Online Hydrologic Modeling of Agricultural Erosion: Future Climate Scenarios

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REACCH REU 2013

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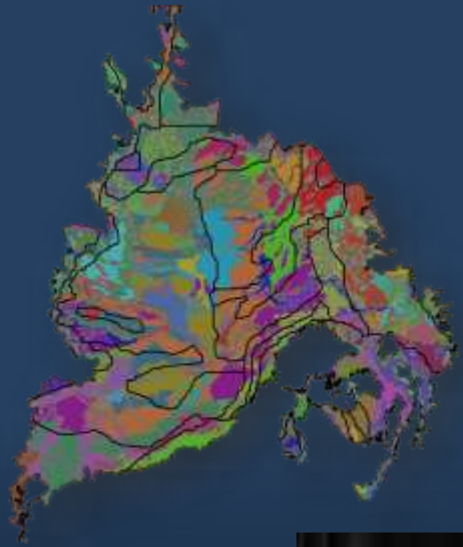



Palouse 1920s – 1930s

Motivation

- Recent studies have shown a significant decline in erosion (Kok et al., 2009; Brooks et al., 2010)
  - Due to reduced tillage management practices
- 1000+ water bodies in Idaho violate the CWA
  - Most dominant is sediment
  - Similar for the PNW

Motivation

- Little evidence of significant declining pollutant loading in many watershed studies (Mulla et al., 2008)
  - Failure to implement BMPs in the most critical areas of the watershed.

Motivation

- Better tools are needed to identify these critical areas and improve them with appropriate BMPs. (Mulla et al., 2008)
  - Simple
  - Minimal data requirements
  - Minimal calibration

REACCH Solutions

- 2005 Tillage practices in the PNW (Kok et al., 2009)
  - Conventional till – 40%
  - Mulch till – 50%
  - No till – 10%

The Big Picture

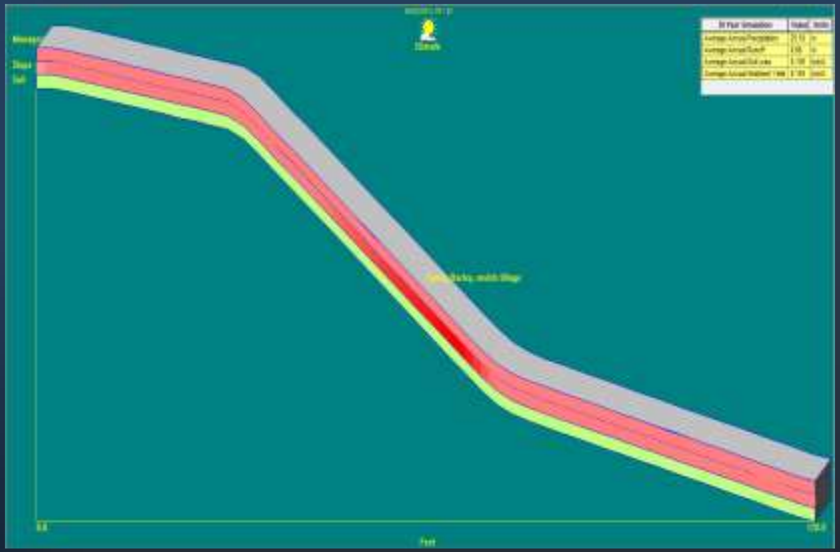
- Will current BMPs be as effective in the future?
  - Changing climate zones
  - Will rainfall intensity increase?
    - More runoff and erosion
- How can we mitigate these impacts?

Current Needs

- Targeted erosion control practices
- Simple modeling tools
  - Efficient and effective management practice
  - Minimize
    - Erosion
    - Runoff
    - Pollutants

WEPP Model

- **W**atershed **E**rosion **P**rediction **P**roject
- Developed by the USDA
- Process-based hydrology and erosion model
  - Not empirical
- Extensive input
- Time consuming
- Data readily available
  - Soil (USDA SURRGO)



HCT: Hydrologic Characterization Tool

Select Data Files

REACCH

Select State for climate: REACCH [Select]

Select climate file: rosalia

Select slope file:
- [ ] Flat (2_2_2)
- [ ] Mod Flat (2_5_2)
- [x] Moderate (2_8_2)
- [ ] Mod Steep (5_12_5)
- [x] Steep (5_35_5)

[Add Custom Slope]

Select Soil Type:

Soil Type	Depth to Restrict (cm)	Remove Soil
REACCH---palouse	◉ 152	☐
REACCH---ritzville	◉ 152	☐
REACCH---naff	◉ 43	☐
naff	Add Soil Type	

[Add Custom Soil]

Select Management Practice:

Management	Tillage Practice	Buffer (m)	Remove Management
REACCH---ww_barley_pea_High_Precip	○ CT ○ MT ◉ NT	0	☐
REACCH---ww_barley_pea_High_Precip	○ CT ◉ MT ○ NT	0	☐
REACCH---ww_barley_pea_High_Precip	◉ CT ○ MT ○ NT	0	☐
ww_barley_pea_High_Precip	Add Management Practice		

* Tillage Practices: Conventional Till (CT), Mulch Till (MT), No Till (NT)

How many years would you like to simulate? 30

[Select Files]

- Based on the WEPP Model
- Uses common default parameters
- Few inputs
  - Climate
  - Soil
  - Management practice
  - Slope

HCT Limitations

- Static data
  - New regions, climates, soils and management must be added manually
- Represents a single slope
  - Characteristic land type

Objectives

- Create tools to generate soil and climate files
  - Climate tool (Stephen)
  - Soil tool (USDA STATSGO 2006)
- Improve HCT scope
  - Incorporate future climate scenarios
  - Generate widespread soil files
- Apply HCT throughout the REACCH region
  - 2 AEZs
  - Future climate scenarios
  - Predict runoff & erosion rates

Soil File Generation

- Uses USDA STATSGO Soil Survey data (2006)
  - Access Database files
    - SQL

- Soil File Tool (Python)
  - Gathers Data
  - Sorts
  - Output

Soil File Generation

- ArcMap interface
  - Select soil unit

- Console interface
  - Input: unit key into the soil tool
  - Output: CT, MT, and NT soil files

Climate File Generation

- Stephen Fricke (John Abatzoglou)
- RCP 4.5 (CNRM-CM5 Model)
- Generate WEPP file with Cligen 5.3
- Climate tool (PERL)
  - Adds wind speed & solar radiation

```
********************************************************************
*                                                                  *
*             USDA - WATER EROSION PREDICTION PROJECT              *
*                WEPP CLIMATE INPUT DATA GENERATOR                 *
*                                                                  *
*                  CONTINUOUS SIMULATION AND                       *
*                     SINGLE STORM OPTIONS                         *
*                  with Command Line Options,                      *
*                      and Corrections to                          *
*                Rainfall Intensity Calculations                   *
*                 and Random Number Generation.                    *
*                                                                  *
*                        VERSION 5.32000                           *
*                    Revised from VERSION 4.2                      *
*           (Use -h or /h to list command line options.)           *
*                                                                  *
********************************************************************
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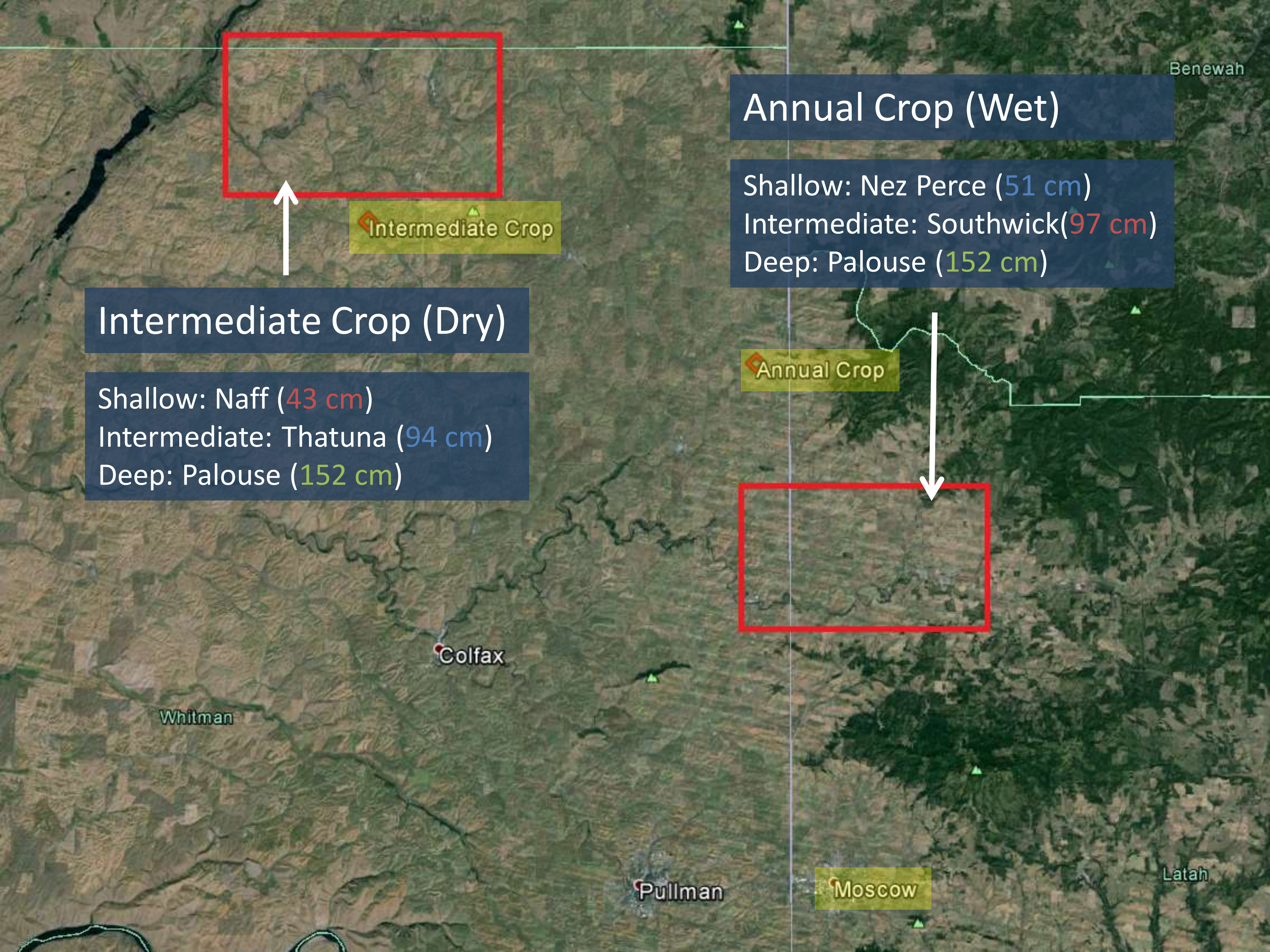
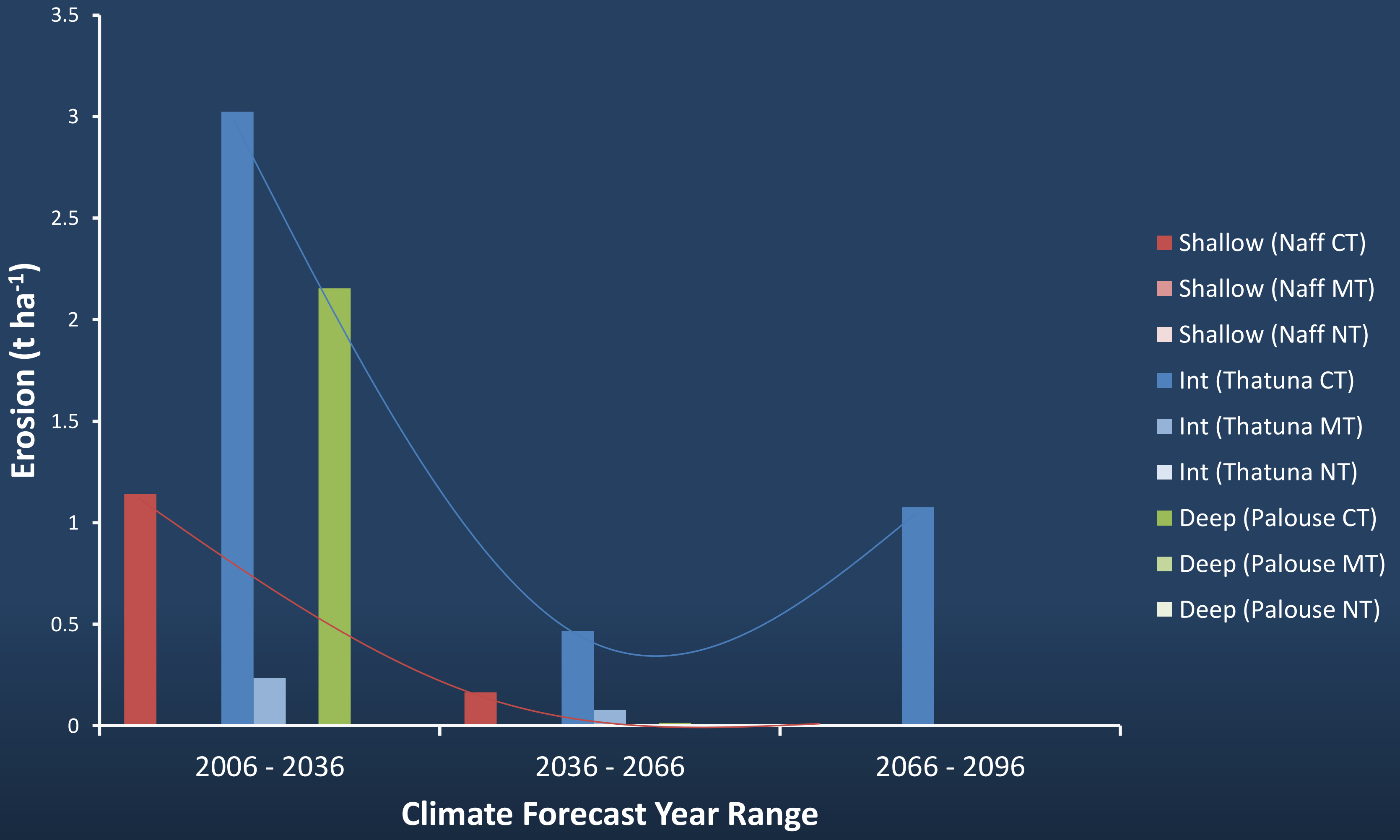


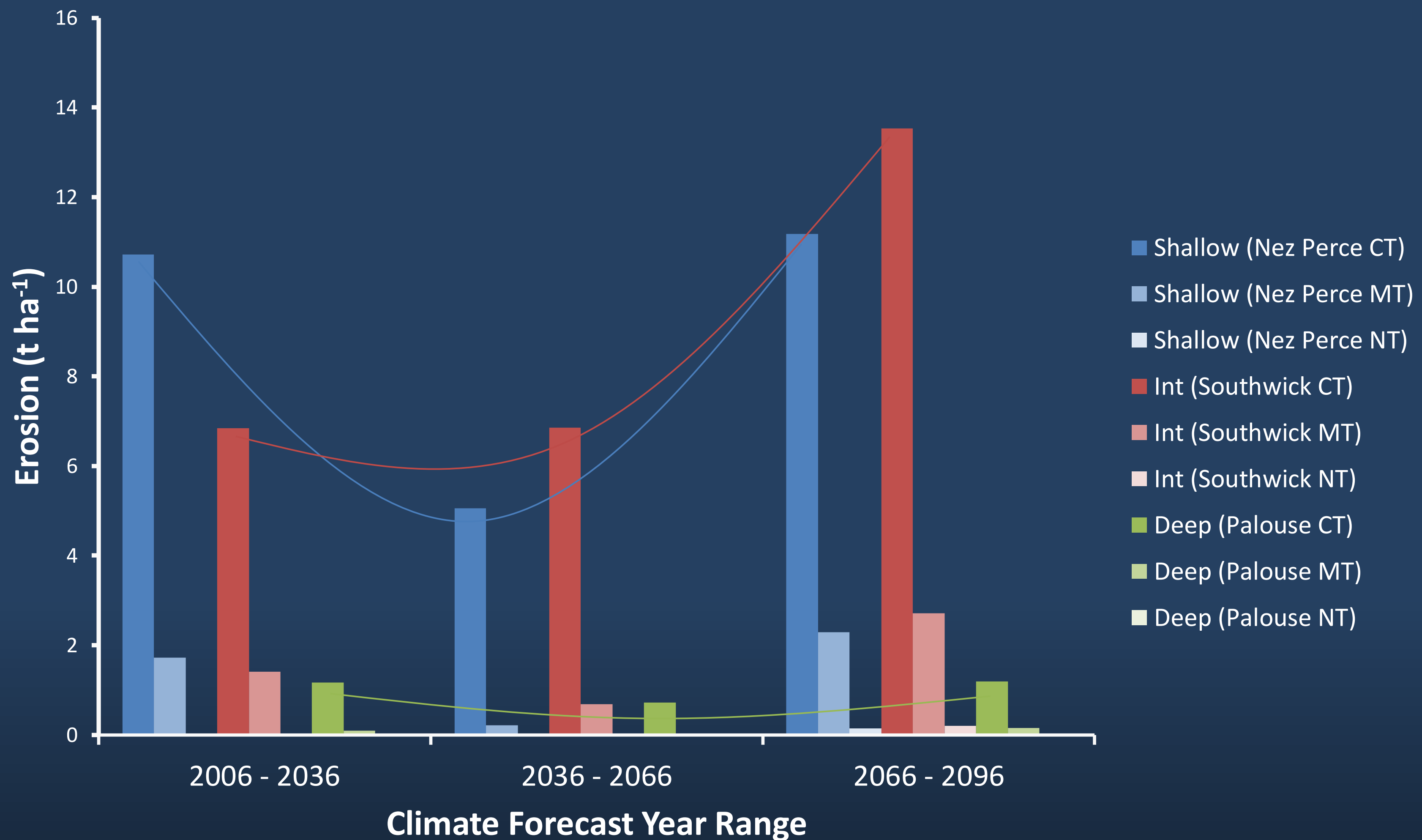
Annual Crop (Wet)
Shallow: Nez Perce (51 cm)
Intermediate: Southwick(97 cm)
Deep: Palouse (152 cm)
Intermediate Crop (Dry)
Shallow: Naff (43 cm)
Intermediate: Thatuna (94 cm)
Deep: Palouse (152 cm)
Intermediate Crop
Annual Crop
Benewah
Colfax
Whitman
Pullman
Moscow
Latah

Erosion Comparison: Intermediate Crop (Dry)



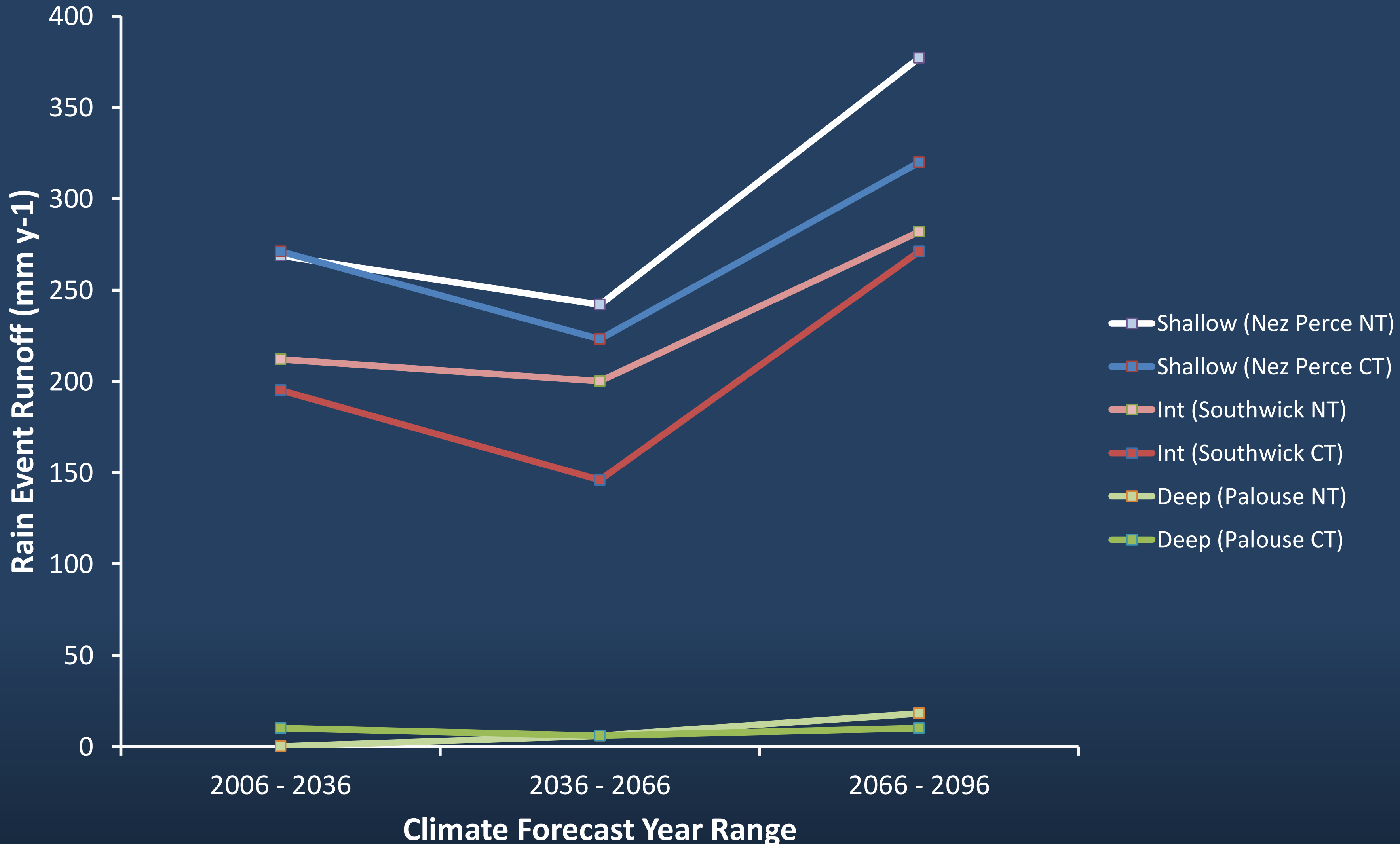
Tillage Practices: Conventional Till – **CT**; Mulch Till – **MT**; No Till – **NT**

Erosion Comparison: Annual Crop (Wet)



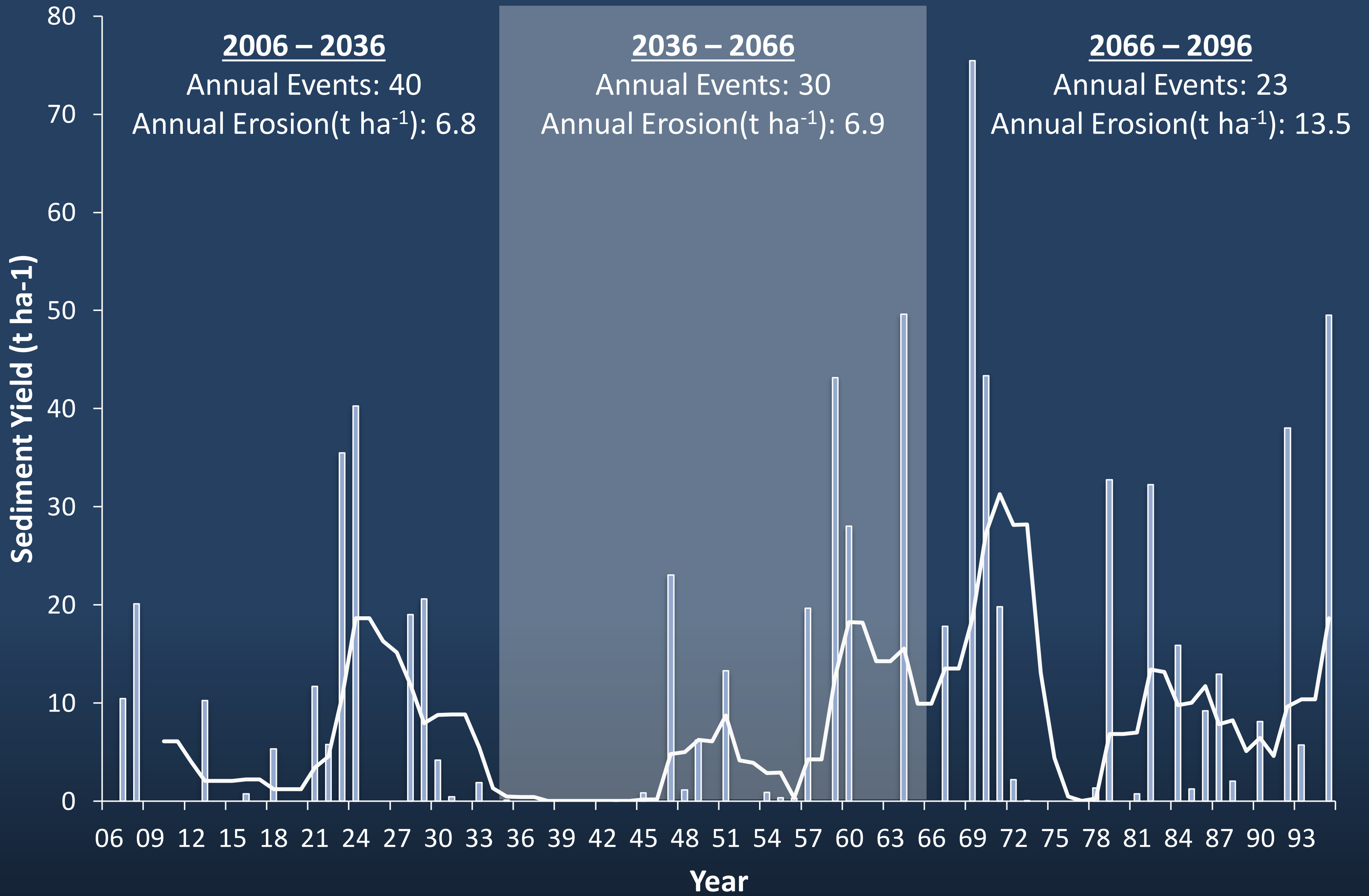
Tillage Practices: Conventional Till – **CT**; Mulch Till – **MT**; No Till – **NT**

Rain Runoff: Annual Crop Zone



Tillage Practices: Conventional Till – **CT**; Mulch Till – **MT**; No Till – **NT**

Erosion Events by Year: Annual Crop Wet



Summary

- Developed WEPP soil and climate file generation tools (Python, Perl)
- Mulch Till is an effective practice
  - ~85% reduction in soil erosion
- Future climate simulations suggest
  - Fewer erosion events
  - Increasing magnitude

Future Application

- HCT
  - Dynamic map-based data selection
    - Soil
    - Server side climate generation
- Soil Creation
  - ArcMap tool
- Investigate the assumption of static rainfall intensity characteristics in future climate scenarios

Acknowledgements

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- Ryan Boylan
- Stephen Fricke & John Abatzoglou

References:

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