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Relationship between Soil Moisture Content and Salinity Degree in the Salt-Affected Soils in Khon Kaen, Northeast Thailand

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新道から統合へー社会からの発展
東北工業大学



Introduction

Salt-affected soil is an excessive accumulation of salts, includes various compounds of sodium, potassium, calcium, magnesium, sulfates, chlorides, etc.



Introduction (cont.)

Salt-affected soil types

Classification	Electrical conductivity (dS m ⁻¹) ^a	Soil pH	Sodium adsorption ratio (SAR) ^b	Exchangeable sodium percentage (ESP)	Soil physical condition
Normal	<4.0	<13	6.5-7.51	<15 below	Good
Saline	>4.0	<8.5	<13	<15	Normal to poor
Sodic	<4.0	>8.5	>13	>15	Very poor
Saline-sodic	>4.0	<8.5	>13	>15	Poor

^adS m⁻¹ = mmho cm⁻¹.

https://www.researchgate.net/publication/308675539_Halotolerant_Plant_Growth_Promoting_Bacteria_Mediated_Salinity_Stress_Amelioration_in_Plants/figures?lo=1&utm_source=google&utm_medium=organic

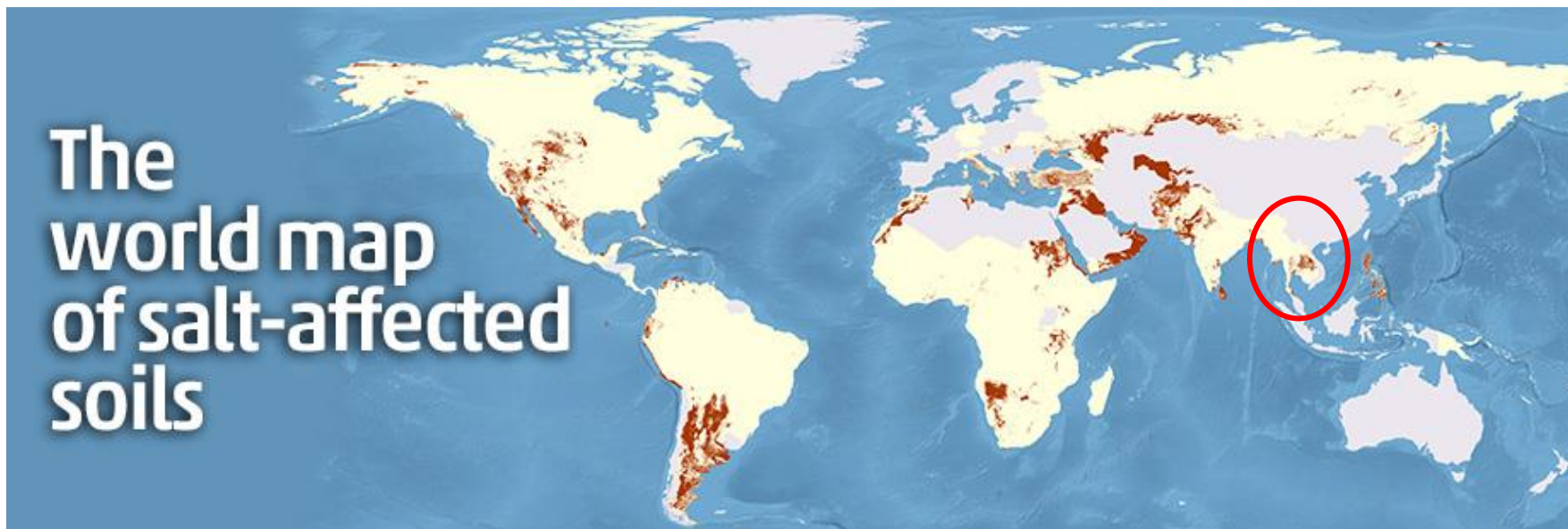
Salinity Class	Non-saline	Slightly saline	Moderately saline	Severely saline	Very severely saline
ECe (dS/m)	< 2	2- 4	4 - 8	8 - 16	>16

Introduction (cont.)

The spatial distribution of salt-affected soil with $EC_e > 2$ dS/m, $ESP > 15\%$ and $pH > 8.2$ at two depth intervals (0-30 cm and 30-100 cm)

>> 85% of salt-affected top soils are saline, 10% are sodic and 5% are saline-sodic

>> 62% of salt-affected sub soils are saline, 24% are sodic and 14% are saline-sodic.



<https://www.fao.org/global-soil-partnership/gasmap/en/>

Introduction (cont.)

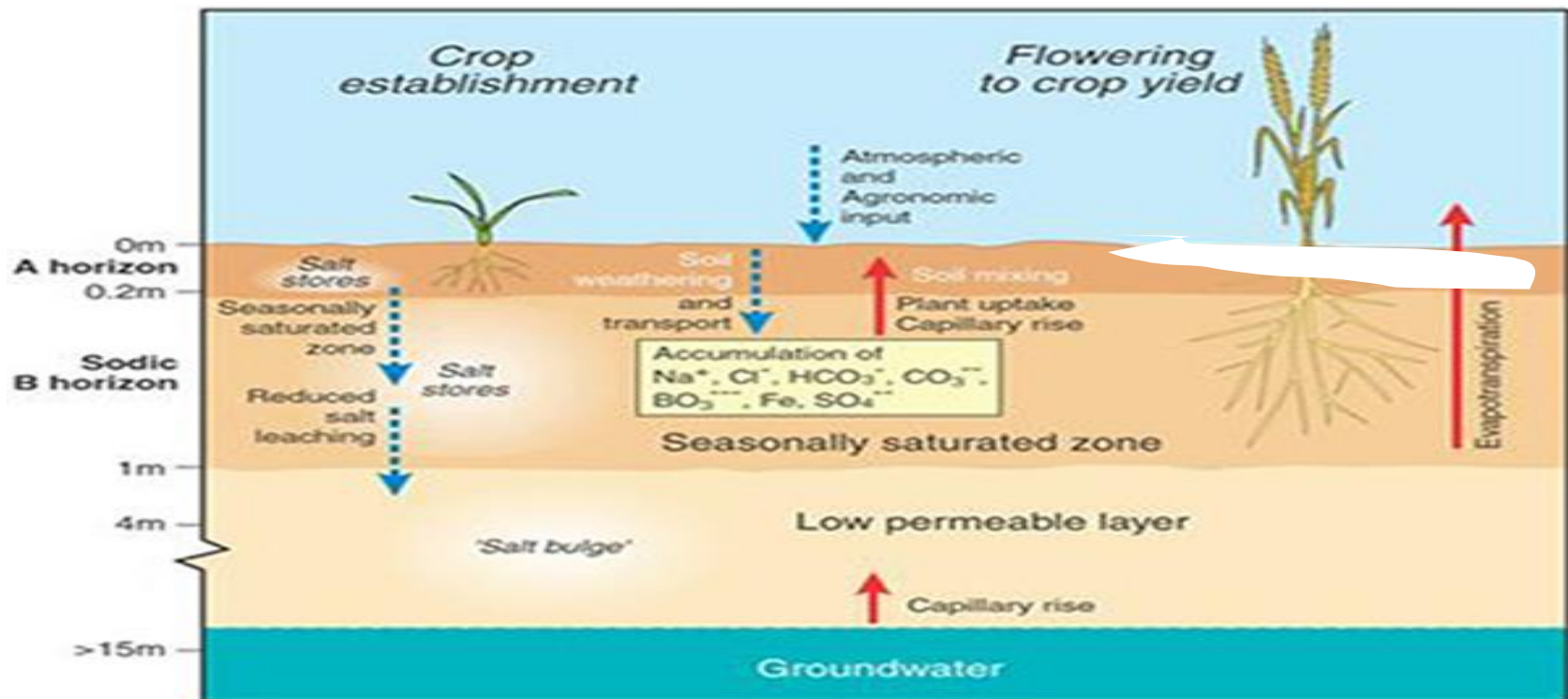
Salt-affected soil is influenced by factors

>>primary factors

– climate, precipitation, and parent material

>>secondary factors

-- manmade, climate change, landform, and rainfall pattern



Introduction (cont.)

Impact of a salt-affected soil

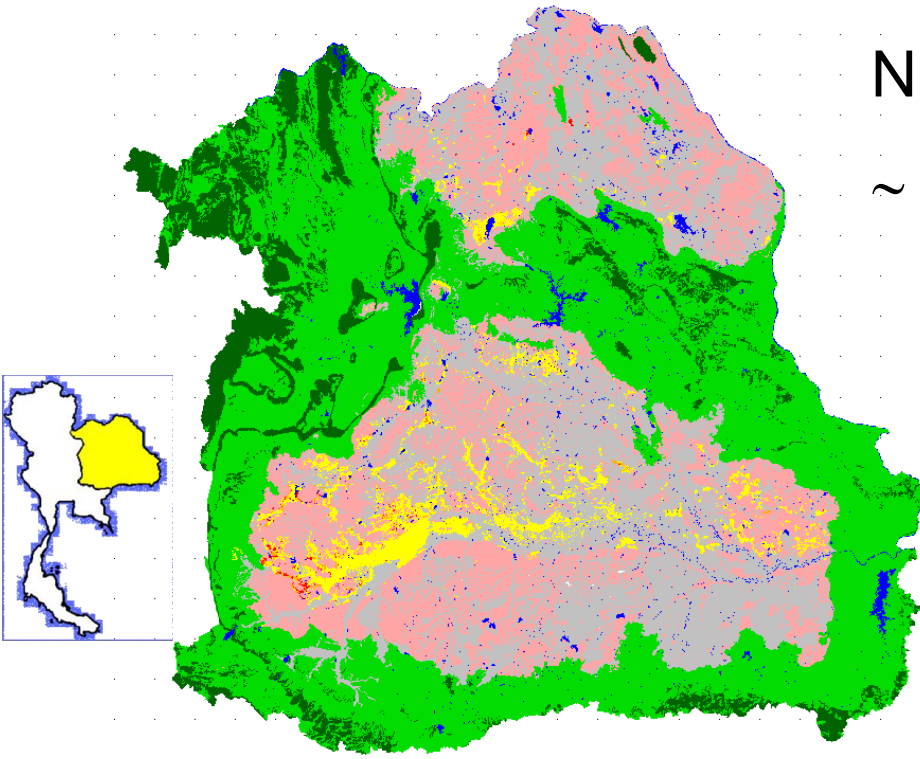
- Decrease a productivity land
- Decrease soil fertility, soil biodiversity
- Decrease crop yield
- Water pollution
- Increase crop nutrient toxic



Introduction (cont.)

NE region → 17 M ha

~ 50% → under salt effects



Inland salt-affected soils in NE Thailand



Introduction (cont.)

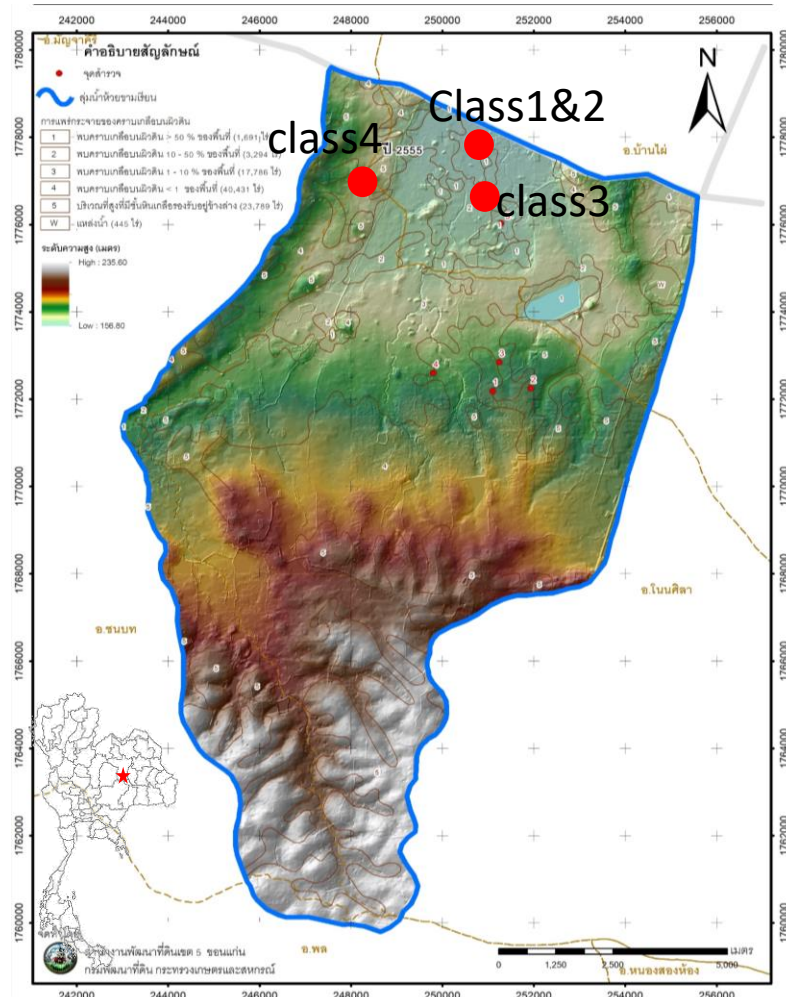
LDD's Classification scheme (classified based mainly on % salt crust in the middle of the dry season)

Class	Description	
1	salt crust > 50% of the soil surface	Severely 53,000 ha
2	salt crust > 10-50%	
3	salt crust > 1-10%	Moderately 600,000 ha
4	salt crust > 0-1%	Slightly 4.3 M ha
5	no salt crust but underlain with rock salt	
6	salt free areas	Potentially 3 M ha
Others	e.g., settlement, and water body etc.	

Objectives

- study on the variation of a salt-affected soil properties as ECe and SAR
- explanation the relationship between soil moisture content and salinity degree in the salt-affected soil.

Study Site



Class1 very severely > soil surface covered by salt crust > 50 %



Class2 severely > soil surface covered by salt crust 10- 50 %



Class 3 moderately > soil surface covered by salt crust 1-10 %



Class4 slightly > soil surface covered by salt crust < 1%

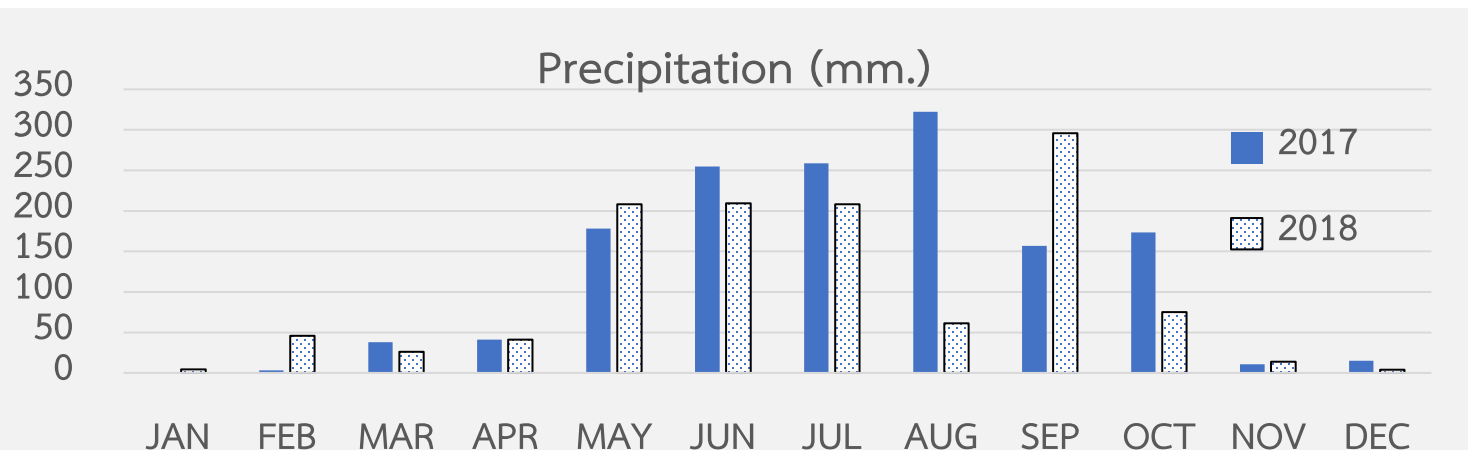


Study Site (cont.)

Annual precipitation is 1,451.97 mm in 2017
and 1,192.97 mm and 2018

Average rainfall in Khon Kean \approx 1,200 mm

(METEOROLOGY STATION, KHON KAEN PROVINCE: 2003 – 2015)



Methodology

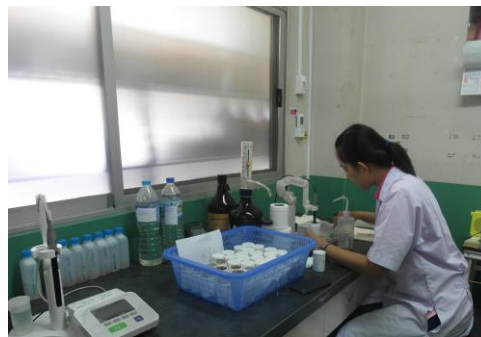
- **Taking soil samples** soil samples were monthly taken at 0-30 cm depth in 4 classes of a salt crust on soil surface based on map percentage of salt crust on soil surface

class	Soil texture	Number of soil samples
1: very severely salinity	Sandy loam, loam, silt loam	240
2: severely salinity	Loam, sandy loam	360
3: moderately salinity	Sandy loam, clay loam, sandy clay loam	360
4: slightly salinity	Sandy loam, loamy sand, clay loam, sandy clay loam	240

Methodology (cont.)

■ Analyze of soil samples

- >> Electrical conductivity of the saturated extract (ECe)
- >> Sodium Adsorption Ratio (SAR)
- >> Soil Moisture Content (SMC), Permanent Wilting Point (PWP), and Field Capacity (FC)



Methodology (cont.)

■ Statistical analysis

>> mean, minimum, and maximum

>>coefficient of variation (CV)were determined for each class separately

(Wilding, L.P., 1985)

little variability >>CV <15%

moderate variability >> CV =15-35 %

high variability >> CV >35%

>> linear regression

Result and Discussion

Variation of ECe and SAR in a dry season

Dry									
value		class1		class2		class3		class4	
		2017	2018	2017	2018	2017	2018	2017	2018
ECe (dS m ⁻¹)	Min	6.48	5.57	1.00	0.75	0.92	1.07	0.33	0.33
	Max	121.05	165.50	36.41	53.90	16.46	21.10	4.54	7.04
SAR	Min	18.66	16.64	8.39	3.76	1.22	2.08	0.46	0.38
	Max	196.31	244.57	68.41	103.22	80.98	80.16	10.74	28.47
TYPES		saline- sodic	saline- sodic	normal, saline, saline- sodic, sodic	normal, saline, saline- sodic, sodic	normal, saline, saline- sodic	normal, saline, saline- sodic	normal, saline, saline- sodic	normal, saline, saline- sodic

Result and Discussion (cont.)

Variation of ECe and SAR in a wet season

Wet									
value		class1		class2		class3		class4	
		2017	2018	2017	2018	2017	2018	2017	2018
ECe (dS m ⁻¹)	Min	3.56	3.17	0.58	0.69	0.54	0.50	0.30	0.23
	Max	136.35	157.00	60.95	113.80	35.80	25.73	10.74	28.47
SAR	Min	11.72	10.42	5.28	3.29	0.48	1.14	0.24	0.25
	Max	195.09	289.09	99.95	169.92	78.65	77.40	14.78	47.26
TYPES		slightly saline, saline- sodic	slightly saline, saline- sodic	normal, saline, saline- sodic, sodic	normal, saline, saline- sodic, sodic	normal, saline, saline- sodic, sodic	normal , saline, saline- sodic, sodic	normal, saline, saline- sodic, sodic	Normal, saline, saline- sodic, sodic

Result and Discussion (cont.)

Variation of ECe and SAR

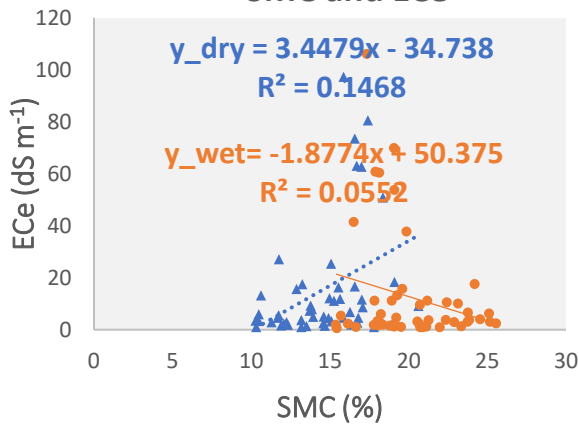
Dry									
value		class1		class2		class3		class4	
		2017	2018	2017	2018	2017	2018	2017	2018
ECe (dS m ⁻¹)	Mean	41.73	67.94	8.74	12.43	4.90	6.11	1.10	1.31
	CV(%)	65.24	78.16	78.81	105.99	74.39	72.85	66.09	103.95
SAR	Mean	81.17	108.51	28.19	29.39	21.73	19.29	3.98	3.82
	CV(%)	51.99	67.92	51.05	79.15	79.93	76.23	69.76	126.76

Wet									
value		class1		class2		class3		class4	
		2017	2018	2017	2018	2017	2018	2017	2018
ECe (dS m ⁻¹)	Mean	42.14	59.61	7.30	11.02	3.83	5.36	3.98	3.82
	CV(%)	84.31	83.44	168.29	165.00	117.21	97.44	69.76	126.76
SAR	Mean	81.69	100.43	21.53	27.48	16.77	18.71	3.37	5.76
	CV(%)	61.57	73.22	90.31	96.93	94.58	73.69	96.18	157.92

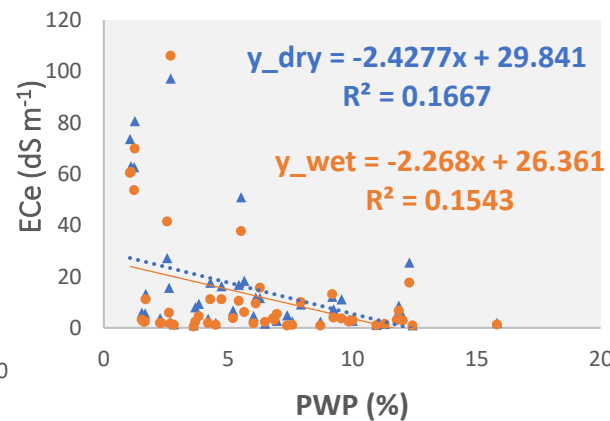
Result and Discussion (cont.)

Relation ECe and SAR with soil moisture content

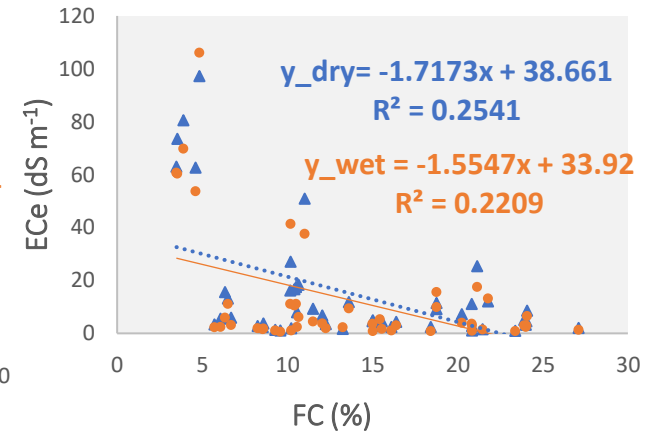
SMC and ECe



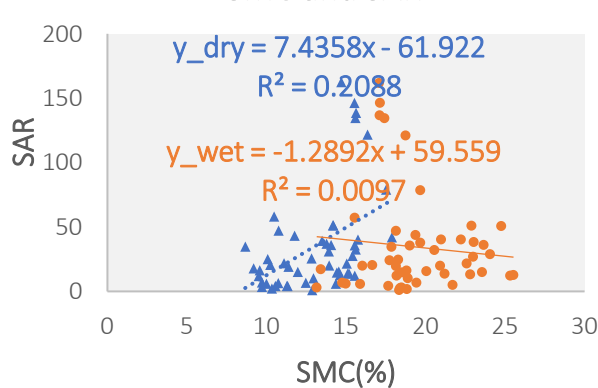
PWP and ECe



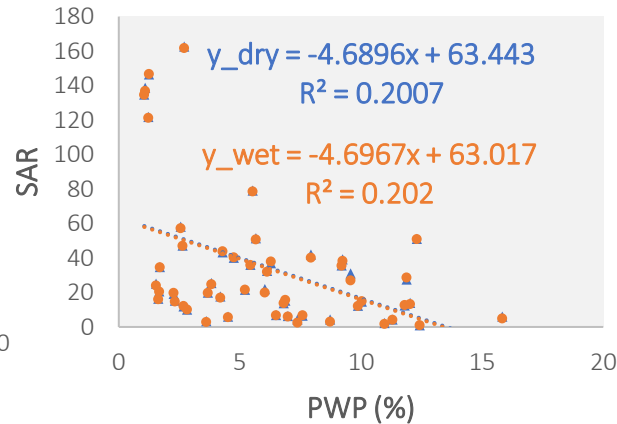
FC and ECe



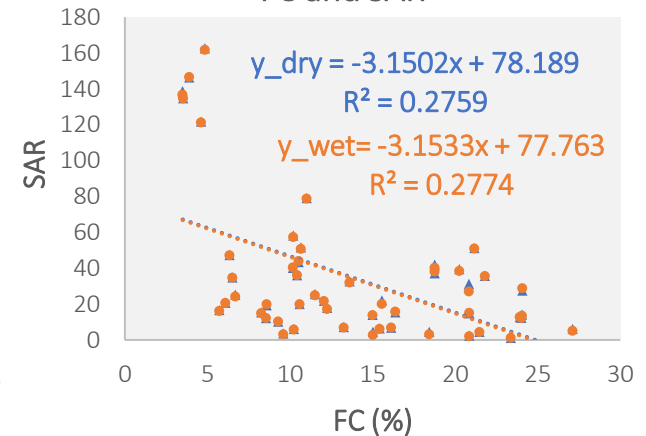
SMC and SAR



PWP and SAR

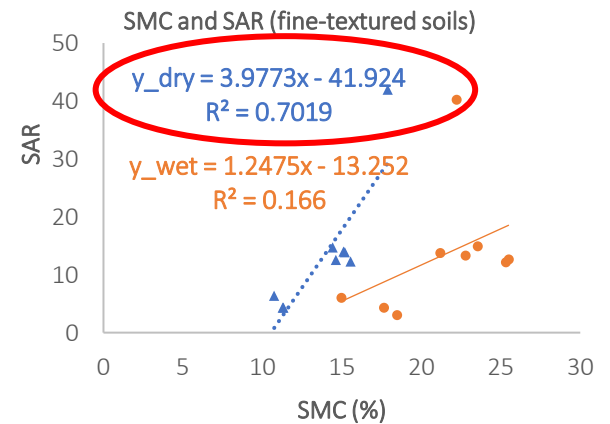
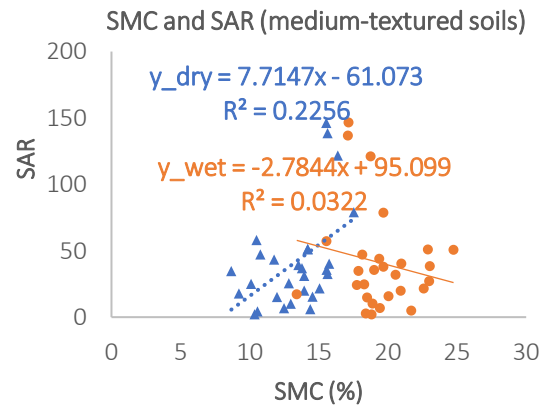
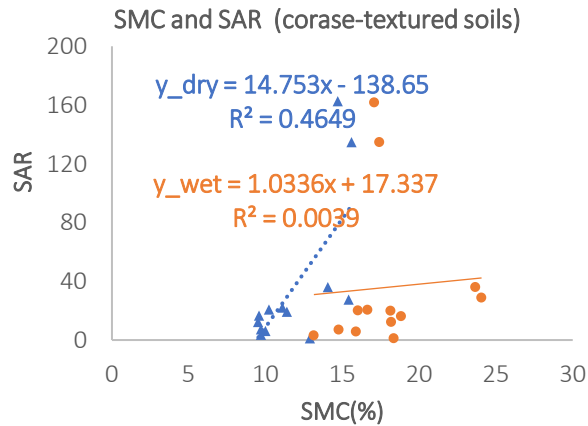
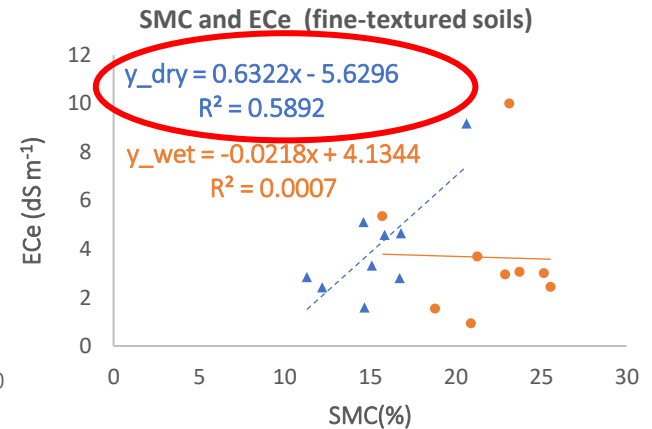
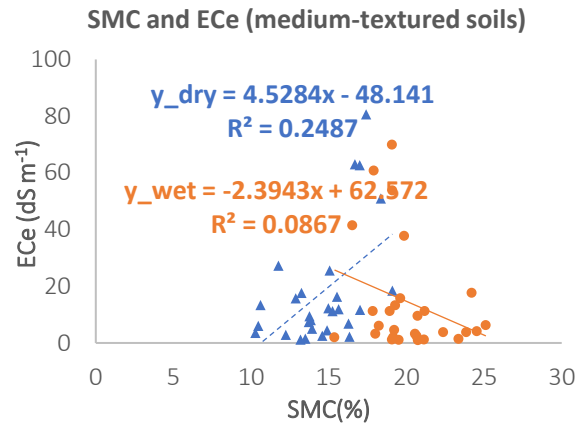
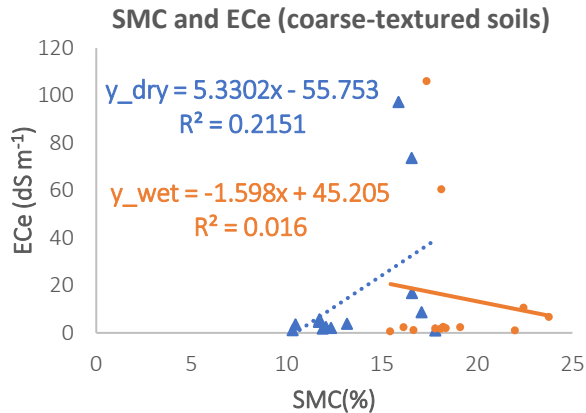


FC and SAR



Result and Discussion (cont.)

Relation ECe and SAR with soil moisture content under different soil texture



Summary

- The variation of ECe and SAR is high (C.V >35%) at 0-30 cm. soil depth.
- ECe and SAR are higher variability in wet season than dry season.
- ECe and SAR is positive relation to SMC in a dry season but it showed a negative trend with SMC in a wet season.
- Soil moisture content at PWP and FC showed a negative correlation with ECe and SAR in both a wet season and a dry season.
- It is a positive correlation between a salinity and soil moisture content under different soil texture in a dry season, especially, in a fine-textured soil. While, in a wet season was not clarified for both salinity as ECe and SAR.

Future Work

- The long-term continuing study will provide a better understanding of salt variation in the soil profile.
- It is significant to understand changes and spatial responses, climate, and the water cycle.
- The irrigation research will be more study to expose how much of suit water for crop and leaching salt from the root zone and how to manage a salt-affected soil under the climate change situation.

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Thank you

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