Pluvial Flooding at Auckland Coastal Settlements

23rd May 2018

Auckland Council
Te Kaunihera o Tāmaki Makaurau

Contents

- The Problem
- Describing the Problem
- Two Examples
- Discussion/Thoughts
- Summary and Conclusions

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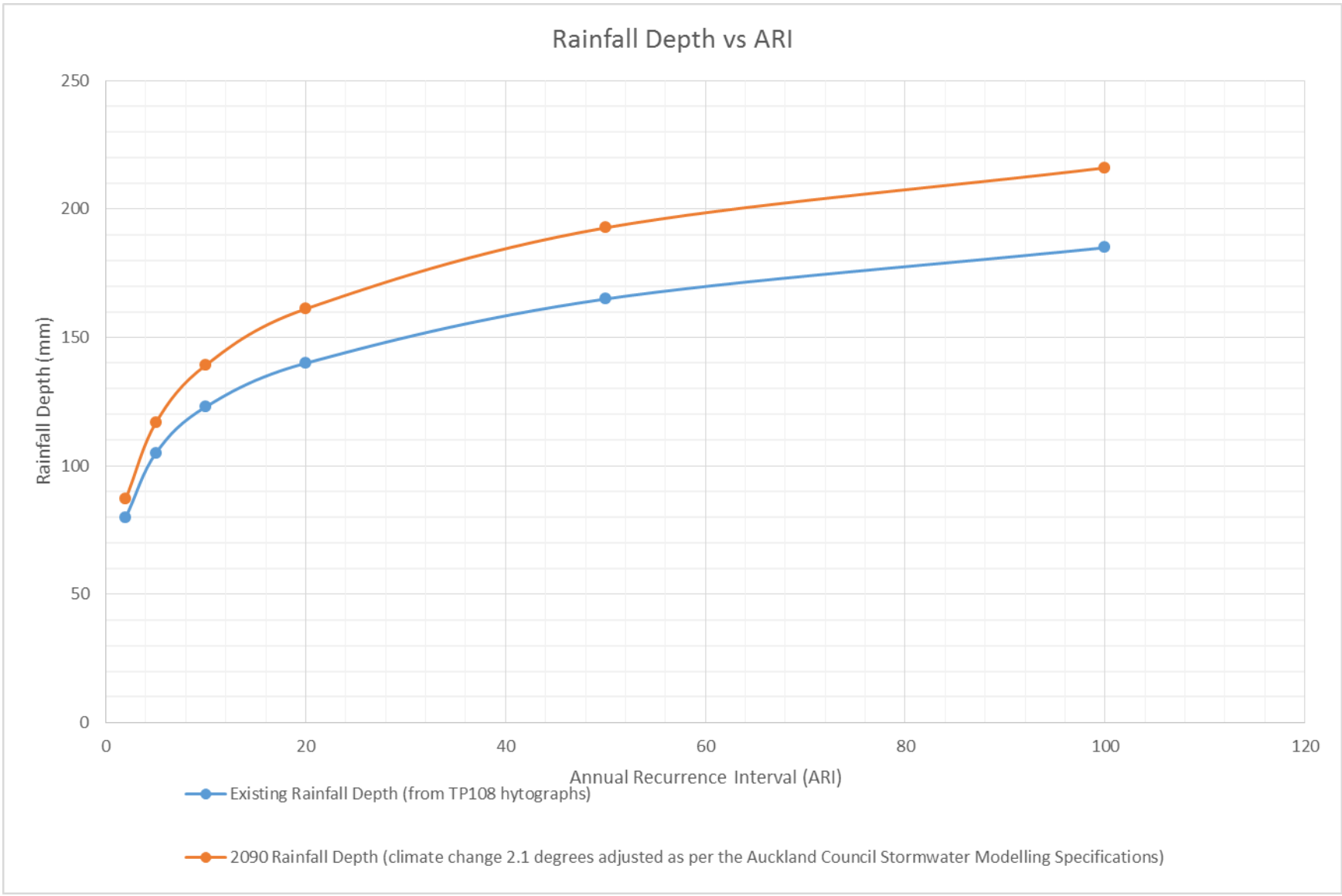
The Problem

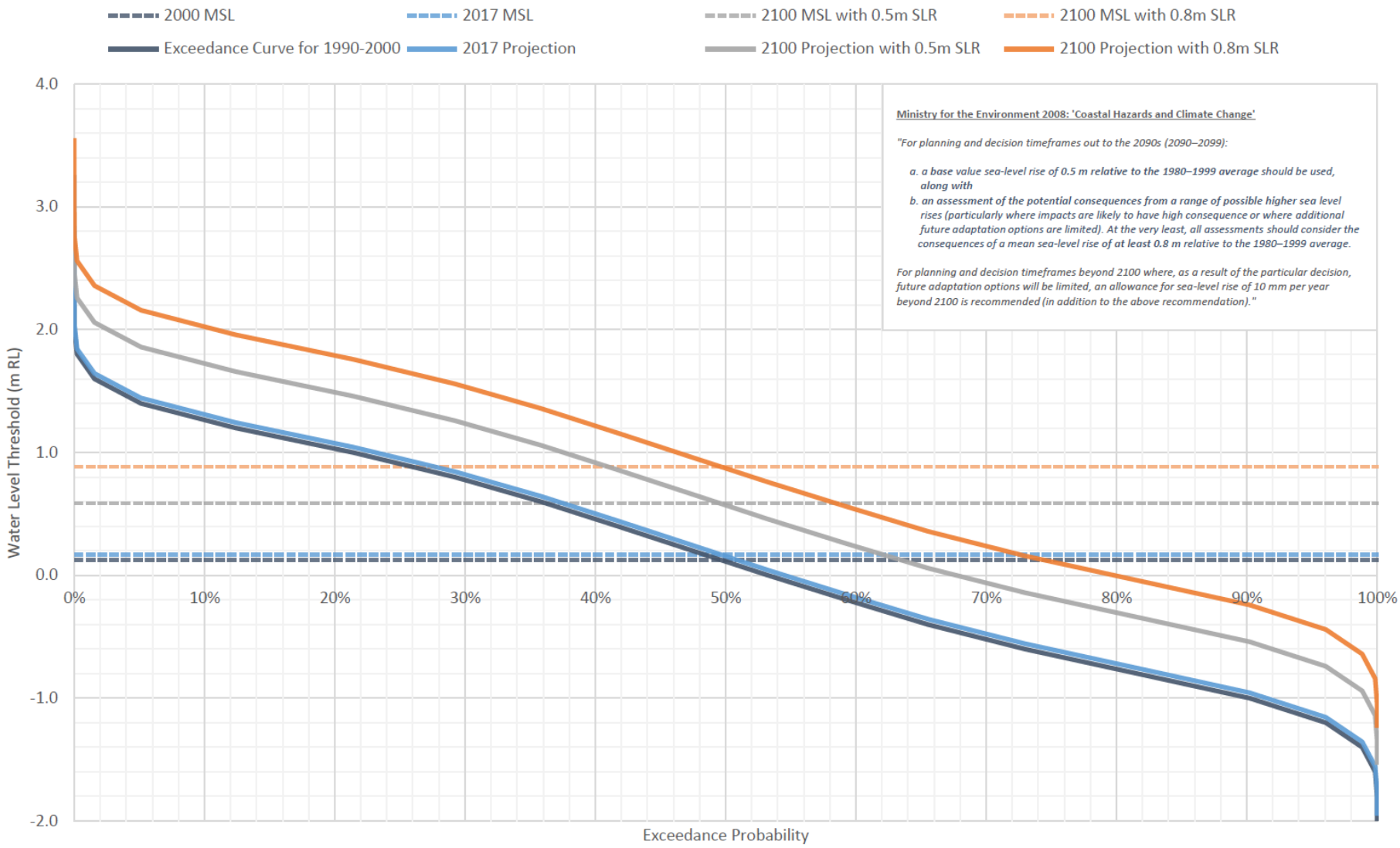
Bucklands Beach, November 2017 (source: Auckland Council)

Tamaki Drive, January 2011 (source: NZ Herald)

Describing the Problem



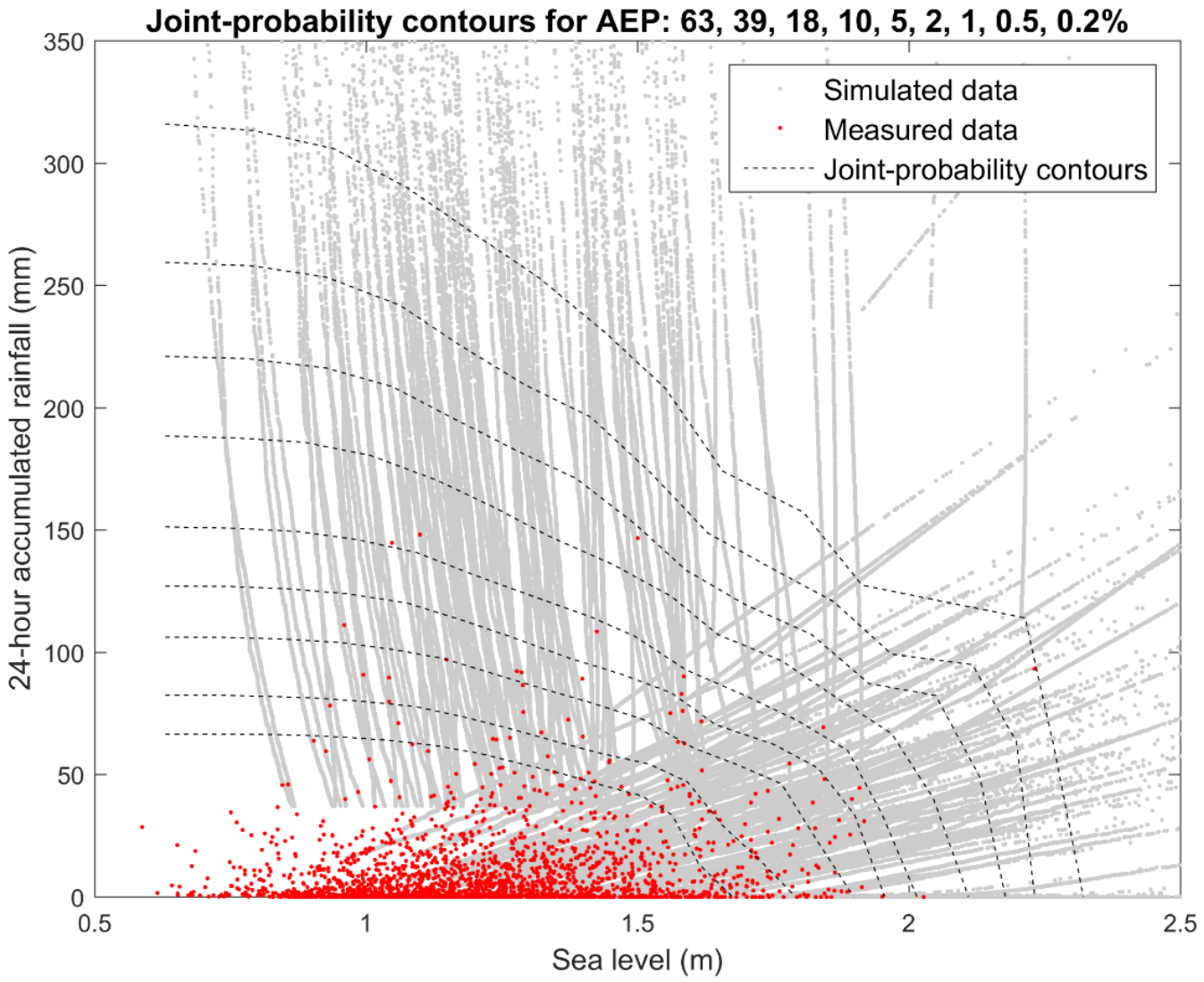
Projected Exceedance Percentile Curve for Auckland Tides



Rainfall and Sea Level Combinations

Rainfall ARI	Tailwater ARI	NIWA water level mRL	Tailwater exceedance	Joint AEP
100	2	1.99	0.00005704	Minuscule
50	5	2.07	0.00002282	Minuscule
20	10	2.13	0.00001141	Minuscule
10	20	2.18	0.0000057	Minuscule
5	50	2.25	0.00000228	Minuscule
2	100	2.30	0.00000114	Minuscule

Albert Park rain gauge vs Ports of Auckland sea level gauge



Rainfall, Sea Level ARI

Scott Stephens, Niwa, 2018

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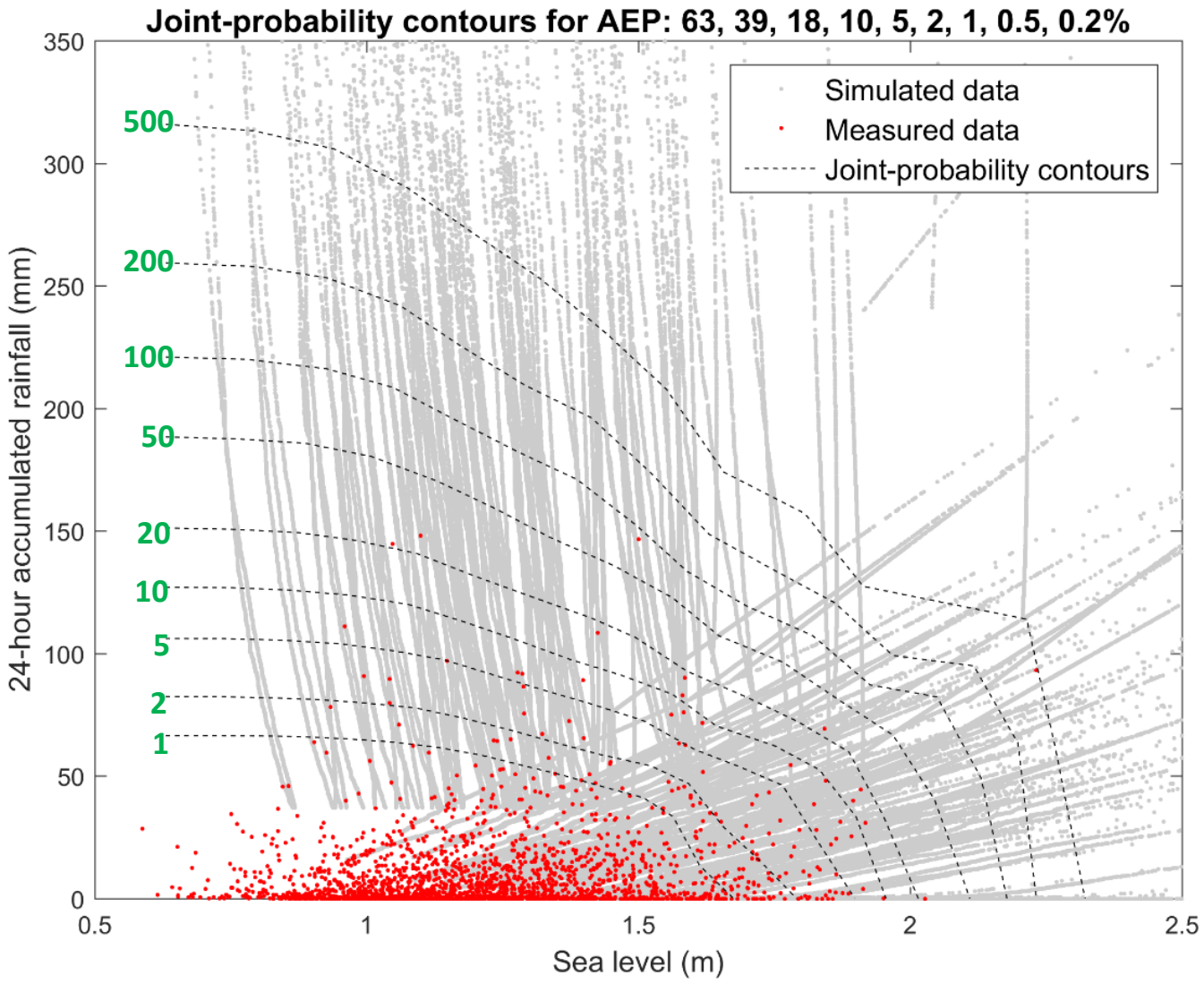

Combined ARI

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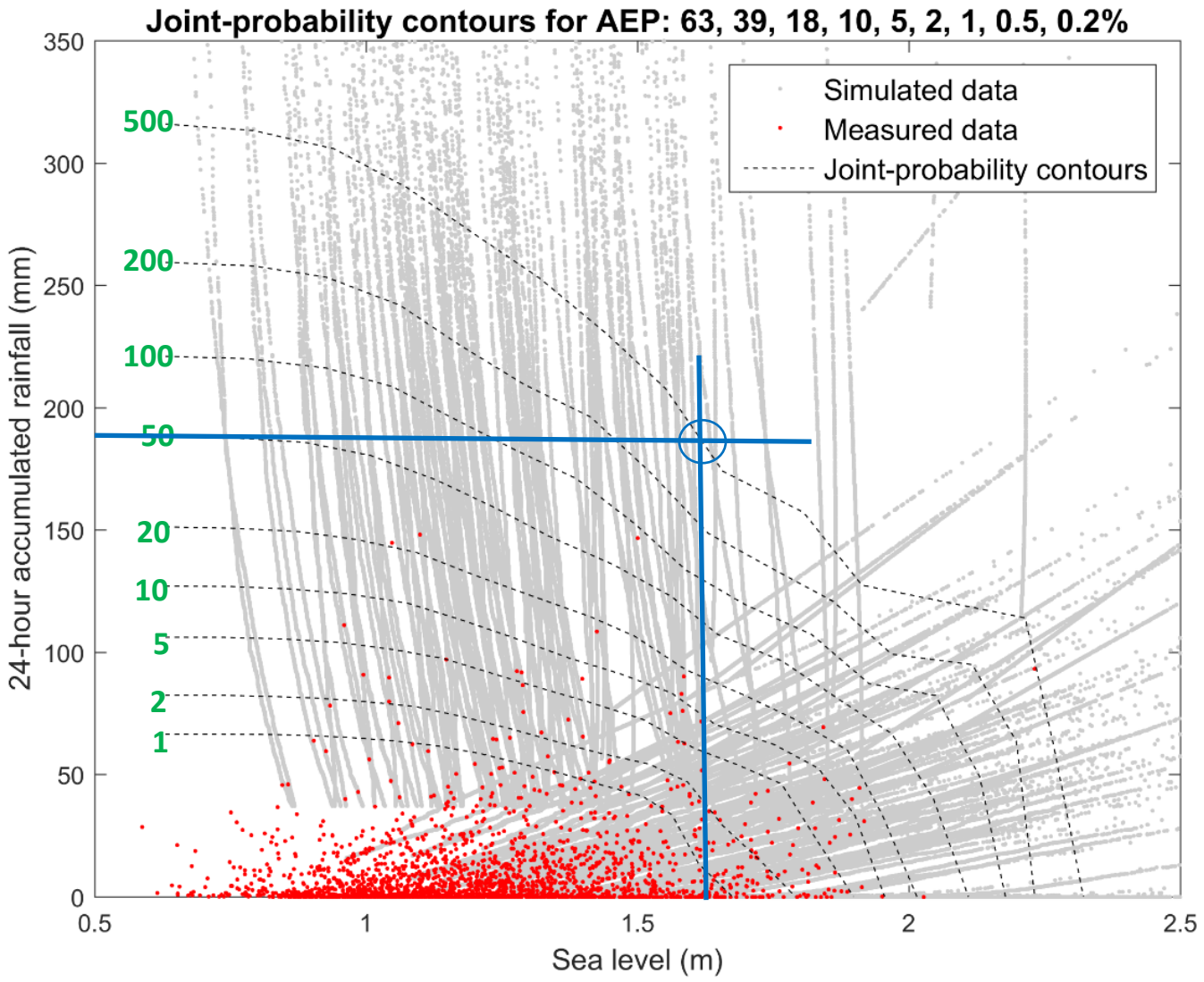

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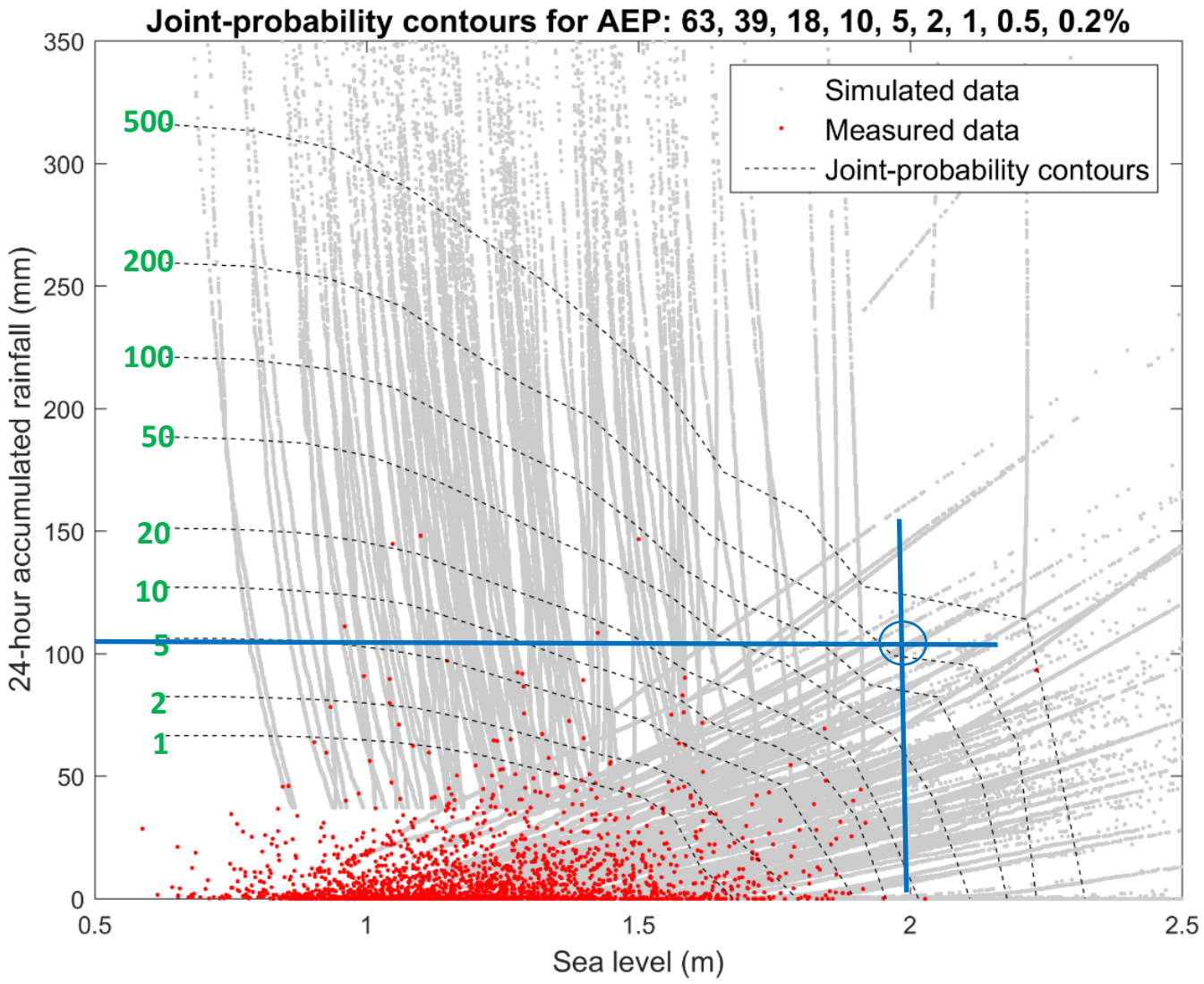

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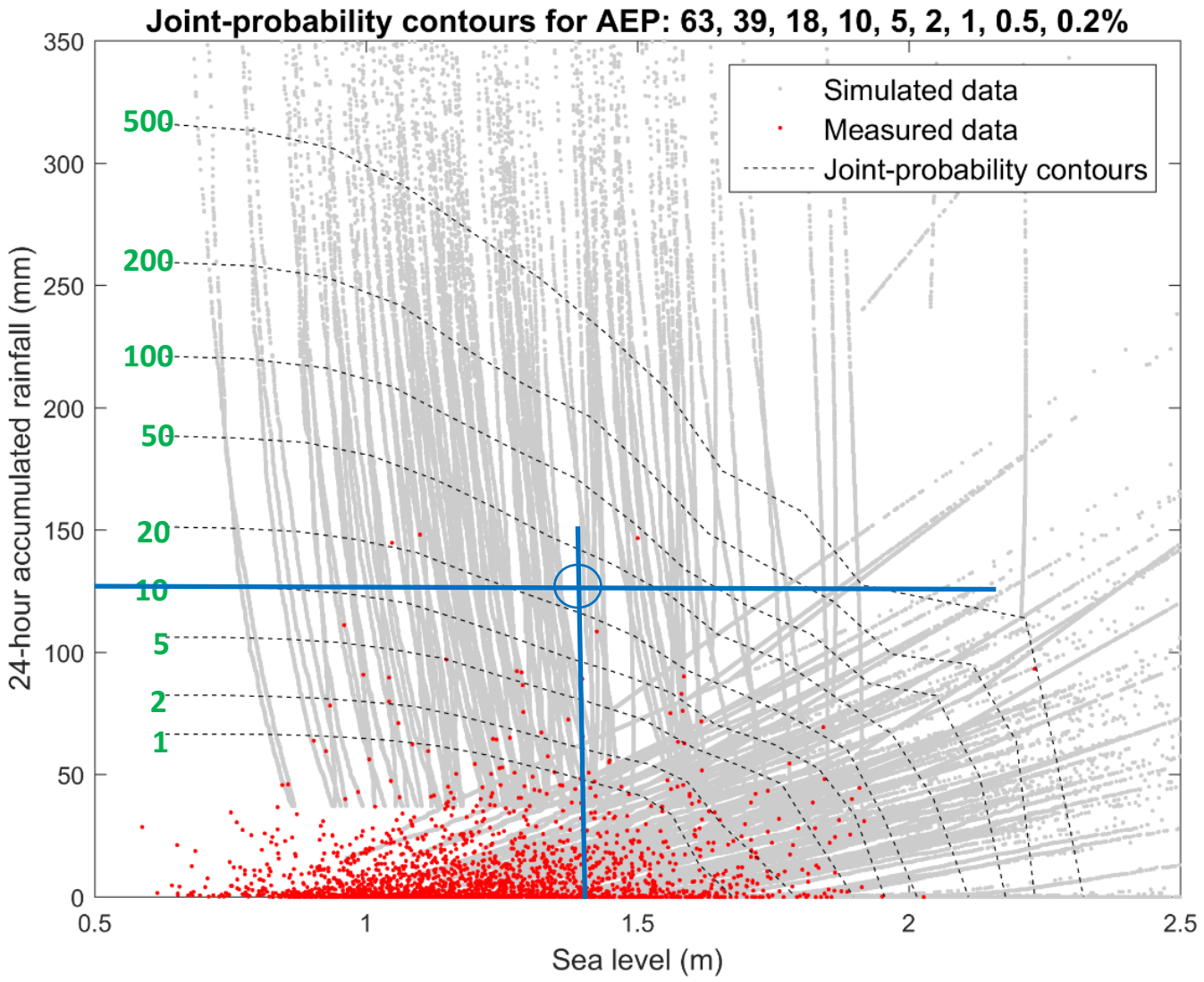

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Rainfall, Sea Level ARI

Scott Stephens, Niwa, 2018

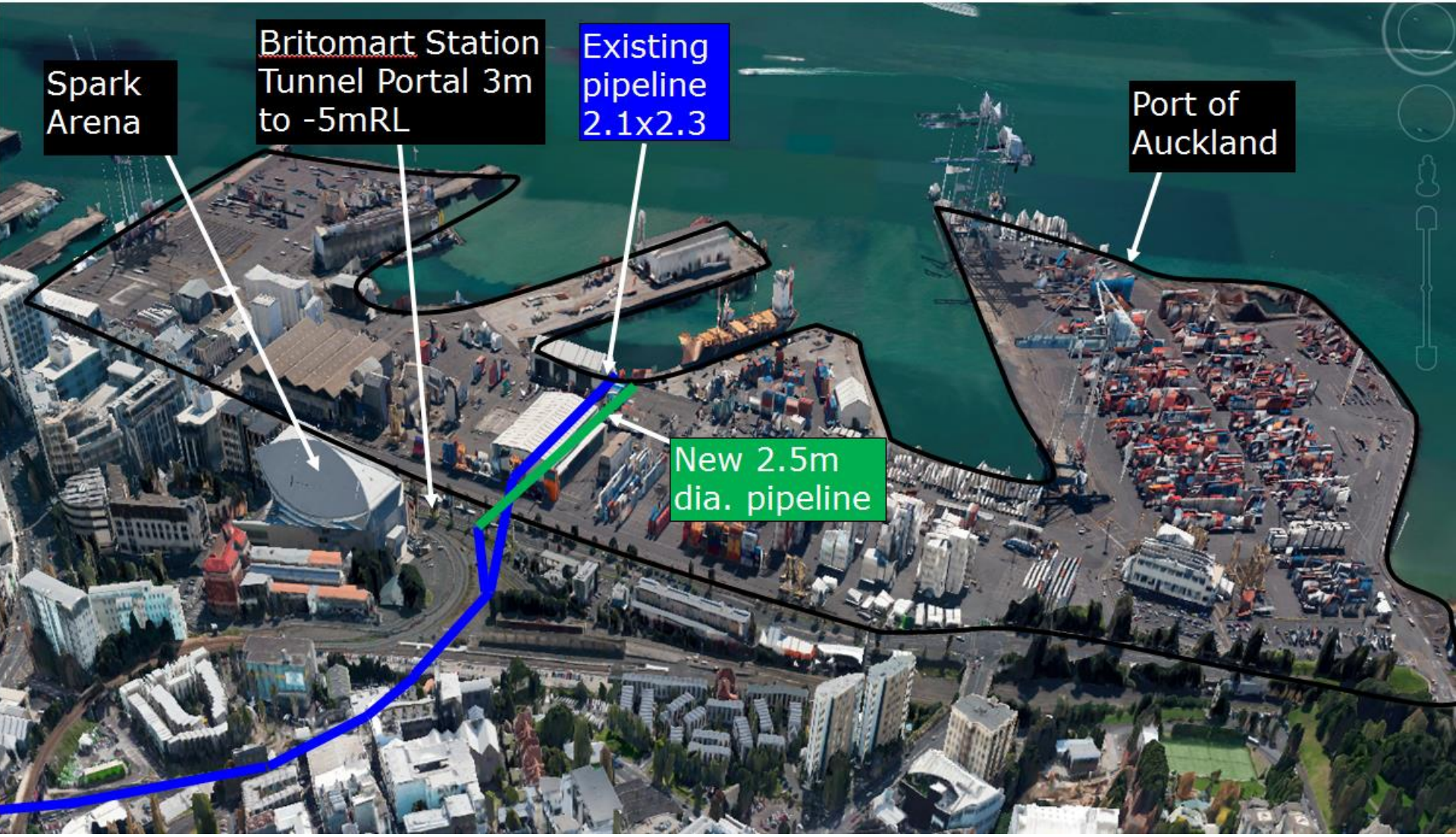
Adaptive management

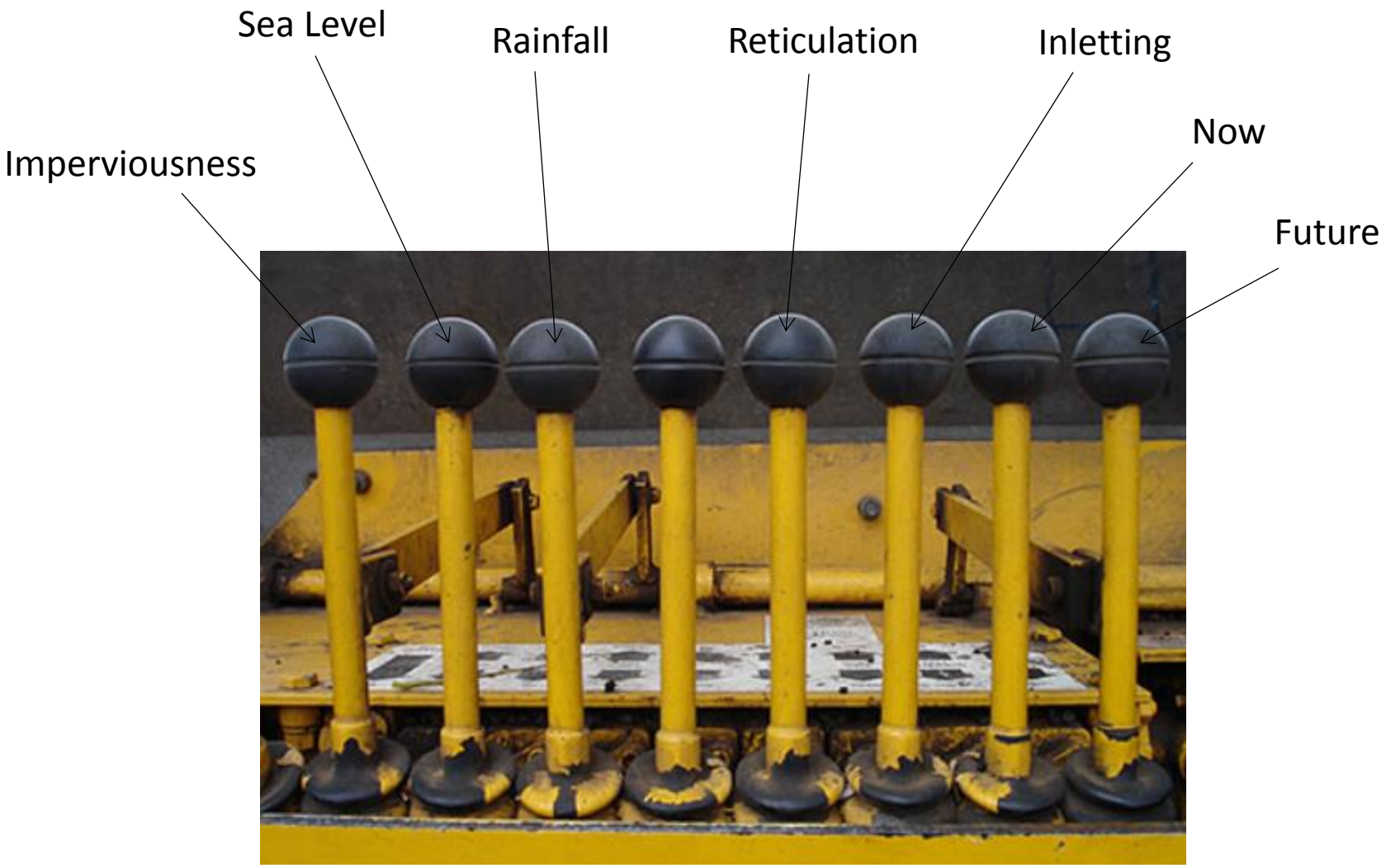
- Need to understand the risk today
- How will that risk change?

Parliamentary Commissioner for the Environment

Te Kaitiaki Taiao a Te Whare Pāremata

Britomart Station Tunnel Portal




Sea Level
Rainfall
Reticulation
Inletting
Now
Future
Imperviousness

Testing the Asset performance

		Rainfall AEP (%)		
Outlet Size	**Rainfall (mm)**	**2017**	**2059**	**2100**
2.1x2.3	105	20.0%	22.5%	25.0%
	117	12.5%	16.3%	20.0%
	140	5.0%	7.5%	10.0%
	185	1.0%	1.9%	2.8%
	216	0.7%	0.8%	1.0%
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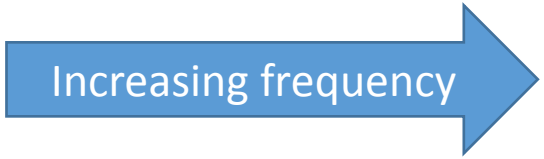


Testing the Asset performance

		Rainfall AEP (%)				Sea Level Exceed Prob		
Outlet Size	**Rainfall (mm)**	**2017**	**2059**	**2**	**Sea Level**	**2017**	**2057**	**2100**
2.1x2.3	105	20.0%	22.5%	25	1.89	0.5%	7.8%	15.0%
	117	12.5%	16.3%	20	1.89	0.5%	7.8%	15.0%
	140	5.0%	7.5%	10	1.6	2.0%	15.0%	28.0%
	185	1.0%	1.9%	2	1.39	5.0%	19.5%	34.0%
	216	0.7%	0.8%	1	1.89	0.5%	7.8%	15.0%
	216	0.7%	0.8%	1	1.2	12.0%	26.0%	40.0%
	216	0.7%	0.8%	1	0.7	33.0%	44.0%	55.0%

Decreasing frequency

Increasing frequency

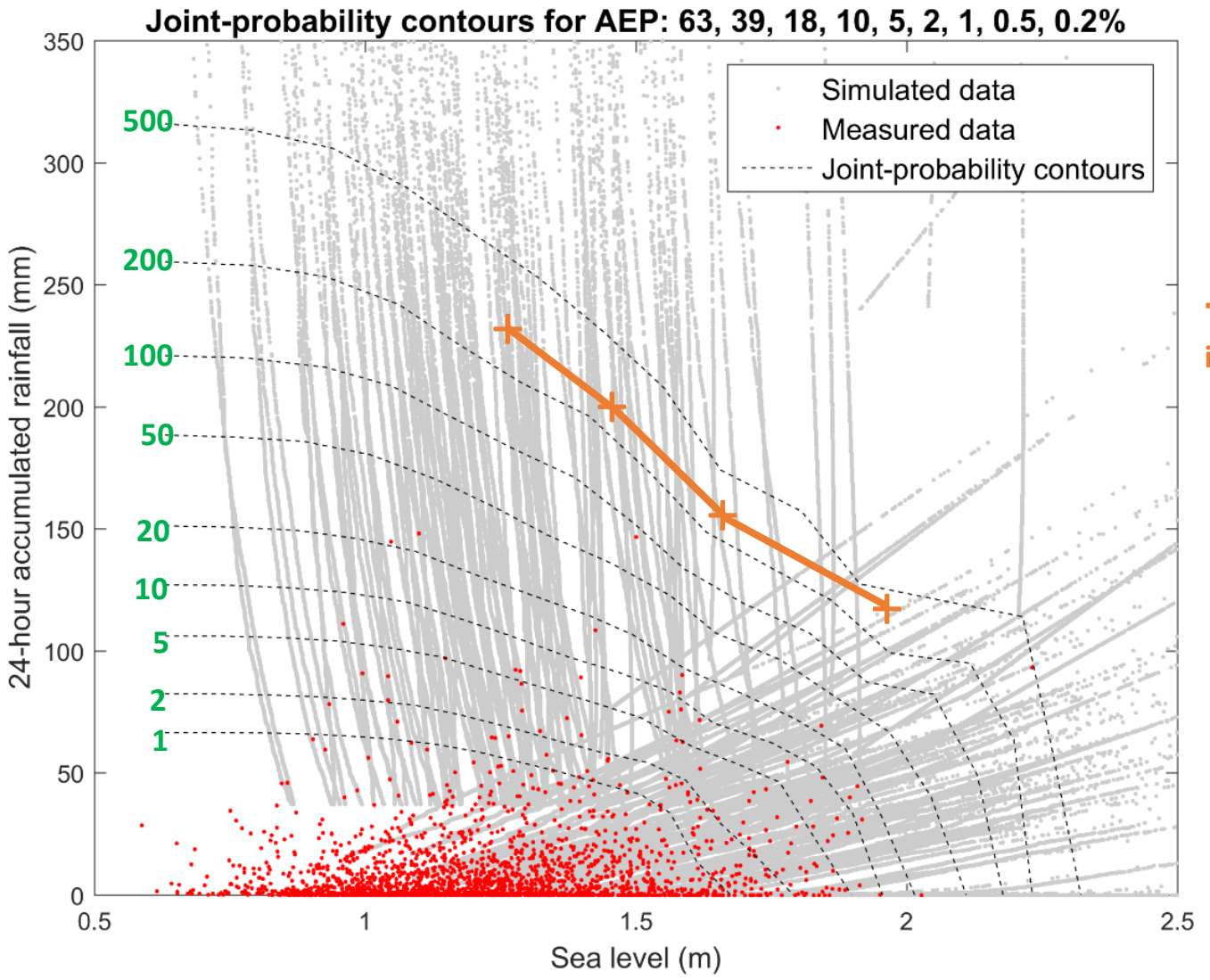
Testing the Asset performance

				Asset Protected?		Joint Probability (ARI)		
Outlet Size	**Rainfall (mm)**	**Sea Level**	**HGL at Britomart**	**Britomart Station**	**Old Railway Building**	**2017**	**2057**	**2100**
2.1x2.3	105	1.89	3.04	No	No	100-200	10-20	5-10
	117	1.89	3.06	No	No	100-200	20-50	5-10
	140	1.6	3.04	No	No	100-200	20-50	10-20
	185	1.39	3.00	No	No	100-200	50-100	20-50
	216	1.89	>3	No	No	500+	200-500	100-200
	216	1.2	3.05	No	No	200-500	50-100	50-100
	216	0.7	2.94	Yes	Yes	100-200	50-100	50-100
2.1x2.3 + 1.8 circ^2	117	1.89	2.87	Yes	Yes	100-200	20-50	5-10
	216	1.6	2.93	Yes	Yes	100-200	100-200	50-100
1.6x1.8 + 2.6 circ^2	117	1.89	2.91	Yes	Yes	100-200	20-50	5-10
	216	1.6	2.97	Yes	Yes	100-200	100-200	50-100

Increasing frequency

Increasing cost to fix

Albert Park rain gauge vs Ports of Auckland sea level gauge



Combined ARI

Rainfall, Sea Level ARI

\+ ED imperviousness

Scott Stephens, Niwa, 2018

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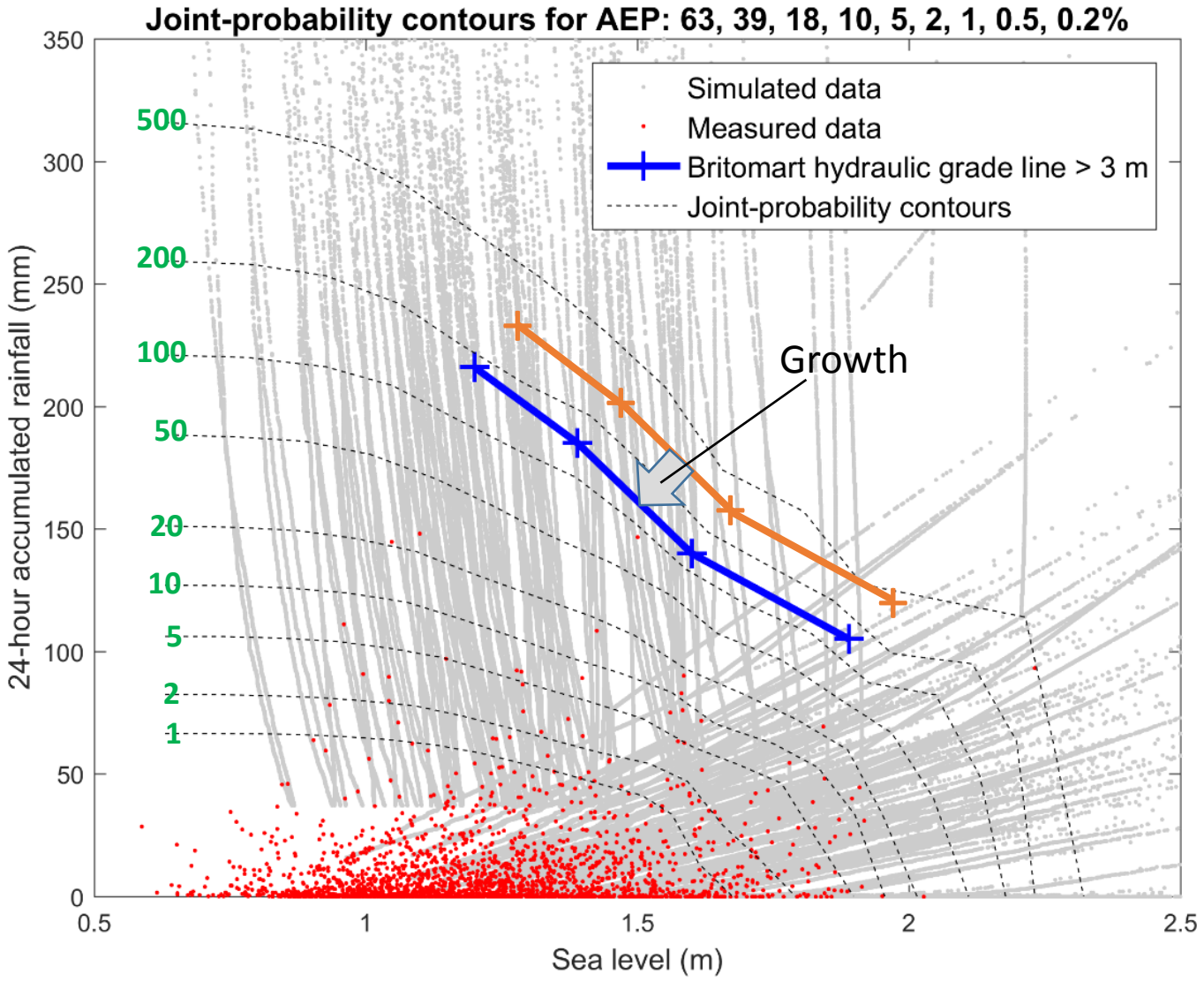

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Rainfall, Sea Level ARI

+ ED imperviousness

+ MPD imperviousness

Scott Stephens, Niwa, 2018

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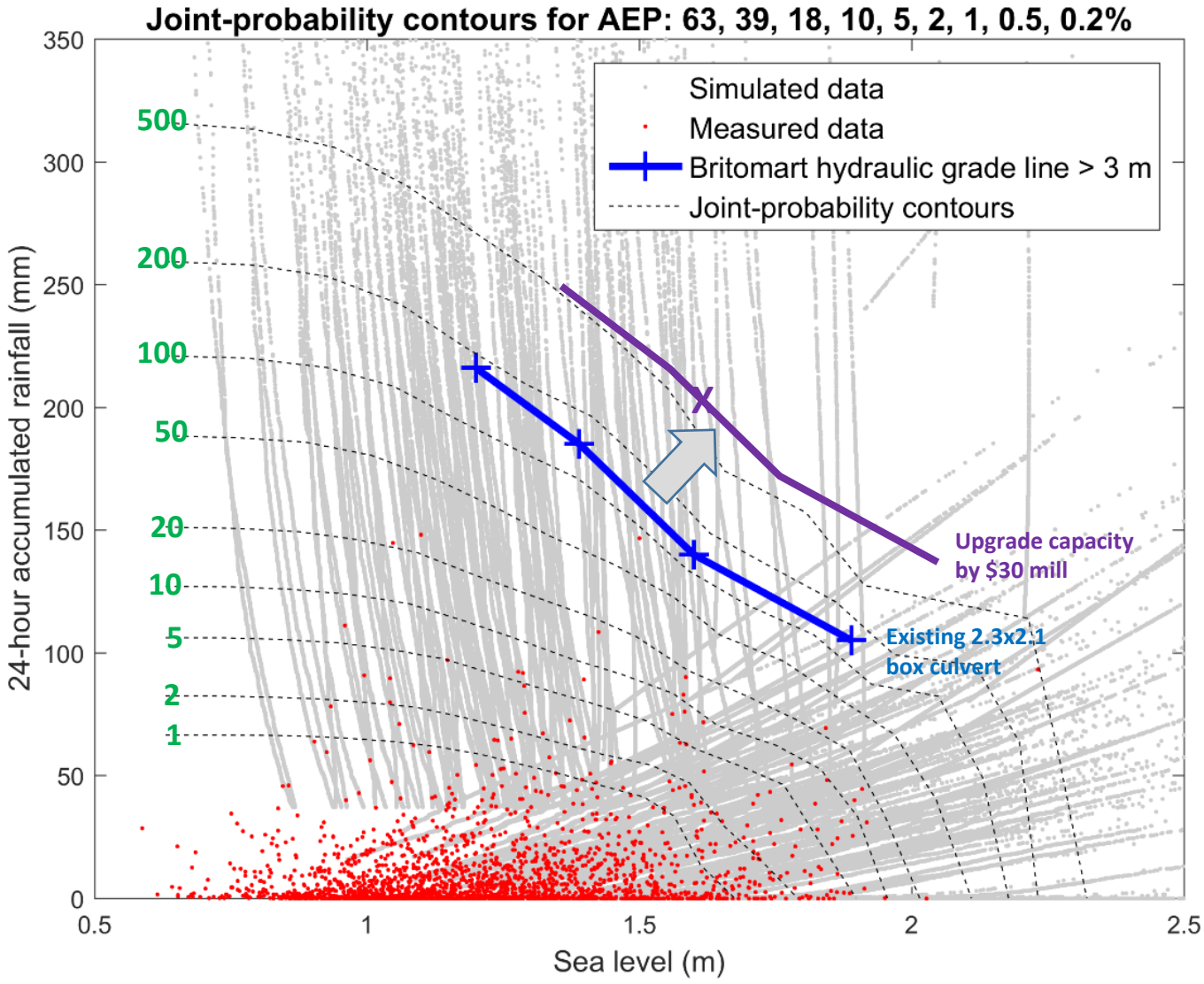

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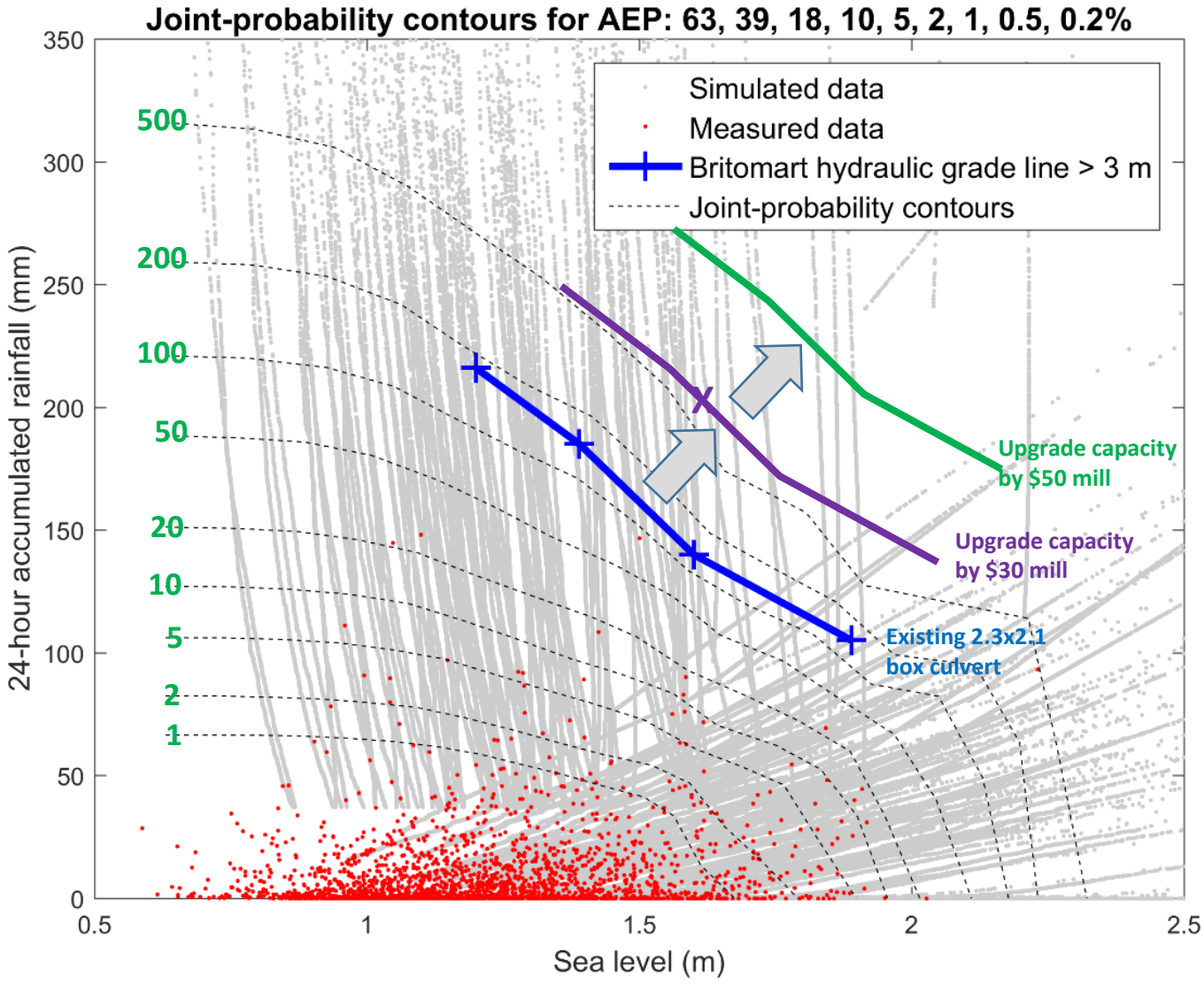

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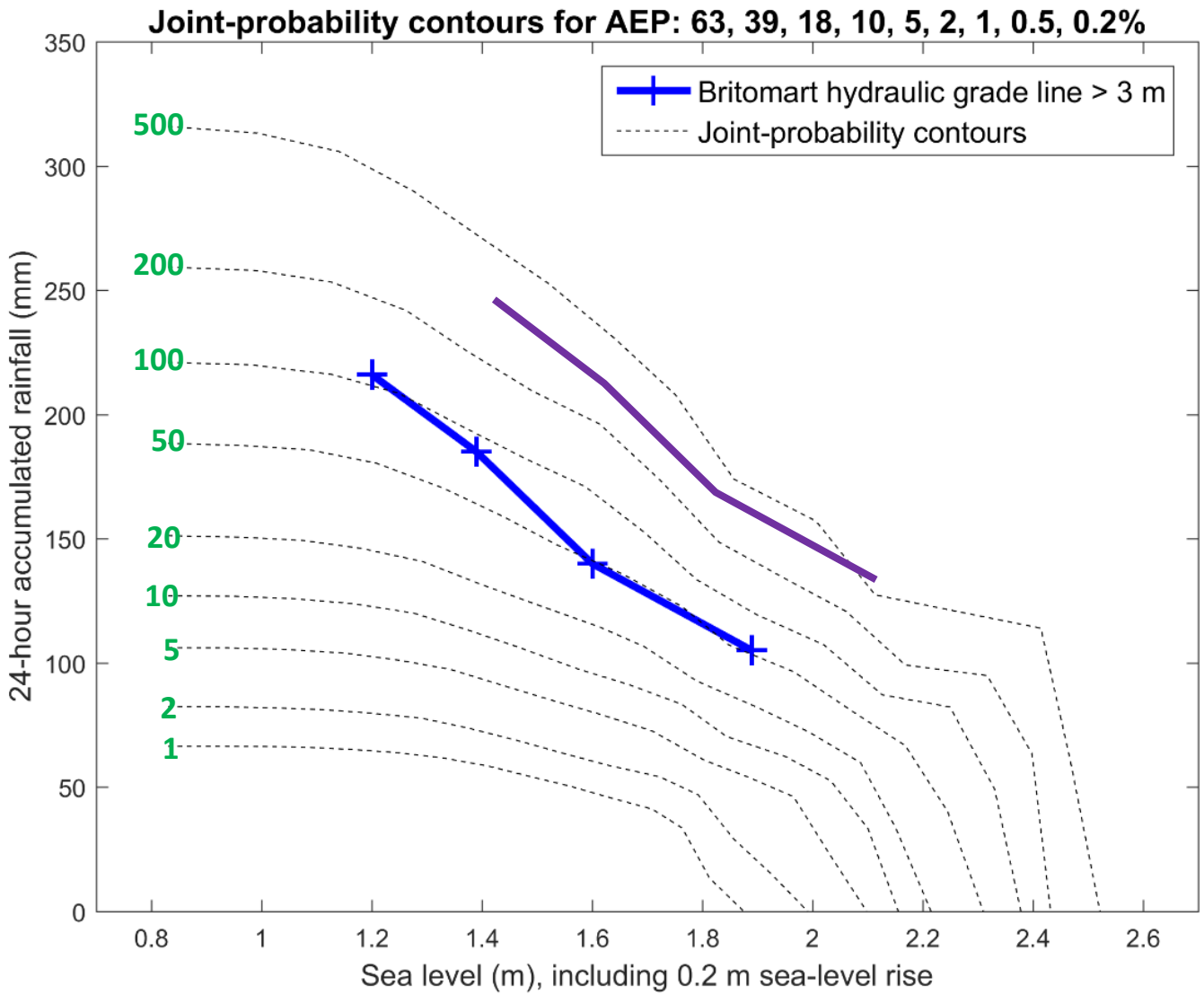

Scott Stephens, Niwa, 2018

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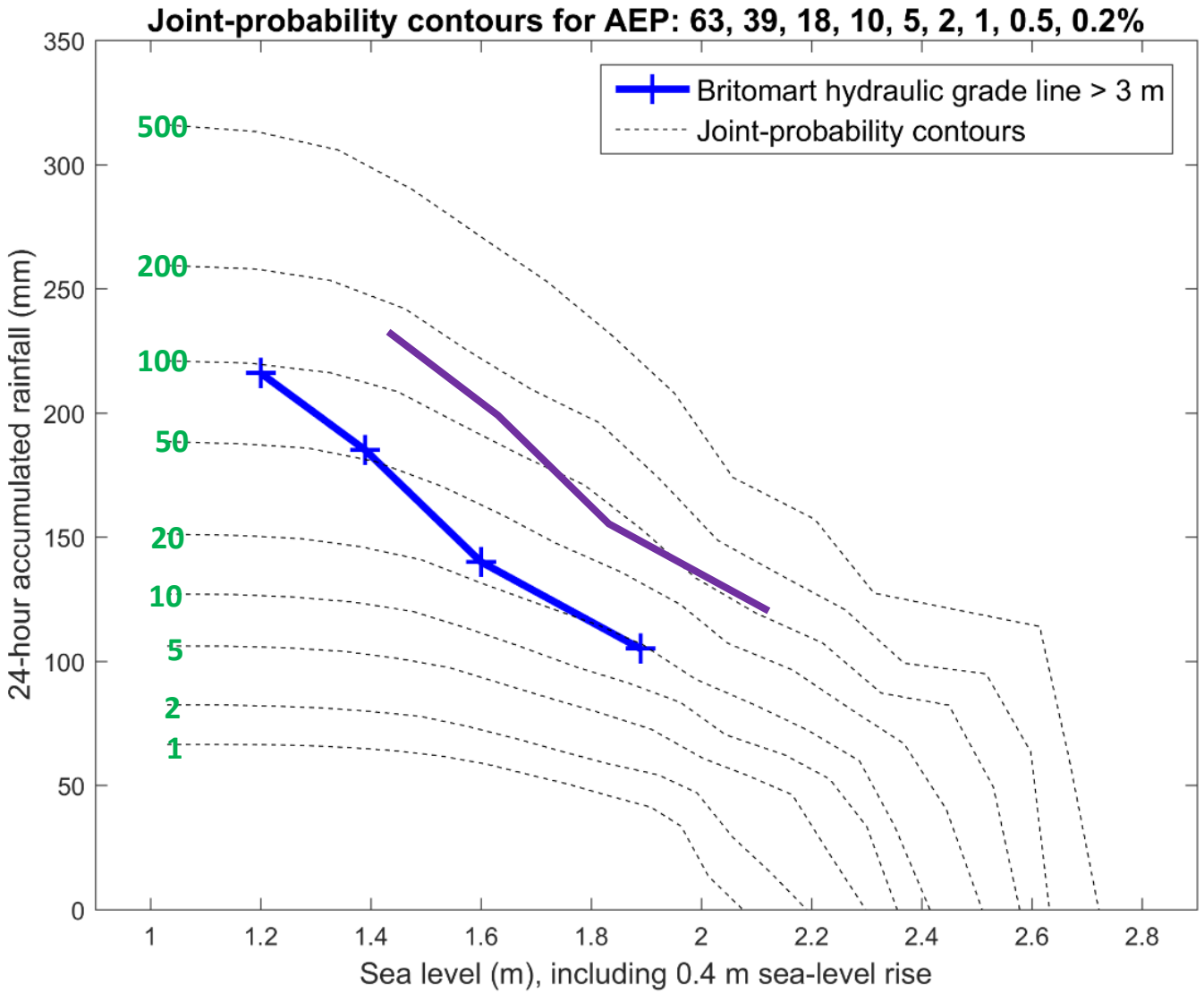

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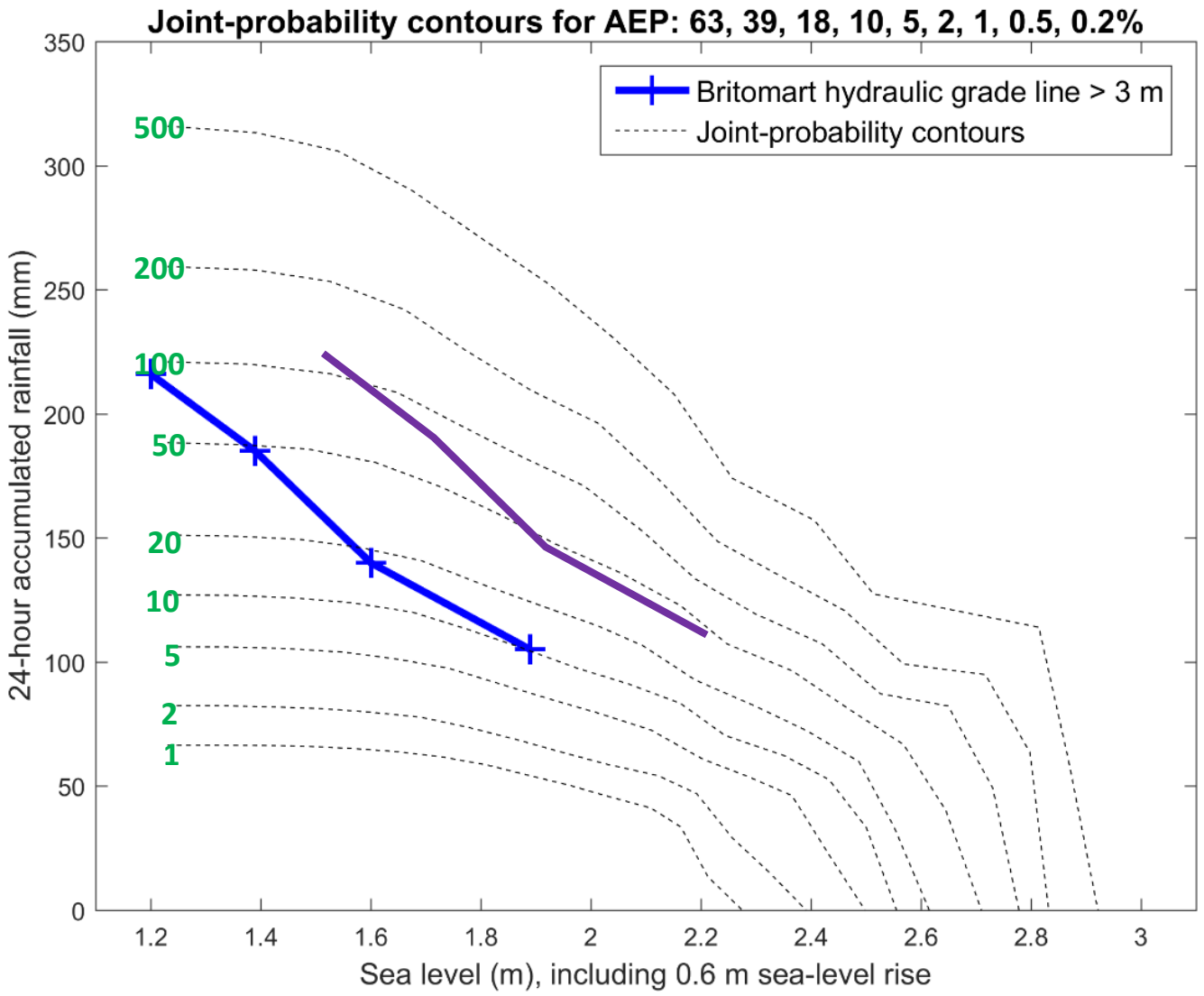

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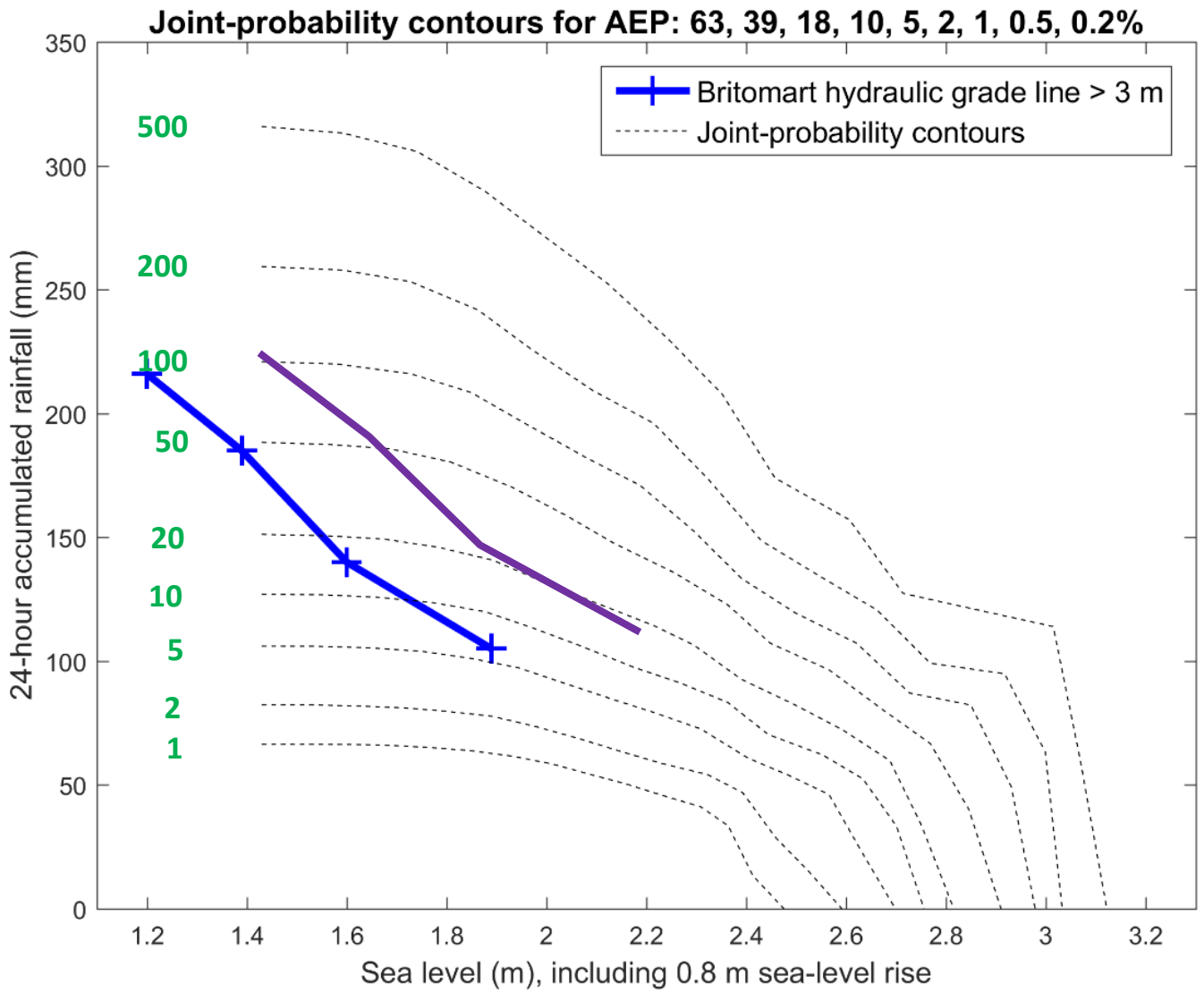

Scott Stephens, Niwa, 2018

The result

- $50 million is the optimal balance of reduced flood risk and cost
- $30 million is the affordable level
- But only future-proofed 20 years or so

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- $50 million is the optimal balance of reduced flood risk and cost
- $30 million is the affordable level
- But only future proofed 20 years or so

  - Do nothing goes from ARI of 100 to 200 years to an ARI of 5-10 years!!
  - After 20 years we will need to start pumping!

Keeping Water out of Portland Road

Automatic Flood Gates

Stream with 150ha catchment

Keeping Water out of Portland Road

Gates close at 1.2mRL
15% of time

Keeping Water out of Portland Road

Gates close at 1.2mRL
15% of time

Road at 1.5mRL, floods with 10mm of rain when the gates are closed

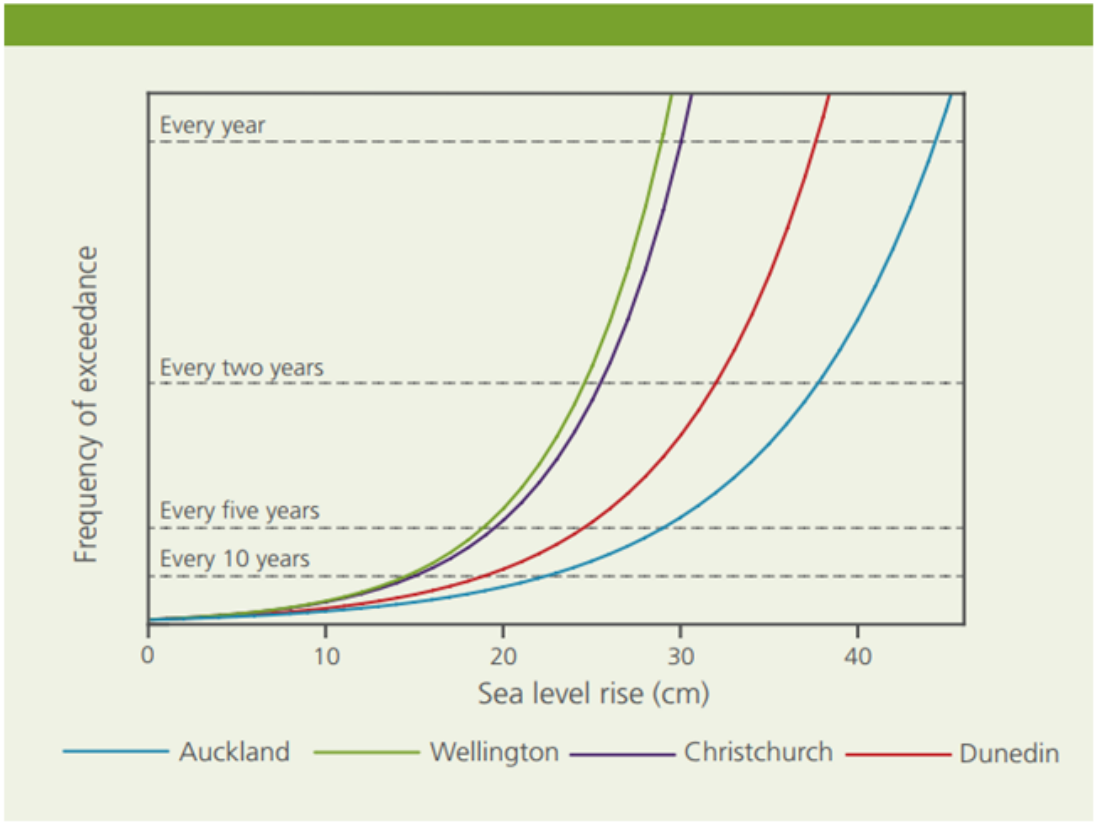
Option	CAPEX ($mill)	
Raise the Road to 1.9 mRL	2.5	Preferred
Diversion of the upstream catchment	2.0	Not effective
Major pump station	3.0	Big O&M $$

Road flooding frequency goes from twice per year to around once per 8 years.

But only good for about 20 years due to sea level rise

How Does Auckland Compare with other areas?

	Within 1.5m of spring high tide mark			
	Auckland	**Wellington**	**Christchurch**	**Dunedin**
Homes	1360	5008	9957	3604
Businesses	60	160	193	185
Roads (km)	56	58	201	72



Preparing New Zealand for rising seas: Certainty and Uncertainty, November 2015, Parliamentary Commissioner for the Environment.

Conclusions

Extreme Rainfall and Sea level together is highly unlikely,…or is it?

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Conclusions

Extreme Rainfall and Sea level together is highly unlikely,…or is it?

Can we afford to engineer against it?

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Conclusions

Extreme Rainfall and Sea level together is highly unlikely,…or is it?

Can we afford to engineer against it?

Frequent rainfall ***and*** highish tides are often the most likely and worst performing scenarios for coastal infrastructure

Can engineer against them for now,… but accept that in the near future, pumping or retreat will be required (Adaptive approach)

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Police stop wakeboarder trying to ride Remuera floodwaters behind car

10 Mar, 2017 7:07pm

Quick Read

Questions?

Whenuapai rain gauge vs Ports of Auckland sea level gauge

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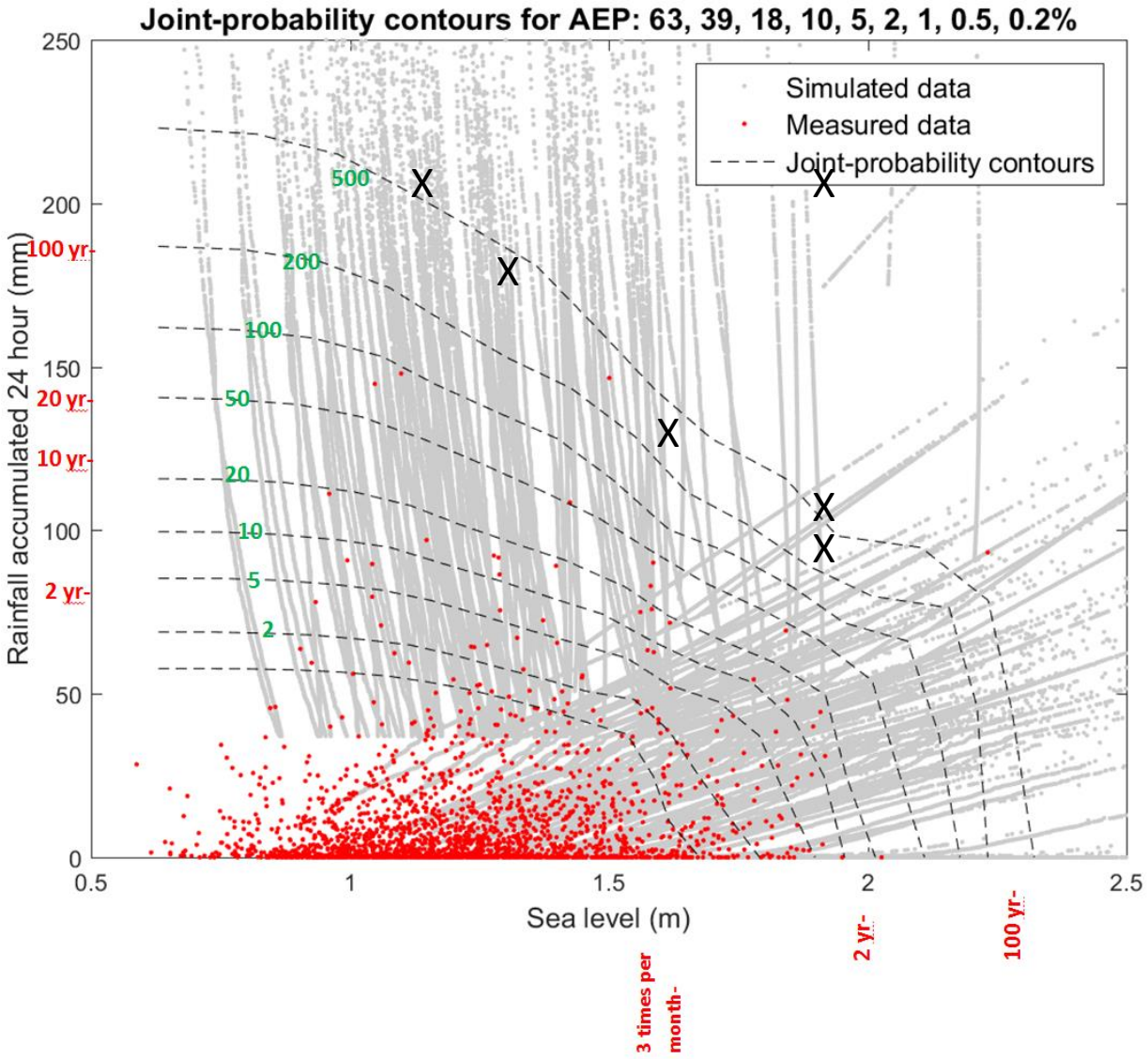

Combined ARI

Rainfall, Sea Level ARI

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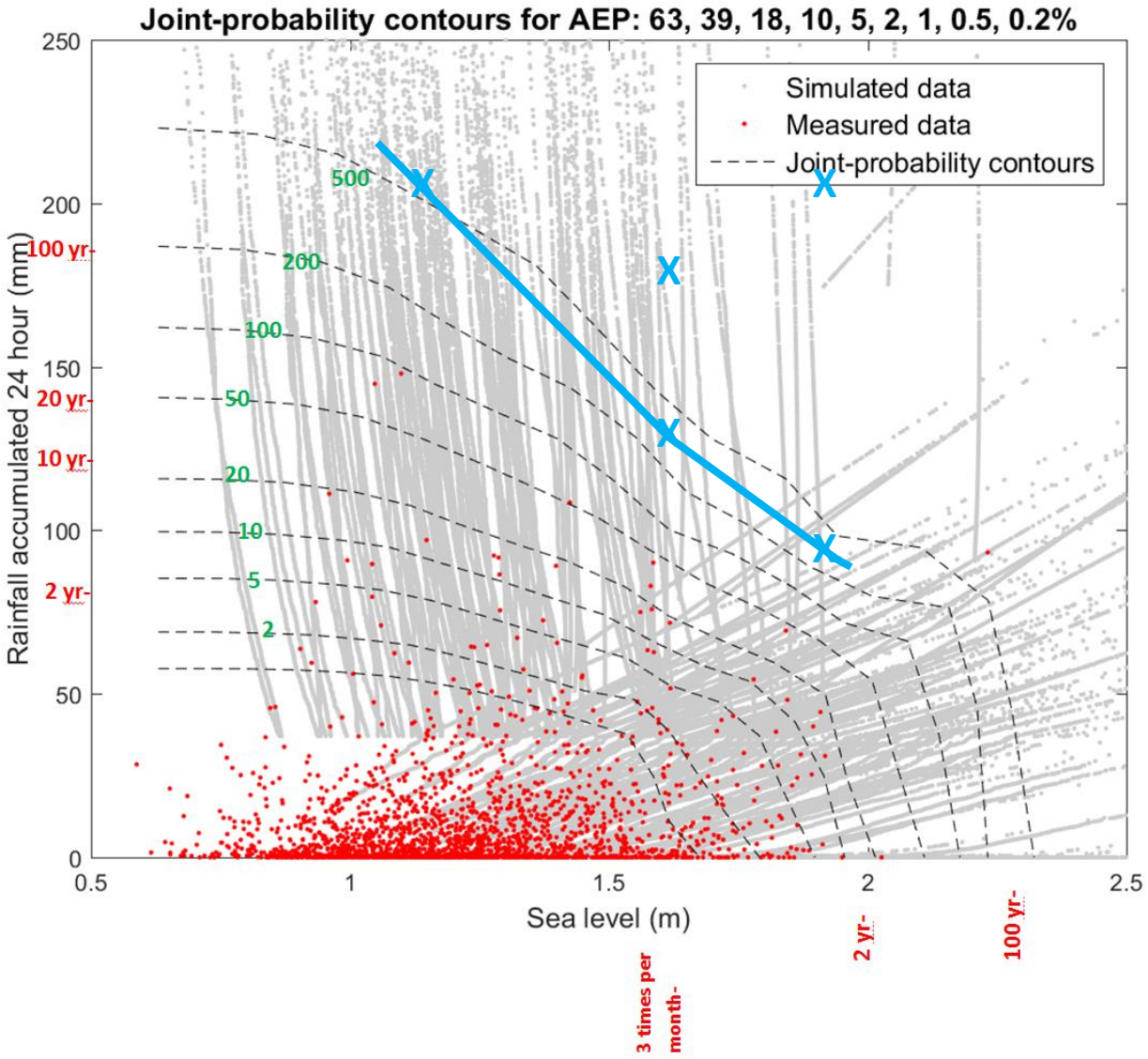

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Today

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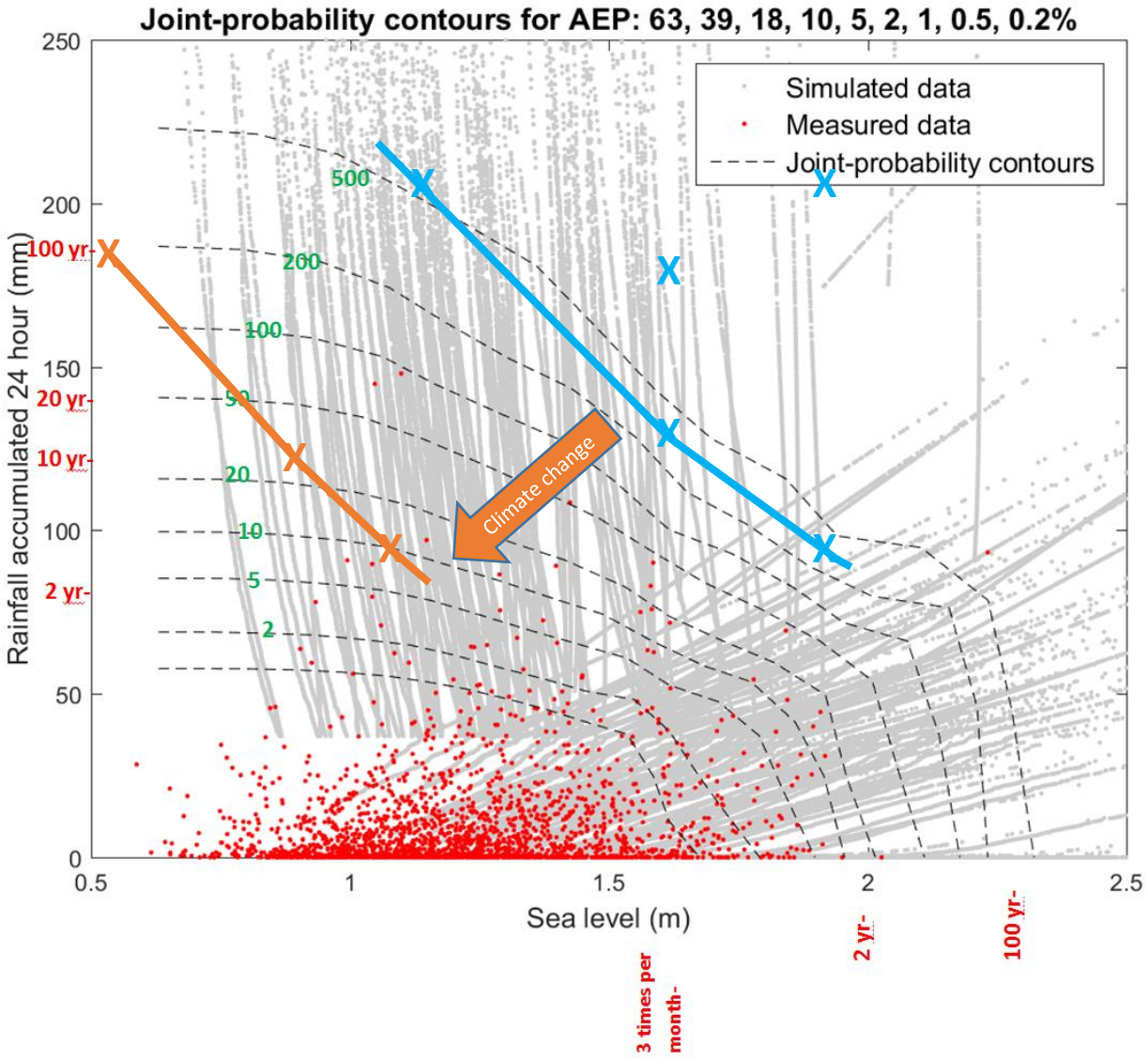

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Today

2100 (0.8m rise)

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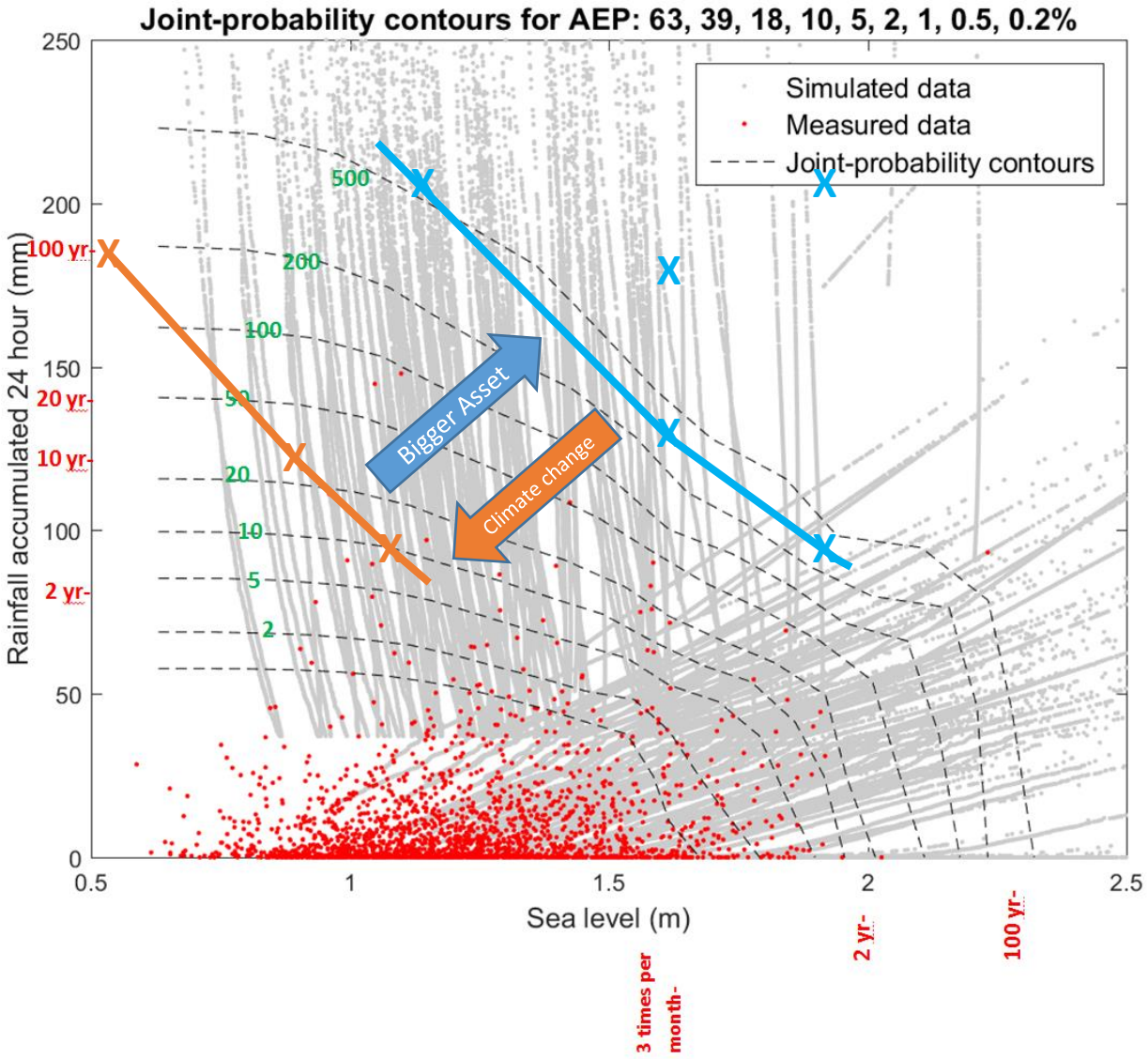

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