



# Impact of Extreme Climate Events on Agricultural Productivity and Profitability

Affects on wheat production in South-West, Western Australian

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# Project Outline

- Why the affect of **EXTREME** climatic events on production and profitability?
- **Methods and Results**
  - Site Location
  - Historical Trend Analysis
  - Defining Climate Extremes
  - Biophysical Model Simulations (APSIM)
- Study was conducted on 2 sites, using 3 variables for 2 data sets
  - Katanning and Merredin (only for historical trend analysis) in SWWA
  - Rainfall, and Minimum and Maximum Temperature
  - Recent Historical (RH) data set (1991-2015) and the 2030 Projection (P) data set (1991-2010)

# Site Location

## Methods

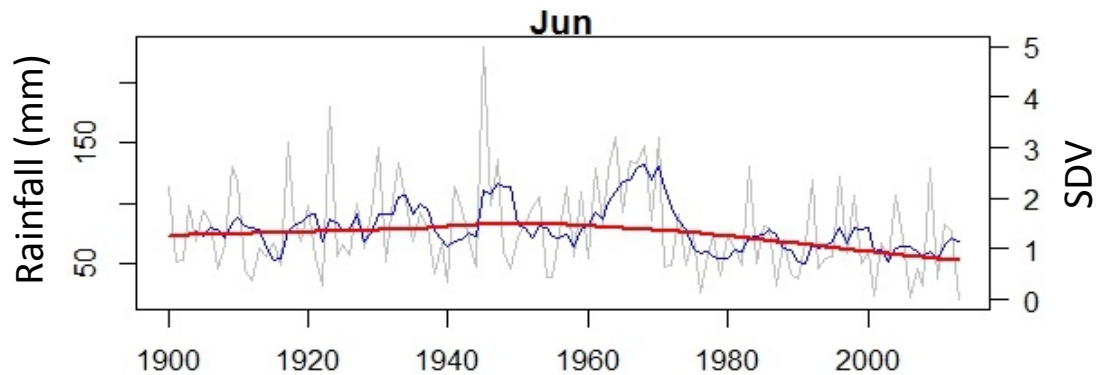
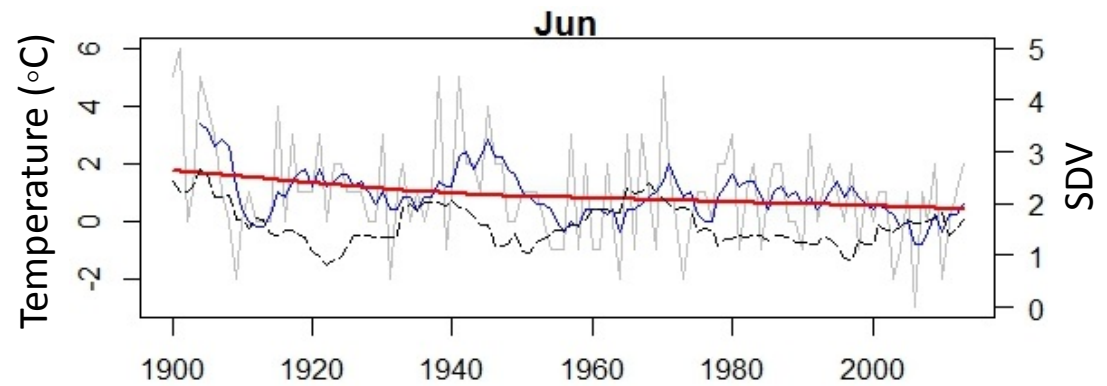
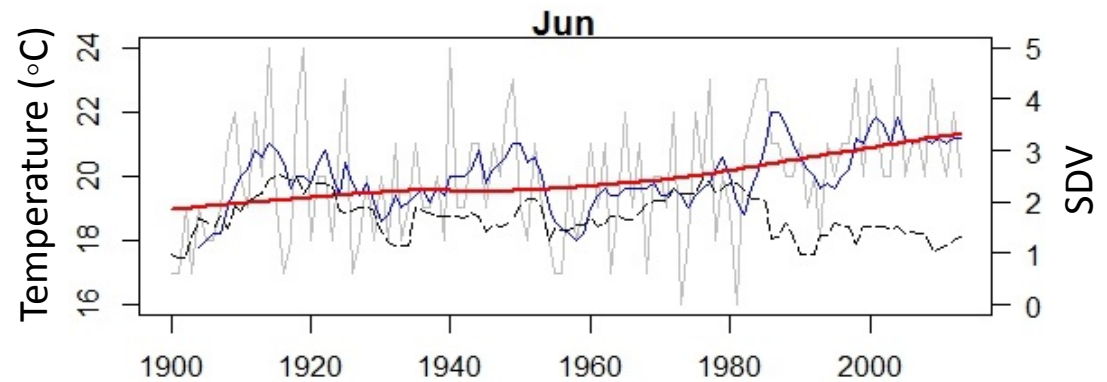
- **Katanning:** High rainfall south (Planfarm, 2014)
- **Merredin:** Low rainfall south (Planfarm, 2014)



# Trend Analysis

## Methods and Results

- Increases in **extreme** maximum temperatures
- Results showed overall decreases in **extreme** minimum temperatures
- Decreases in **extreme** late Autumn/early Winter rainfall only at Katanning



# Defining Climate Extremes

## Methods

- Thresholds defined using a 30-year baseline period from 1961-1990
- 14 total extreme climate indicators used, adapted from: ETCCDI (2013)
  - 8 temperature (4 frequency, 4 intensity – example shown)
  - 6 rainfall (3 frequency, 3 intensity)

Name	Abbreviation	Calculation	Definition
<b>Temperature Variables - Intensity</b>			
Monthly maximum value of daily maximum temperature	$TX_x$	$\underline{TX_{xki}} = \max(\underline{TX_{xki}})$	Hottest daily maximum temperature/month for base period.
Monthly maximum value of daily minimum temperature	$TN_x$	$\underline{TN_{xki}} = \max(\underline{TN_{xki}})$	Hottest daily minimum temperature/month for base period.
Monthly minimum value of daily maximum temperature	$TX_n$	$\underline{TX_{nki}} = \min(\underline{TX_{nki}})$	Coldest daily maximum temperature/month for base period.
Monthly minimum value of daily minimum temperature	$TN_n$	$\underline{TN_{nki}} = \min(\underline{TN_{nki}})$	Coldest daily minimum temperature/month for base period.

# Climate Extremes

## Results

- Decrease in the intensity of extreme minimum temperature and rainfall events from the RH to 2030 P data set

	Temperature		Rainfall
Data Set	Tmax	Tmin	5-day Rainfall
RH	8	7	6
2030, P	10	1	2

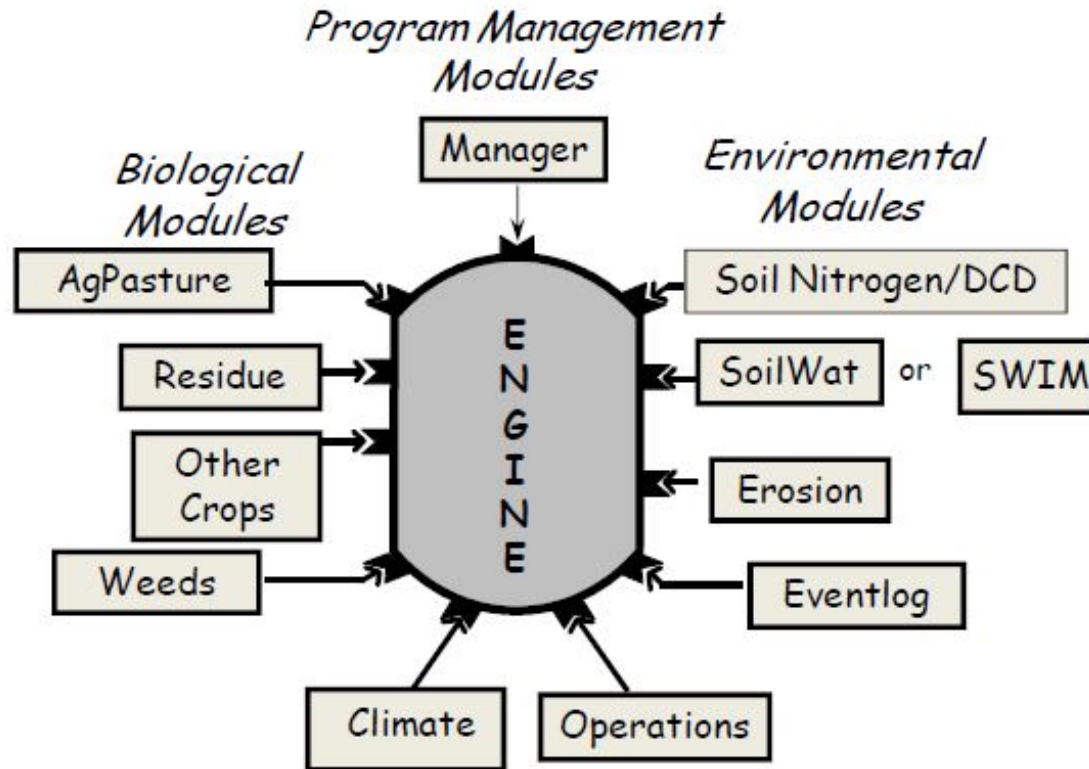
- Increase in the frequency of dry periods and extreme maximum temperatures, decrease in frequency of extreme minimum temperatures

	Temperature		Rainfall
Data Set	Tmax	Tmin	Rmin
RH	1.1%	3.3%	4.3%
2030, P	1.8%	0.5%	5.7%

# Biophysical Model Simulations

## Methods

- **Agricultural Production Systems Simulator - **APSIM**
  - Model run for both the RH and P data sets at Katanning only (Ghahramani et al, 2015)**



# Biophysical Model Simulations

## Methods

- Only the data input (met.) file and the CO2 variables changed within the User Interface (UI)

The screenshot displays the ApsimUI software interface. The window title is "ApsimUI - C:\Users\pec030\Documents\APSIM\katanning.apsim - SILO.apsim". The interface includes a menu bar with options like "New...", "Open...", "Save", "Save as...", "Export", "Checkpoint", "Insert a new graph", "Excel", "Options...", "Factorials", "Run on cluster", "Help", "Run", and "Stop".

The left sidebar shows a tree view of the simulation structure. The "katanning" folder is expanded, showing sub-items like "met", "clock", "summaryfile", "paddock", "soil", "Modifications", "Manager", "Frost and Heat\_wheat", "wheat yield", "Annual rainfall", "Gc", "output\_variables", "SurfaceOrganicMatter", "wheat", "Fertiliser", "Available Dry Matter", "tracker", "harvest\_end\_year", and "XY". A red arrow points to the "met" file, and another red arrow points to the "CO2" variable under "Frost and Heat\_wheat".

The main window displays the content of the "C:\Users\pec030\Downloads\Katanning.sim" file. The content is a text-based data input file for weather data, starting with "[weather.met.weather]" and providing station information, coordinates, and temperature statistics. It also includes a table header for the data output.

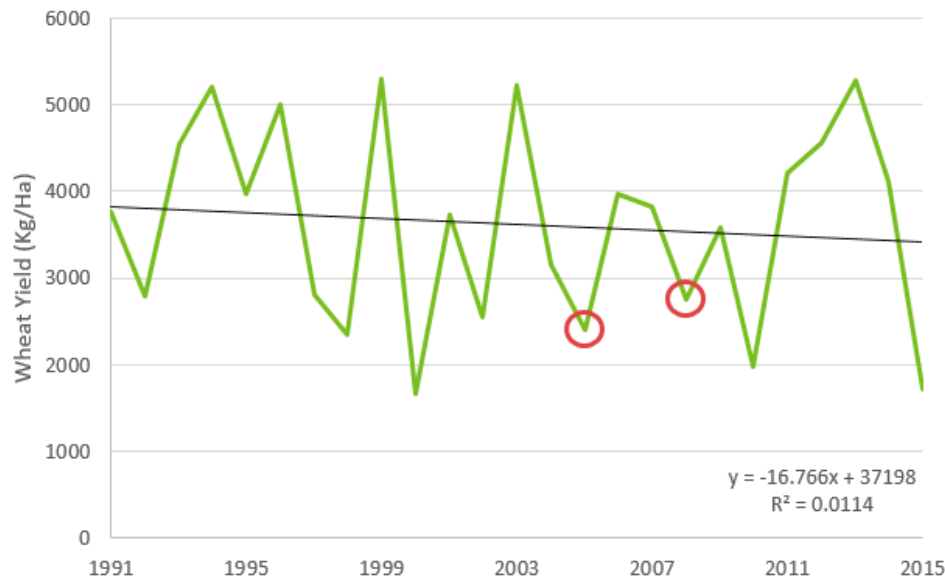
```
[weather.met.weather]
!station number = 010579
!station name = KATANNING COMPARISON
latitude = -33.6886 (DECIMAL DEGREES)
longitude = 117.5553 (DECIMAL DEGREES)
tav = 15.91 (oC) ! Annual average ambient temperature. Based on 1 Jan 1957 to current.
amp = 12.63 (oC) ! Annual amplitude in mean monthly temperature. Based on 1 Jan 1957 to current.
!Data Extracted from Silo on 20160201" for APSIM
! *** Some early data in this file is only possible because of the Climarc project, Thanks Climarc ***
!As evaporation is read at 9am, it has been shifted to day before
!ie The evaporation measured on 20 April is in row for 19 April
!The 6 digit code indicates the source of the 6 data columns
!0 actual observation, 1 actual observation composite station
!2 interpolated from daily observations
!3 interpolated from daily observations using anomaly interpolation method for CLIMARC data
!6 synthetic pan
!7 interpolated long term averages
!more detailed two digit codes are available in SILO's 'Standard' format files
!
!For further information see the documentation on the datadrill
! http://www.longpaddock.qld.gov.au/silo
!
year day radn maxt mint rain evap vp code
() () (MJ/m^2) (oC) (oC) (mm) (mm) (hPa) ()
```



# Recent History (RH) APSIM Results

## Results

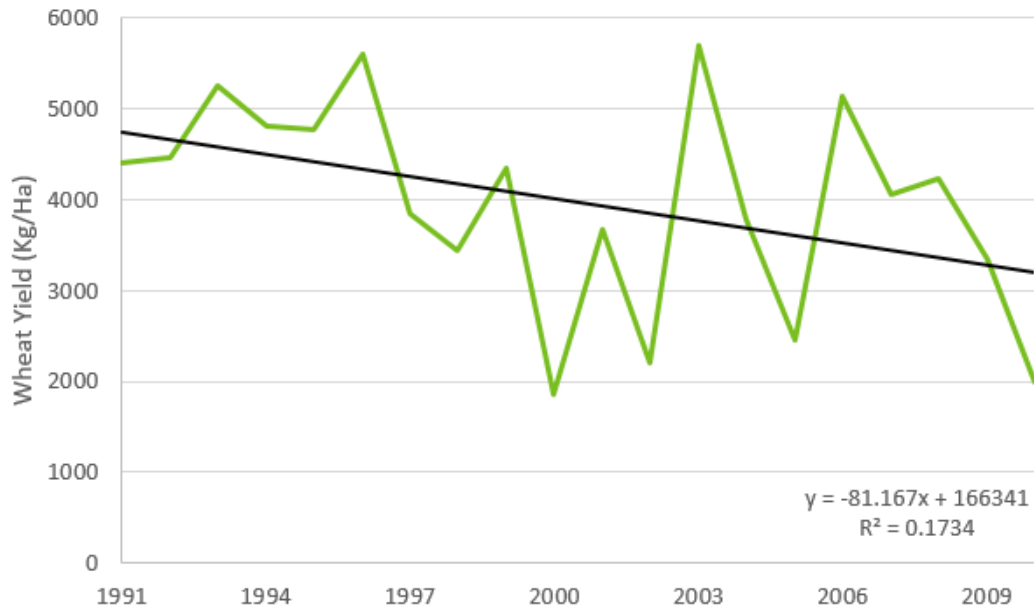
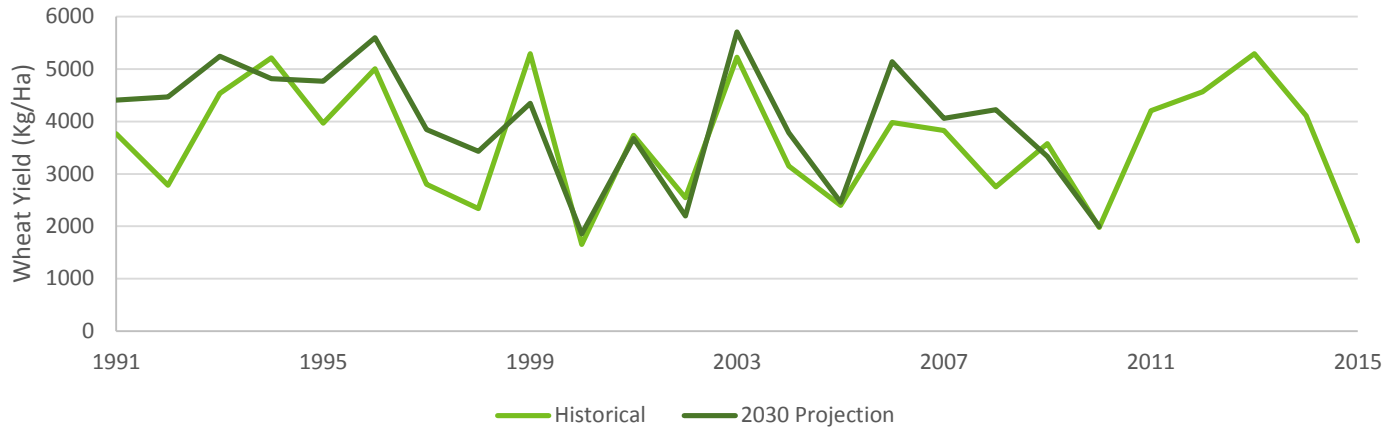
Year	Growing Season Rainfall (mm)	Wheat Yield (Kg/Ha)	Wheat Biomass (Kg/Ha)	Number of Extreme Events			
				Tmax	Tmin	1-Day R	5-day R
2004	336.5	3149.0	10845.0	1	0	0	0
2005	514.6	2398.1	8413.3	0	2	3	5
2006	251.2	3976.9	14069.6	2	2	0	0
2007	377.7	3824.5	11236.4	0	0	1	0
2008	393.2	2750.8	12226.7	0	1	1	0
2009	346.7	3576.4	10116.9	1	0	0	0
2010	196.1	1979.4	8913.5	0	1	0	0



Indicator	Growing Season Average (% change)
<b>Temperature Frequency Indicators</b>	
Tmax	1.1
Tmin	3.3
<b>Rainfall Frequency Indicators</b>	
Rmax	-2.6
Rmin	4.3

# Projected (P) 2030 Simulation Results

## Results



Indicator	Growing Season Average (% change)
<b>Temperature Frequency Indicators</b>	
Tmax	1.8
Tmin	0.5
<b>Rainfall Frequency Indicators</b>	
Rmax	-3.6
Rmin	5.7

# Summary

## Concluding Points

- Extreme event **intensity decreasing** over time
- Extreme event **frequency increasing** over time
  
- Overall, **yield is decreasing across the SWWA wheat belt due to extreme temperature events**
  - Wheat yield increased from the RH to the 2030 P data set
  
- Approximate **net loss of wheat yield/Ha from extreme events \$440** for SWWA (Planfarm and Bankwest, 2015).

# Thank you

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