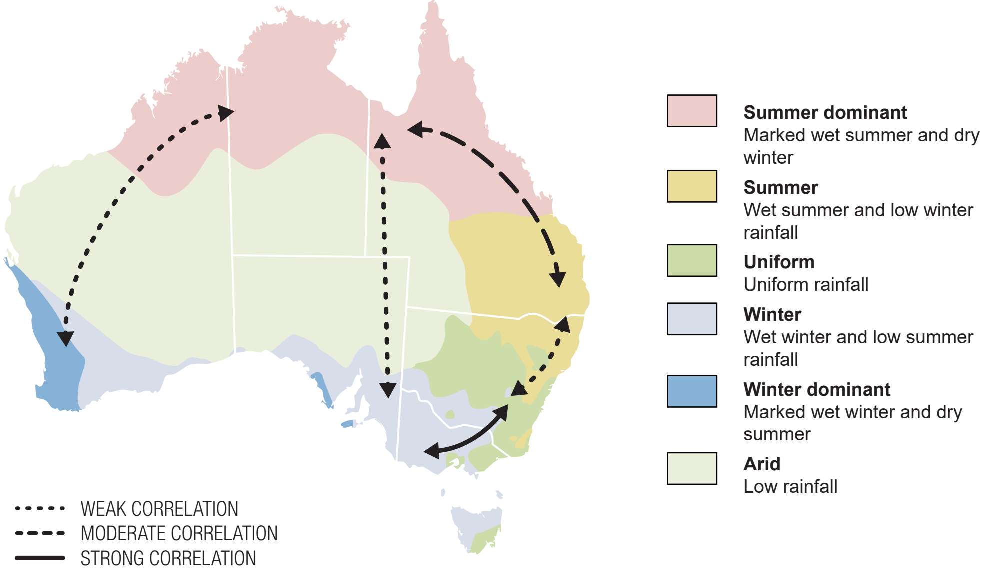
While rainfall is not the sole factor contributing to agricultural output, rainfall fluctuations may impact, either positively or negatively, the overall output of a particular region. It follows therefore, that if a particular agricultural enterprise in a winter dominant region is heavily affected by a poor rainfall year, regions with summer dominant rainfall will not necessarily face the same difficulties.

Years of excessively dry seasons can cause financial losses for lessees. For this reason a diverse portfolio of lessees, with many not experiencing drought, will improve both the perception and the reality of RFF's property portfolio. This is an important supporting point for diversification of the RFF portfolio into climatically dispersed areas.

[15] BOM (2016) 'Monitoring El Nino'

Figure 5 - Correlation between annual rainfall in each of the main weather zones[16]

Summer dominant	Summer dominant				
Summer	0.33	Summer			
Uniform	0.29	0.13	Uniform		
Winter	0.19	0.06	0.64	Winter	
Winter dominant	0.11	0.04	0.28	0.35	Winter dominant



The table and map above present results from RFM's correlation analysis. The table presents correlation coefficients, where '1' indicates a perfect correlation, and lower values approaching zero indicate close to uncorrelated rainfall patterns. The map simplifies this analysis by presenting these relationships between rainfall zones.

1.4 Climate change

Modelling conducted by the Commonwealth Science and Industry Research Organisation (CSIRO)[17] predicts overall temperatures in Australia will rise in future years based on forecast levels of greenhouse gases in the atmosphere.

Rainfall in Australia is influenced by a variety of factors, making it difficult to associate rainfall patterns directly with increased global temperatures. However, at a local level changing temperatures are expected to affect agricultural and water management practices[18]. On a larger scale, increases in air temperatures, ocean temperatures and sea levels can affect the level of influence of ENSO events, the Sub-tropical Ridge[19] and other remote drivers of rainfall.

The southward movement of fronts from the Southern Ocean and associated summer dominant rainfall is also expected to continue[20]. This is expected to lead to a further reduction in rainfall in the cooler months, particularly for regions such as the Murray-Darling Basin and other areas of winter dominant rainfall.

The existing contrast in climatic conditions between northern, western and southeastern Australia may be exacerbated by climate change. This is an important consideration in diversifying the RFF portfolio.

[16] Calculated using BOM (2016) monthly rainfall data
[17] CSIRO (2004) 'Climate Change in NSW, Part 1: Past Climate variability and projected change in average climate'
[18] CSIRO and BOM (2015) 'Climate Change in Australia: Information for Australia's Natural Resource Management Regions - Technical Report'
[19] Steffan W, Climate Council of Australia (2015) 'Thirsty Country: Climate Change and Drought in Australia'
[20] CSIRO and BOM (2014) 'State of the Climate 2014'

Section 2:
Summary of the benefits of climatic diversification for RFF

So far this paper has outlined the variety of rainfall conditions affecting different parts of Australia. This section summarises the specific benefits in diversifying the RFF agricultural property portfolio into regions displaying independent rainfall conditions.

2.1 Commodity diversification

The large variety of weather conditions affecting Australia has resulted in a diverse range of agricultural pursuits across the continent. This is because different climatic zones are better suited to a variety of crops and industries.

Having assets located in a greater variety of climatic zones would give RFF exposure to new lessees producing commodities with different seasonal and commodity price cycles. For example, summer based crops and pasture in northern locations have low market related correlation with winter based crops and pasture in southern and western locations.

In addition, different commodities are subject to varying levels of exposure to non-climate related factors, such as the value of the Australian dollar, the oil price and overseas market conditions. Diversifying the RFF portfolio into new commodities will help reduce the likelihood of multiple lessees facing commodity price pressure at the same time.

2.2 Addressing year to year rainfall variability

As outlined in Section 1, different locations are subject to independent levels of rainfall variability with low correlation between geographically dispersed rainfall zones. Owning assets located in areas with low to negative correlation to each other helps hedge against rainfall volatility. Diversification of the RFF asset base across the Australian continent will reduce the risk of a low rainfall year affecting all lessees in the portfolio at the same time.

2.3 Addressing the effects of climatic extremes

The adverse effects of some remote drivers such as El Niño are more or less severe in different areas. Acquiring assets outside the area of influence of a single remote driver like El Niño is beneficial. For example, any future assets acquired in southwestern and northern Australia may be less affected by El Niño than new or existing assets in parts of southeastern Australia. Conversely, RFF's existing assets in southeastern Australia may be less affected by the variation caused by other remote drivers such as the IOD.

2.4 Preparing for possible climate change impacts

While researchers cannot predict the exact impacts of climate change, a number of studies indicate that an increase in global temperatures is likely to see an increase in the year on year fluctuation of rainfall, as well as an increase in extreme weather events. Climatic diversification will moderate RFF's long term exposure to any volatility caused by climate change.

Conclusion

Seasonal rainfall variability places risk on many farmers and agribusinesses. However, RFM's studies have shown that extreme weather conditions, such as droughts, could be buffered by geographic diversification. By expanding its asset base into different climatic zones, RFF will lower the aggregate level of risk of seasonal or long-term climate stress affecting numerous lessees at the same time. Moreover, RFF may be better able to moderate the impacts of any future adverse climate changes. The introduction of new commodities and lessees will also provide benefits through a diversification of commodity price cycles and other non-climate related factors.