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Benefits and Implications of Agricultural Drainage in Southeast Saskatchewan

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The Issue

- ↑ precipitation
- Flooding
- Waterlogged soils

(GIWS, 2013)

The Solution

- Agricultural drainage
  - Increase land
  - Reduces cost
  - Extends growing season
  - Greater nutrient availability

(GIWS, 2013)

Concerns

- Minimal research on how drainage affects the soil
- Water quality issues

Questions

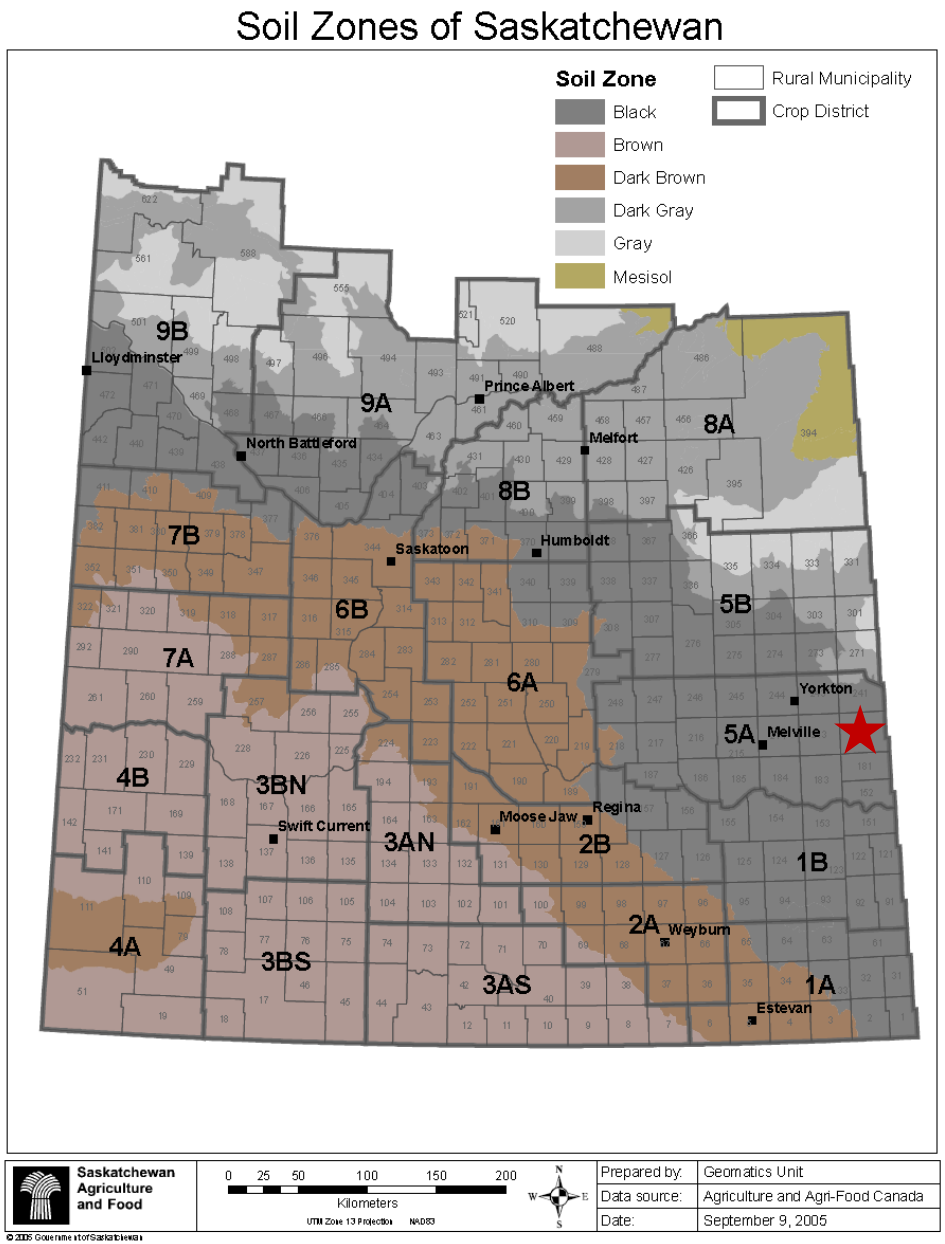
1. How does drainage change soil properties?

   Field Study

2. Could nutrient losses vary across soils drained for different durations of time?

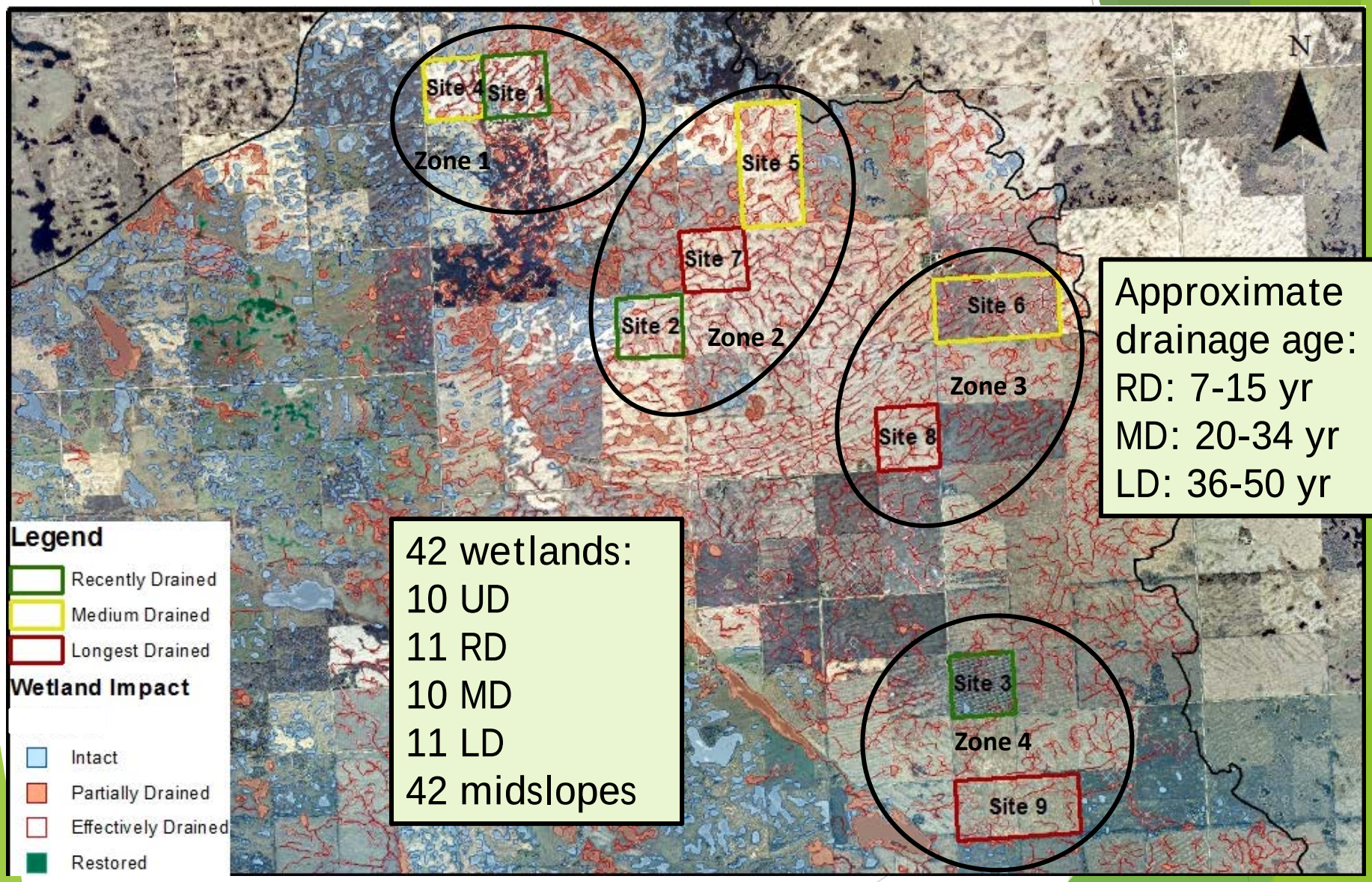
   Greenhouse Experiment

Study Area



- RM of Churchbridge
- Smith Creek Watershed
- Oxbow and Yorkton soils

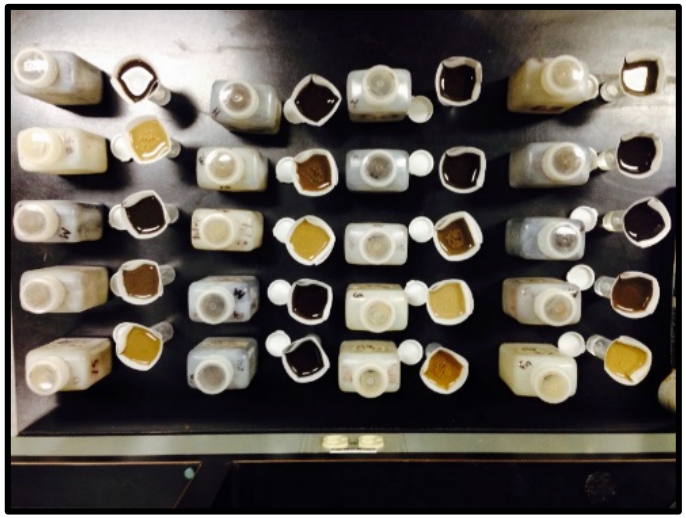
Methods: Field Study



Source of data: Saskatchewan Geospatial Imagery Collaborative and Ducks Unlimited

Methods: Field Study

- Field descriptions
- pH, EC and texture
- Bulk density
- Structure
  - Wet aggregate stability



- **Carbon**
  - TC, IC, **OC**
  - WEOC
  - LF/HF
- **Available N, P, K**
- **Net mineralization**
- **Potential Nitrification**
- **P sorption/desorption**

Methods: Greenhouse Experiment

- 5 x 3 x 2 (drainage x moisture x fertilizer)
  - Drained for: 0, 14, 20, 42 yr
  - Moisture: Below, normal, above
  - Fertilizer: 300 kg N ha^{-1}, 20 kg P ha^{-1}
- 3 reps
- Leachate 1/week
- 6 wk. duration

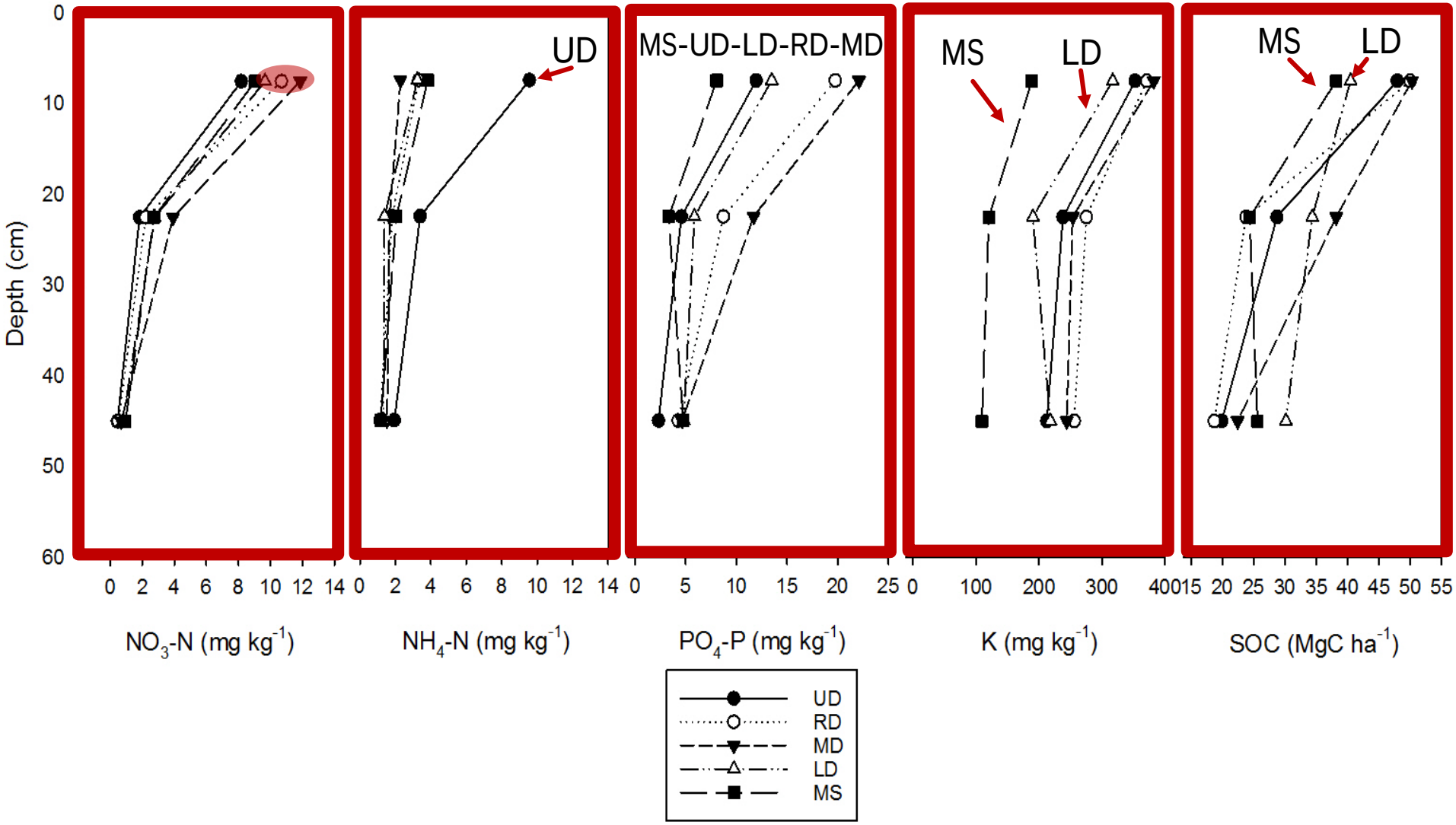
- Analyzed N and P
  - Wheat
  - Soil
  - Leachate

Results:

Field Study

Nutrient Availability and SOC

Nutrients and OC ↑ / remain consistent in RD and MD but ↓ in LD and MS



Nutrient Availability

Drainage Category†	n	Net Mineralized N (mg $kg^{-1}d^{-1}$)	Potential Nitrification (mg $kg^{-1}d^{-1}$)	P Sorption (mg PO_4-P kg^{-1})	P Desorption (mg PO_4-P kg^{-1})
UD	10	0.25^{ab}‡	35.0^{c}	597.1^{a}	44.1^{c}
RD	11	0.18^{ab}	46.7^{bc}	586.9^{ab}	55.7^{ab}
MD	10	0.38^{a}	74.4^{a}	571.4^{b}	61.1^{a}
LD	11	0.24^{ab}	54.7^{ab}	573.6^{b}	46.0^{bc}
MS	42	0.11^{b}	38.9^{c}	569.8^{b}	45.0^{c}
P value		0.0277	<0.0001	0.0181	<0.0001

†UD=undrained, RD=recently drained, MD=medium drained, LD=longest drained, MS=midslope.

‡ANOVA used to test differences. Means with same letter in same row are not significantly different according to Tukey Kramer test (P>0.10).

Results:

Greenhouse Experiment

Plant Uptake and Yield

Drainage Category†	Mass (g pot^{-1}) ‡	P Uptake (mg pot^{-1})	N Uptake (mg pot $^{-1}$)
UD	15.99^{b}§	26.69^{c}	226.85^{d}
RD	16.75^{b}	35.65^{b}	289.18^{b}
MD	20.63^{a}	43.23^{a}	329.44^{a}
LD	18.59^{ab}	35.21^{b}	307.43^{ab}
MS	17.67^{ab}	21.62^{d}	257.55^{c}
P value	0.0017	<0.0001	<0.0001

†UD=undrained, RD=recently drained, MD=medium drained, LD=longest drained, MS=midslope.
‡Averaged across all moisture treatments.
§ ANOVA used to test differences. Means with same letter in same row are not significantly different according to Tukey HSD test (P>0.05).

Nutrient Loss to Water

- Greater nutrient availability = greater nutrient losses
  - PO_4^{-3}
  - NH_4^+

Drainage category†	NH_4^+ in leachate (mg pot^{-1}) ‡	NO_3^- in leachate (mg pot^{-1})	PO_4^{-3} in leachate (mg pot^{-1})
UD	0.27[a]§	20.12	0.10[ab]
RD	0.15[b]	21.94	0.13[a]
MD	0.08[b]	27.05	0.09[ab]
LD	0.08[b]	16.92	0.06[bc]
MS	0.09[b]	28.96	0.02[c]
P value	<0.0001	0.4286	0.0001

†UD=undrained, RD=recently drained, MD=medium drained, LD=longest drained, MS=midslope.
‡Averaged across all moisture treatments.
§ ANOVA used to test differences. Means with same letter in same row are not significantly different according to Tukey HSD test (P>0.05).

Conclusions

1. Drainage ↑/maintain OC, NO_3, PO_4, K, mineralization, and nitrification initially
   - Benefits appear to decrease after 50 yr
2. Not all soils contribute equally to nutrient losses
   - Most improved soils have greatest nutrient loss potential

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Thank you!
Questions?

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