Drought intensity, future expectations, & climate-change adaptation

Waikato farmers prepare for potentially worse drought than 2008

RNZ

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

Northland facing fifth drought in 7 years

The Northern Advocate

31 Jul, 2015 10:00am

Drought means big trouble for Kiwi farmers

NZFarmer.co.nz

MARTY SHARPE
Last updated 10:28, January 12 2015

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

NZFarmer.co.nz

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

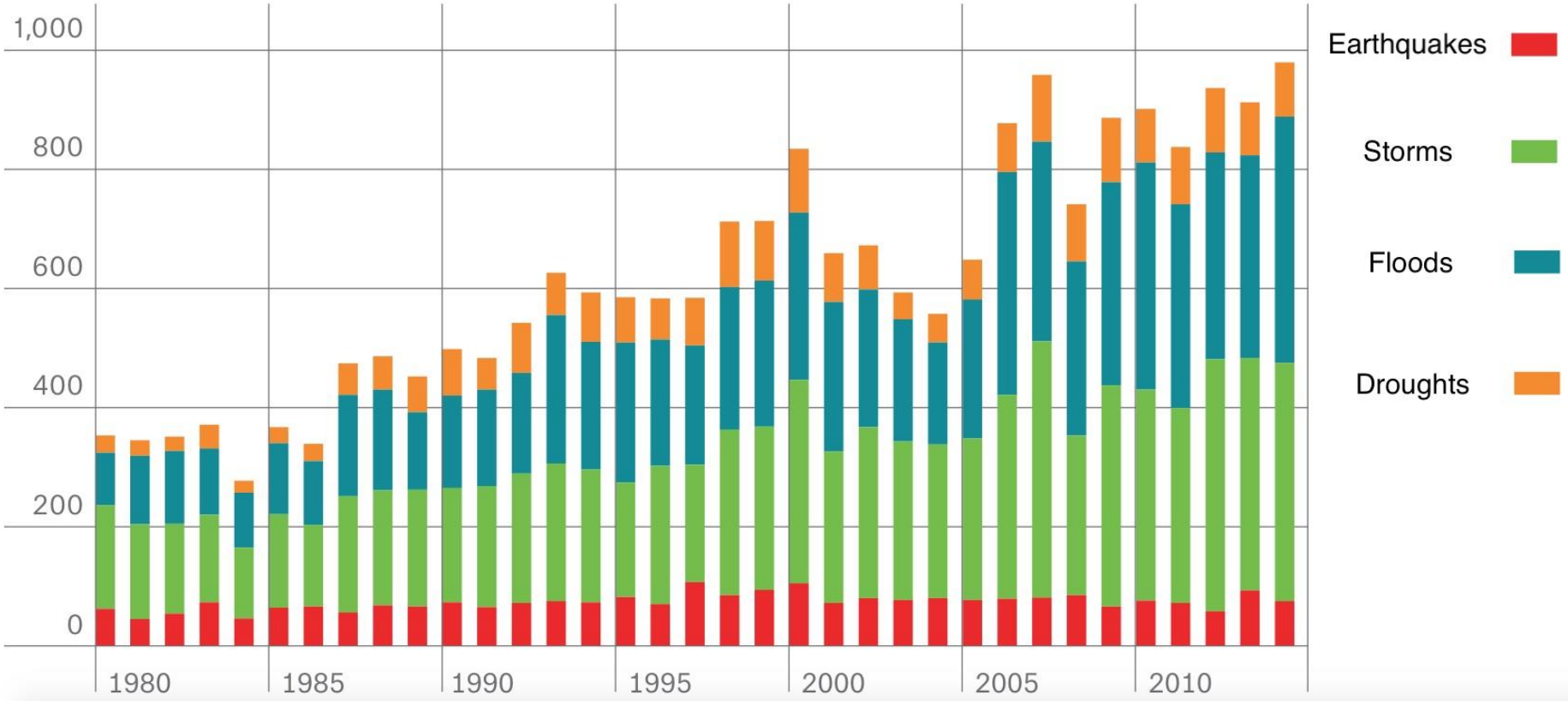
Newshub. July 31, 2018

Drought costs NZ $2.8 billion

Friday, 14 August 2009, 10:56 am

SCOOP Parliament

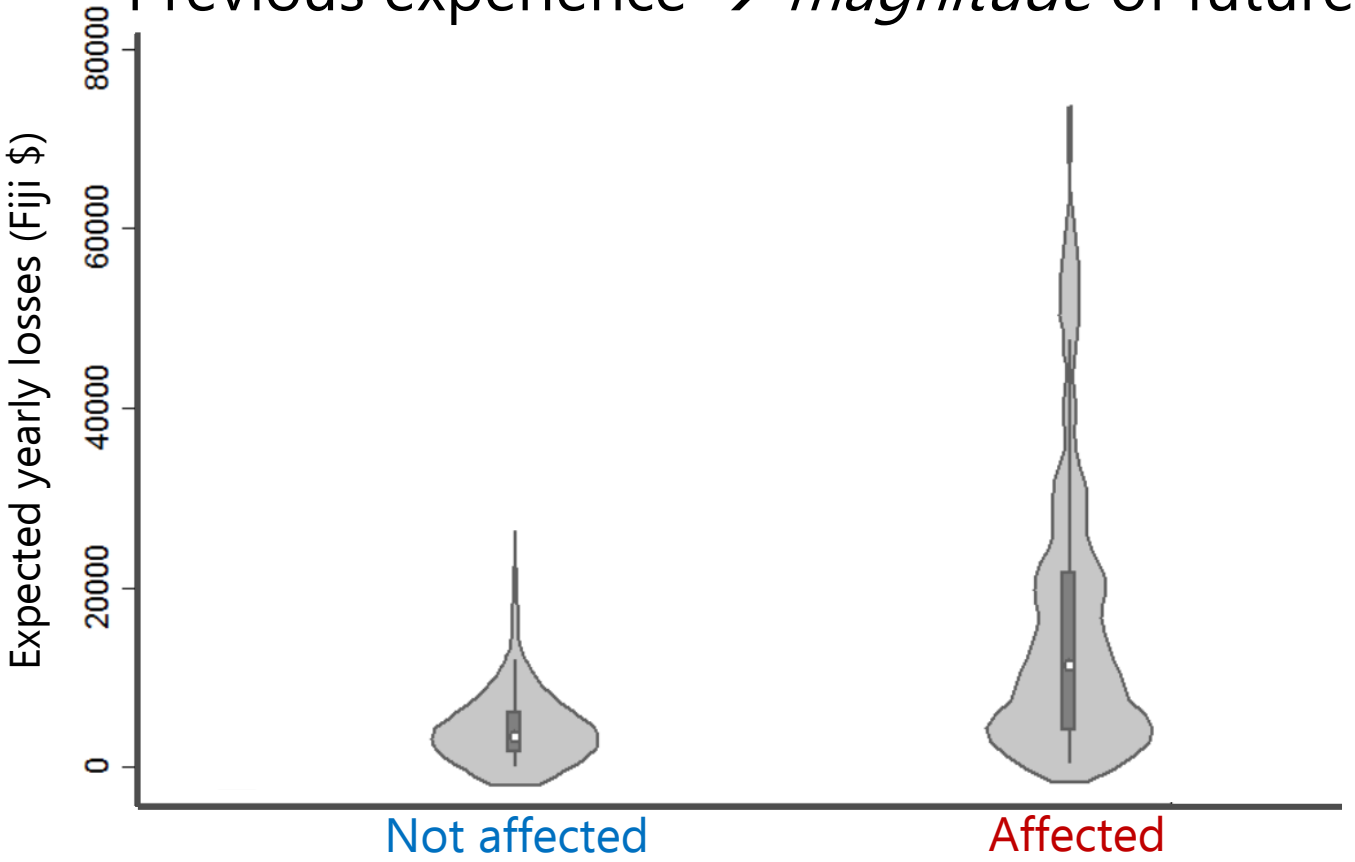
Drought intensity, future expectations, & climate-change adaptation



Source: Munich RE (2015)

Future expectations of disaster risk

Previous experience → *magnitude* of future disasters



Brown et al. (2018)

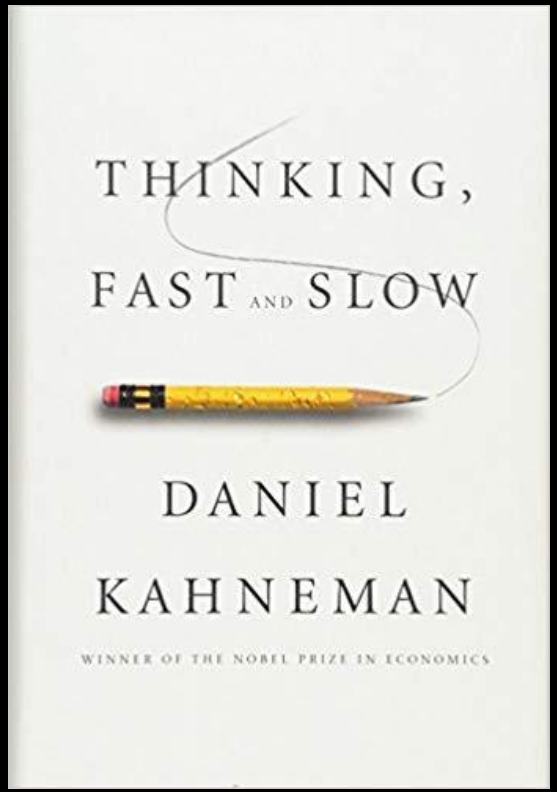
Future expectations of disaster risk

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

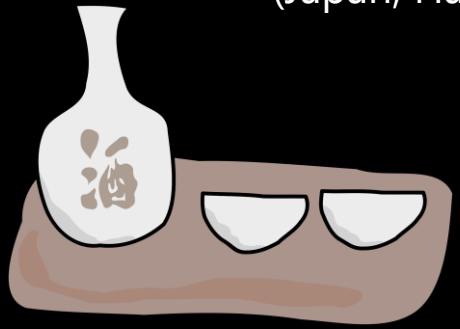
Availability heuristic (Tversky and Kahneman 1974)



Future expectations of disaster risk

Previous experience → *behavioural changes*

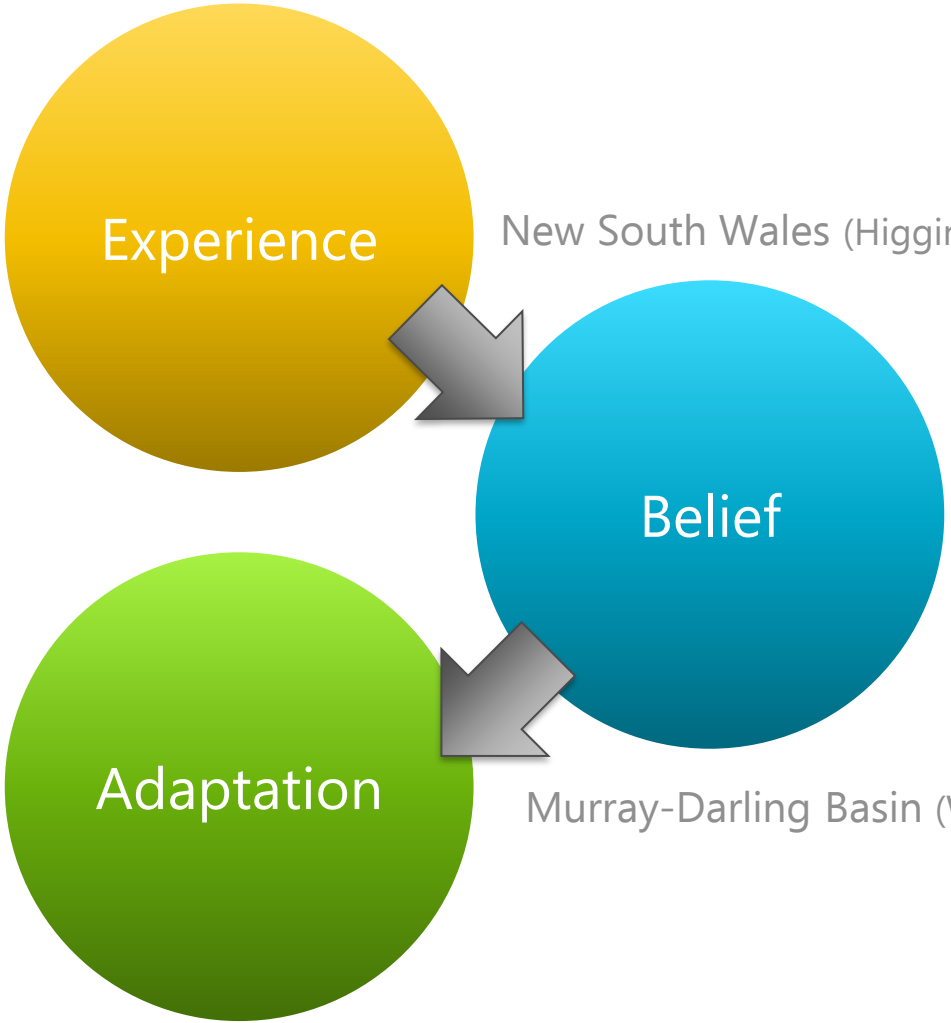
- Higher price premiums on houses not in floodplains after floods (US, Kousky 2010; Atreya et al. 2013)
- Exposure to floods prompts better drainage, higher insurance uptake (Lower Hutt, Lawrence et al. 2014)
- Earthquakes lead to higher smoking, drinking, & gambling (Japan, Hanaoka et al. 2015)



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



New South Wales (Higginbotham et al. 2014)

Murray-Darling Basin (Wheeler et al. 2013)

Manaaki Whenua
Landcare Research

Drought intensity, future expectations, & climate-change adaptation

Pamela Booth Pike Brown Patrick Walsh

Does recent experience with drought matter?

What is the time frame of reference when considering intensity?

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

Does the intensity of the drought matter?

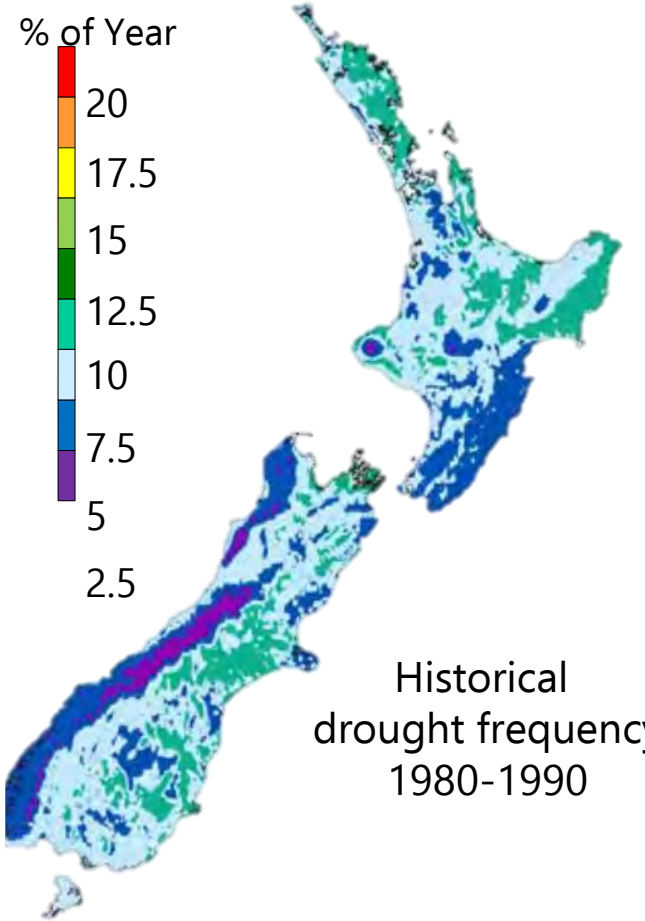
Do expectations of future drought affect land use planning?

Drought intensity

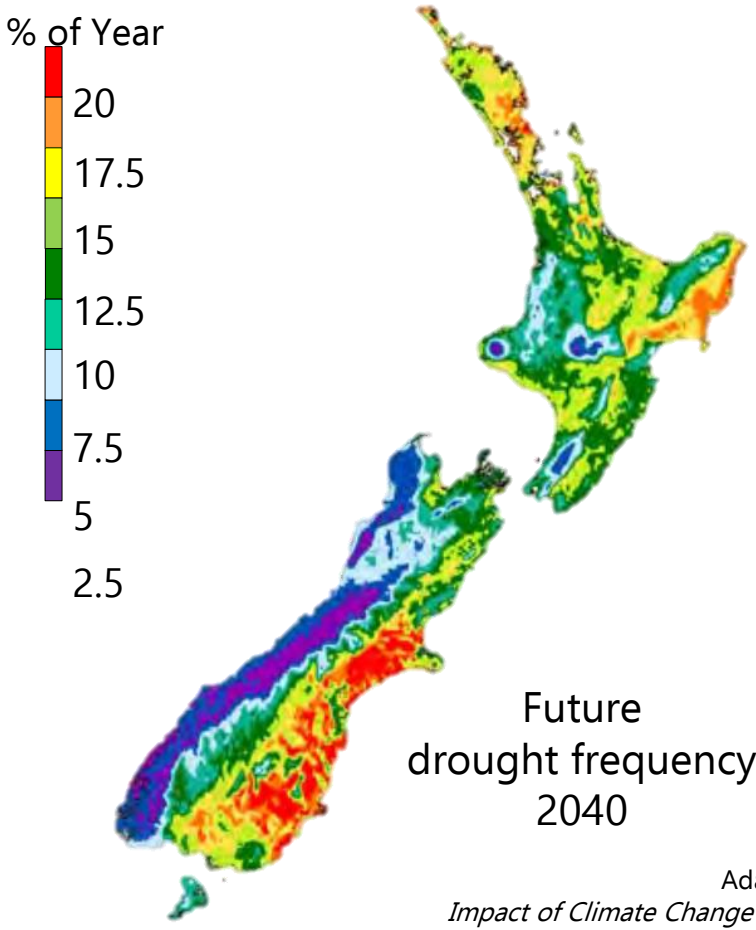
Drought intensity

- 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



Historical drought frequency 1980-1990

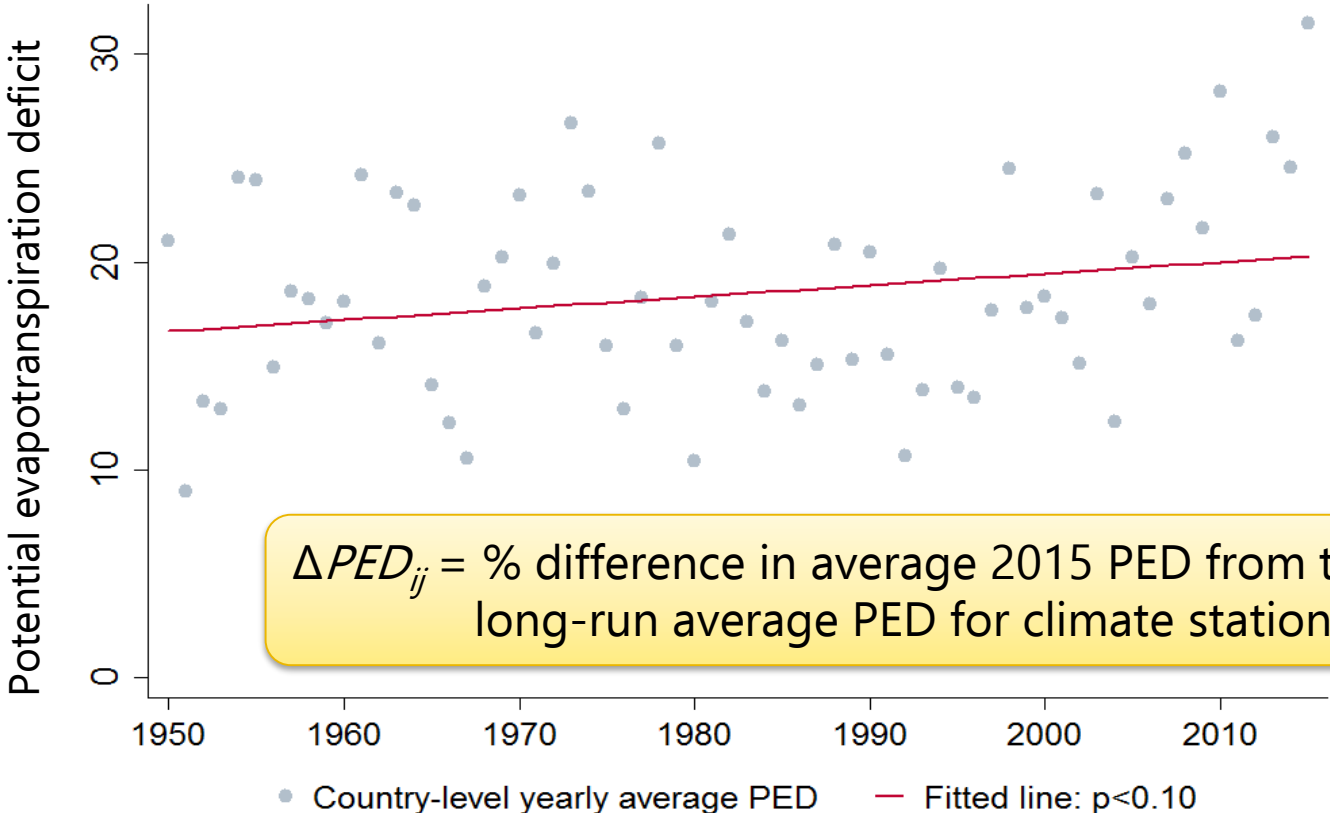


Future drought frequency 2040

Adapted from *Clark et al. 2012. Impact of Climate Change on Land-base Sectors. MPI.*

Drought intensity

How to measure drought intensity with moving averages?



ΔPED_{ij} = % difference in average 2015 PED from the *j*-years long-run average PED for climate station *i*

Rural Decision Makers SURVEY 2017

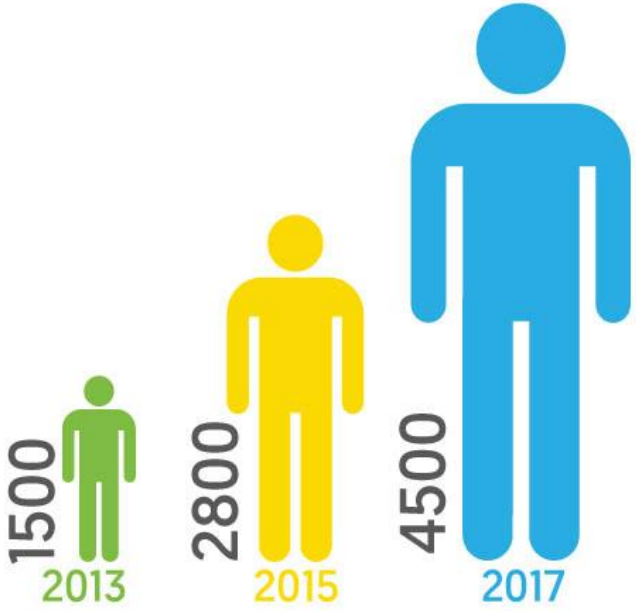
Ministry for Primary Industries
Manatū Ahu Matua

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



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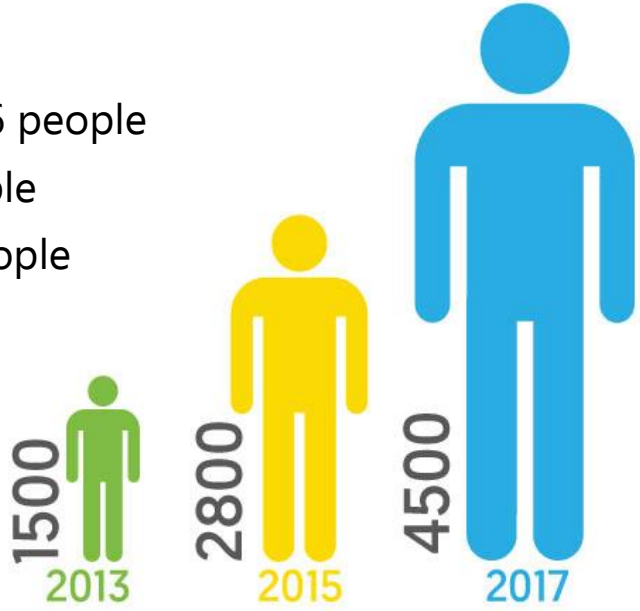
Survey Analytics

- 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



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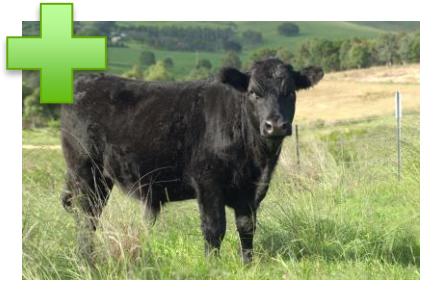
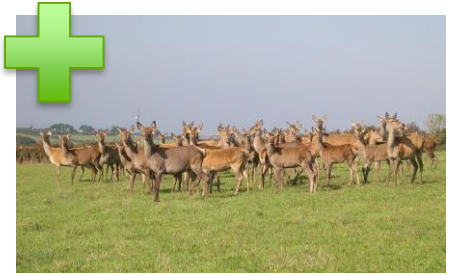
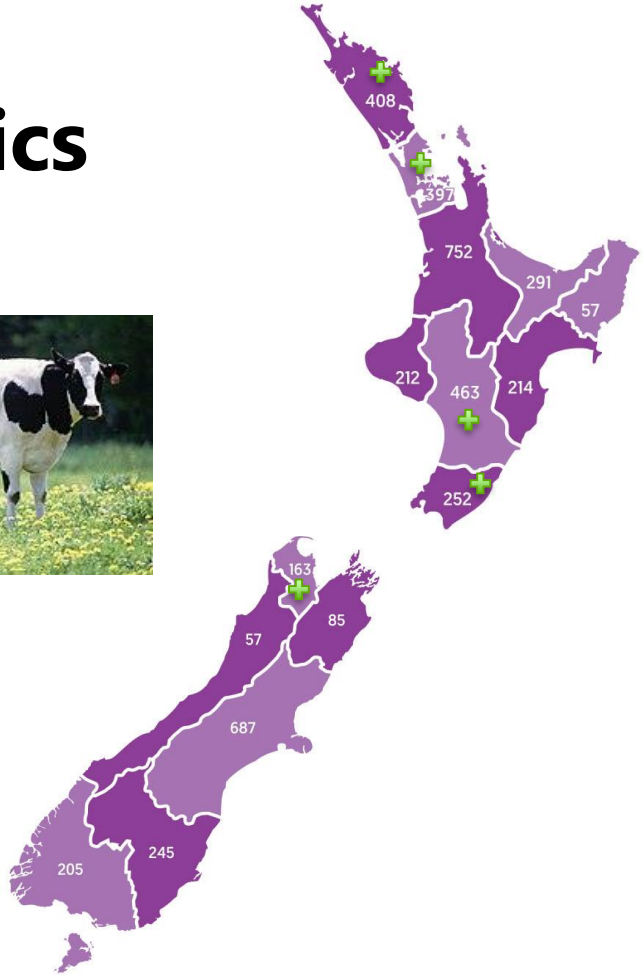
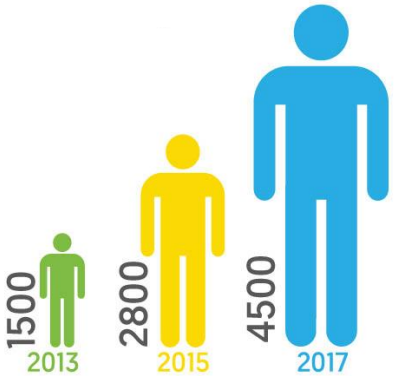
Survey Analytics





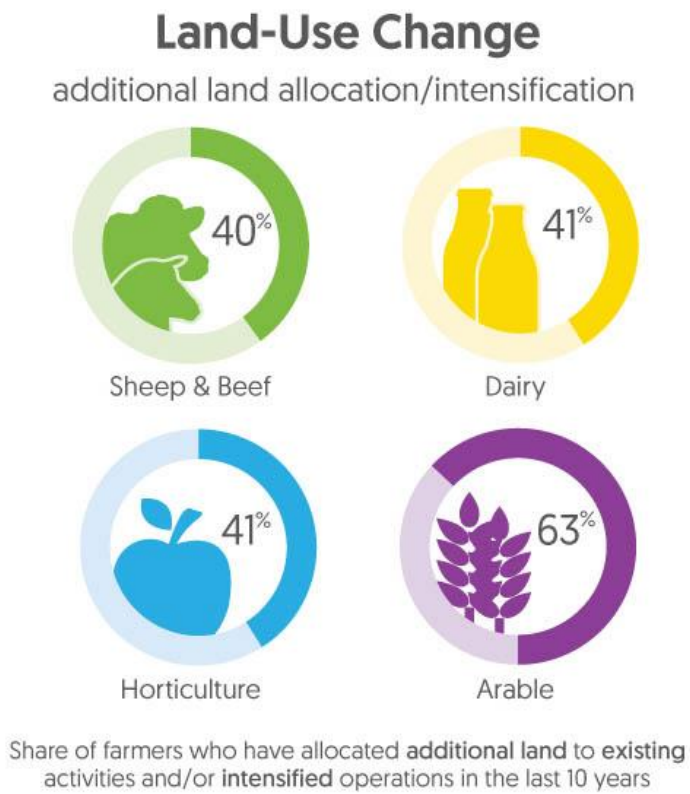




Rural Decision Makers
SURVEY2017

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



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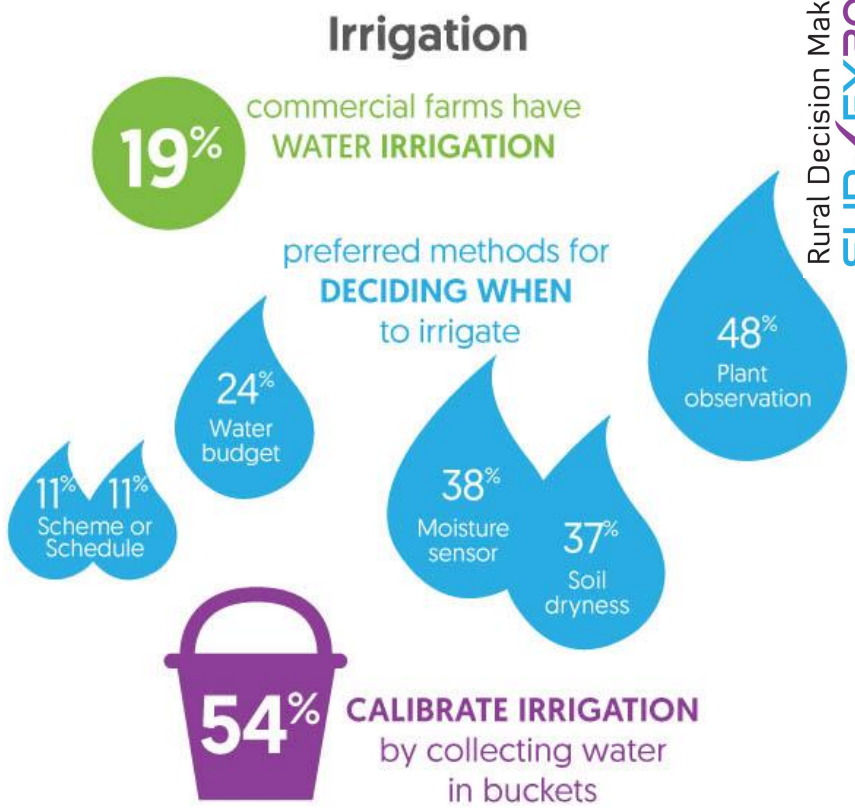

Rural Decision Makers SURVEY 2017

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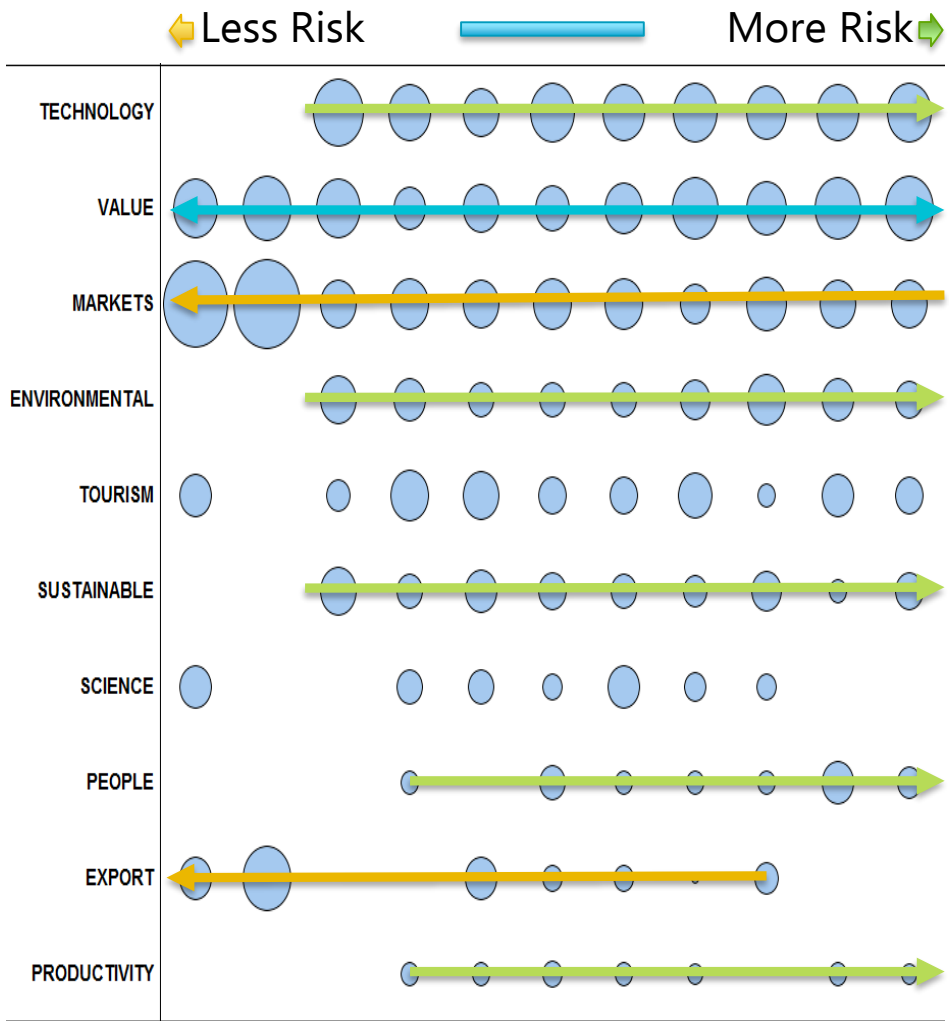

Questionnaire

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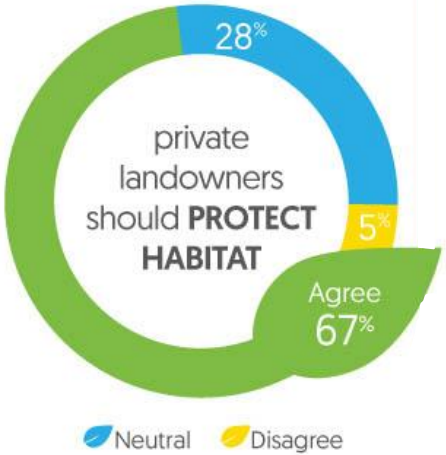
Habitat Conservation Values



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 beliveve the private landowners **should protect habitat** for conservation of **native species.**

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Questionnaire

- Ownership and structure
- Land use, land-use change
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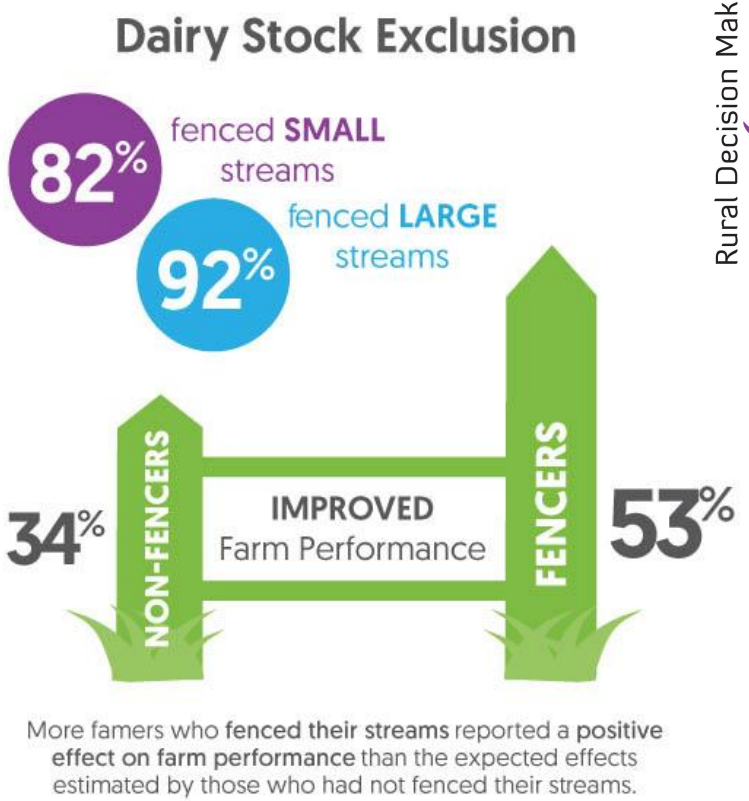
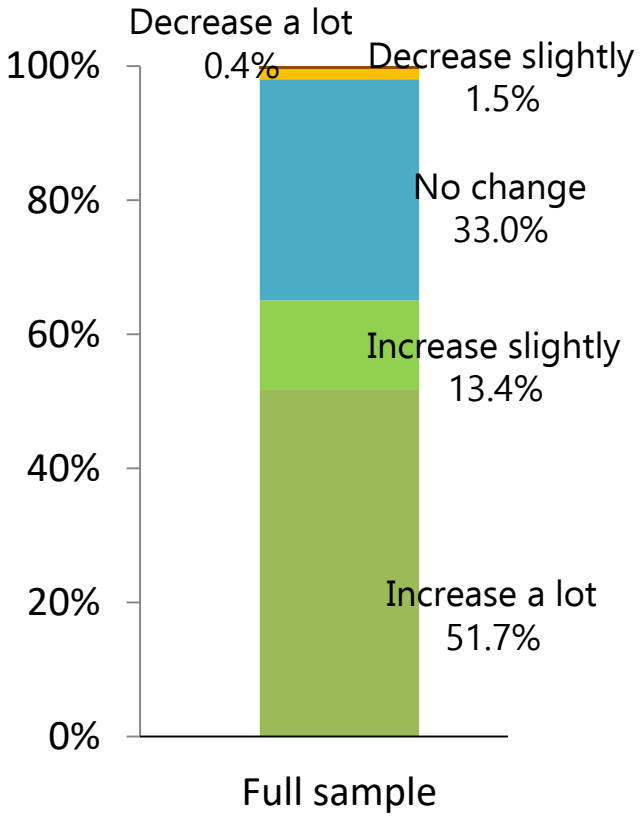
Rural Decision Makers SURVEY2017



Future expectations

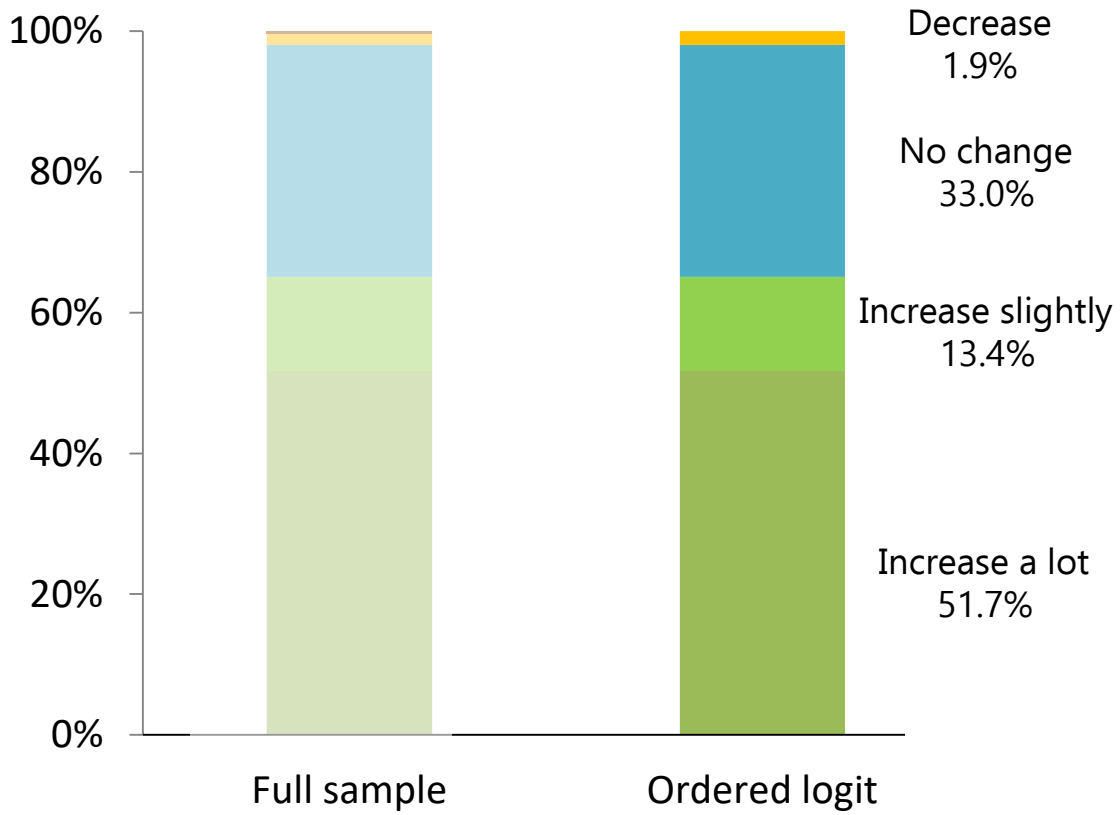
Which of the following best describes how you personally expect the prevalence of drought in to change by 2050?



N = 561

Rural Decision Makers SURVEY2015

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



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Rural Decision Makers SURVEY2015

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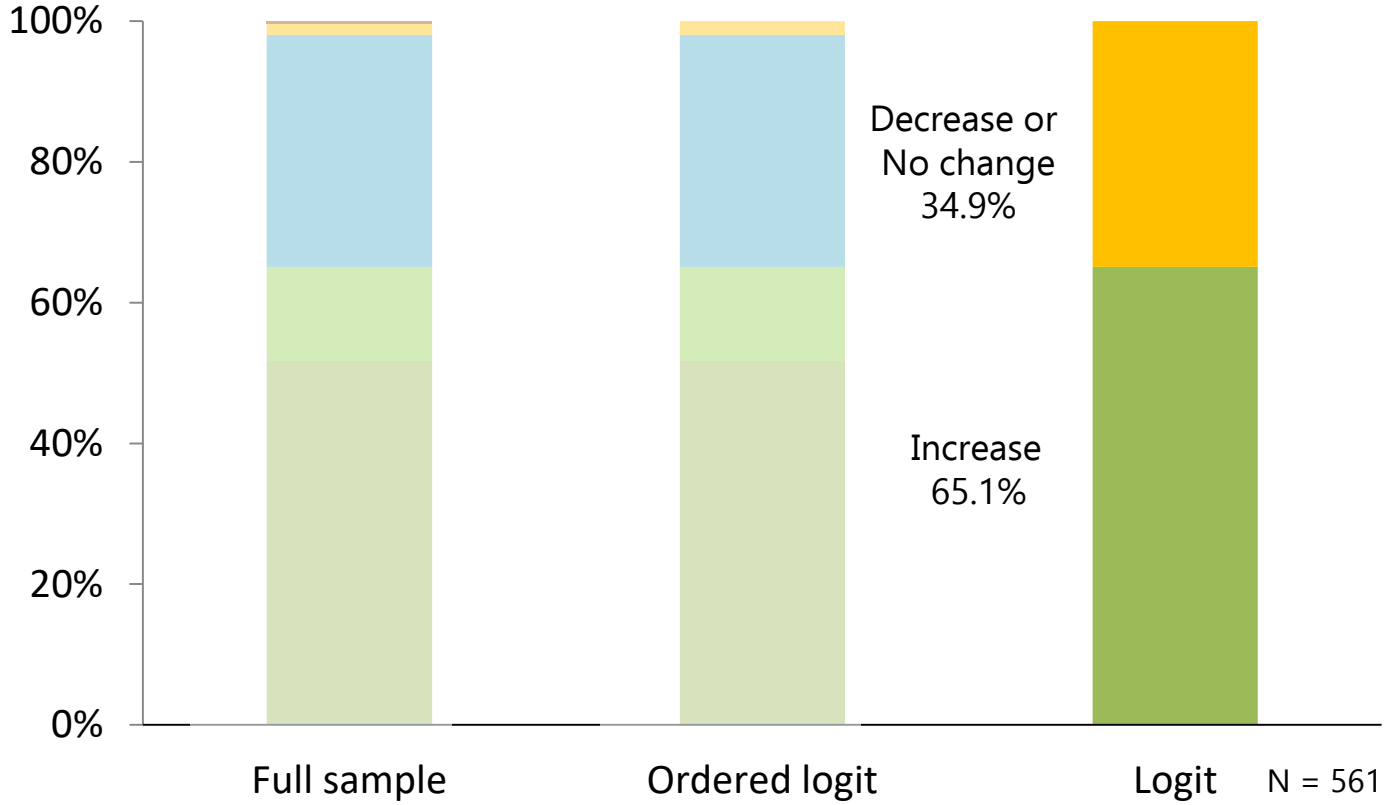

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Average Marginal Effects from Logit Regression

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			

Rural Decision Makers SURVEY2015

Average Marginal Effects from Logit Regression

	Dependent Variable: Expect the prevalence of drought to increase = 1			
Independent Variables	(1)	(2)	(3)	(4)
Age (years)	0.00312	0.00280		
	(0.00213)	(0.00203)		
★ Male (=1)	-0.170***	-0.157***		
	(0.0318)	(0.0335)		
★ Bachelors degree or more (=1)	0.0927**	0.0894**		
	(0.0427)	(0.0414)		
★ Farming for 6 generations or more (=1)	-0.145***	-0.139***		
	(0.0425)	(0.0456)		
Maximum farming experience (years after age 18)	-0.00233	-0.00208		
	(0.00188)	(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		

Rural Decision Makers SURVEY2015

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

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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?

Average Marginal Effects from Logit Regression

	Dependent Variable: Expect the prevalence of drought to increase = 1			
Independent Variables	(1)	(2)	(3)	(4)
Age (years)	0.00312	0.00280	0.00208	0.00163
	(0.00213)	(0.00203)	(0.00213)	(0.00183)
★ Male (=1)	-0.170***	-0.157***	-0.146***	-0.164***
	(0.0318)	(0.0335)	(0.0318)	(0.0342)
★ Bachelors degree or more (=1)	0.0927**	0.0894**	0.0919**	0.0881**
	(0.0427)	(0.0414)	(0.0403)	(0.0392)
★ Farming for 6 generations or more (=1)	-0.145***	-0.139***	-0.146***	-0.146***
	(0.0425)	(0.0456)	(0.0456)	(0.0460)
Maximum farming experience (years after age 18)	-0.00233	-0.00208	-0.00140	-0.00115
	(0.00188)	(0.00175)	(0.00192)	(0.00187)
★ Agreement: habitat on public land should be protected		0.0169*	0.0171	0.0181*
		(0.0102)	(0.0111)	(0.01000)
Agreement: habitat on private land should be protected		0.00573	0.00559	0.00478
		(0.0112)	(0.0116)	(0.0110)
★ Agreement: right to hunt on public land		-0.0133*	-0.0142**	-0.0153**
		(0.00735)	(0.00713)	(0.00758)
★ I would reduce farm output if I could maintain same level of profit		0.0107*	0.00965*	0.00889
		(0.00623)	(0.00556)	(0.00607)
★ Farm is profitable (=1)			-0.0963**	-0.101***
			(0.0391)	(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

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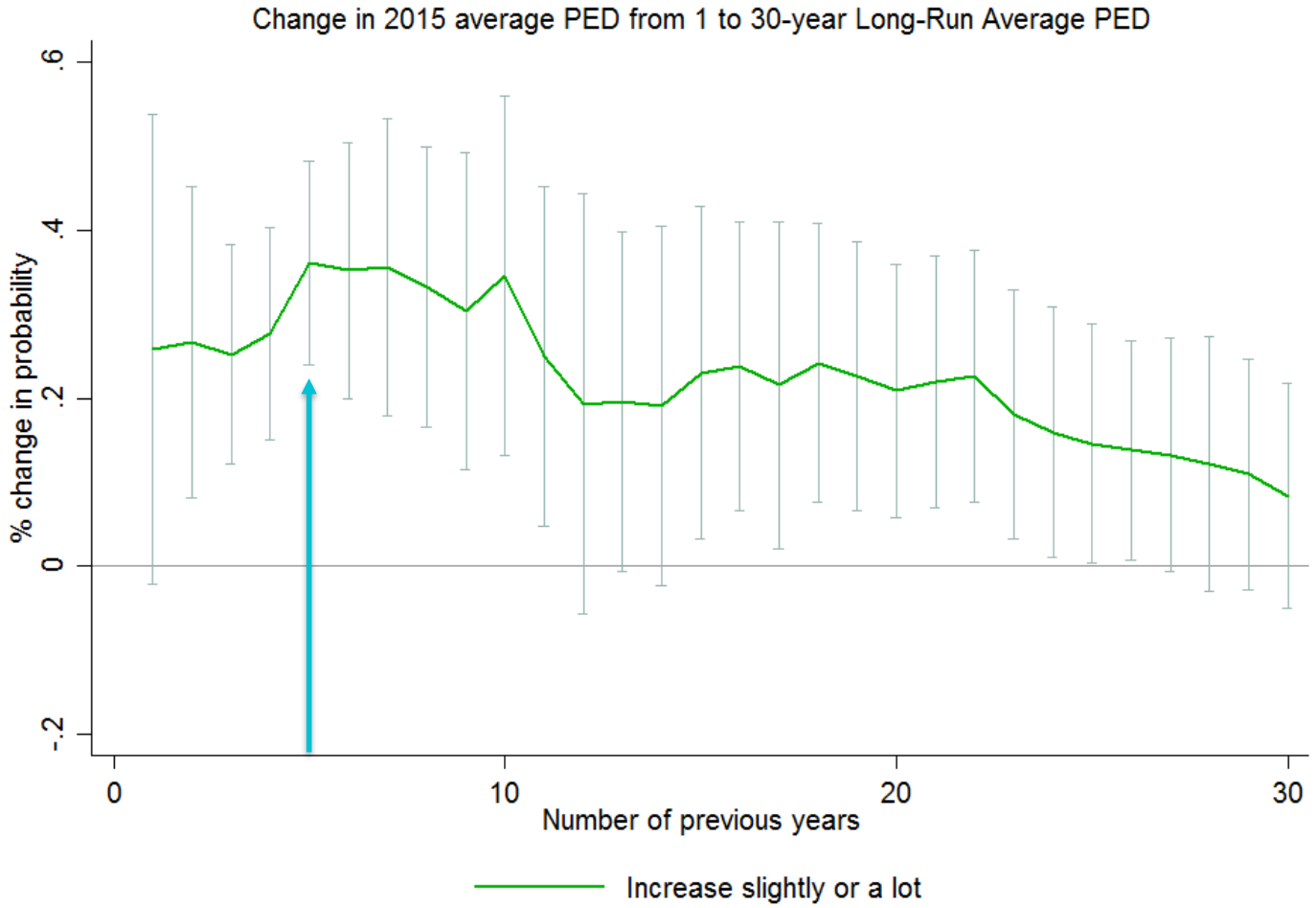
Logit



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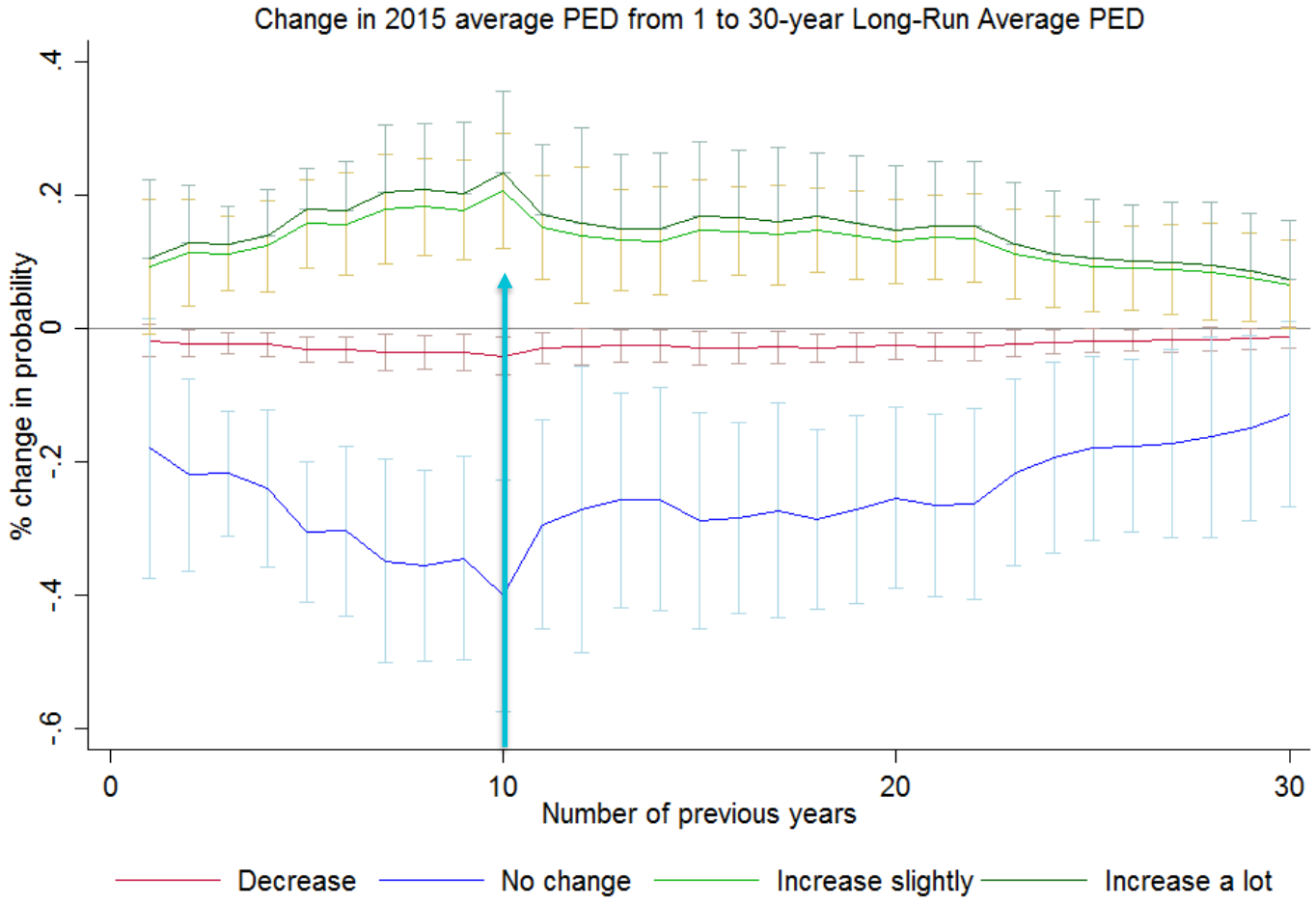
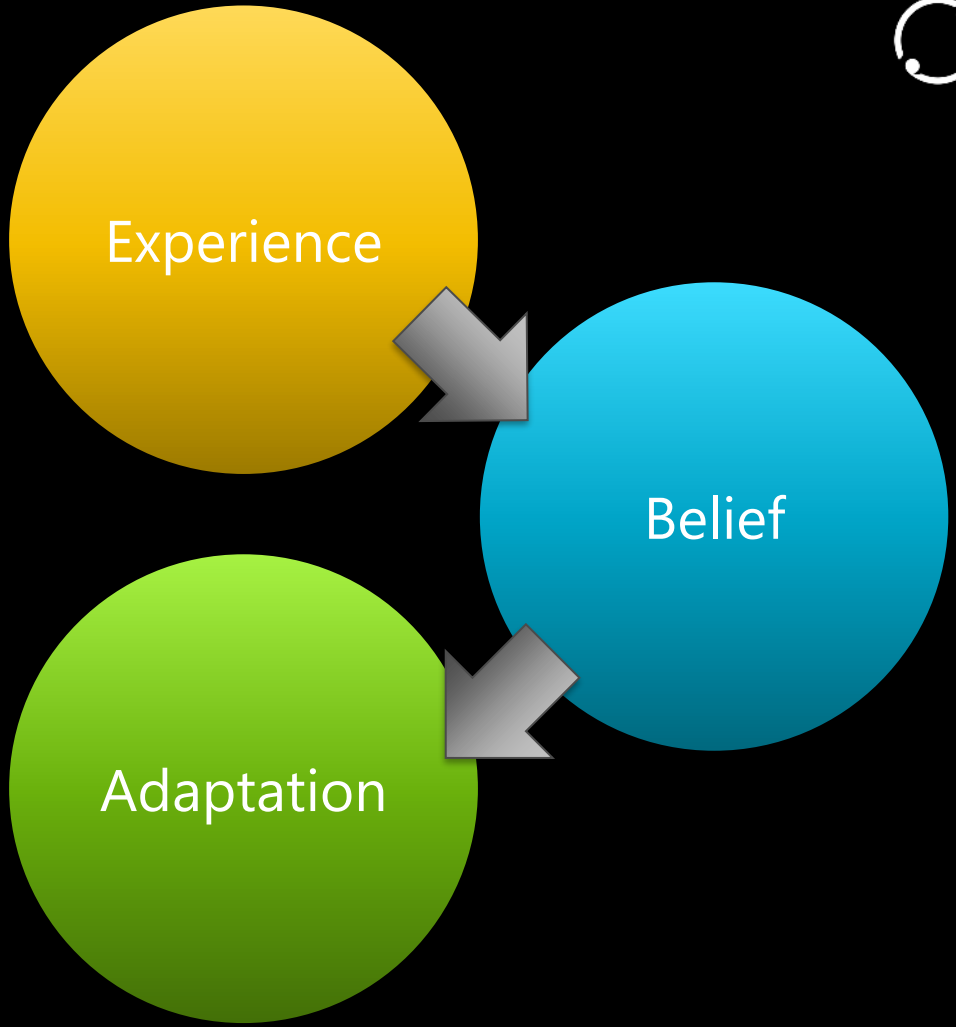
Ordered logit

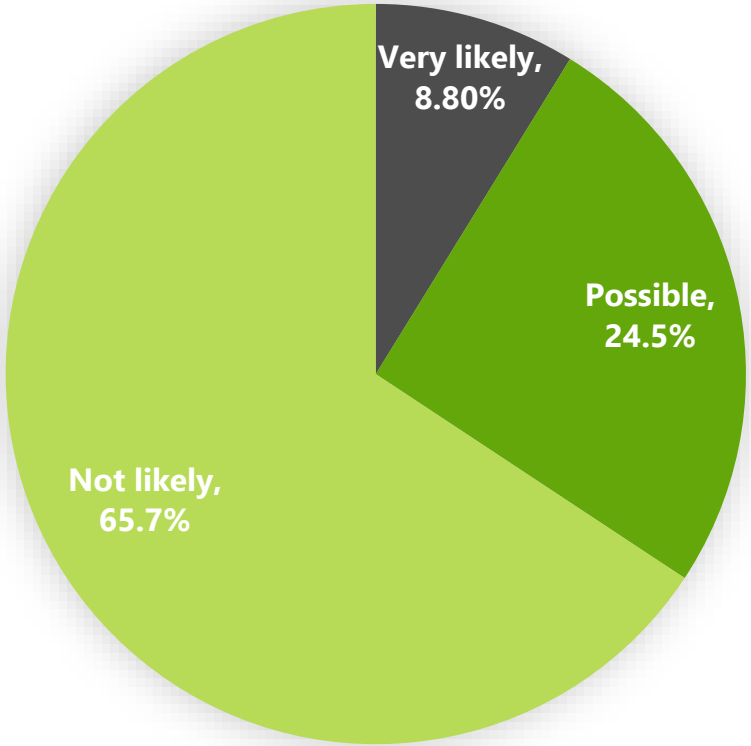


Rural Decision Makers
SURVEY2015



Climate-change adaptation

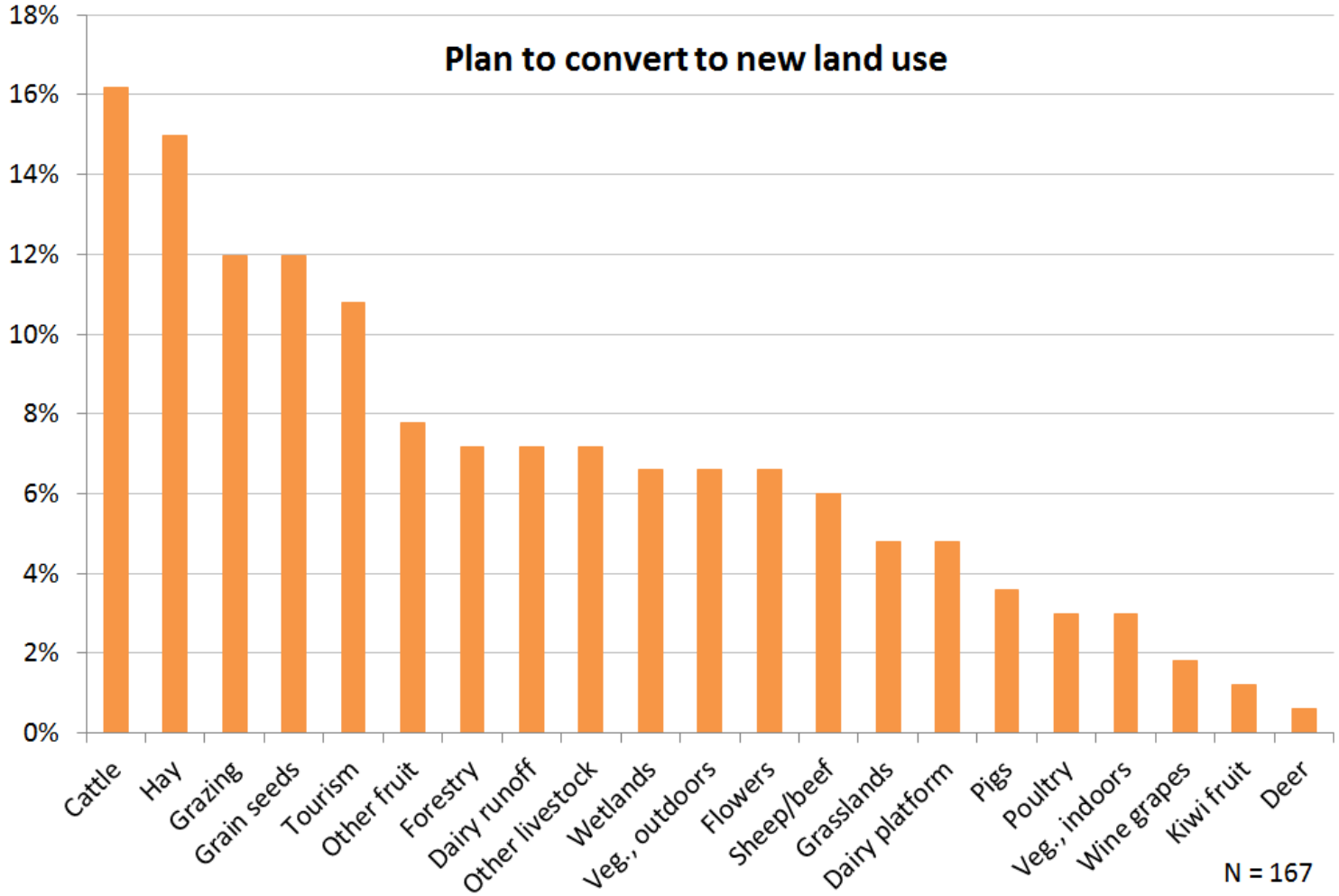
How likely do you think you are to convert land to new uses in the next 2 years?



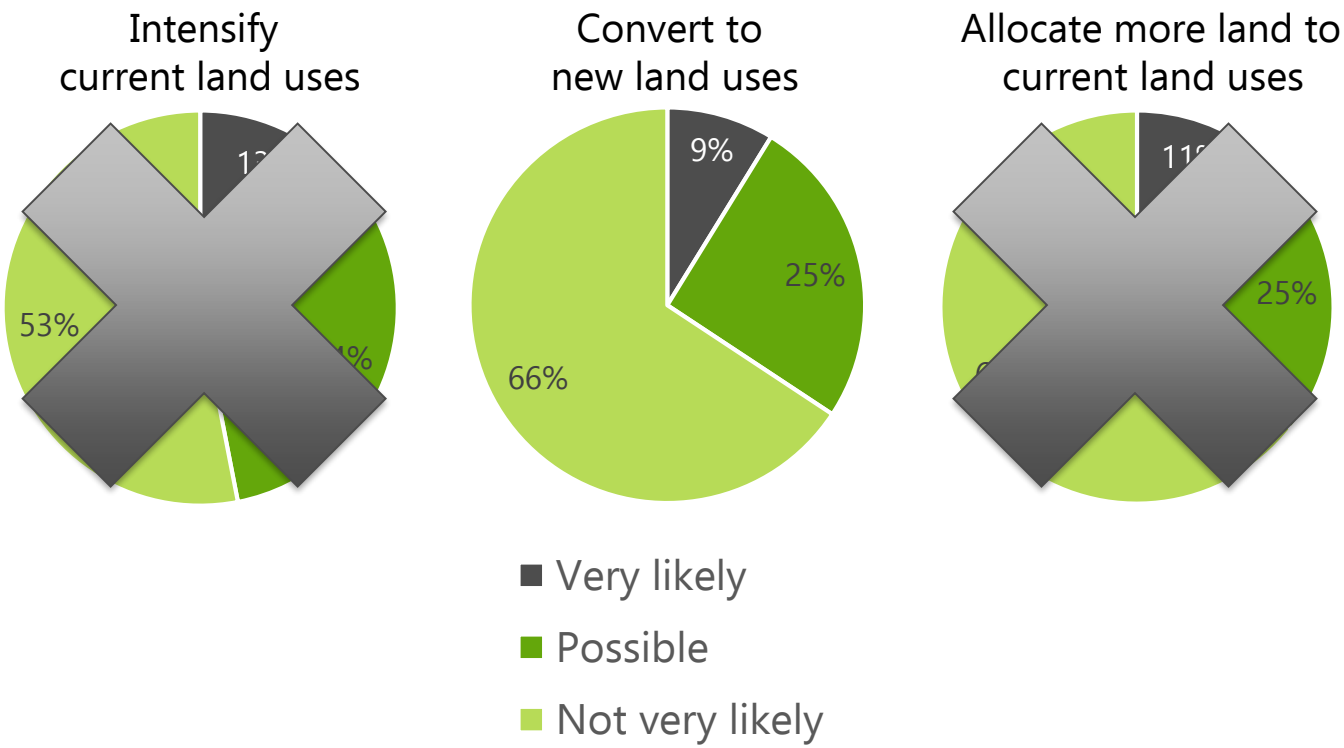
Average Marginal Effects of Likelihood of Future Land-Use Change

Independent Variables	Dependent variable: Likelihood of converting to new land use within next 2 years		
	Not likely	Possible	Very likely
★ Age (years)	0.00963***	-0.00607***	-0.00357***
	(0.00223)	(0.00153)	(0.00108)
★ Male (=1)	-0.08988*	0.05826	0.03162**
	(0.0499)	(0.03787)	(0.01302)
Bachelor's degree or more (=1)	-0.01097	0.0069	0.00406
	(0.03375)	(0.02148)	(0.0123)
Farming for 6 generations or more (=1)	-0.02414	0.01498	0.00915
	(0.0538)	(0.03235)	(0.02155)
Maximum farming experience (years)	-0.00132	0.00083	0.00049
	(0.00161)	(0.00101)	(0.00061)
★ Agreement: habitat on public land should be protected	0.01794*	-0.0113	-0.00664*
	(0.01073)	(0.00711)	(0.00392)
★ Agreement: habitat on private land should be protected	-0.02001***	0.0126**	0.0074**
	(0.00761)	(0.00517)	(0.00297)
Agreement: right to hunt on public land	-0.00073	0.00046	0.00027
	(0.00919)	(0.00582)	(0.00337)
I would reduce farm output if I could maintain same level of profit.	0.00652	-0.00411	-0.00241
	(0.00689)	(0.00465)	(0.00229)
Farm is profitable (=1)	-0.01765	0.01112	0.00653
	(0.03149)	(0.02035)	(0.01123)
★ Currently lease land (=1)	-0.07428*	0.04605**	0.02823
	(0.04194)	(0.02141)	(0.02094)
★ **Drought prevalence will increase (=1)**	**-0.03523***	**0.02234***	**0.01289***
	(0.01799)	**(0.01189)**	**(0.00679)**
Observations		557	

Rural Decision Makers
Rural Decision Makers 5
SURVEY2015


Plan to convert to new land use
18%
16%
14%
12%
10%
8%
6%
4%
2%
0%
Cattle
Hay
Grazing
Grain seeds
Tourism
Other fruit
Forestry
Dairy runoff
Other livestock
Wetlands
Veg., outdoors
Flowers
Sheep/beef
Grasslands
Dairy platform
Pigs
Poultry
Veg., indoors
Wine grapes
Kiwi fruit
Deer
N = 167

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



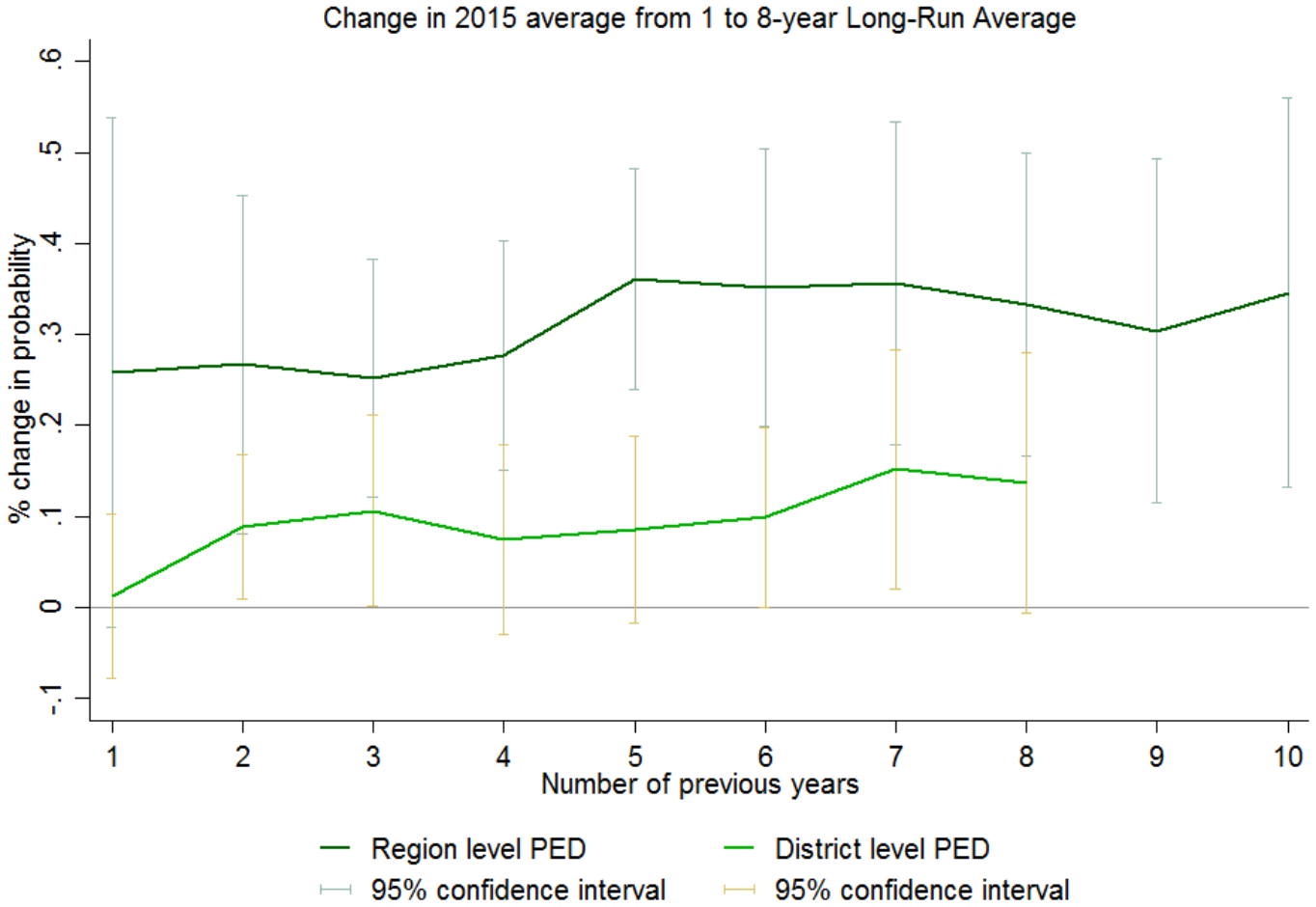
Rural Decision Makers SURVEY2015

Robustness checks

District-level data

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

District PED



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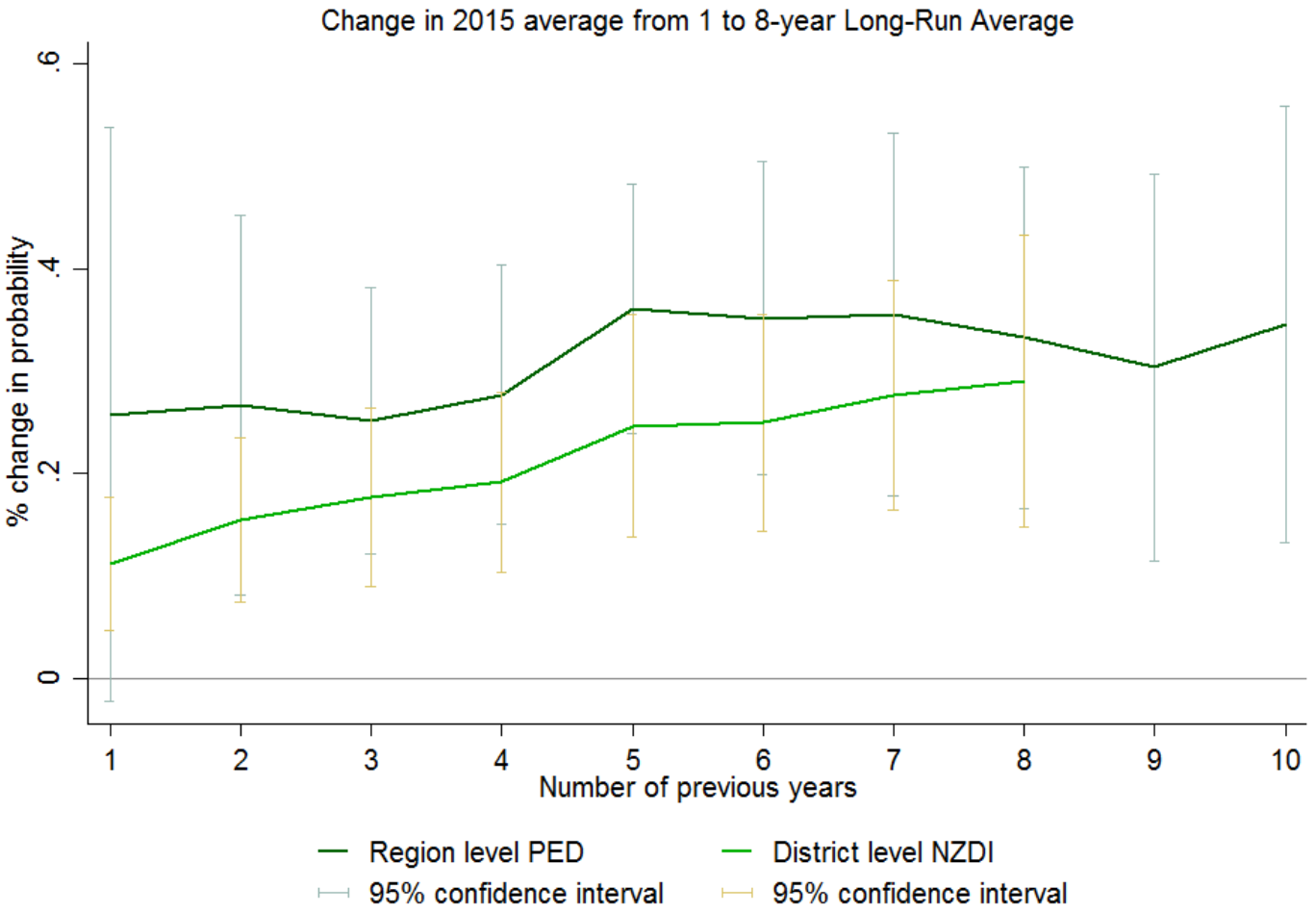
SURVEY2015

Robustness checks

More complete measure of drought

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

District NZDI



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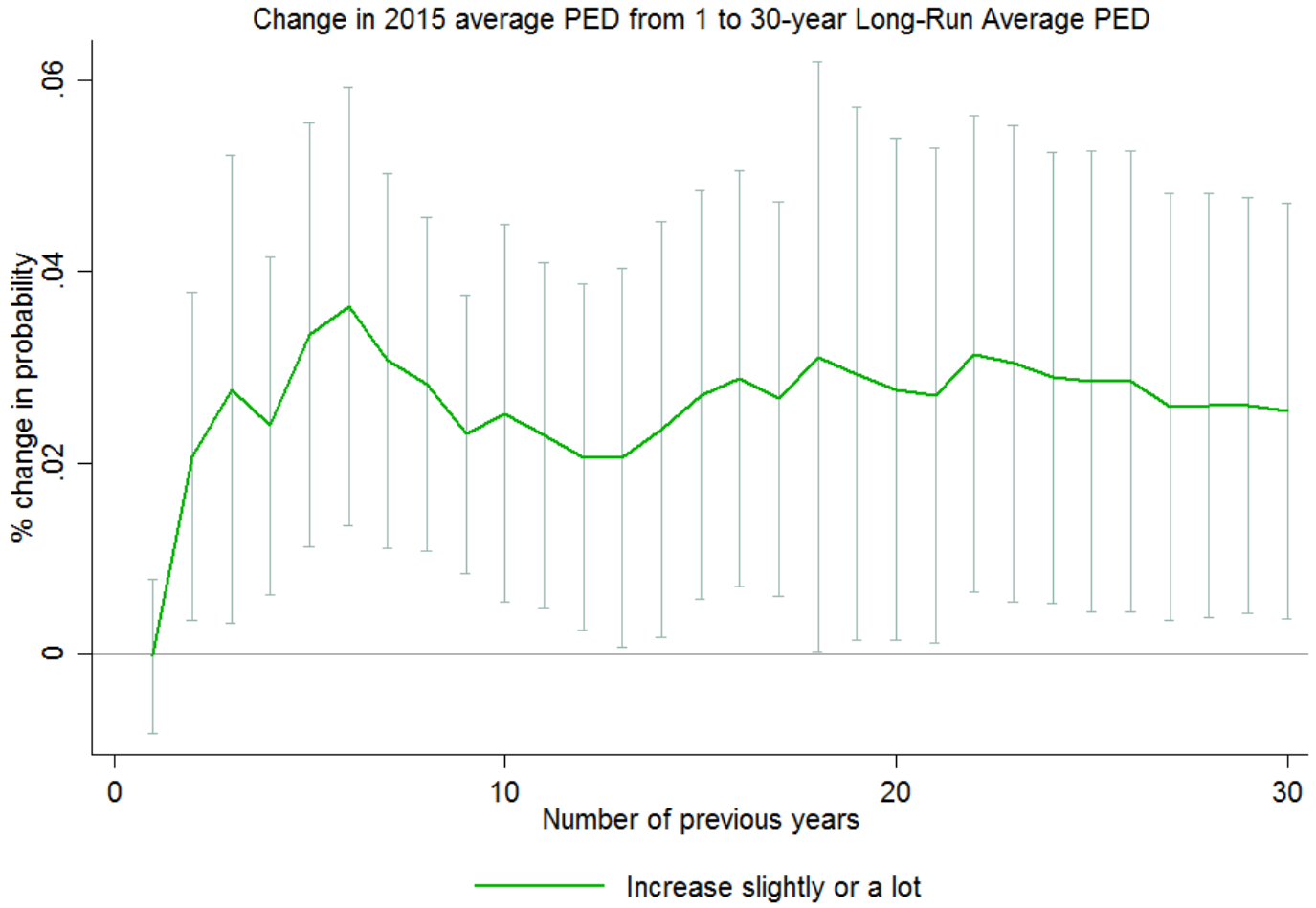
Robustness checks

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



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Manaaki Whenua
Landcare Research

Drought intensity, future expectations, & climate-change adaptation

Pamela Booth Pike Brown Patrick Walsh

Does recent experience with drought matter?

What is the time frame of reference when considering intensity?

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

Does the intensity of the drought matter?

Do expectations of future drought affect land use planning?

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

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SURVEY2019

Winter 2019