Severe localised Grain Production Losses from atypical frosts in the Marrabel Valley Catchment 2011 – 2014.

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This report summarises evidence and observations of 13 long term Waterloo and Marrabel farmers regarding abnormal frost occurrence and severe frost damage to grain crops in elevated areas commencing in 2011.

Overview

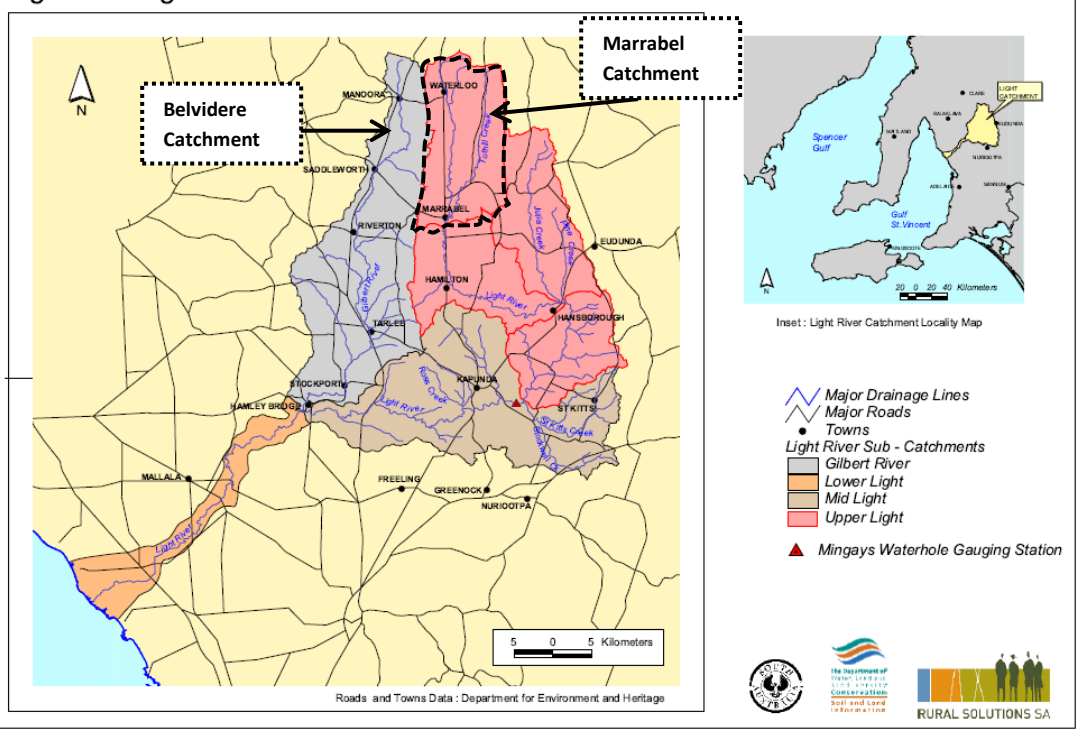
For the four cropping seasons from 2011- 2014, a majority of farmers in the Marrabel Valley have experienced unprecedented and widespread frost damage of grain crops on sloping paddocks high above the valley floor. Historically these areas have not been affected by frost as the steep slope of the valley sides ensures that cold air flows towards the lower lying areas where it is normal for frost to form.

The onset of these seasons of atypical and the abnormal frosts and frost damage coincides with the commencement of operation of an 18 km long wind farm which is located on a central ridgeline in the clearly defined catchment area. Four contiguous years of significant production losses have prompted this call for an investigation into whether the wind farm is affecting the near surface meteorology of the Marrabel Catchment. This Catchment covers 21,392 hectares [1.] and contains some of the most highly productive and high value cropping land in South Australia, consequently further investigation is justified.

Area description

The Marrabel land system (MRB) is a well-defined sub catchment of the Upper River Light Catchment in the Mid North of South Australia. MRB is bounded by two North South Ranges: The Belvidere Range to the West and the Tothill Range to the East. See Figure1 - source: “Upper Light River salinity management plan 2003”. [1.]

Figure 1 : Light River Catchment



The "Upper Light River salinity management plan"2003 (page 11) describes the catchment as:

***"MRB** – **Marrabel land system** Area: 21,392 ha (30.5% of area)*
This land system is the largest land system and occurs in the Marrabel and Hansborough sub-catchment. It is a river valley bounded by steep, rocky and non-arable ridges, but within which virtually all the land is arable. The landscape comprises gently sloping fans towards the river flats with undulating rises. ***The rises are low and gentle near the river but become higher and steeper towards the edges of the valley****."*[1].

Land Values and Yield Potential

Cropping land values in the MRB peaked in January 2012 with the sale of 3 blocks of land, each 65.5 ha selling up to $4273/acre or $10572.52/ha.
This area has historically been recognised as one of the most reliable cropping areas of the state with an average rainfall of 525mm at Marrabel township in the south west [1].

Subject to seasonal variations and soil types MRB farmers expect to reliably produce at least the following yields on average:

3 - 4 t/ha Wheat Grain	3 - 4 t/ha Barley Grain
1.2 -1.8 t/ha Canola Grain	5 - 10t/ha cereal hay

As it has become increasing apparent that unusual frost distribution patterns in the catchment area have significantly reduced incomes on an annual basis, many land parcels for sale in in 2014 have failed to attract a buyer, even at a reduced price.
Repeated unexpected frost damage in the last four years has significantly reduced farmer's returns and their ability to repay finance on such expensive land purchases.

Surveyed Farmers [2].

In January 2015, 13 farming businesses in and adjoining the MRB responded to written surveys and personal interviews which were conducted to quantify the extent of production losses due to unusual frosts. See Map Appendix A

The farm operations surveyed are multigenerational farms, some farms have been owned by the same families since settlement in the latter 1800s and most current operators have cropped their land for around 40 – 55 + years.

Location of Frosts – Expected and Unexpected

9 farmers with cropping land in the MRB responded that frosts and associated grain yield losses are a **normal expected occurrence** in the following areas of their properties: (some) **Gullies, Creek flats, Creek lines, Low lying areas and occasionally Sides of rises, along the Light River in the bottom of the valley, uphill side of tree plantations.**

All farmers responded that they **did not expect frosts** and grain yield losses from frost damage in the following areas: (some) **Sides of Rises, Tops of Rises, Sides of Hills, Tops of Hills.**

However the 9 farmers in the MRB responded that since 2011, they had observed unexpected frosts and sustained crop yield losses in the following unusual locations: Against dam banks (bodies of water), At elevation, Sides of Hills, Tops of Hills, Tops of Rises.
3 of the farmers have land in both the Marrabel and adjacent Belvidere catchments and have responded that the **frosts in unusual (elevated) locations were confined to the Marrabel Catchment**.

1 farmer only has cropping land in the Belvidere Catchment. He reported that frost observed in the Belvidere Catchment occurred in normally frost prone areas, and he had not noticed unusual frost distribution on his land, but had observed it on other farms in the MRB Catchment.

Several farmers also identified that their paddocks were on the steeper Western slopes of the Marrabel valley and elevated well above the usual frost zone and are sufficiently steep that cold air should drain down off the slope to pool in the floor of the valley and thence drain down the Light River towards Marrabel township.

Severity of Frosts and Frost Damaged Crops

Increased severity of frosts and **significant frost damage to the grain yield of crops** in **normally frosted low lying areas** were also reported by farmers in the Marrabel Catchment for the years 2011 - 2014.

Other observations of increased cold air mass in the valley suggesting a connection between frost and turbine activity

One farmer described his experience driving up the Marrabel Valley before 7 am one frosty late August morning in 2014. The farmer noticed that the air was quite still in the valley, but the turbines of the wind farm were turning quite strongly due to a North Easterly wind at the turbine hub height on the ridgeline. All the area in the valley floor to the south west (downwind) of the turbines was a mass of frost and a white cold air mass seemed to be falling and billowing in the same way that the "fog " is given off from dry ice. He described the "visible cold air mass" as pushing up the slopes and gullies of the valley as though driven by something – although there seemed to be no "wind" at ground level. The cold air mass was rising up the slopes in a way that completely contradicted the way cold air normally moves in that it wasn't sinking to the lowest spot - but being pushed up the side slopes of the valley. As the farmer commutes along the whole length of the Marrabel Valley to the family farm every day, approaching his farm from the southern end, he has witnessed the unusual way frosts have formed in the catchment on several occasions in the last four years as well as seeing the obvious frost damage and resulting yield decreases in his own and other's crops.

Grain Production Losses and Financial losses / future farm viability due to frost damage in unexpected places

There is increasing local concern in this historically very safe area about **ongoing farm viability** as some farmers have suffered significant financial losses for 4 years in a row in paddocks where frost has never before been a problem.

Farmers who have borrowed heavily to buy land at a price reflecting pre 2011 potential, are increasingly concerned that this land is no longer able to achieve that potential.

Actual yields have fallen far short of expected yields over the past 4 years and unexpected frost damage in unexpected places has been a major factor.

With the current lapse of productivity, Growers are increasingly concerned about : being unable to repay borrowings ; being unable to on sell the land ; and their future viability.

Some MRB farmers have provided specific examples of 2014 Grain Production losses and Financial losses from paddocks where unexpected frost damage occurred. Some of their examples are presented in Appendix B. Some yield maps are also available, but not provided with this report.

These attached examples only relate to unusual frost damaged areas where frost has not occurred prior to 2011.

Frost damage occurring on expected normal frost prone areas has not been included.

Affected farmers who participated in this survey conservatively estimate that a combined total of approximately $10 million has been lost by farmers in the Marrabel catchment due to Atypical frosts during the last 4 years.

Adelaide University Preliminary Research 2014

In 2014, after being contacted by concerned Marrabel farmers regarding atypical frost damage, 4 Adelaide University Aerospace Engineering Honours students embarked on a preliminary research project to investigate whether wind turbines can affect the growth of plants[3]. . Their initial investigations included wind tunnel experiments and taking into account sources of hot and cold air , changes in wind speed and the effects of topography. Based on this preliminary research , it is possible that the Waterloo turbines could be mixing additional cold air into the local environment which could be a possible explanation for frost distribution and severity changes in the Marrabel catchment. Further research in needed to provide conclusive results.

Related Turbine specification facts : Waterloo wind farm of 37 Vestas V90 turbines:

Area swept by the blades of each turbine= 0. 6362 hectares,

Total swept area of Waterloo wind farm turbine blades : 37 x 0. 6362 hectares = 23.5395 hectares in a single line 18 km long.

Conclusion

A majority of farmers surveyed in the Marrabel Catchment have sustained significant production losses from atypical frost formation every year since the Waterloo wind farm began operating.

Preliminary investigations by the University of Adelaide School of Mechanical Engineering have identified that industrial wind turbines can cause mixing of cold upper level air which can cause a drop in air temperatures at ground level . This has the potential to increase the number of frosts in the local environment. Given the recent increase in frost damage and “devastating” associated financial losses seen in this usually reliable and highly productive farming area, further investigation is warranted.

References

1. Harding, A, Henschke, C, Ciganovic P, Dooley T (2003) *Upper Light River Salinity Management Plan* Northern and Yorke Agricultural District Integrated Natural Resource Management Committee, Rural Solutions SA. Page 11 http://www.saltlandgenie.org.au/_literature_85409/CMP_-_SA_-_Upper_Light_River_-_Northern_and_Yorke_District
2. Faint J and Morris M, 2015 Personal Interviews and written surveys with Marrabel farmers
3. Raymond P, Sivakumar D, Verma A and Yeldhose A 2014 “Crop thriving near turbines”
4. Vestas 2006. General Specification for V90 – 3.0 MW 60 Hz Variable Speed Turbine