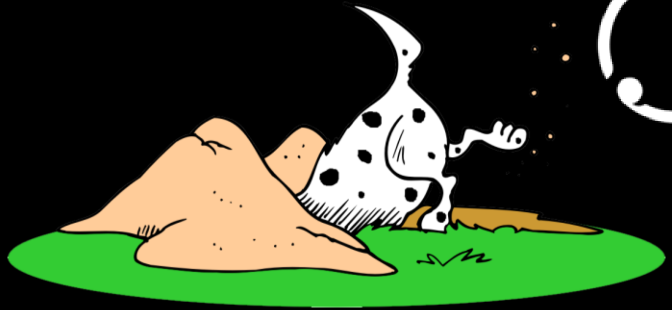
Digging Deeper:



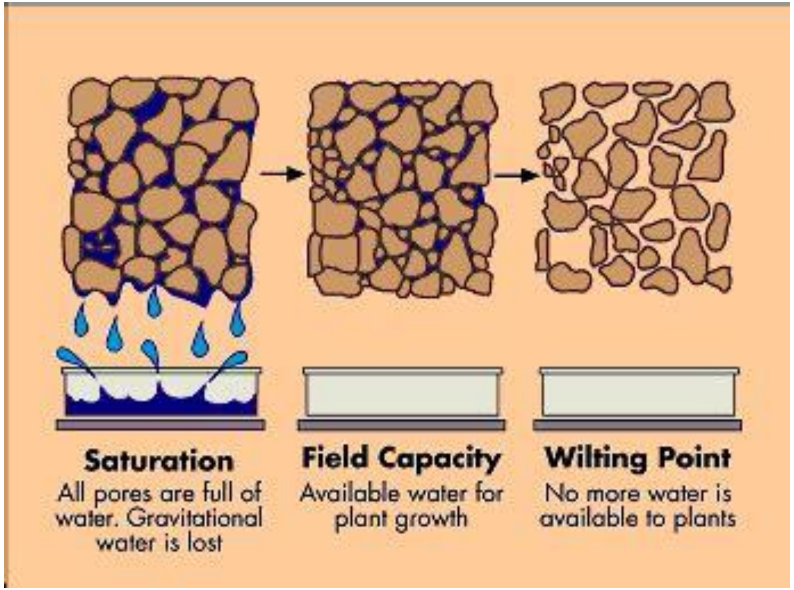
Improved Soil Water Retention Information in S-map

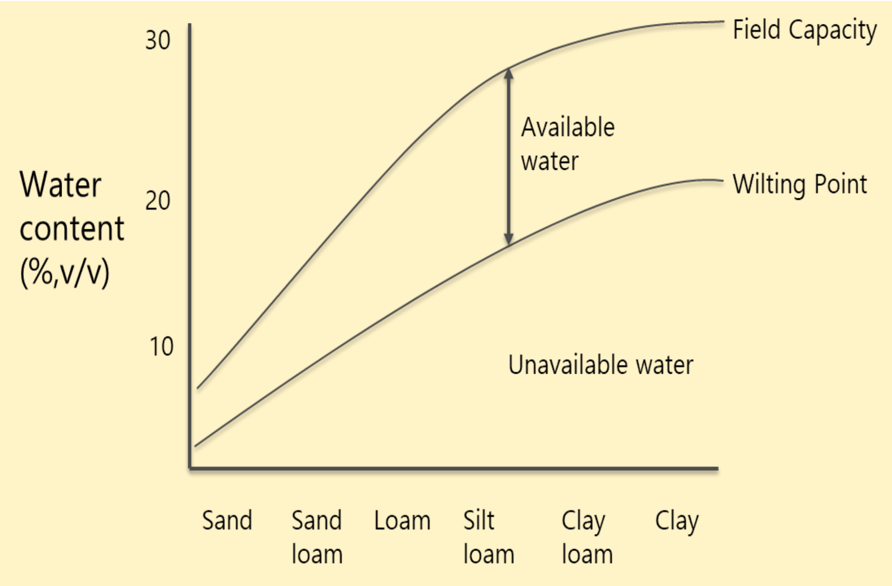
Linda Lilburne & Sam Carrick

MANAAKI WHENUA – LANDCARE RESEARCH

August 2020

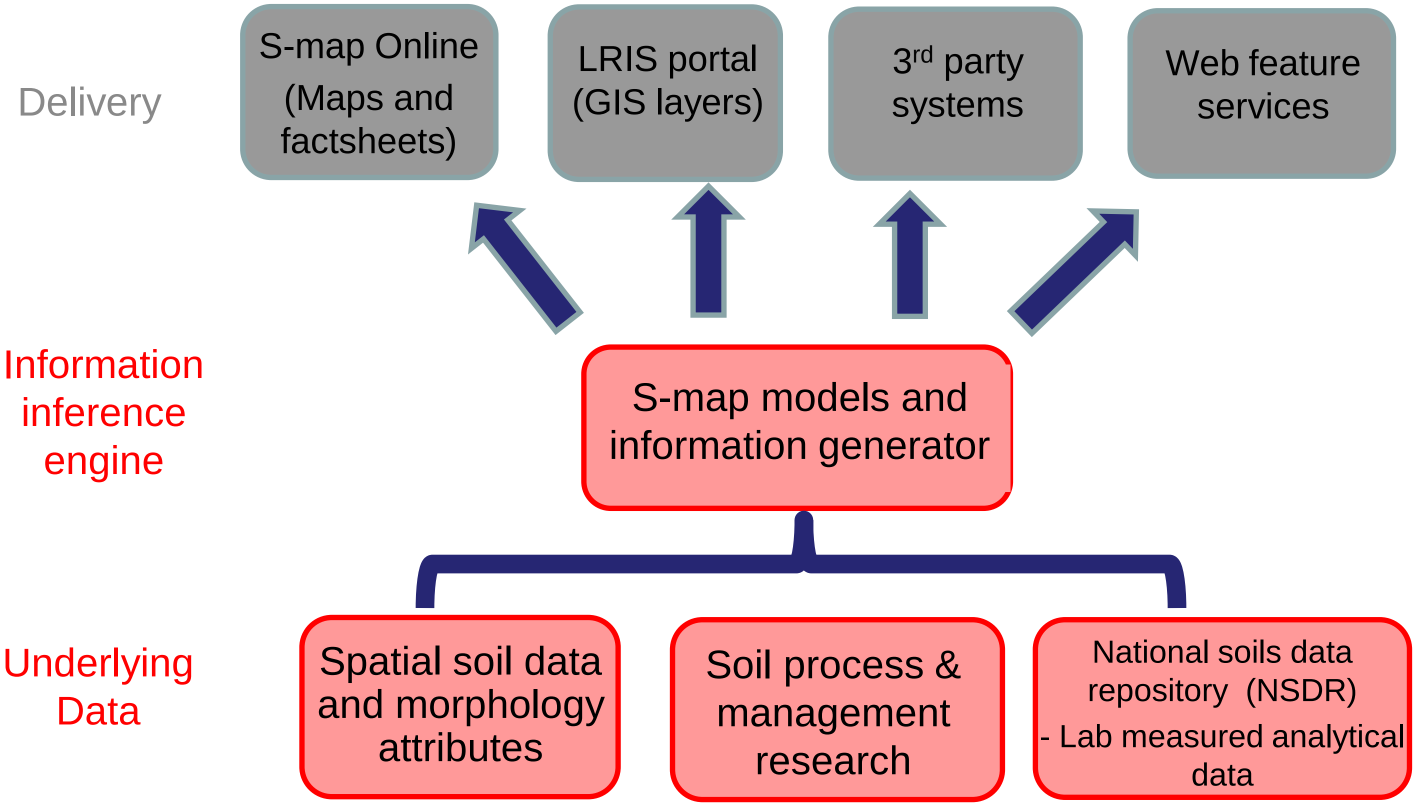
Soil Water Retention?





- National Approach
- Farm-based Approach

S-map information system

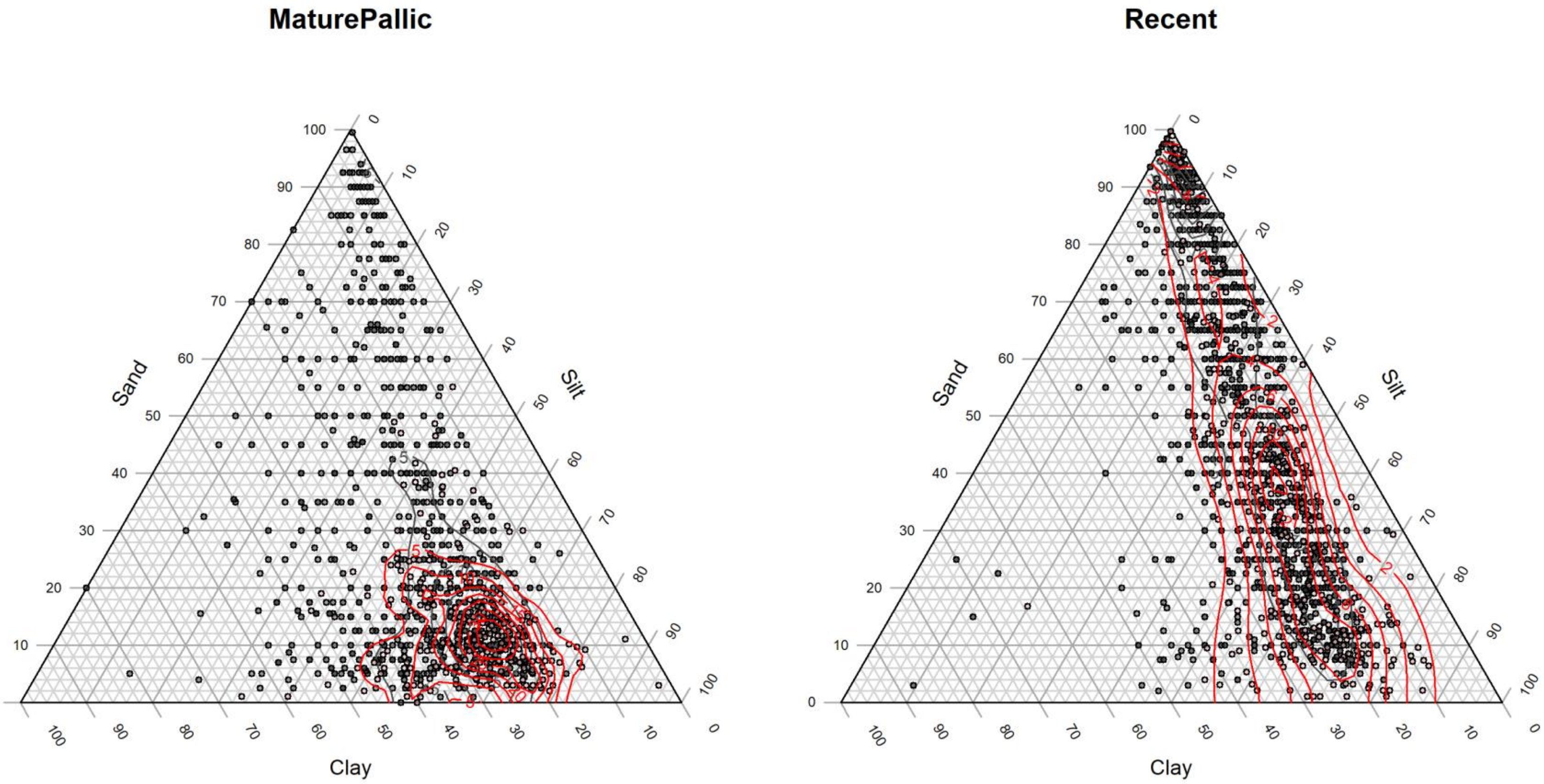


Additional data

- Laboratory data: mix of new and legacy data sources
- QA
- Significant increase in amount of data

	Total number sites		S-map area	Total samples	
Soil Order	**2014**	**2020**	**Mha**	**2014**	**2020**
Allophanic	20	42	0.9	80	264
Allophanic Brown	15	21	0.1	60	134
Granular	2	4	0.1	8	33
Immature Gley	11	24	0.2	50	196
Immature Pallic	13	101	0.5	59	655
Mature Gley	52	103	0.5	242	709
Mature Pallic	**29**	**72**	**1.1**	**147**	**595**
Melanic	9	13	0.1	48	99
Non-allophanic Brown	**56**	**139**	**2.2**	**236**	**726**
Organic	0	5	0.1	0	41
Oxidic	6	8	0	29	58
Podzol	20	29	0.5	80	206
Pumice	**9**	**18**	**1.1**	**40**	**108**
Recent	**52**	**85**	**1.2**	**229**	**634**
Semi-arid	12	11	0.1	55	97
Ultic	7	9	0.1	36	86
Total	**313**	**684**	**9.1**	**1399**	**4641**

Representativeness of the measured data



Plots showing the distribution of S-map horizon textures (black points and contours) with the distribution of texture in the training dataset (red contours)

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Pedotransfer functions for the soil water characteristics of New Zealand soils using S-map information

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A R T I C L E I N F O

Handling Editor: A.B. McBratney

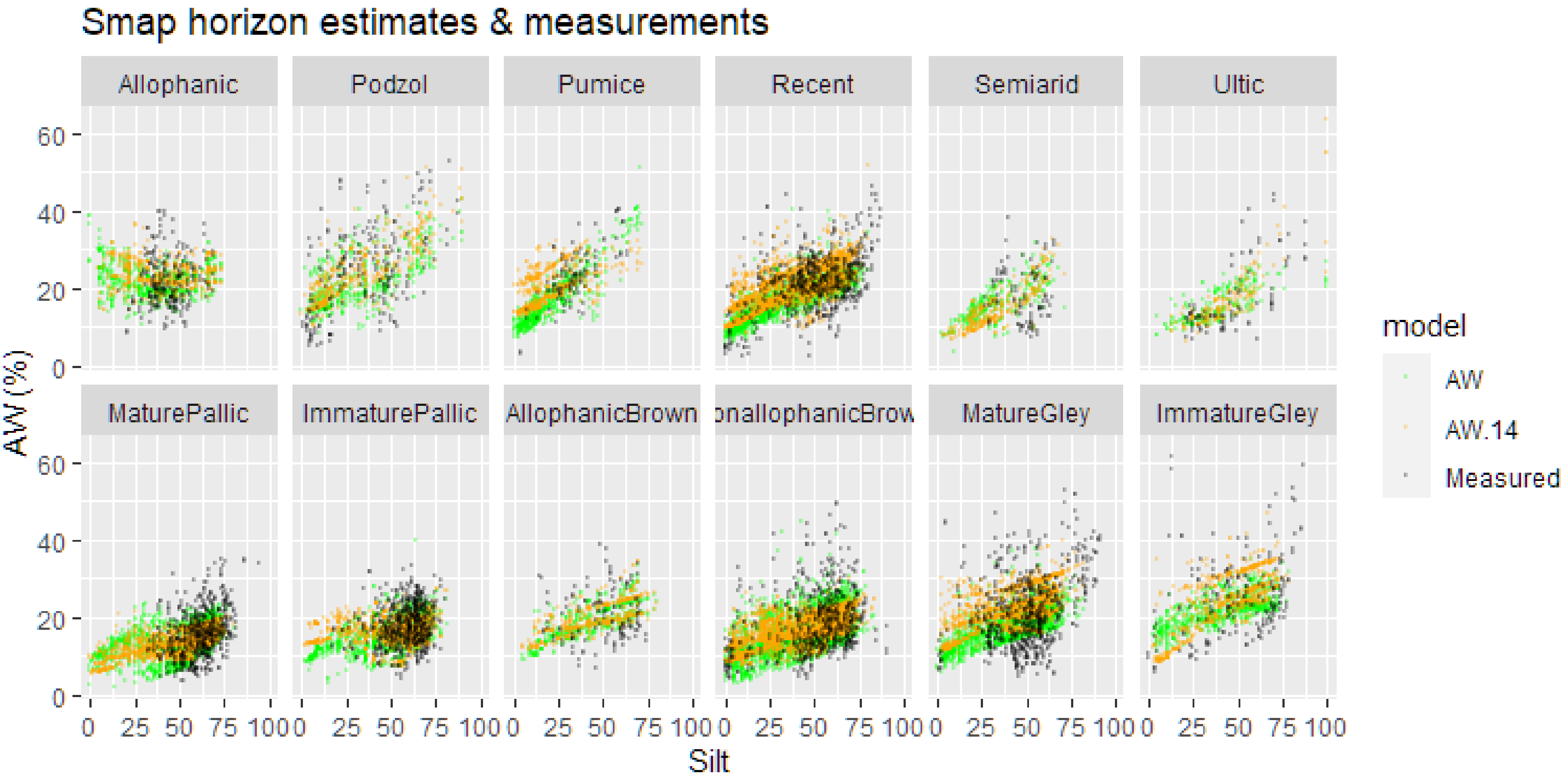
Keywords:
Pedotransfer functions
Soil water response
Hydraulic properties

A B S T R A C T

Empirical pedotransfer functions (PTFs) have been developed for estimates and the uncertainty of soil water content at different tensions, using explanatory variables from a soil information system for New Zealand (S-map). The explanatory variables include the soil order classification, texture, and parsed information from the S-map functional horizon description. Three models have been considered. The first uses a linear model based on the logit transformation to convert the bounded soil water response range to unbounded form. The second uses beta regression, which models the location and scale of the response separately. Finally, we consider a common response model that includes the tension as an explanatory variable to fit the soil water response at all tensions.

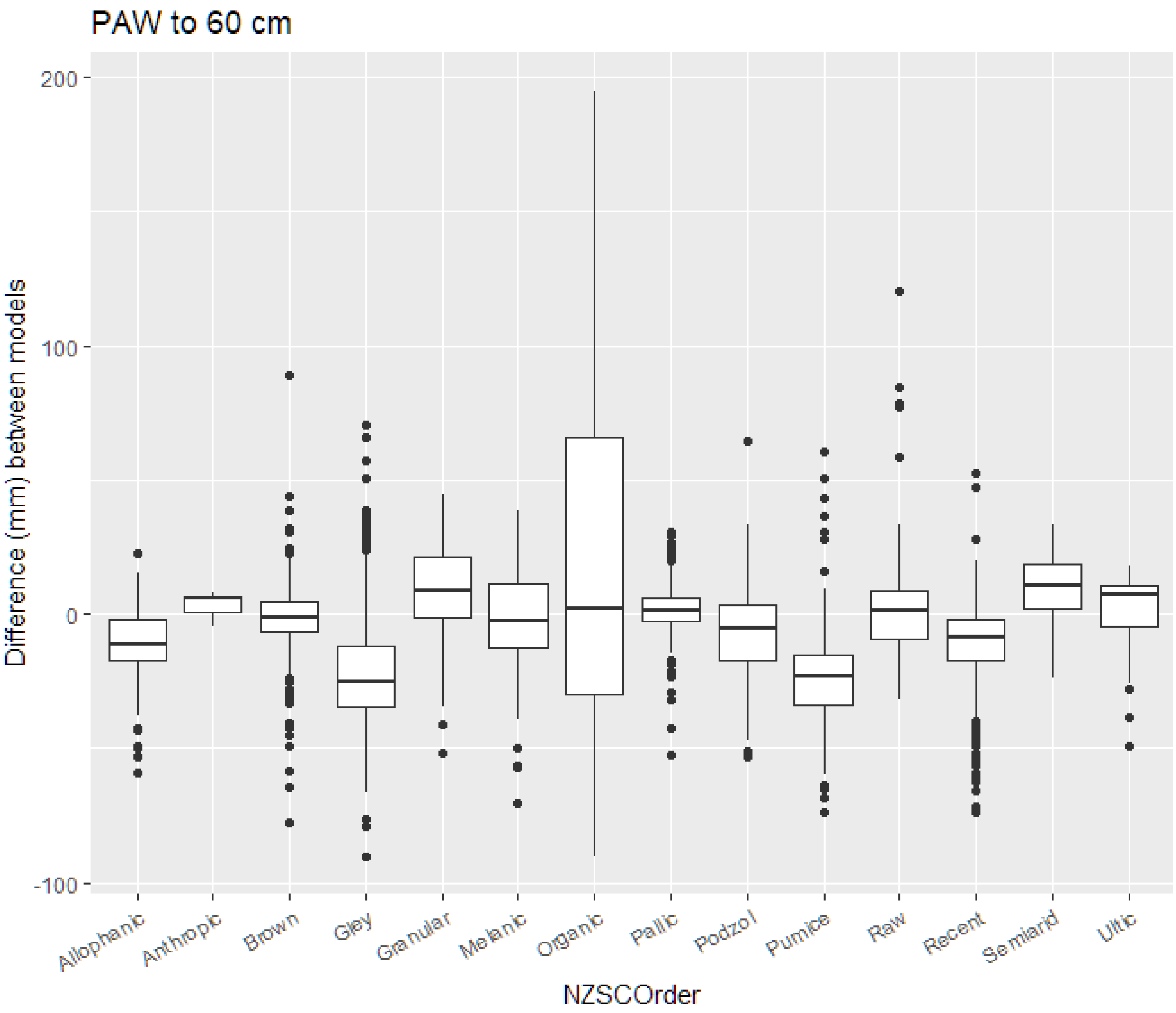
A feature of the PTFs is the consistent development of the uncertainty of estimates. All regressions are constrained within the range bounded by 0 and 100%, while the logit transformation and beta regression models are constrained so that response differences are bounded; this ensures that the response is monotonic with respect to tension. For the logit and beta regression methods, the constraint of range (0–100%), monotonicity, and order of uncertainty calculation are simultaneously maintained for all tensions, ensuring that derived estimates such as total available water (TAW), and macroporosity, and their uncertainty, are physically consistent.

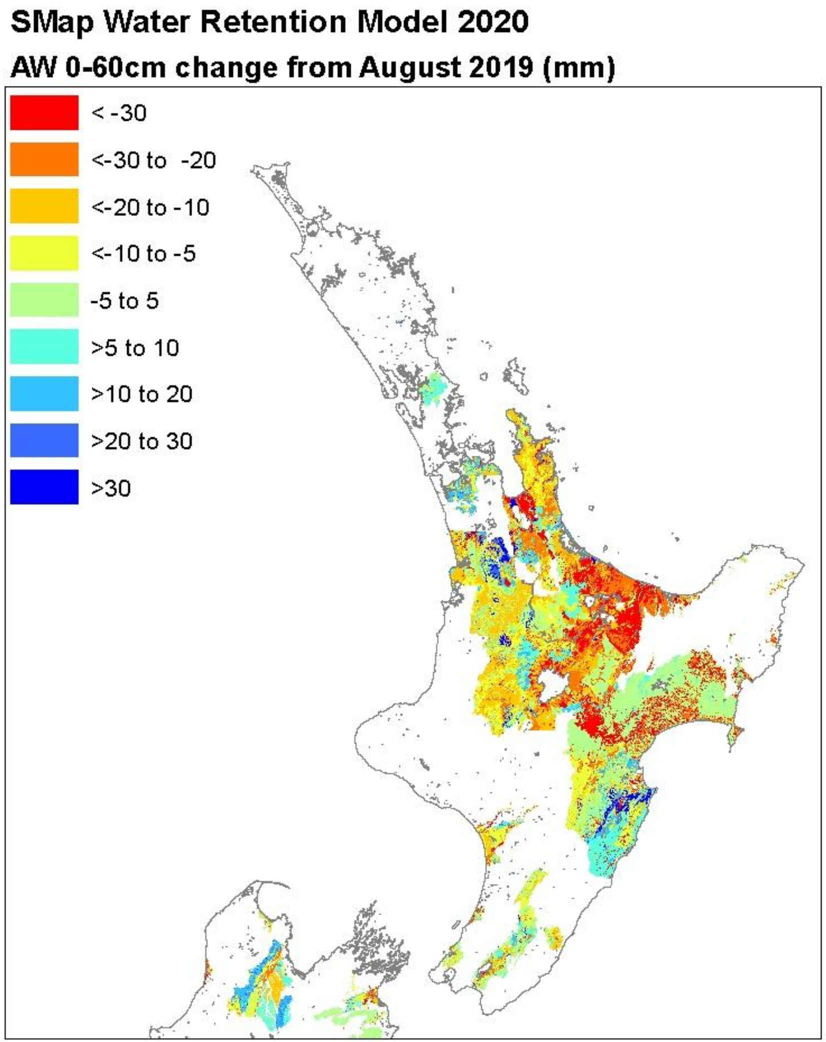
The available data was split between a fitting and an independent validation dataset used for verification of the uncertainty model. Using the independent validation dataset, none of the models showed any evidence of over-fitting. The logit-transformation model was selected because it provided the lowest reliable estimate of mean absolute error and root mean square error in soil water response, TAW, and macroporosity, with uncertainty estimates based on posterior simulation. In the case of certain soil orders, a bias in the estimated TAW is evident at high values, although its origin is not clear. The selected model is used as the soil hydraulic response pedotransfer function used in the S-map inference engine to provide estimates of water content and available water for a wide range of New Zealand soils.

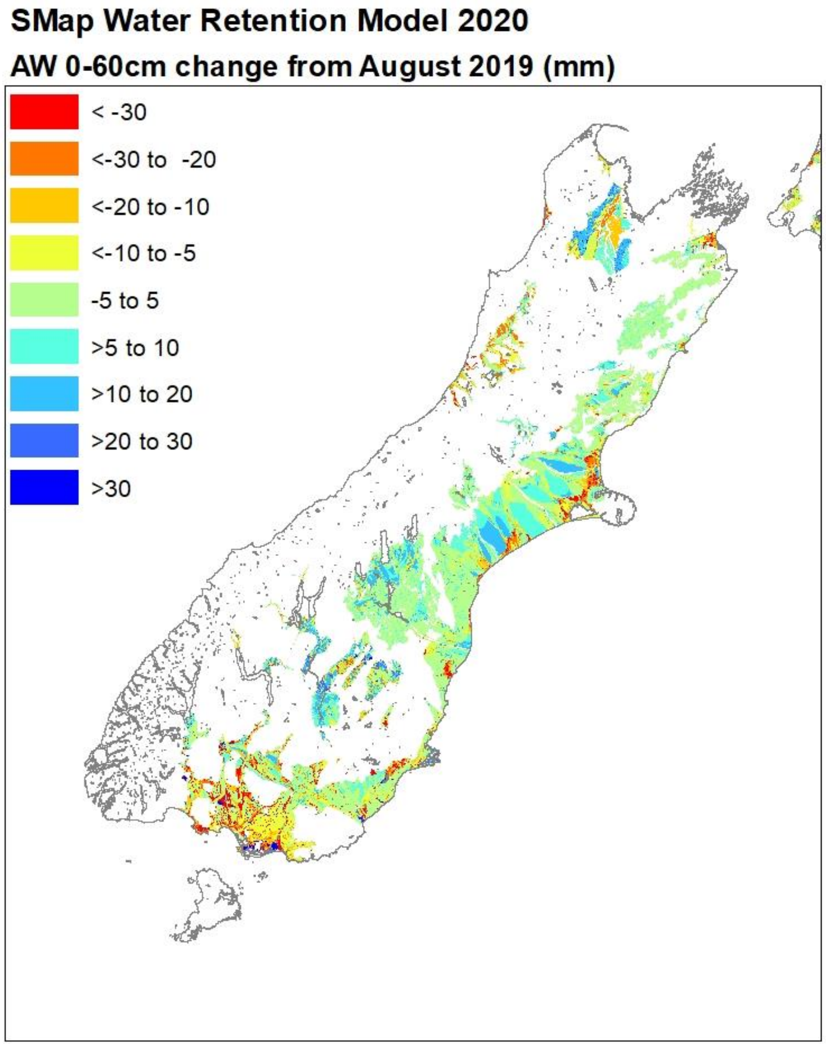

Smap horizon estimates & measurements
Allophanic
Podzol
Pumice
Recent
Semiarid
Ultic
MaturePallic
ImmaturePallic
AllophanicBrown
onallophanicBrow
MatureGley
ImmatureGley
AW (%)
0
20
40
60
0
25
50
75
100
Silt
model
AW
AW.14
Measured

2014 model	2020 model
Logistic regression	Beta Regression (McNeill et al. 2018) Additional input parameter (depth) Change the default values for Organic horizons
sites for development : 313	684 sites
samples used to train model: 1,119	3,713 samples
samples used to validate model: 280	928 samples
Very low sites and samples for some soil orders	All soil orders increased by 2 to 4 fold, but some still have low site and sample numbers
Stones have 0% water	Water content of stones based on recent research
Limited error info	Full error model
Less robust: 838 sibling horizons in S-map cannot be predicted 424 siblings (10%) do not have Overseer soil moisture values (predictions were too unreliable)	More robust: 4 sibling horizons in S-map cannot be predicted 4 siblings do not have Overseer soil moisture values

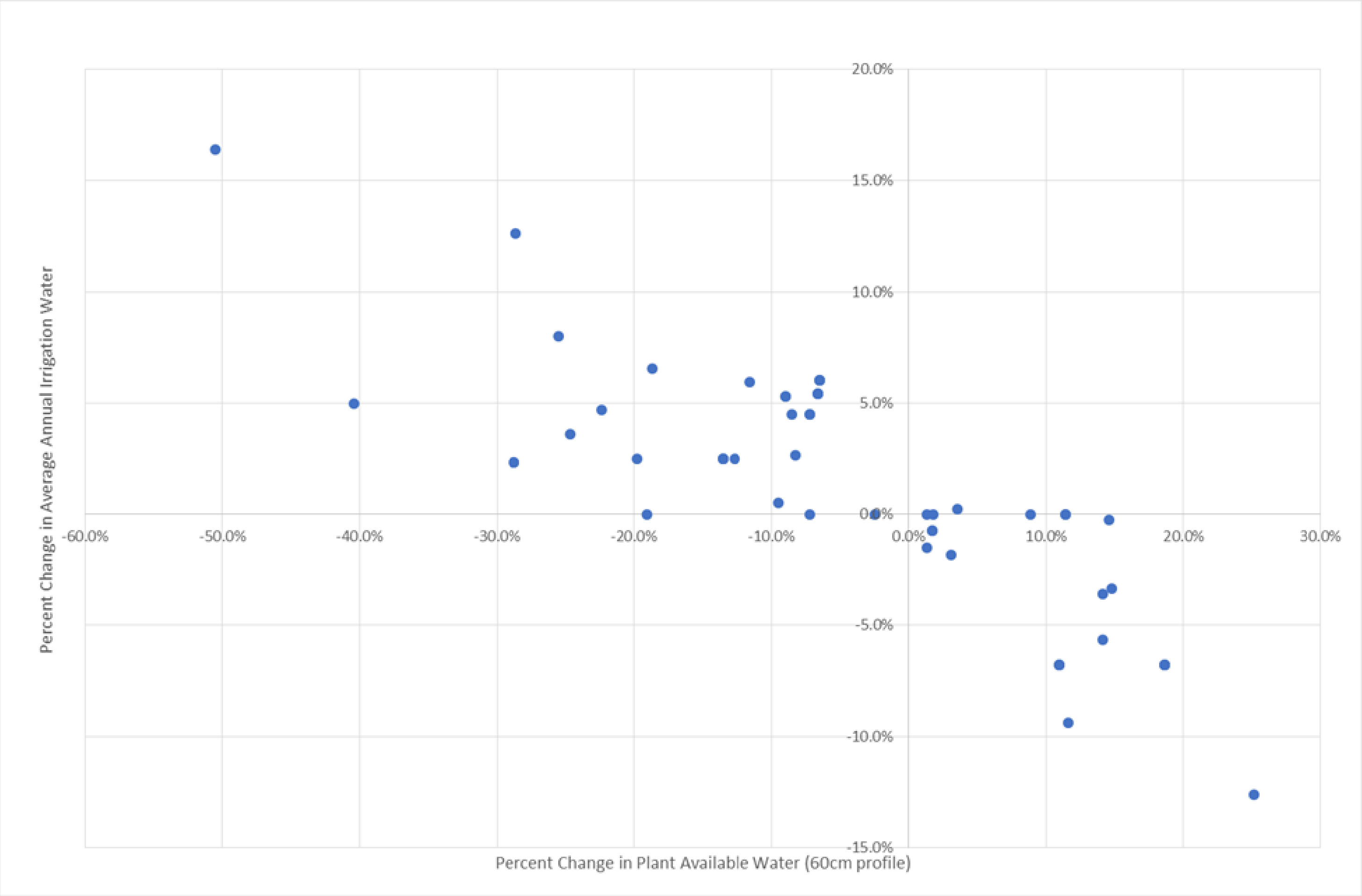
NZSC Order	AW60 2020 median change (mm)	Smap area (Mha)
Allophanic	**-9.8**	**0.9**
Anthropic	6	<0.1
Brown	**-1.3**	**2.3**
Gley	-23.5	0.7
Granular	8.4	0.1
Melanic	-2.3	0.1
Organic	1.9	0.1
Pallic	**1.6**	**1.6**
Podzol	-5.4	0.5
Pumice	**-23.2**	**1.1**
Raw	1.7	0.3
Recent	**-8.2**	**1.2**
Semiarid	8.7	0.1
Ultic	6.4	0.1
Overall	-4.5	9.1




SMap Water Retention Model 2020
AW 0-60cm change from August 2019 (mm)
< -30
<-30 to -20
<-20 to -10
<-10 to -5
-5 to 5
>5 to 10
>10 to 20
>20 to 30
>30


SMap Water Retention Model 2020
AW 0-60cm change from August 2019 (mm)
< -30
<-30 to -20
<-20 to -10
<-10 to -5
-5 to 5
>5 to 10
>10 to 20
>20 to 30
>30

Irricalc impact analysis



Overseer

Overseer impact analysis

Nutrient budgets will not be auto-updated

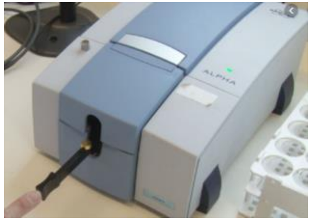
Percentage change	N loss/ha count	N loss/ha %	GHG count	GHG %
> 50% increase	108	0.3%	-	0%
> 40% increase	245	0.8%	-	0%
> 30% increase	593	1.8%	-	0%
> 20% increase	1,714	5.3%	-	0%
> 10% increase	5,560	17.1%	-	0%
0 to 10% increase	9,286	28.6%	16,780	56.7%
no change	4,835	14.9%	1,782	6%
0 to 10% decrease	9,007	27.8%	10,985	37.1%
> 10% decrease	866	2.7%	7	0%
> 20% decrease	149	0.5%	7	0%
> 30% decrease	51	0.2%	7	0%
> 40% decrease	25	0.1%	7	0%
> 50% decrease	11	0.03%	7	0%

S-map Farm Test - vision

To develop a method by which a range of consultants, who may have limited soil expertise, can cost-effectively characterise a broad range of soil profile attributes at the farm or paddock scale, and which would support farm management decisions and planning.

S-map Farm Test – proof of concept study

Collection of rapid soil cores
(**by consultants, technical staff**)



Rapid, cost efficient lab spectral scan by Vis Near or Mid Infra Red

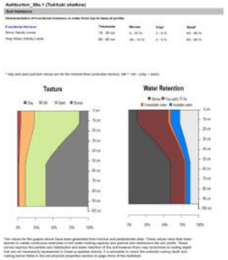
S-map calibration equations

Quantitative prediction of a range attributes from scan e.g:

- Particle size
- Carbon
- Water holding capacity
- Soil order
- P-retention
- pH

Farm specific soil characterization for a range of uses e.g.

- Overseer
- FEP's
- Crop production models
- Irrigation mgmt
- Effluent mgmt



API direct data feed

OVERSEER®

Key messages

- S-map is science driven (which means change from time to time)
- Better information for farm management & environmental outcomes
- MBIE prog has allowed us to double the reference data

New national model

- Significant improvement in the soil water retention model robustness
- National scale model -> all soil moisture data values will change

Proof of concept S-map Farm Test

- Real potential for applying S-map science at the farm scale
- Presented a proof of concept of how that might work – hope to put together a partnership to progress this

Acknowledgements: MBIE, MPI, Regional Councils, FANZ, farmers