Impact of Extreme Climate Events on Agricultural Productivity and Profitability

Affects on wheat production in South-West, Western Australian

Matthew Peck

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Griffith University - B. Environmental Planning (Honours)/B. Sc. (Env. Sc. & Climate Change Adaptation)

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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

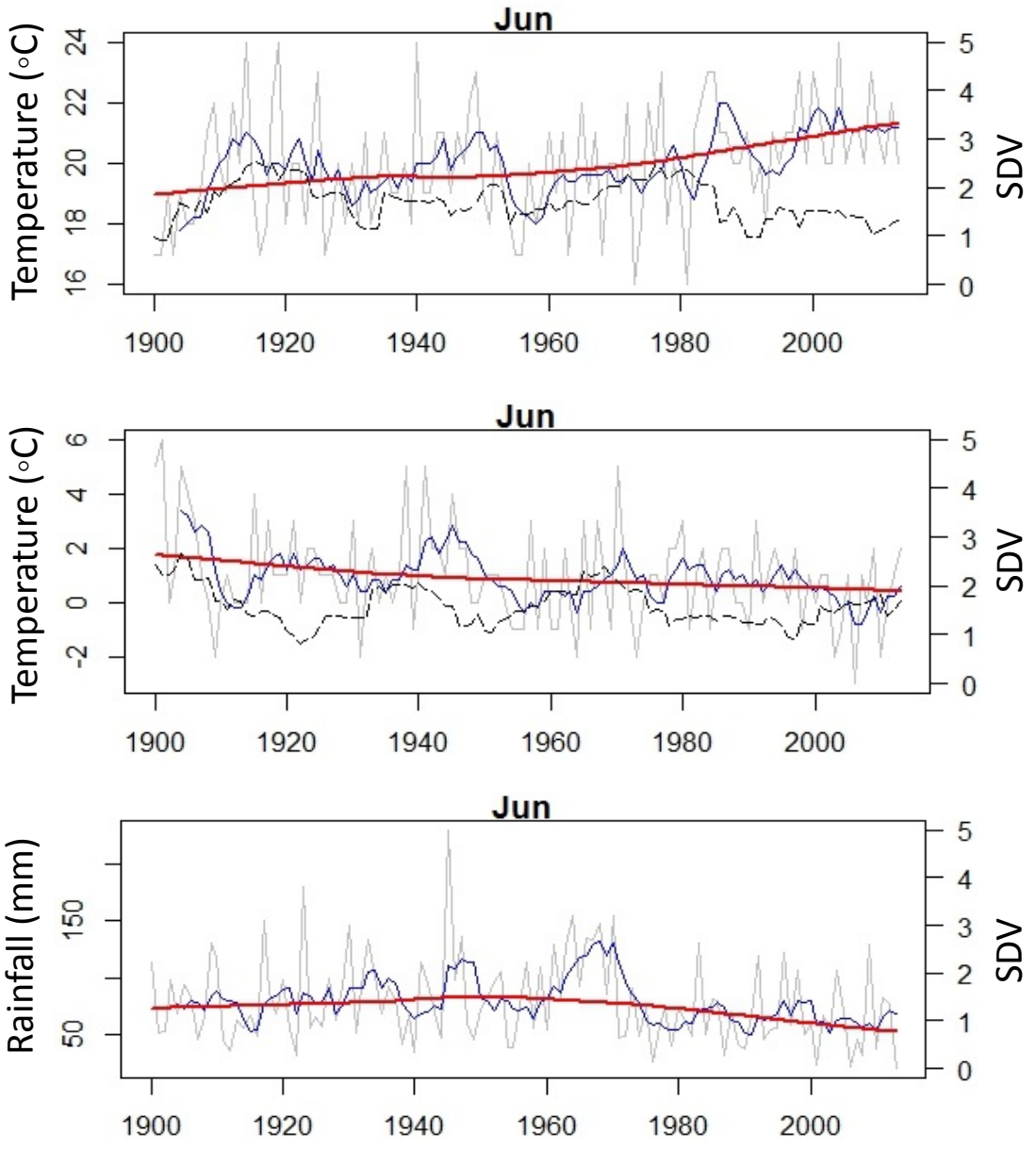
Methods

- **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
Temperature Variables - Intensity			
Monthly maximum value of daily maximum temperature	TX_x	$TX_{xkj} = max(TX_{xkj})$	Hottest daily maximum temperature/month for base period.
Monthly maximum value of daily minimum temperature	TN_x	$TN_{xkj} = max(TN_{xkj})$	Hottest daily minimum temperature/month for base period.
Monthly minimum value of daily maximum temperature	TX_n	$TX_{nkj} = min(TX_{nkj})$	Coldest daily maximum temperature/month for base period.
Monthly minimum value of daily minimum temperature	TN_n	$TN_{nkj} = min(TN_{nkj})$	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

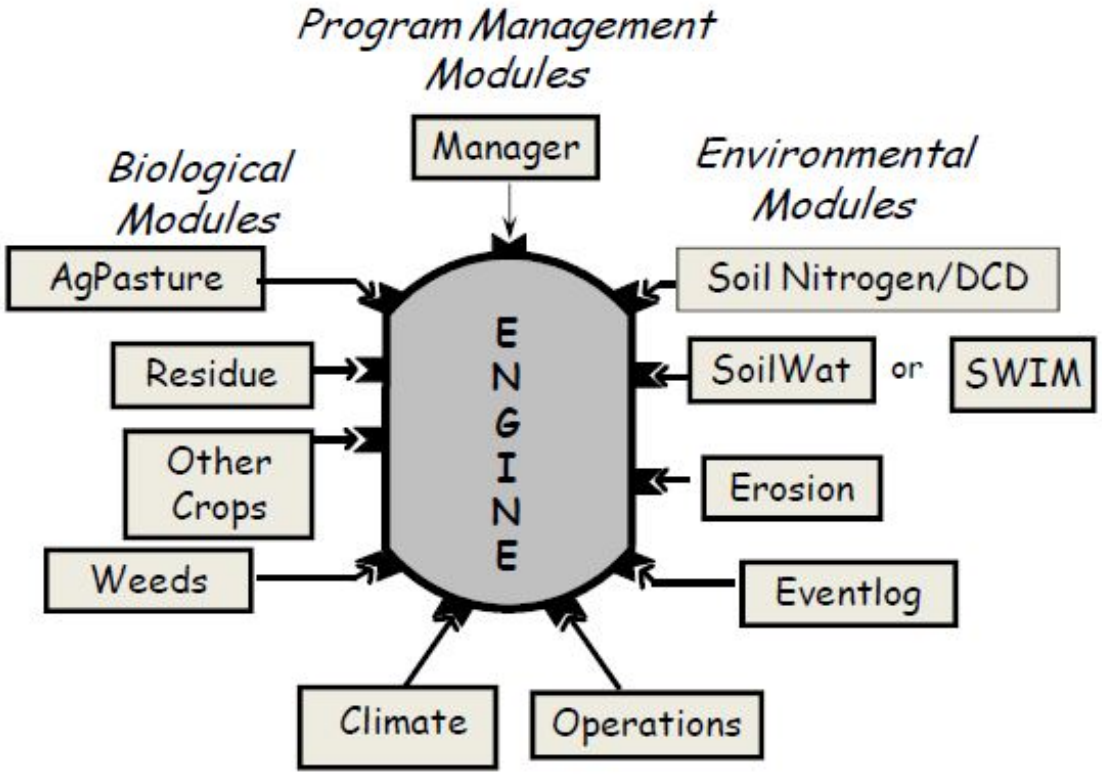
- Increase in the frequency of dry periods and extreme maximum temperatures, decrease in frequency of extreme minimum temperatures

	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

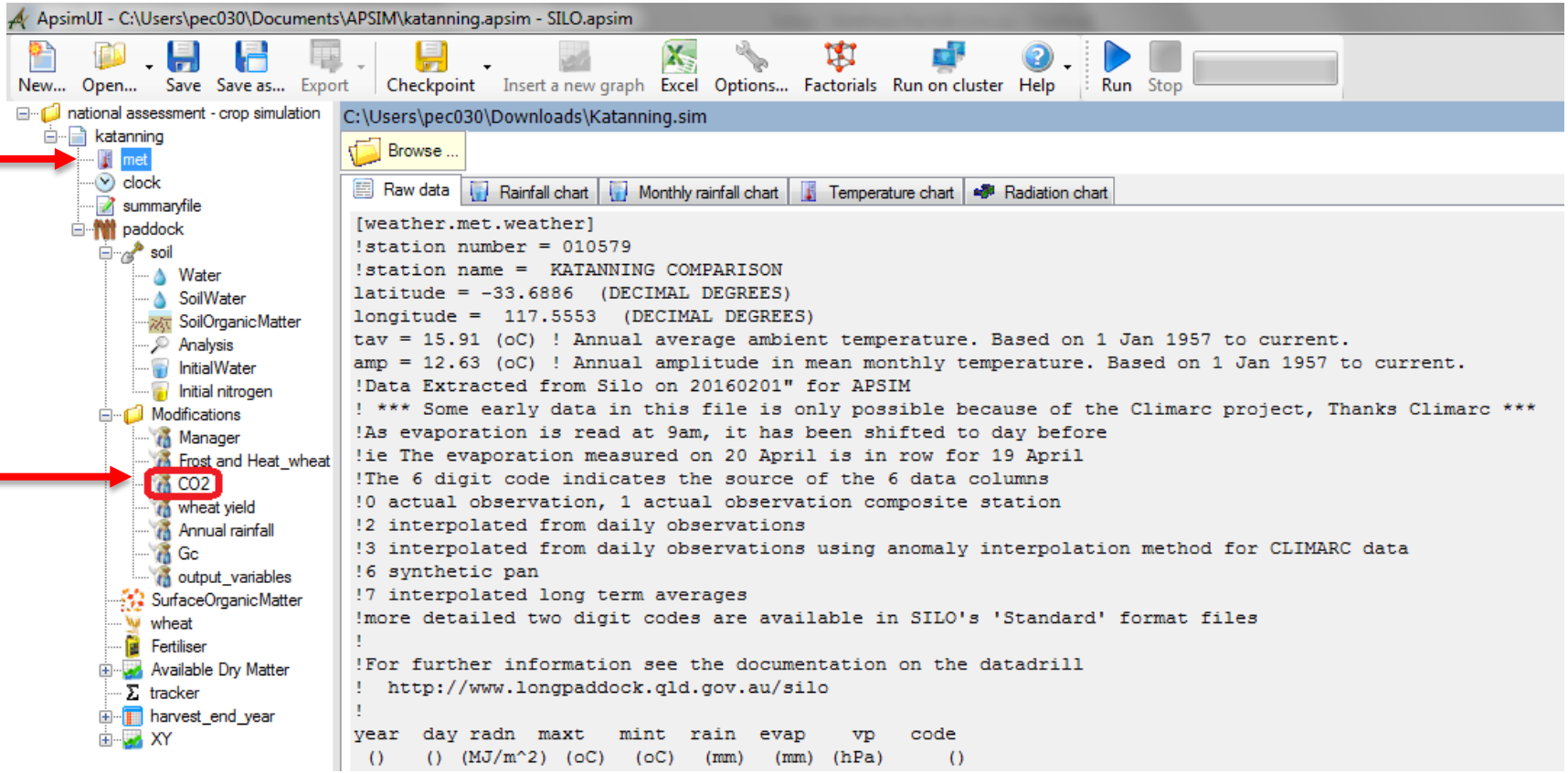
- **A**gricultural **P**roduction **S**ystems **SI**mulator - **APSIM**
  - Model run for both the RH and P data sets at Katanning only (Ghahramani et al, 2015)



Biophysical Model Simulations

Methods

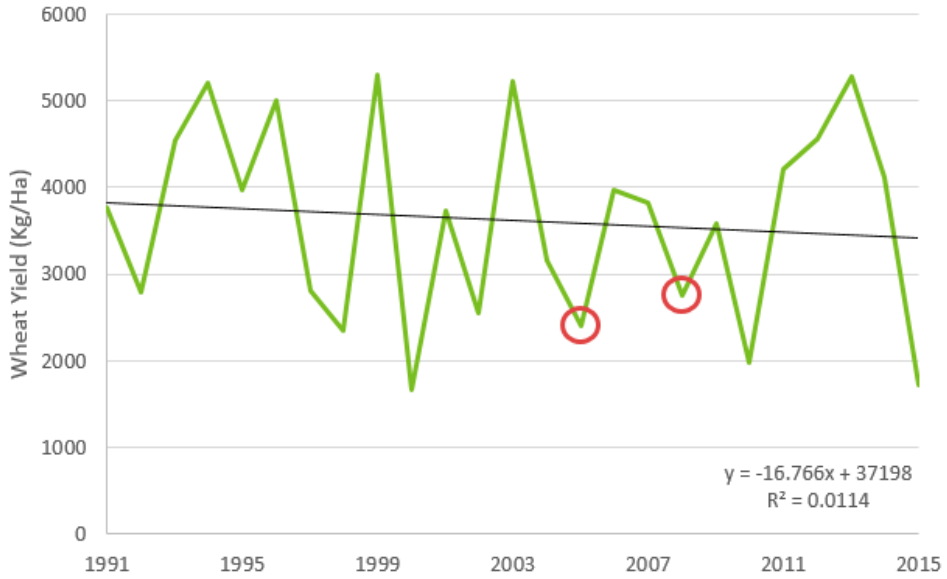
- Only the data input (met.) file and the CO2 variables changed within the User Interface (UI)



Recent History (RH) APSIM Results

Results

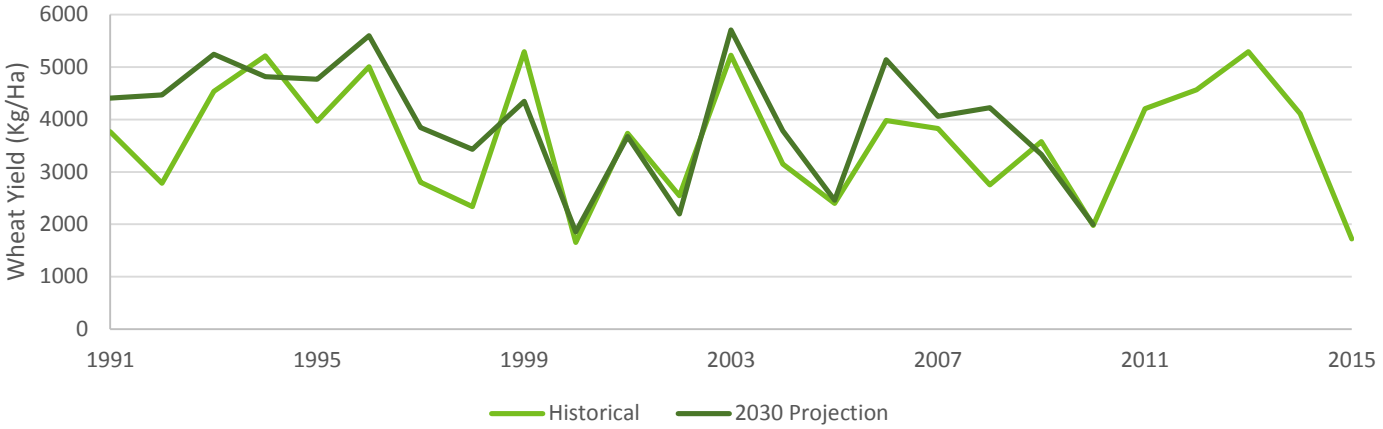
Year	Growing Season Rainfall (mm)	Wheat Yield (Kg/Ha)	Wheat Biomass (Kg/Ha)	Number of Extreme Events			
				Tmax	Tmin	1-Day R	5-day R
2004	336.5	3149.0	10845.0	**1**	0	0	0
2005	514.6	2398.1	8413.3	0	**2**	**3**	**5**
2006	251.2	3976.9	14069.6	**2**	**2**	0	0
2007	377.7	3824.5	11236.4	0	0	**1**	0
2008	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

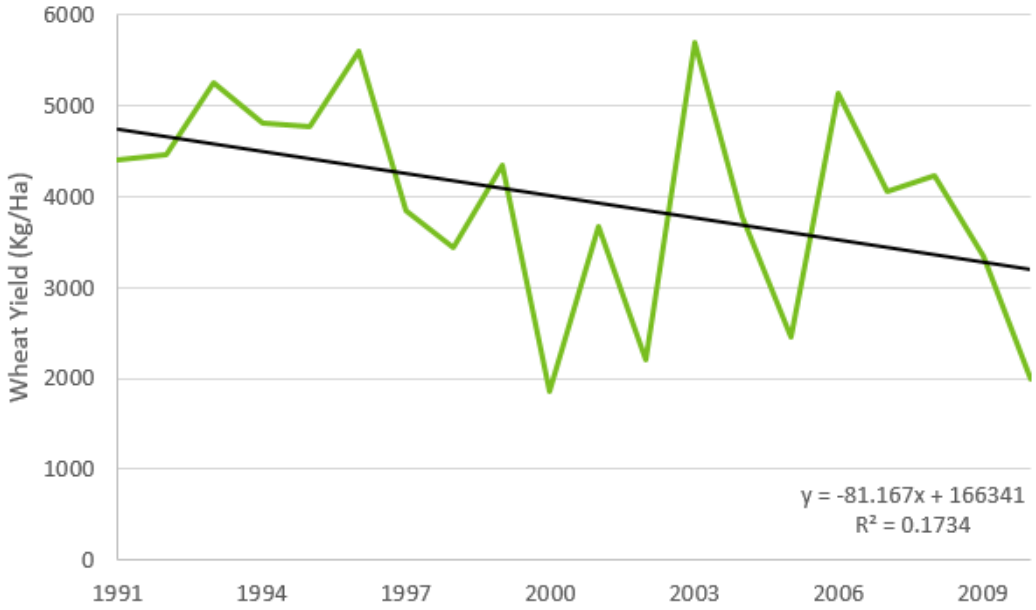


Indicator	Growing Season Average (% change)
Temperature Frequency Indicators	
Tmax	1.1
Tmin	3.3
Rainfall Frequency Indicators	
Rmax	-2.6
Rmin	4.3

Projected (P) 2030 Simulation Results

Results





Indicator	Growing Season Average (% change)
Temperature Frequency Indicators	
Tmax	1.8
Tmin	0.5
Rainfall Frequency Indicators	
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

Soil and Plant Modelling/Agriculture - CSIRO

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Matthew Peck

t +61 4 23 339 780
e matthew.peck@griffithuni.edu.au
w http://matthewpeck8.wix.com/matthew-peck

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