

Drought intensity, future expectations, & climate-change adaptation



Waikato farmers prepare for potentially worse drought than 2008



From **Morning Report**, 8:09 am on 6 March 2013

Northland facing fifth drought in 7 years

31 Jul, 2015 10:00am



Drought means big trouble for Kiwi farmers

MARTY SHARPE

Last updated 10:28, January 12 2015



Farmers on a knife-edge as 4th year of drought looms for parched North Canterbury

PAT DEAVOLL

Last updated 15:38, February 9 2017



Drought officially declared in Southland New Zealand

Thursday, February 1st, 2018

Another El Niño likely to hit New Zealand this summer -

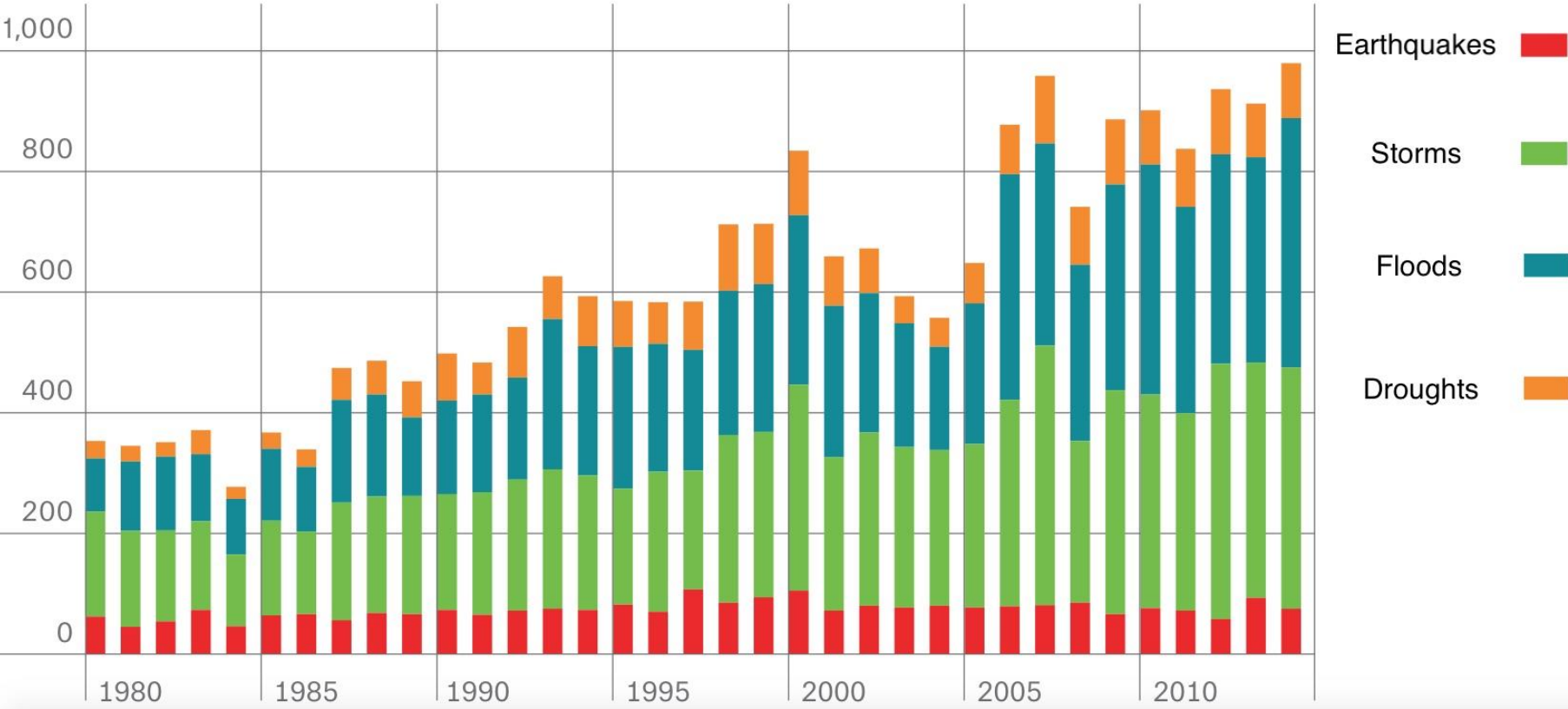
NIWA **Newshub**. July 31, 2018

Drought costs NZ \$2.8 billion

Friday, 14 August 2009, 10:56 am



Drought intensity, future expectations, & climate-change adaptation

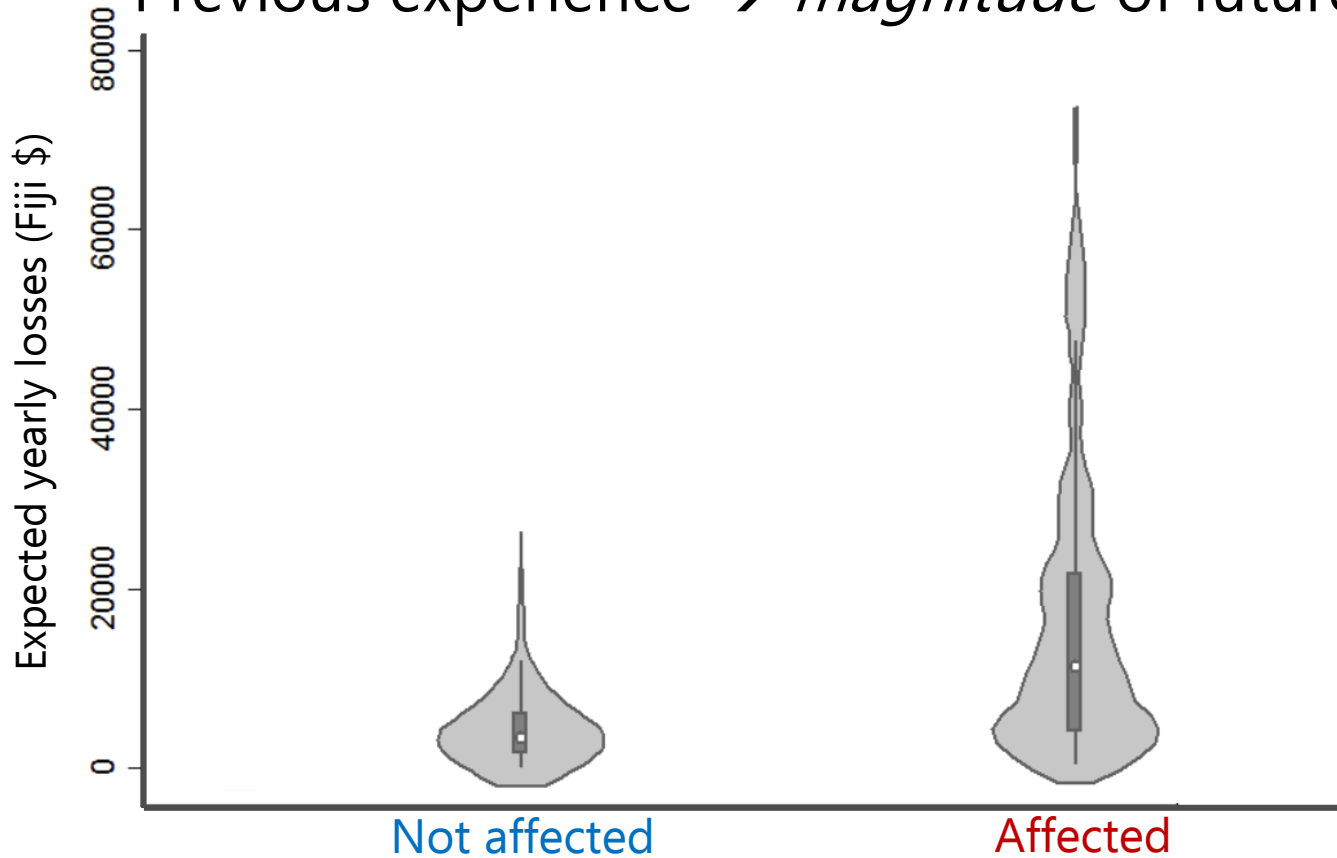


Source: Munich RE (2015)

Future expectations of disaster risk



Previous experience → *magnitude* of future disasters





Future expectations of disaster risk

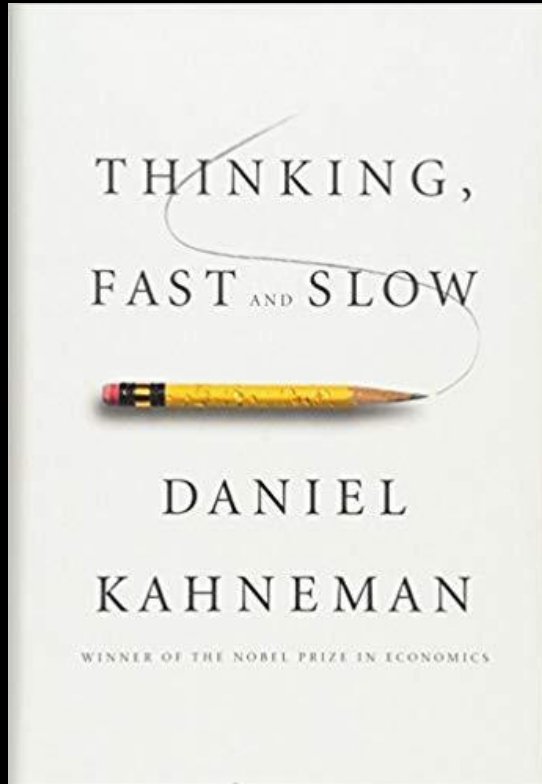
Previous experience → *frequency* of future disasters

- Flooding (Botzen et al. 2009)
- Avalanches (Letier 2011)
- Earthquakes (Kung and Chen 2012)
- Landslides (Lin et al. 2008)
- Hurricanes (Peacock et al. 2005)
- Cyclones (Brown et al. 2018)

Future expectations of disaster risk



Availability heuristic (Tversky and Kahneman 1974)

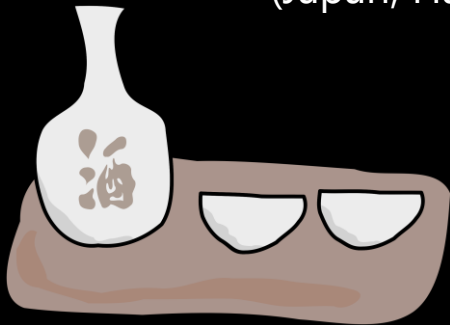




Future expectations of disaster risk

Previous experience → *behavioural changes*

- Higher price premiums on houses not in floodplains after floods (US, Kousky 2010; Atreya et al. 2013)
- Exposure to floods prompts better drainage, higher insurance uptake (Lower Hutt, Lawrence et al. 2014)
- Earthquakes lead to higher smoking, drinking, & gambling (Japan, Hanaoka et al. 2015)

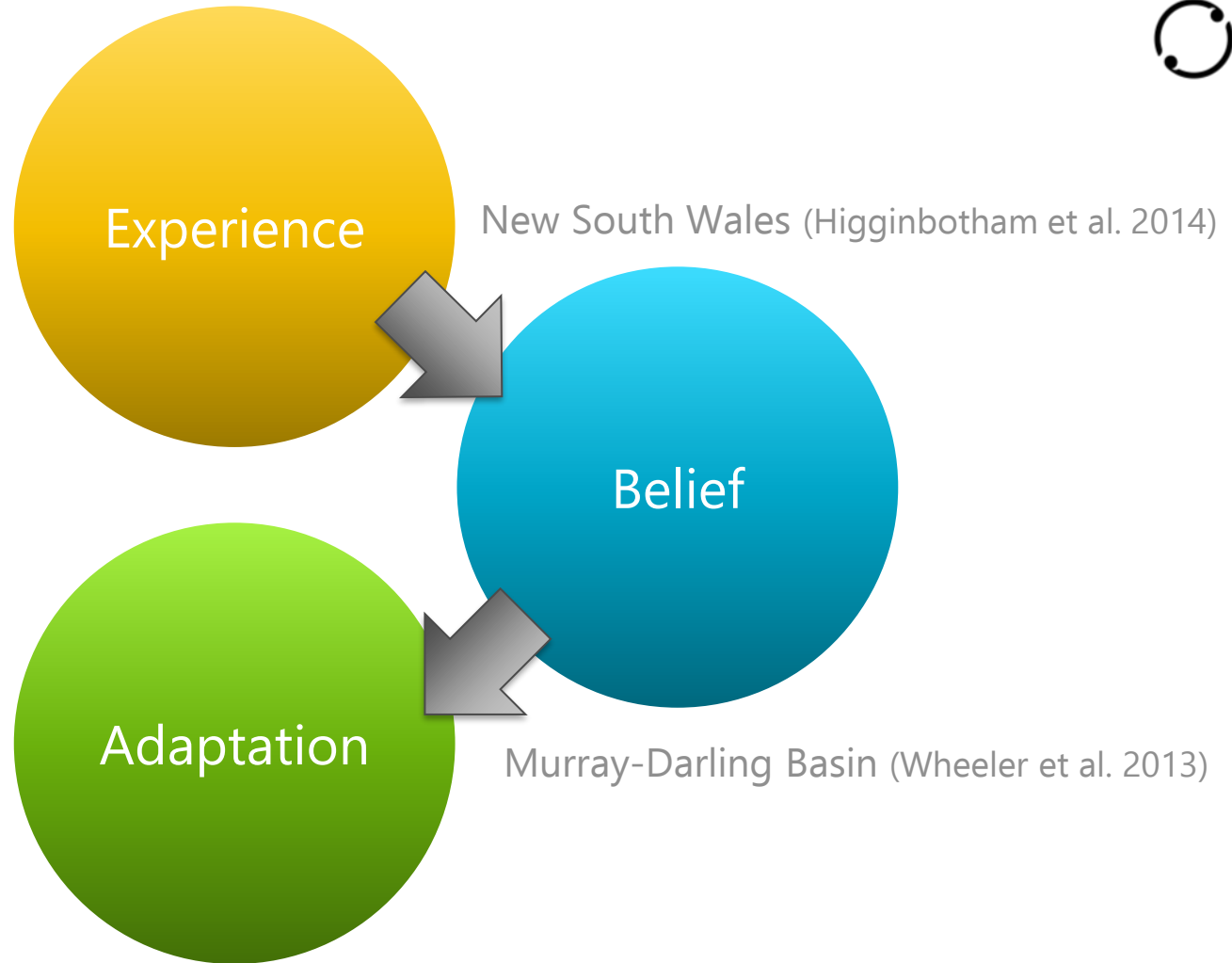


Future expectations of ~~disaster risk~~ *climate change*



- Extreme weather events
 - Precipitation (Thomas et al. 2007)
- Demographics
 - Well-educated, female (Hornsey et al. 2016)
- Values / ideology
 - Liberal political views (Hamilton & Stampone 2013)
- Concern for effects (Leiserowitz 2006)
- Normal variability in weather
 - Temperatures on the day that a survey is conducted (Lorenzoni & Pidgeon 2006)

Adaptation





Drought intensity, future expectations, & climate-change adaptation

Pamela Booth

Pike Brown

Patrick Walsh

Does recent experience
with drought matter?

Do demographics, values, etc.
affect farmers' expectations of
future drought in NZ?

Does the
intensity of
the drought
matter?

What is the time frame
of reference when
considering intensity?

Do expectations of future
drought affect land use
planning?



Waikato farmers prepare for potentially worse drought than 2008



From **Morning Report**, 8:09 am on 6 March 2013

Drought intensity

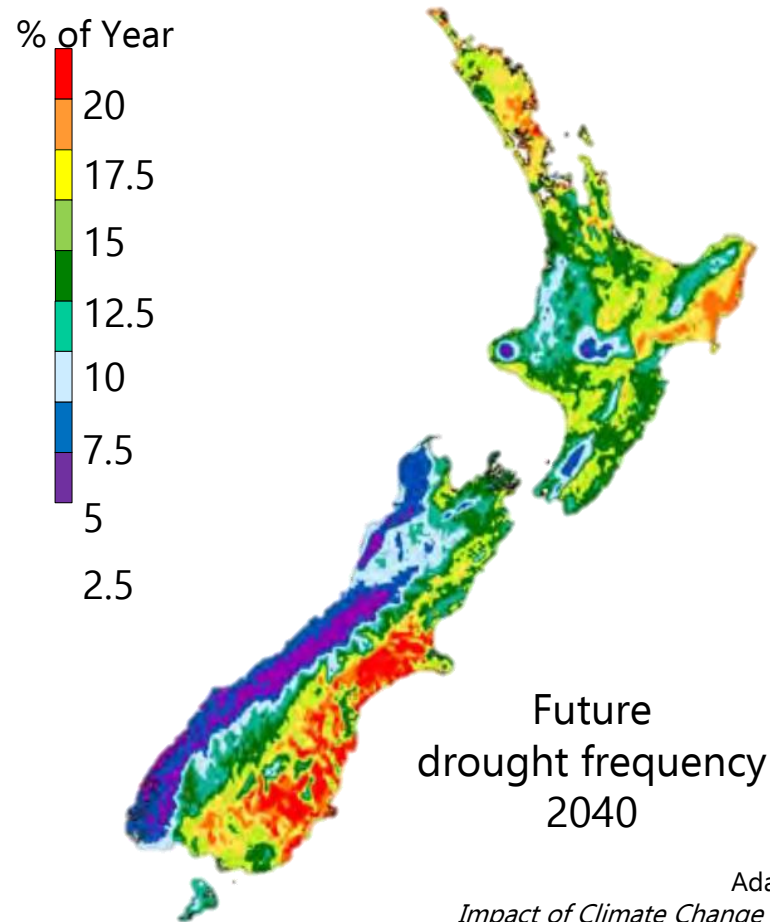
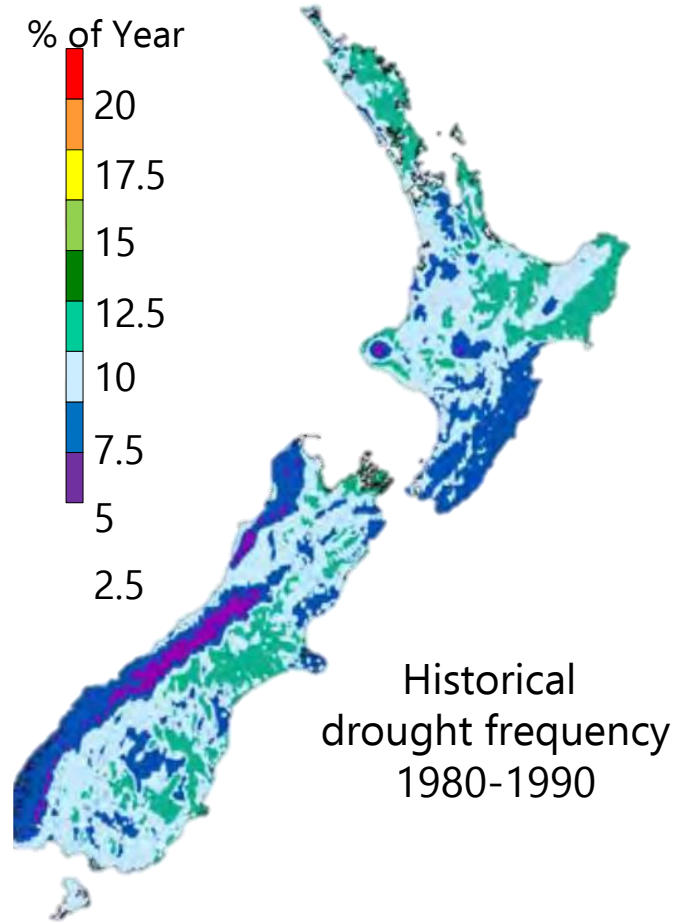
Drought intensity

- Potential Evapotranspiration Deficit (PED)
 - Millimetres of water needed to supplement current precipitation to maintain vegetation growth under no water scarcity
- Spatially and temporally explicit
 - 17 climate stations
 - 67 years (1948-2015)
 - January – June





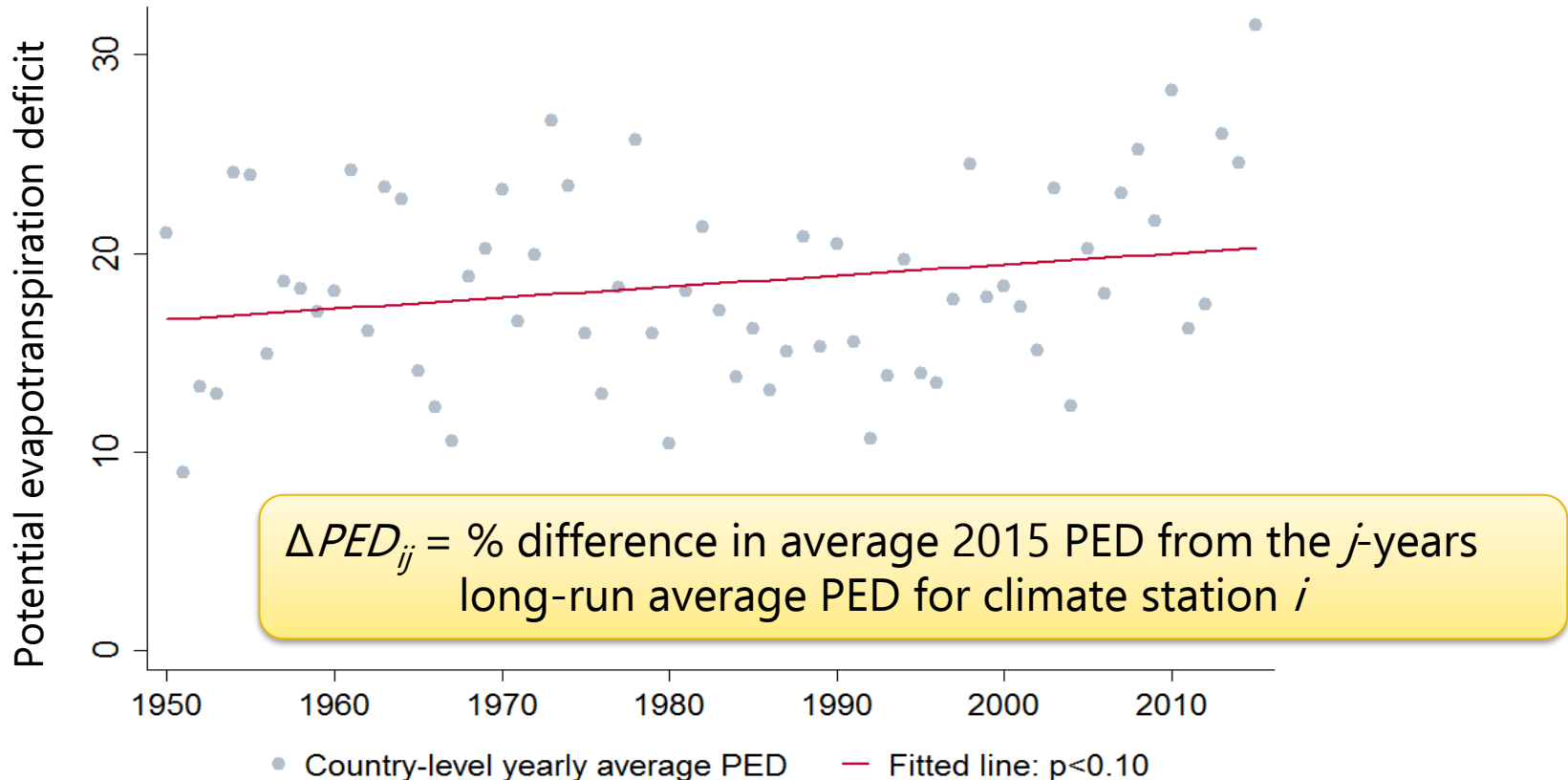
Drought intensity



Drought intensity



How to measure drought intensity with moving averages?





Rural Decision Makers SUR✓VEY2017

Ministry for Primary Industries
Manatū Ahu Matua



Ministry for the
Environment
Manatū Mō Te Taiao

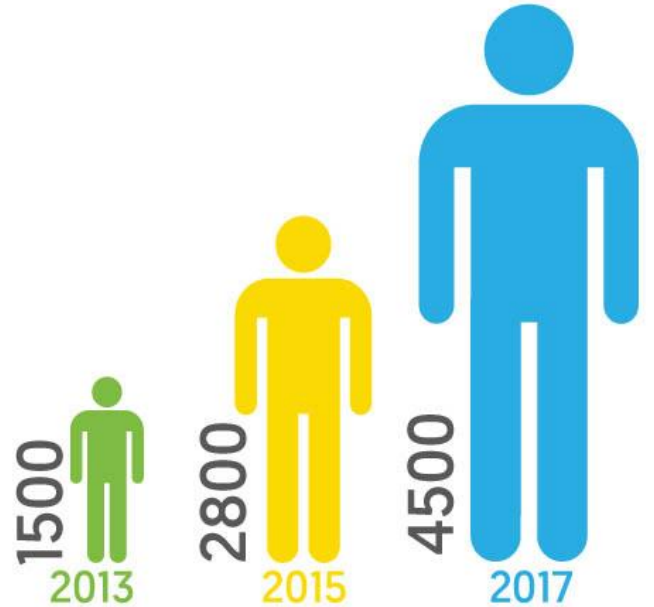


**MINISTRY OF BUSINESS,
INNOVATION & EMPLOYMENT**
HĪKINA WHAKATUTUKI



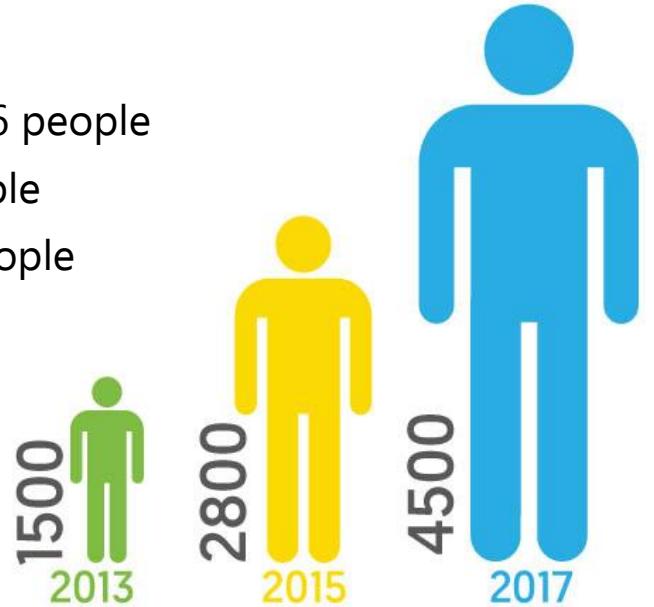
Survey Analytics

- SRDM 2013
 - 192 questions
 - 1,564 complete responses
 - 25 minutes completion time
- SRDM 2015
 - 288 questions
 - 2,834 complete responses
 - 27 minutes completion time
- SRDM 2017
 - 237 questions
 - 4,488 complete responses
 - 21 minutes completion time

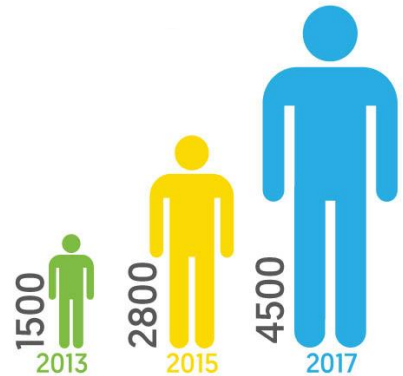
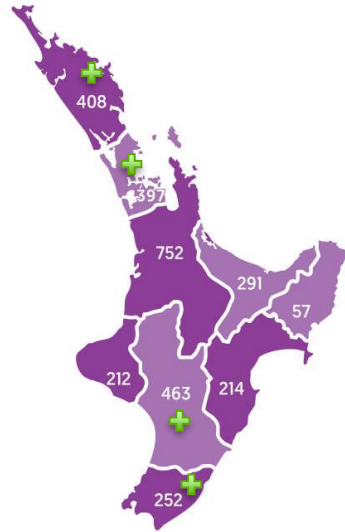
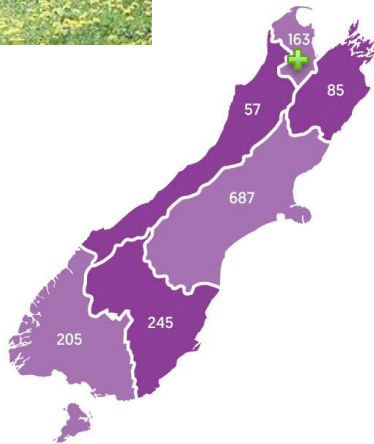
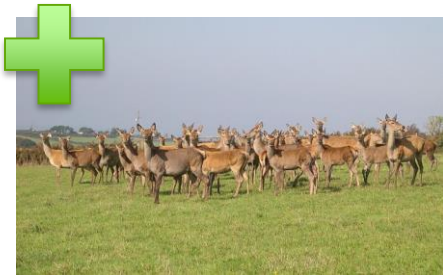


Survey Analytics

- Business Outlook Survey (ANZ) = 300-400 firms
- 2016-17 Economic Survey (Dairy NZ) = 429 herds
- 2016 NZ National Consumer Survey (MBIE) = 1,246 people
- 2016 NZ Mental Health Survey (HPA) = 1,300 people
- Consumer Confidence Index (Westpac) = 1,556 people
- Public Perceptions on NZ's Environment (Lincoln) = 2,468 households
- 2016 General Social Survey (Stats NZ) = 8,000 people
- NZ Attitudes and Values Survey (Auckland) = 13,000 people



Survey Analytics



Questionnaire

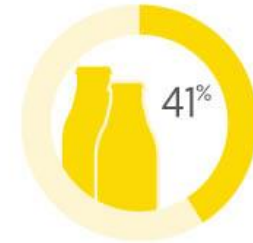
- **Ownership and structure**
- **Land use, land-use change**
- **Livestock, forestry practice**
- **Water and irrigation**
- **Management practices**
- **Technology adoption**
- **Climate change**
- **Vertebrate, plant pests**
- **Networks, farming support**
- **Values, norms, risk tolerance**
- **Farming objectives, profitability**
- **Labour / employment**
- **Demographics, education**
- **Community participation**
- **Opportunities, challenges**
- **Future planning**

Land-Use Change

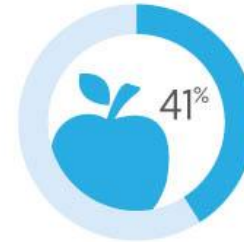
additional land allocation/intensification



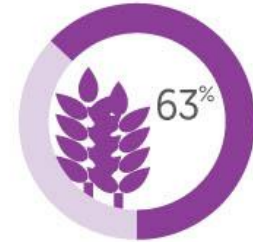
Sheep & Beef



Dairy



Horticulture



Arable

Share of farmers who have allocated additional land to existing activities and/or intensified operations in the last 10 years

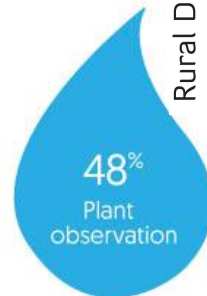
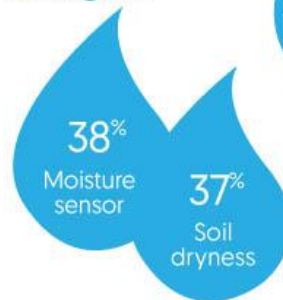
Questionnaire

- Ownership and structure
- Land use, land-use change
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Irrigation



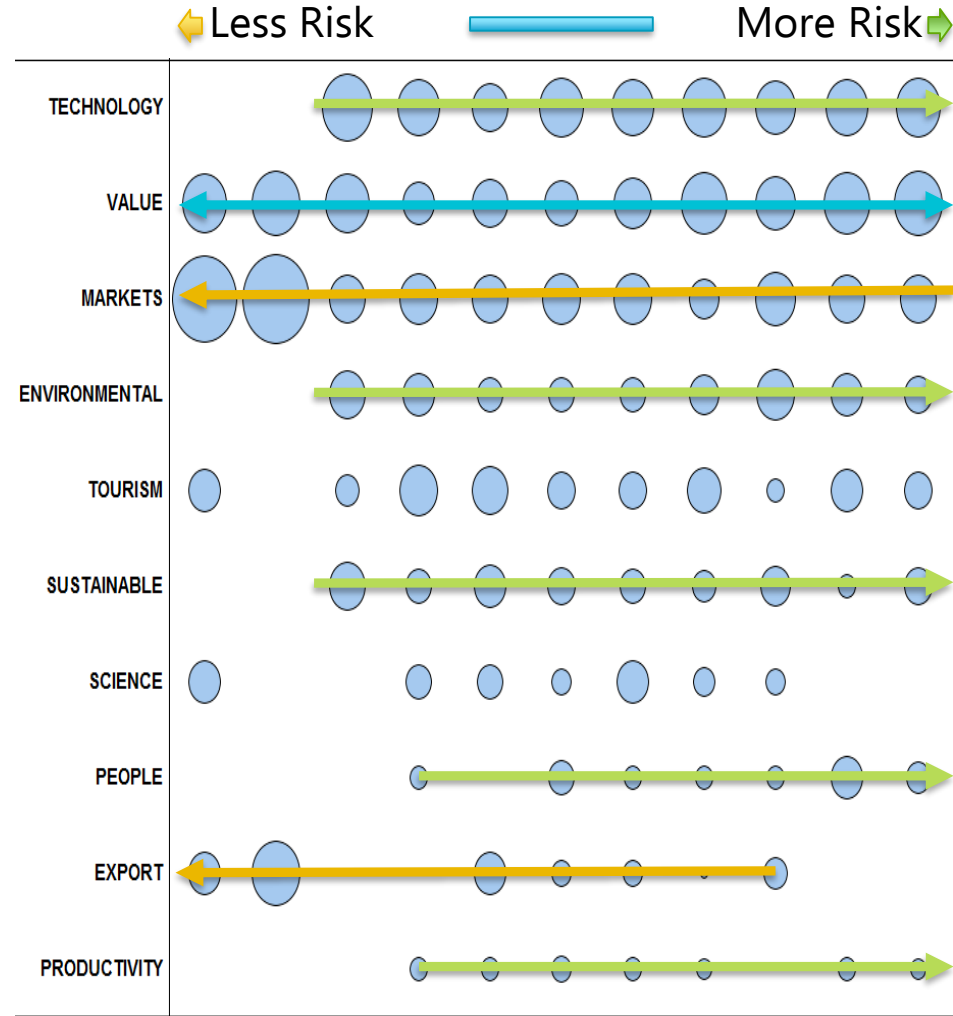
preferred methods for DECIDING WHEN to irrigate



54% CALIBRATE IRRIGATION by collecting water in buckets

Questionnaire

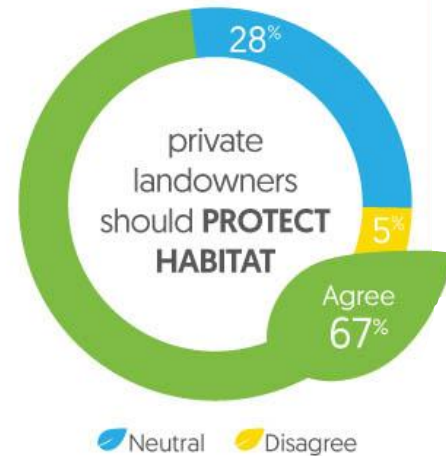
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Questionnaire

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Habitat Conservation Values

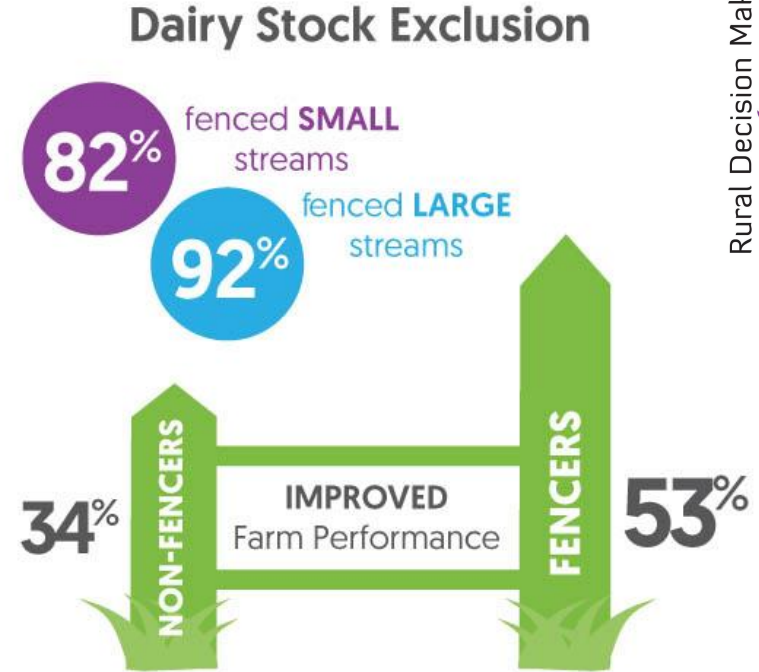


Women
Māori
University graduates
North Islanders
Self-perceived risk takers
1st & 2nd generation farmers
Non-owner operators
Aged 60+
Lifestyle farmers

The respondent groups listed are statistically more likely to believe the private landowners should protect habitat for conservation of native species.

Questionnaire

- Ownership and structure
- Land use, land-use change
- Livestock, forestry practice
- Water and irrigation
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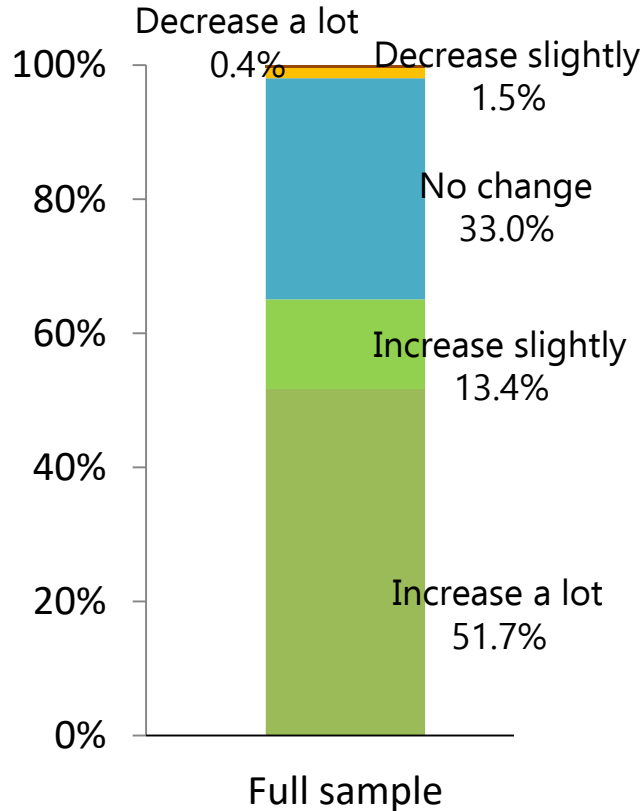
More farmers who fenced their streams reported a positive effect on farm performance than the expected effects estimated by those who had not fenced their streams.



Future expectations

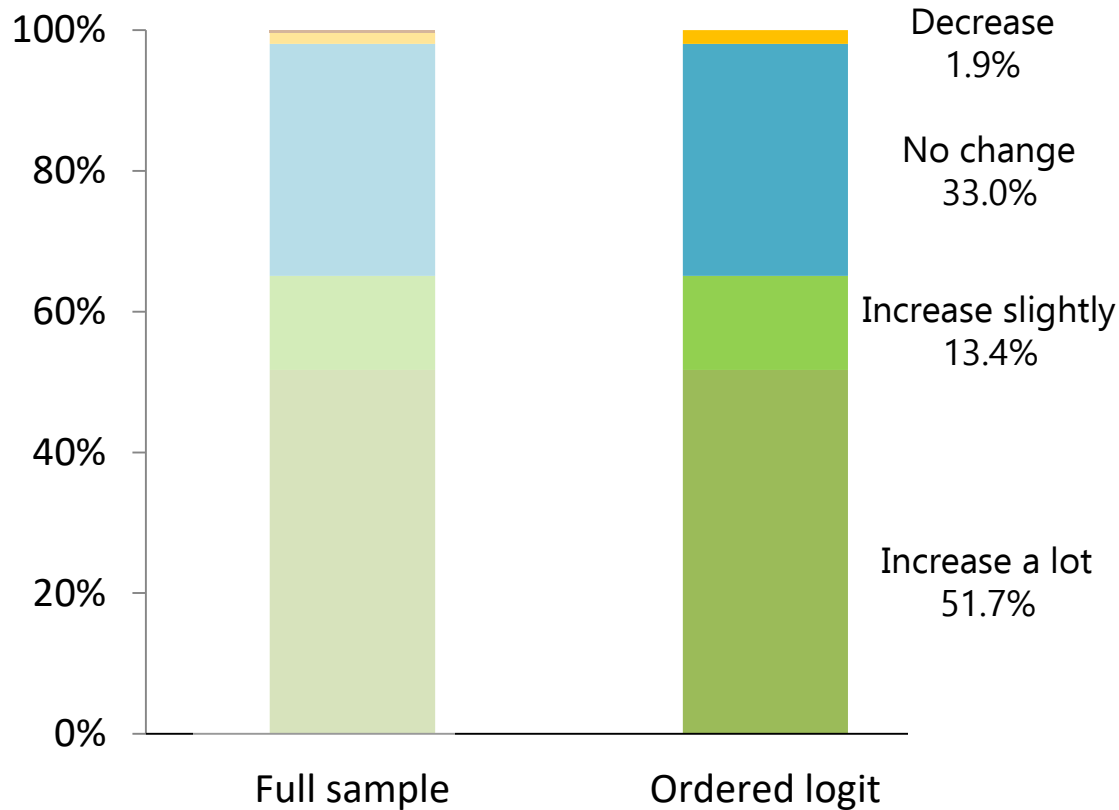


Which of the following best describes how you personally expect the prevalence of drought in to change by 2050?



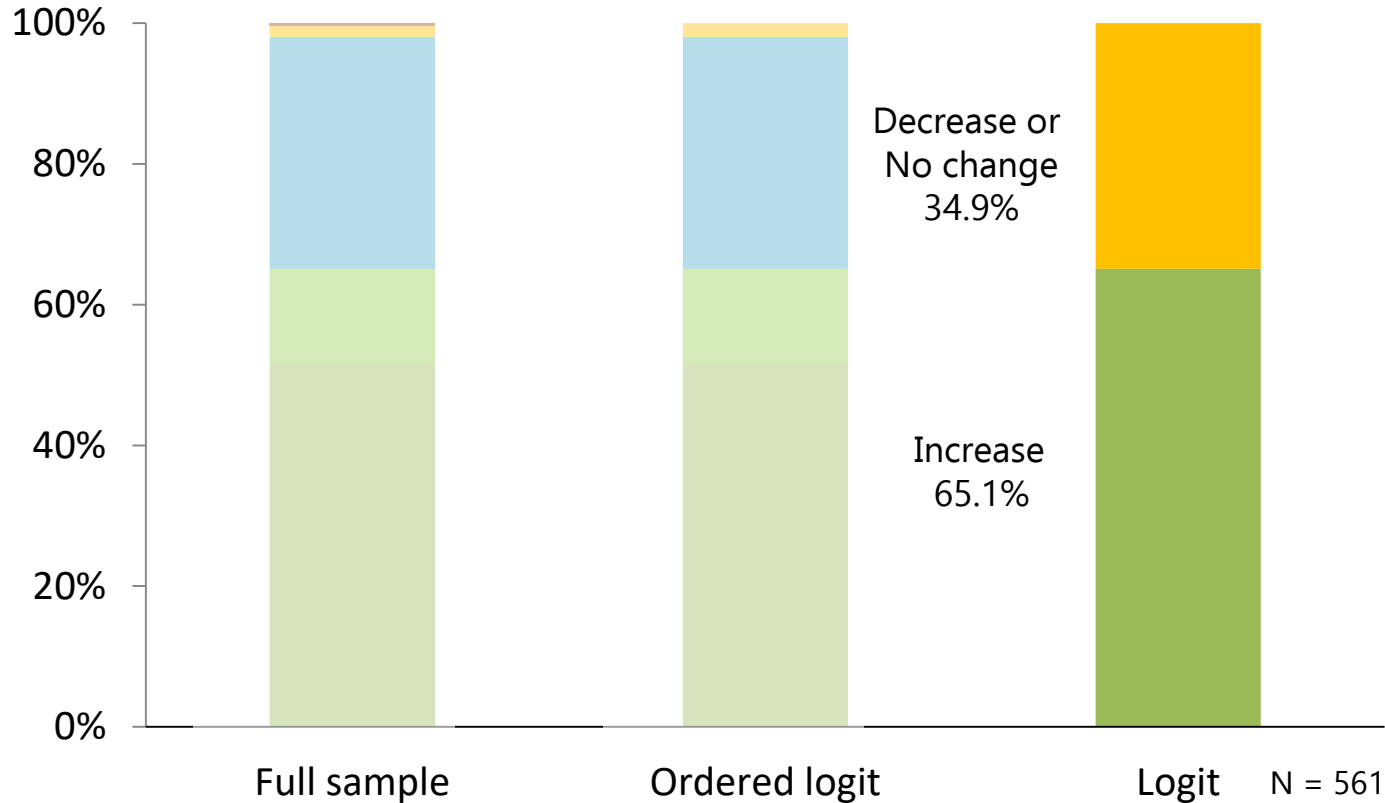
N = 561

Which of the following best describes how you personally expect the prevalence of drought in to change by 2050?



N = 561

Which of the following best describes how you personally expect the prevalence of drought in to change by 2050?



Average Marginal Effects from Logit Regression

Independent Variables	Dependent Variable: Expect the prevalence of drought to increase = 1			
	(1)	(2)	(3)	(4)
Age (years)	0.00312 (0.00213)			
★ Male (=1)	-0.170*** (0.0318)			
★ Bachelors degree or more (=1)	0.0927** (0.0427)			
★ Farming for 6 generations or more (=1)	-0.145*** (0.0425)			
Maximum farming experience (years after age 18)	-0.00233 (0.00188)			

Observations

561

Average Marginal Effects from Logit Regression

Independent Variables	Dependent Variable: Expect the prevalence of drought to increase = 1			
	(1)	(2)	(3)	(4)
Age (years)	0.00312 (0.00213)	0.00280 (0.00203)		
★ Male (=1)	-0.170*** (0.0318)	-0.157*** (0.0335)		
★ Bachelors degree or more (=1)	0.0927** (0.0427)	0.0894** (0.0414)		
★ Farming for 6 generations or more (=1)	-0.145*** (0.0425)	-0.139*** (0.0456)		
Maximum farming experience (years after age 18)	-0.00233 (0.00188)	-0.00208 (0.00175)		
★ Agreement: habitat on public land should be protected		0.0169* (0.0102)		
Agreement: habitat on private land should be protected		0.00573 (0.0112)		
★ Agreement: right to hunt on public land		-0.0133* (0.00735)		
★ I would reduce farm output if I could maintain same level of profit		0.0107* (0.00623)		
Observations	561	561		

Average Marginal Effects from Logit Regression

Independent Variables	Dependent Variable: Expect the prevalence of drought to increase = 1			
	(1)	(2)	(3)	(4)
Age (years)	0.00312 (0.00213)	0.00280 (0.00203)	0.00208 (0.00213)	
★ Male (=1)	-0.170*** (0.0318)	-0.157*** (0.0335)	-0.146*** (0.0318)	
★ Bachelors degree or more (=1)	0.0927** (0.0427)	0.0894** (0.0414)	0.0919** (0.0403)	
★ Farming for 6 generations or more (=1)	-0.145*** (0.0425)	-0.139*** (0.0456)	-0.146*** (0.0456)	
Maximum farming experience (years after age 18)	-0.00233 (0.00188)	-0.00208 (0.00175)	-0.00140 (0.00192)	
★ Agreement: habitat on public land should be protected		0.0169* (0.0102)	0.0171 (0.0111)	
Agreement: habitat on private land should be protected		0.00573 (0.0112)	0.00559 (0.0116)	
★ Agreement: right to hunt on public land		-0.0133* (0.00735)	-0.0142** (0.00713)	
★ I would reduce farm output if I could maintain same level of profit		0.0107* (0.00623)	0.00965* (0.00556)	
★ Farm is profitable (=1)			-0.0963** (0.0391)	
Observations	561	561	561	

Average Marginal Effects from Logit Regression

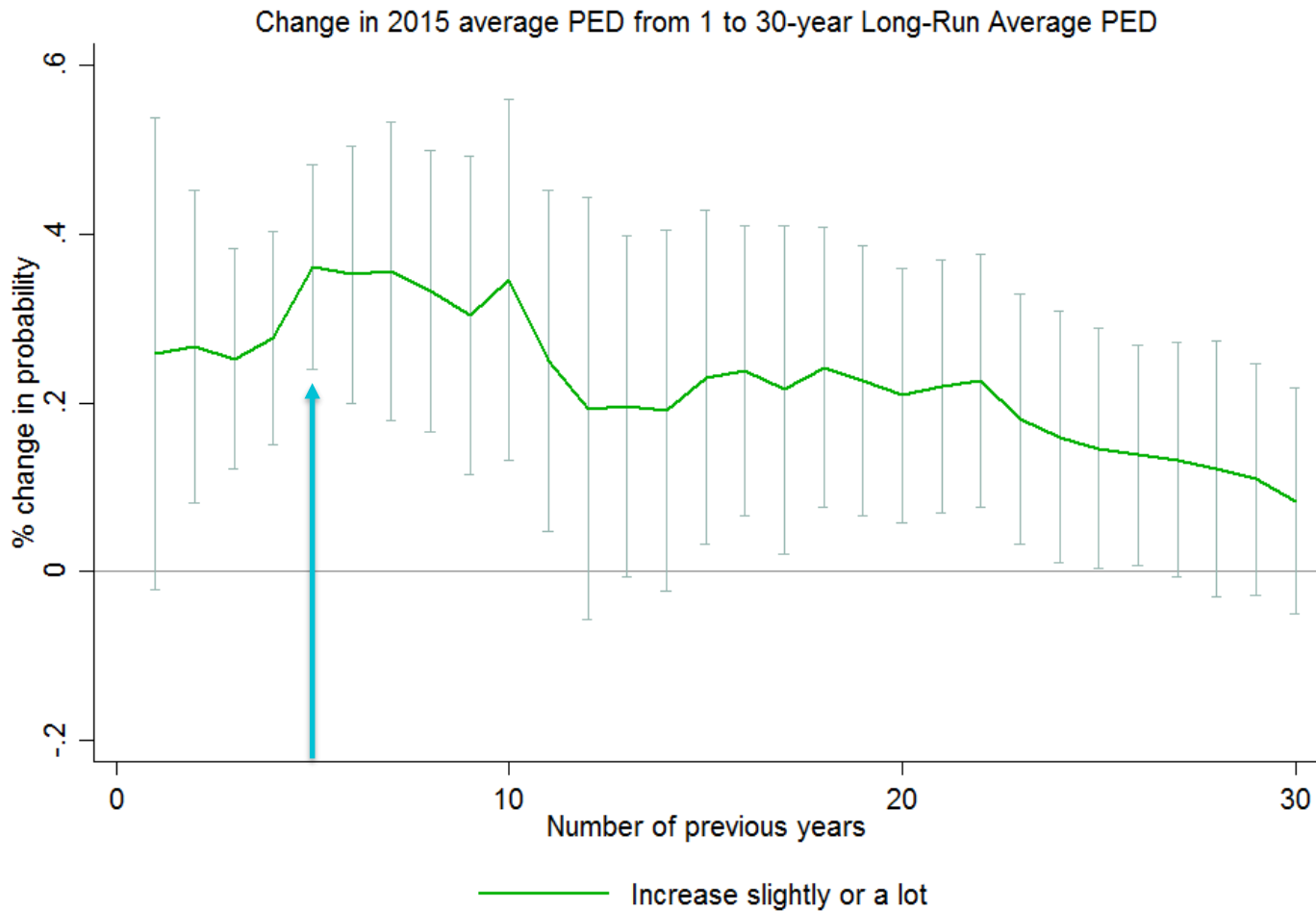
Independent Variables	Dependent Variable: Expect the prevalence of drought to increase = 1			
	(1)	(2)	(3)	(4)
Age (years)	0.00312 (0.00213)	0.00280 (0.00203)	0.00208 (0.00213)	0.00163 (0.00183)
★ Male (=1)	-0.170*** (0.0318)	-0.157*** (0.0335)	-0.146*** (0.0318)	-0.164*** (0.0342)
★ Bachelors degree or more (=1)	0.0927** (0.0427)	0.0894** (0.0414)	0.0919** (0.0403)	0.0881** (0.0392)
★ Farming for 6 generations or more (=1)	-0.145*** (0.0425)	-0.139*** (0.0456)	-0.146*** (0.0456)	-0.146*** (0.0460)
Maximum farming experience (years after age 18)	-0.00233 (0.00188)	-0.00208 (0.00175)	-0.00140 (0.00192)	-0.00115 (0.00187)
★ Agreement: habitat on public land should be protected		0.0169* (0.0102)	0.0171 (0.0111)	0.0181* (0.0100)
Agreement: habitat on private land should be protected		0.00573 (0.0112)	0.00559 (0.0116)	0.00478 (0.0110)
★ Agreement: right to hunt on public land		-0.0133* (0.00735)	-0.0142** (0.00713)	-0.0153** (0.00758)
★ I would reduce farm output if I could maintain same level of profit		0.0107* (0.00623)	0.00965* (0.00556)	0.00889 (0.00607)
★ Farm is profitable (=1)			-0.0963** (0.0391)	-0.101*** (0.0357)
10-year long-run average PED standard deviation				0.00289 (0.00420)
★ Percent difference of 2015 average PED from previous 5-years average PED				0.00361*** (0.000619)
Observations	561	561	561	561

Do demographics, values, etc. affect farmers' expectations of future drought in NZ?

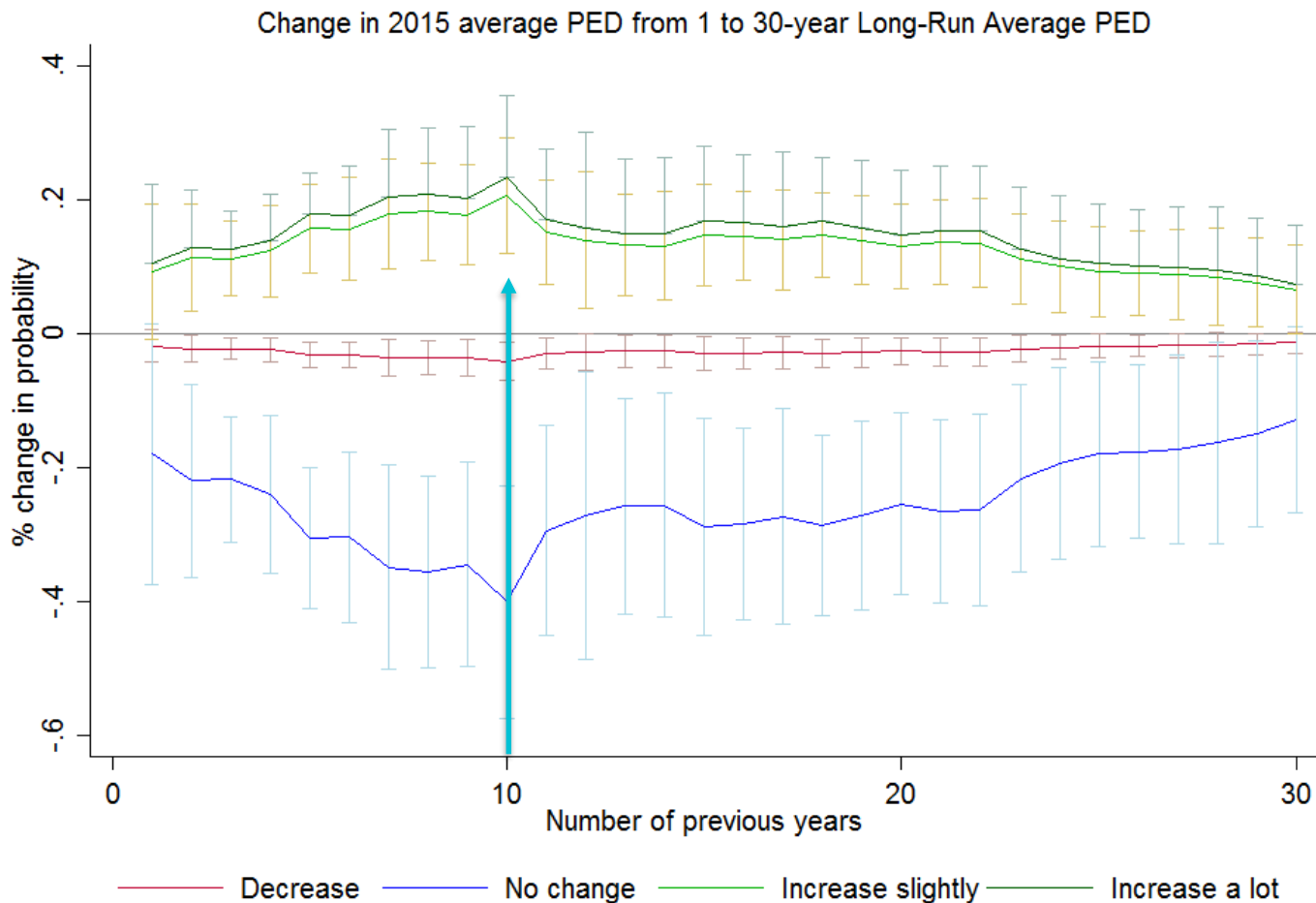
Does recent experience with drought matter?

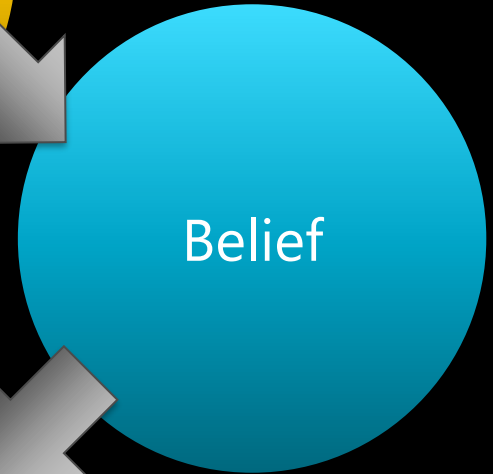
Does the intensity of the drought matter?

What is the time frame of reference when considering intensity?



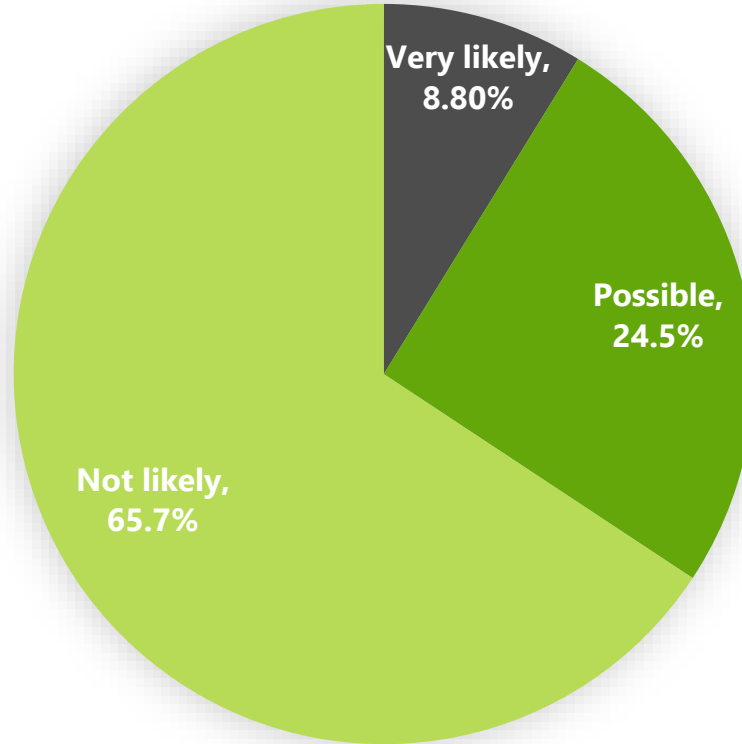
Ordered logit





Climate-change adaptation

How likely do you think you are to convert land to new uses in the next 2 years?



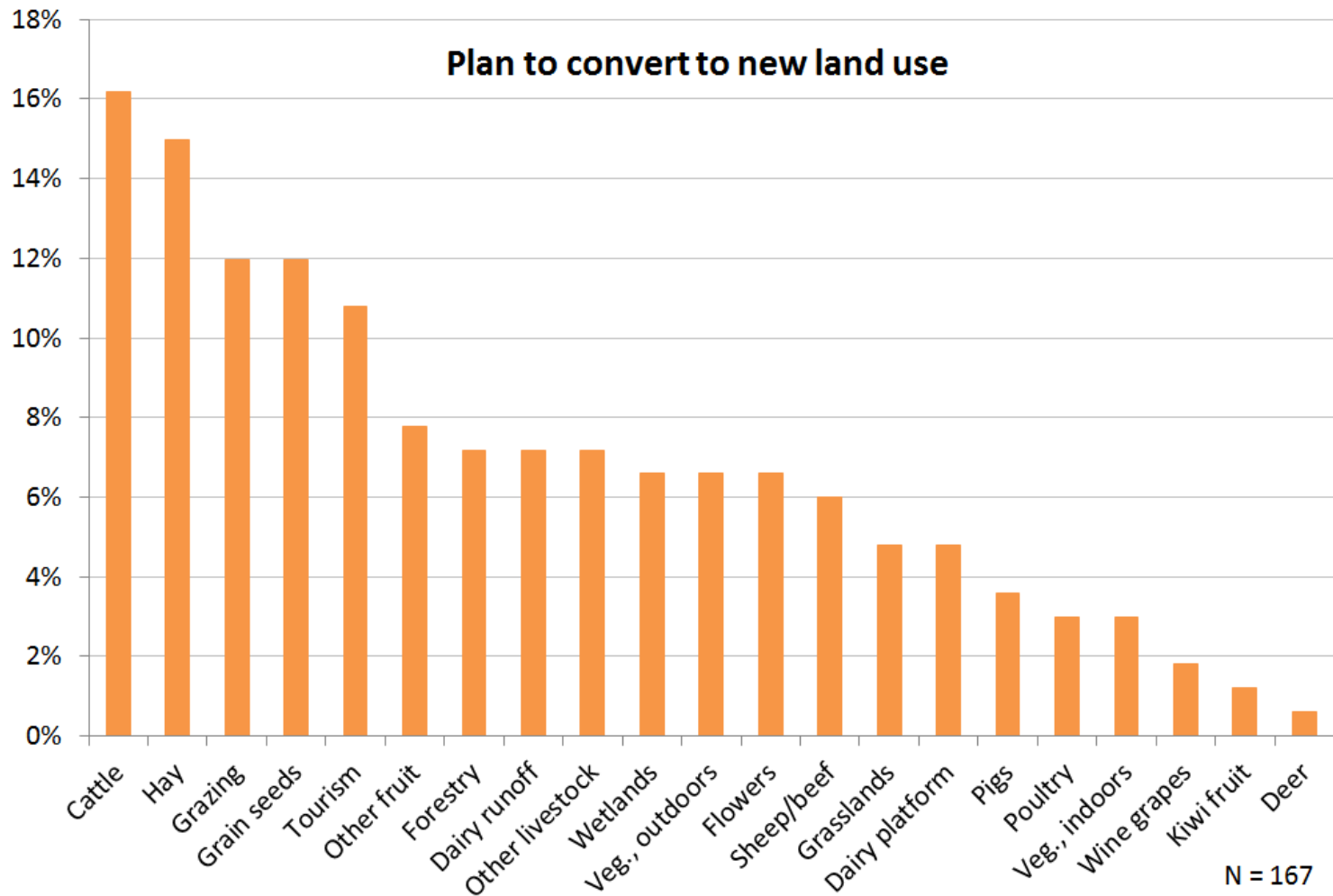
Average Marginal Effects of Likelihood of Future Land-Use Change

Independent Variables	Dependent variable: Likelihood of converting to new land use within next 2 years		
	Not likely	Possible	Very likely
★ Age (years)	0.00963*** (0.00223)	-0.00607*** (0.00153)	-0.00357*** (0.00108)
★ Male (=1)	-0.08988* (0.0499)	0.05826 (0.03787)	0.03162** (0.01302)
Bachelor's degree or more (=1)	-0.01097 (0.03375)	0.0069 (0.02148)	0.00406 (0.0123)
Farming for 6 generations or more (=1)	-0.02414 (0.0538)	0.01498 (0.03235)	0.00915 (0.02155)
Maximum farming experience (years)	-0.00132 (0.00161)	0.00083 (0.00101)	0.00049 (0.00061)
★ Agreement: habitat on public land should be protected	0.01794* (0.01073)	-0.0113 (0.00711)	-0.00664* (0.00392)
★ Agreement: habitat on private land should be protected	-0.02001*** (0.00761)	0.0126** (0.00517)	0.0074** (0.00297)
Agreement: right to hunt on public land	-0.00073 (0.00919)	0.00046 (0.00582)	0.00027 (0.00337)
I would reduce farm output if I could maintain same level of profit.	0.00652 (0.00689)	-0.00411 (0.00465)	-0.00241 (0.00229)
Farm is profitable (=1)	-0.01765 (0.03149)	0.01112 (0.02035)	0.00653 (0.01123)
★ Currently lease land (=1)	-0.07428* (0.04194)	0.04605** (0.02141)	0.02823 (0.02094)
★ Drought prevalence will increase (=1)	-0.03523* (0.01799)	0.02234* (0.01189)	0.01289* (0.00679)

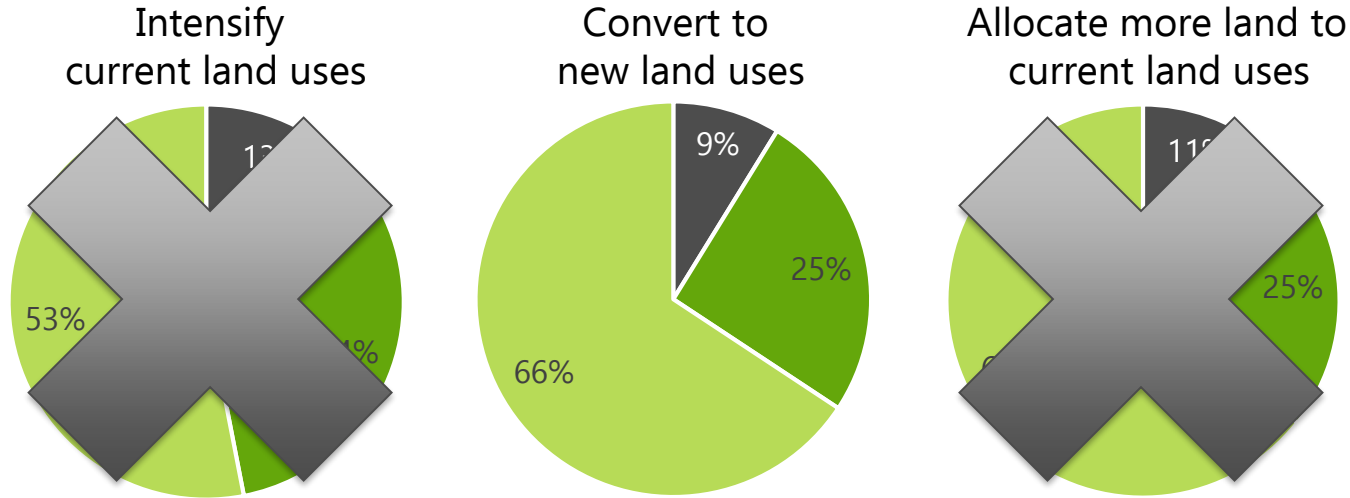
Observations

557





How likely do you think each of the following is to happen on your farm during the next 2 years?



- Very likely
- Possible
- Not very likely

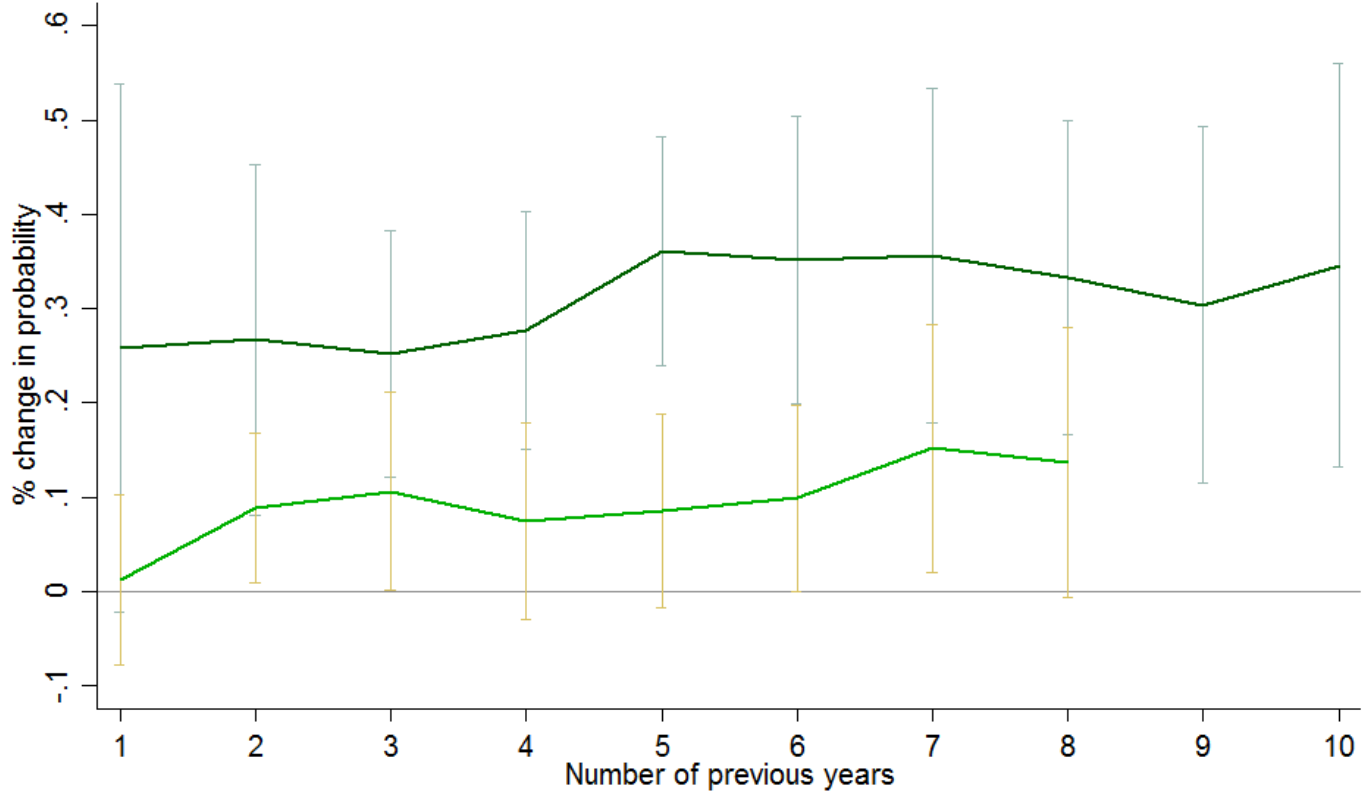
Robustness checks

District-level data

- 2007 to 2015 daily index for 66 districts
- Finding: Similar trend with smaller magnitudes.

District PED

Change in 2015 average from 1 to 8-year Long-Run Average



— Region level PED — District level PED
— 95% confidence interval — 95% confidence interval

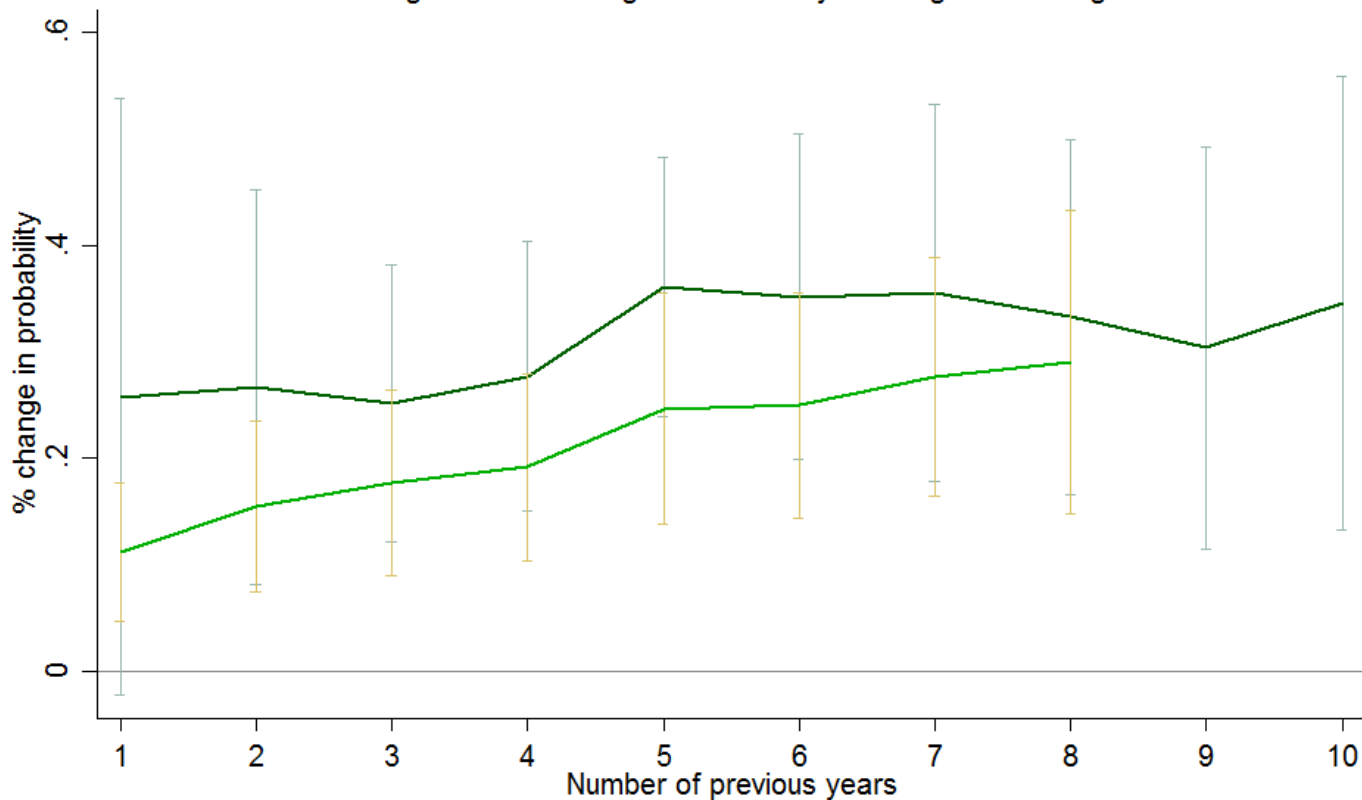
Robustness checks

More complete measure of drought

- Index of drought severity (NZDI)
- Finding: Drought intensity matters. How it is measured doesn't.

District NZDI

Change in 2015 average from 1 to 8-year Long-Run Average



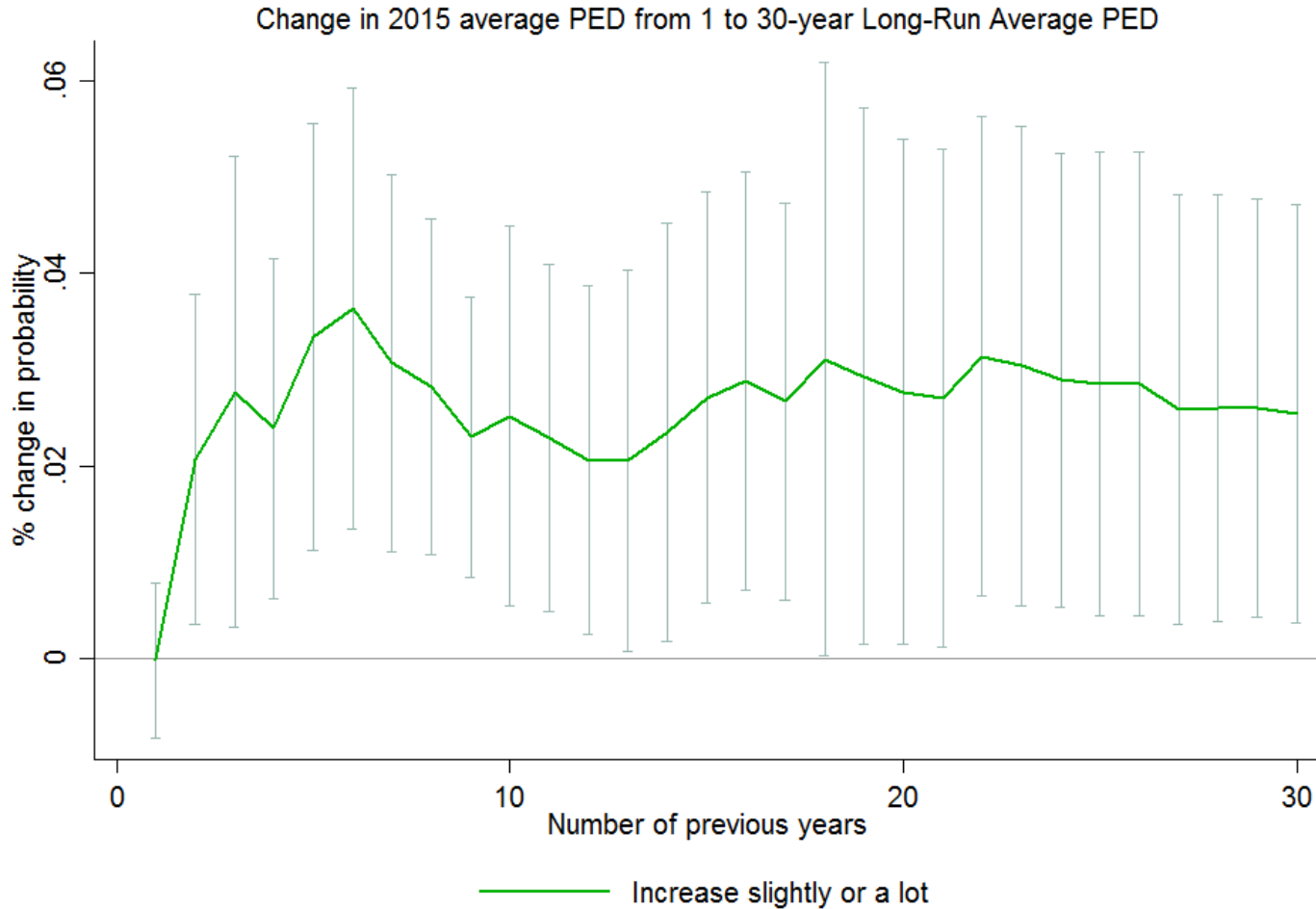
— Region level PED — District level NZDI
— 95% confidence interval — 95% confidence interval

Robustness checks

Six-month PED

- Re-define yearly average PED by 6-months prior to submission
- Finding: Peak at 6-years, magnitude 10% that of growing season.

PED from 6-months prior to the survey





Manaaki Whenua
Landcare Research

Drought intensity, future expectations, & climate-change adaptation

Pamela Booth

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Patrick Walsh

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Does the
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What is the time frame
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Questionnaire

- **Ownership and structure**
- **Land use, land-use change**
- **Livestock, forestry practice**
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Rural Decision Makers
SUR✓VEY2019



Winter 2019