



# Wind Erosion Prediction System Introduction

NRCS Train the Trainer Session



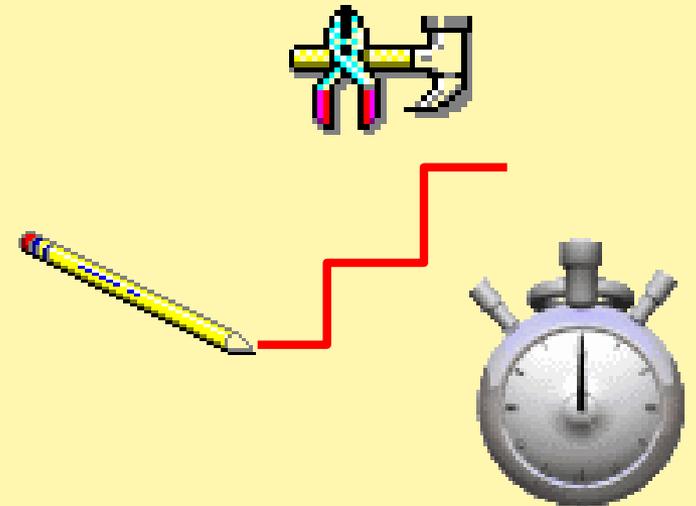
# WEPS

## Wind Erosion Prediction System

Process-based

Daily time-step

Wind erosion model





# Why was WEPS Developed?

- **Wind Erosion Equation (WEQ) does not predict wind erosion where erosion is observed in some areas.**
- **There is a need for more information about wind erosion than just rotational average tons/acre/year we get now.**
- **There is a need for an easier to use and a faster model.**

# Who was Involved?

## Multi-agency Government Commitment



ARS



BLM



NRCS



EPA



# Wind Erosion Equation WEQ

1965

- ▶  **$E = f(I, K, C, L, V)$** 
  - ▷ **I = soil erodibility**
  - ▷ **K = soil ridge roughness**
  - ▷ **C = climatic factor**
  - ▷ **L = field length**
  - ▷ **V = vegetative factor**

# Where are the Factors in WEPS?

## Soil Erodibility - I Factor

- ▶ **Surface Aggregation**
  - ▷ **Size Distribution**
  - ▷ **Dry stability**
- ▶ **Crusted Surface**
  - ▷ **Cover fraction**
  - ▷ **Stability and thickness**
  - ▷ **Loose, erodible material on crust**



# Where are the Factors in WEPS?

## Soil Ridge Roughness - **K Factor**

### ▶ **Surface Roughness**

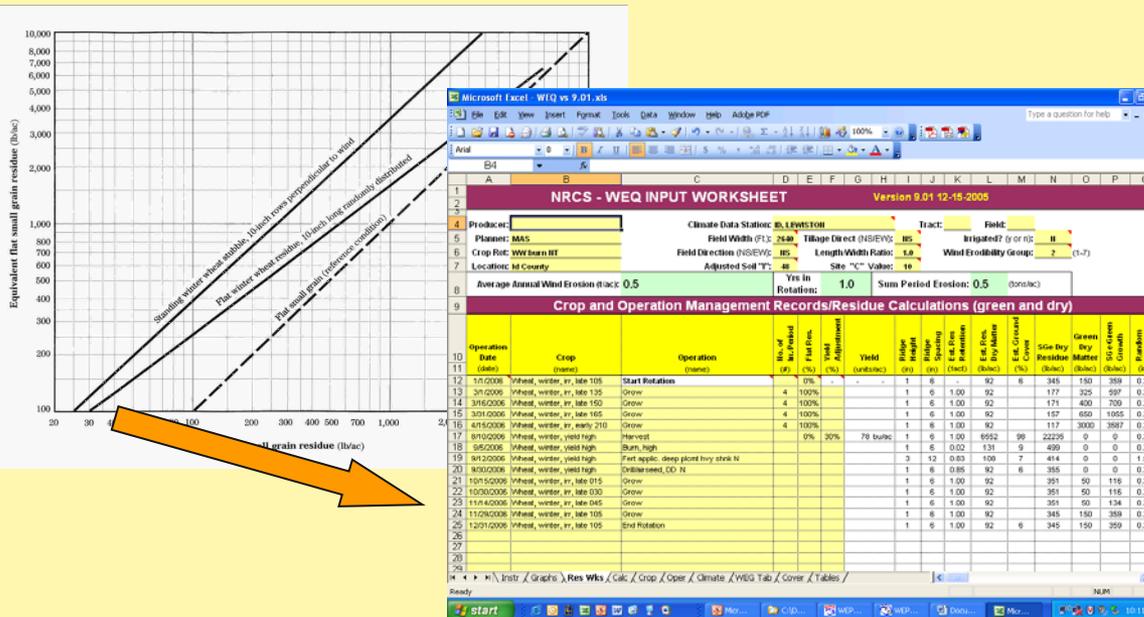
- ▷ **Random**
- ▷ **Oriented  
(Ridges & Dikes)**
- ▷ **Ridge Direction**



# Why is WEPS Needed?

From Charts and Spreadsheets to

To replace the older (1965) technology of WEQ



A modern process based model

# Why is WEPS Needed?



**Provide more accurate assessments of soil loss from agricultural fields**

# Why is WEPS Needed?



**Better tool for designing efficient,  
cost-effective erosion control systems**

# Why is WEPS Needed?

**Provide  
additional  
quantitative  
information  
besides just  
average annual  
soil loss**





# Why is WEPS Needed?

**Provide additional prediction capabilities not available with current technology**



# Why is WEPS Needed?



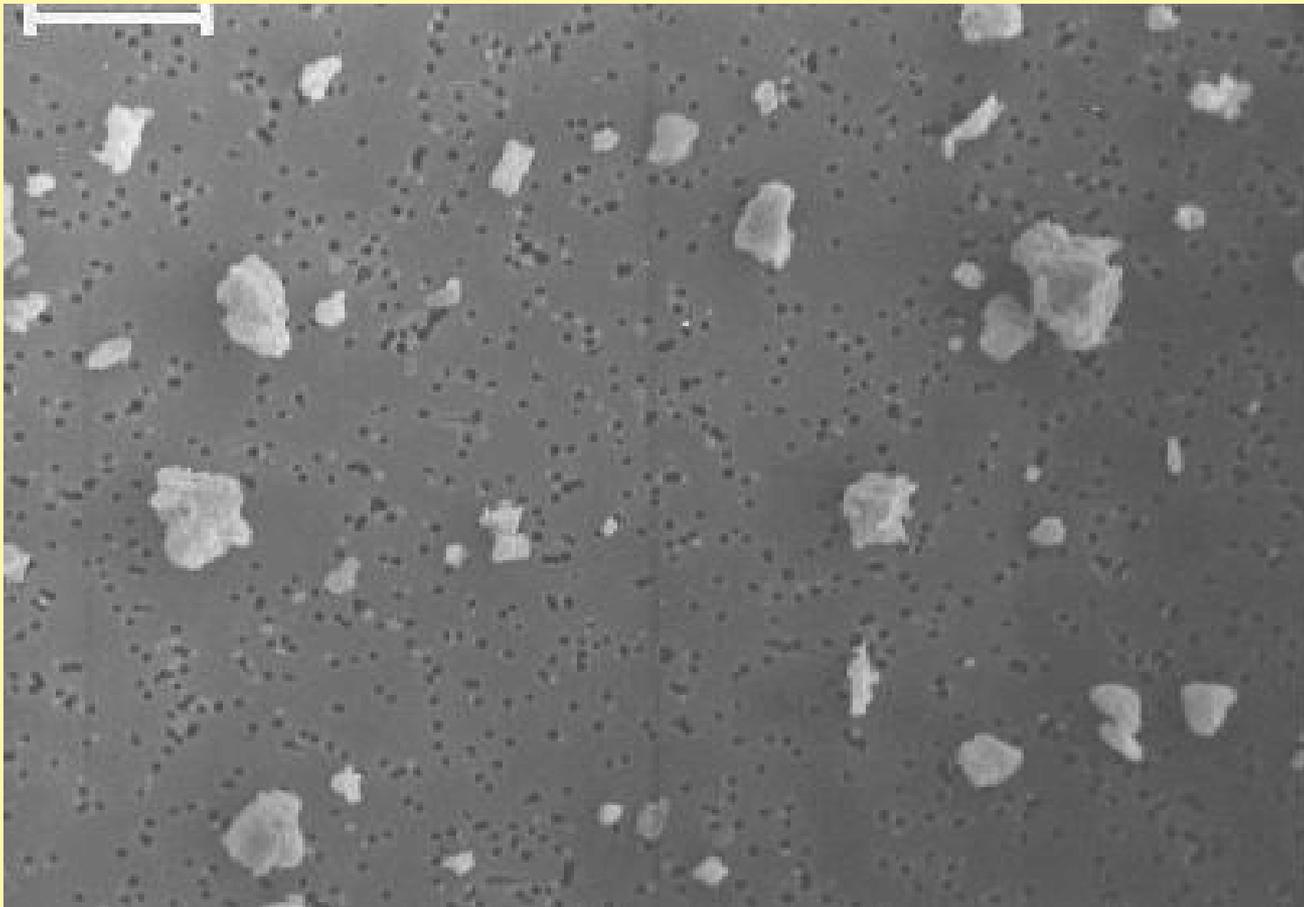
**Estimate soil loss by wind across individual field boundaries**

# Why is WEPS Needed?

**Estimate  
suspension  
soil losses  
and their  
direction**



# Why is WEPS Needed?



- **Estimate PM-10 emissions**
- **In the future, (with funding), PM-2.5 and Operation Dust**

# Why is WEPS Needed?



**Determine  
offsite  
impacts**



# What is the Purpose of WEPS?

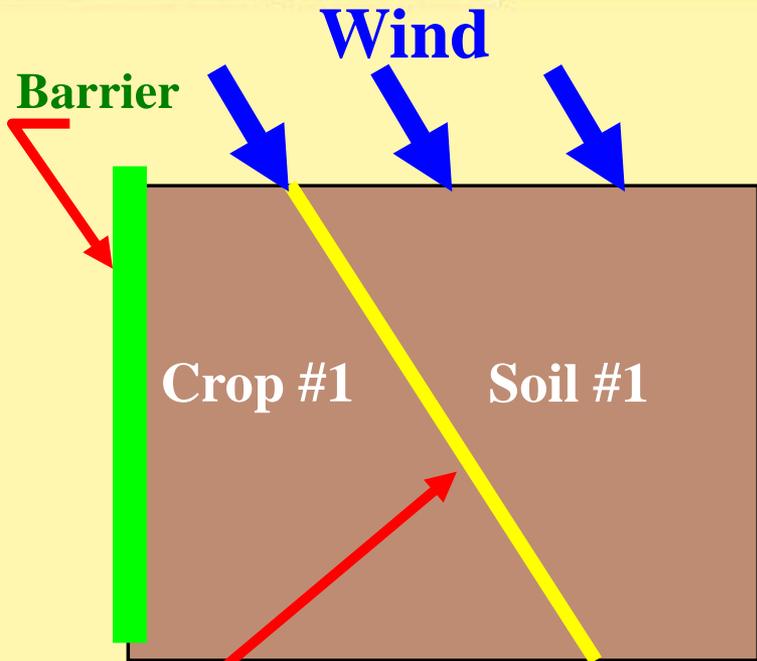
- ▶ **Planning soil conservation systems**
- ▶ **Aid in environmental planning and assessment evaluations**
- ▶ **To estimate offsite impacts of wind erosion**



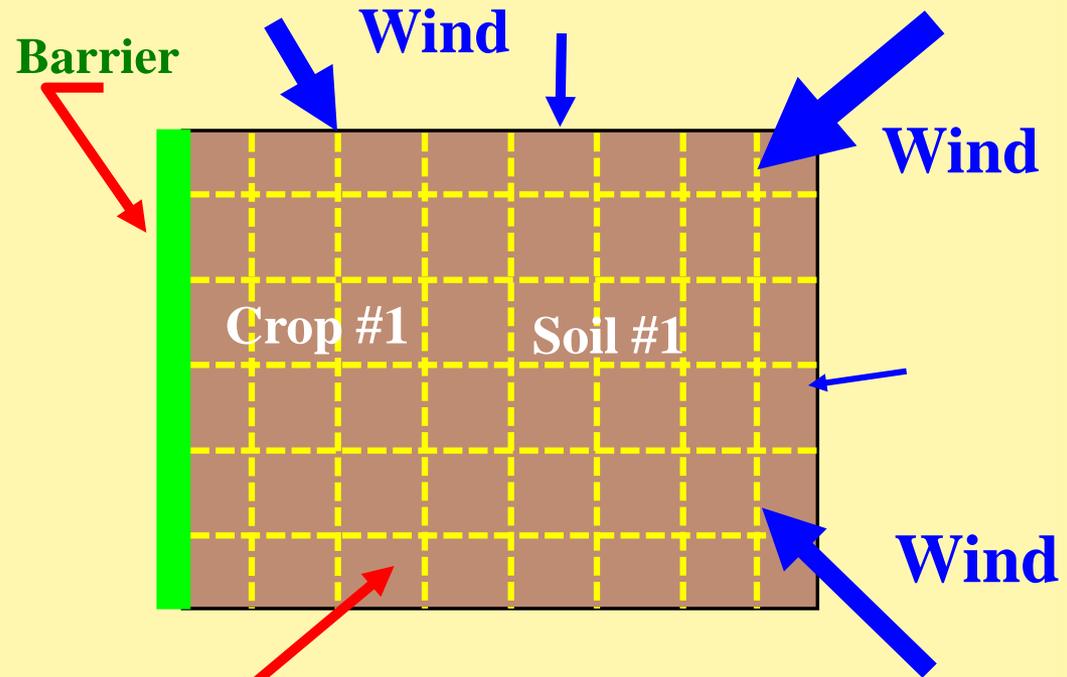


# WEQ

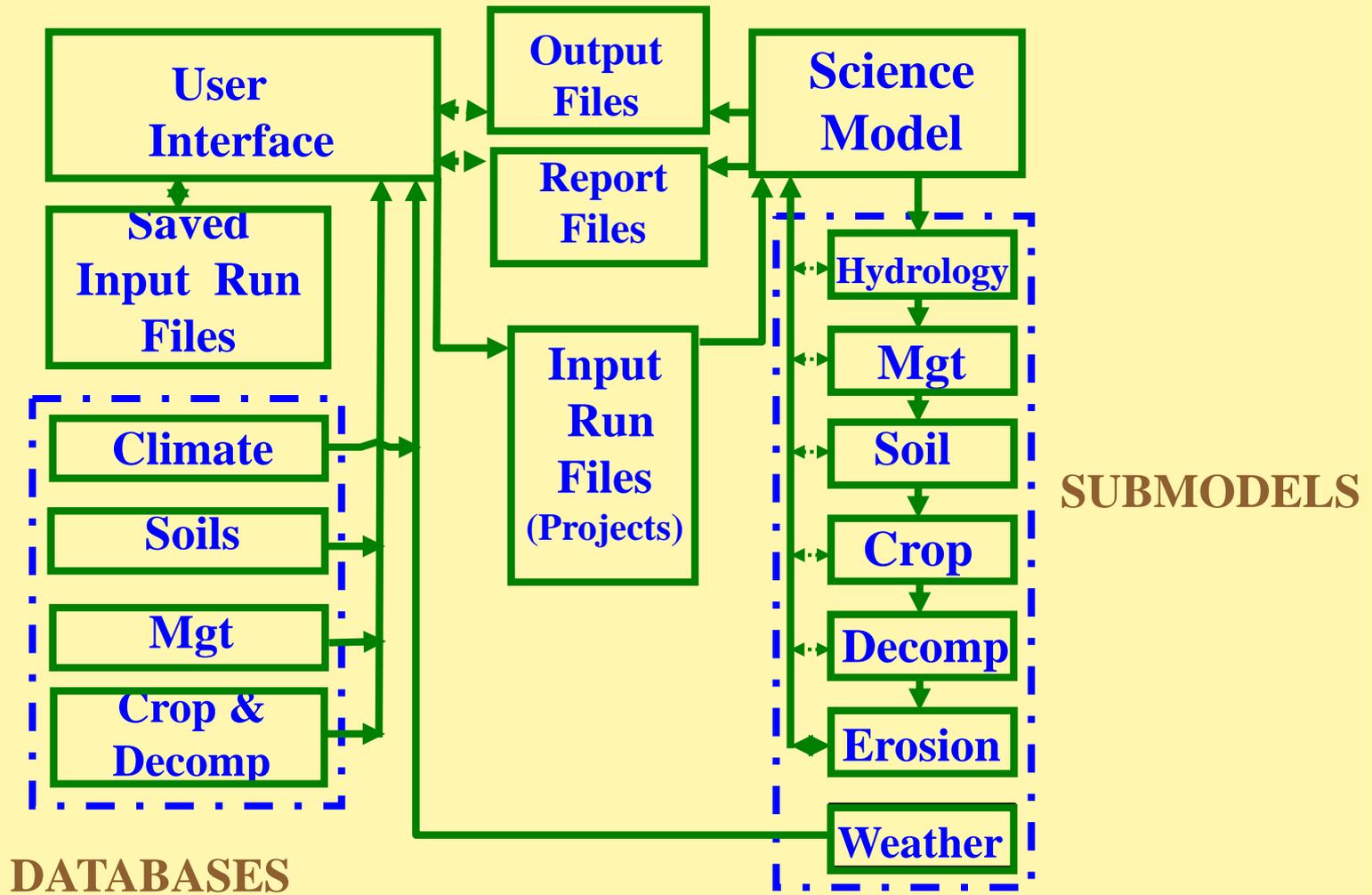
# WEPS



Erosion calculation  
made along a Linear  
Transect



Erosion calculation  
made for Grid Areas





# WEPS Weather

## Purpose

**Drives the  
fundamental physical  
processes simulated by  
WEPS**





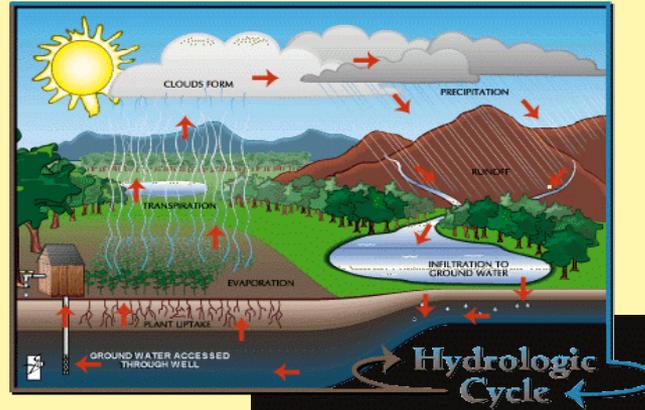
# WEPS Simulates Daily Changes in Field Conditions

- ▶ **Soil aggregation**
- ▶ **Surface wetness**
- ▶ **Surface roughness**
- ▶ **Residue status  
(standing/flat)**





# WEPS Simulates Processes Driven by Daily Weather



- ▶ **Water Balance**
- ▶ **Crop Growth**
- ▶ **Residue Decomposition**

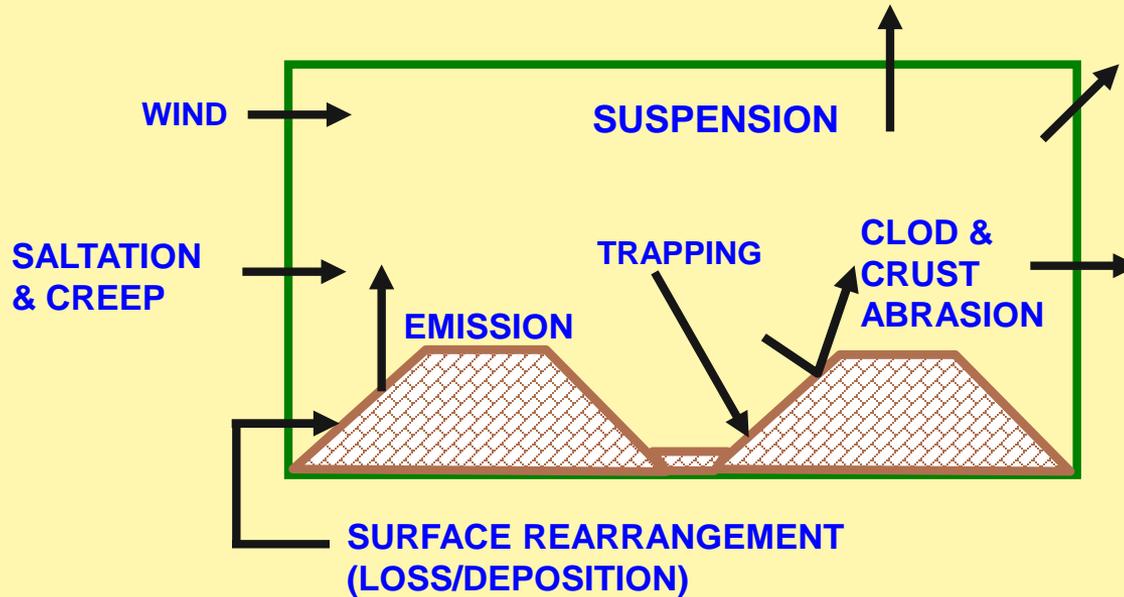


# WEPS Simulates Common Management Practices

- ▶ Tillage
- ▶ Planting
- ▶ Irrigation
- ▶ Harvesting
- ▶ Burning
- ▶ Mulching
- ▶ Manure App.



# WEPS Simulates Wind Erosion Processes



- ▶ **Detachment**
- ▶ **Transport**
- ▶ **Deposition**

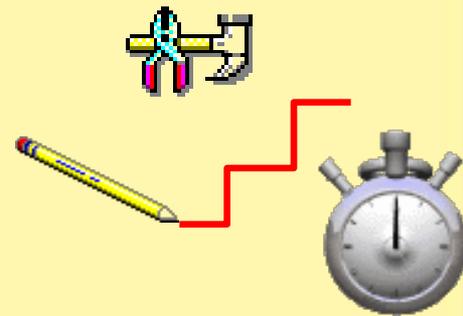


# WEPS Output Flexibility

	<b>WEPS</b>	<b>WEQ</b>
<b>Annual soil loss</b>	✓	✓
<b>Period soil loss</b>	✓	✓
<b>Saltation/Creep</b>	✓	
<b>Suspension</b>	✓	
<b>PM-10</b>	✓	
<b>Surface conditions</b>	✓	✓ Limited
<b>Wind energy</b>	✓	
<b>Boundary loss</b>	✓	

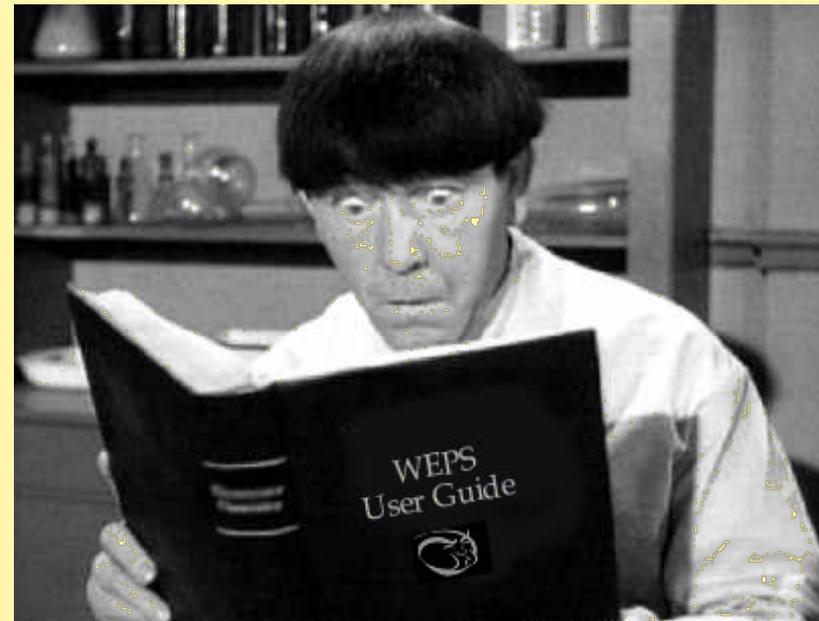
# What is WEPS 1.0?

**First Version of processed-based  
daily time-step  
Wind Erosion Science Model**



**WITH**

**A Simplified  
Graphical User  
Interface and  
Sample Databases**



# WEPS 1.0 Interface

The screenshot displays the WEPS 1.0 software interface with the following sections:

- Runs Location:** C:\F Drive\WEPS\_Projects\TX Issues.wpj
- Client Information:** Client Name, Farm No, Tract No, Field No (all empty).
- Region:** Shape: Square; X-Length: 5279.9 ft; Y-Length: 5279.9 ft; Area: 640.0 ac; Orientation: 0.0.
- Location:** State: NEW MEXICO; County: DONA ANA; Latitude: 32.07 N; Longitude: 106.64 W; Elevation: 3799.21 ft; Cligen: LA TUNA 1 S (7.7 mi); Windgen: LAS CRUCES INTL (22.0 mi); View Map button.
- Simulation:** Run Mode: NRCS; Water Erosion: 0.00 tn/ac; Region Slope: FROM SOIL DB; Soil DB Value: 0.02 ft/ft; Rock Fragments: FROM SOIL DB; Soil DB Value: 0.00 ft<sup>3</sup>/ft<sup>2</sup>.
- Notes:** 10/ 5/ 1 Cotton, stripper skip 1 row 0.693; Edit and Clear buttons.
- Barriers:** N, S, E, W (all set to none); Edit Selected Barrier button.
- Man:** Cotton,Stripper2x1;CT,FC,CZM19\_test.man
- Soil:** Amarillo\_4\_100\_LFS

Specify:

- ▶ Region
- ▶ Location
- ▶ Soil
- ▶ Mgt
- ▶ Barriers (if used)

# WEPS 1.0 Interface

## Management/Crop Rotation Editor for WEPS (MCREW)

Rotation : C:\Program Files\USDA\WEPS\WEPS 1.0 (pre-release 18e)\projects\Core Crops.wpj\oats; FC, st pt, disk, fcult, z1.man

Date (MMM dd, yy)	Operation Name	Crop or Residue	Row/Ridge Dir. (Deg.)	Calib. Yield?	Target Yield	Target Yield Units	Yield H2O (%)
Apr 15, 01	Disk, tandem light finishing		0				
Apr 20, 01	Cultivator, field 6-12 in sweeps		0				
Apr 20, 01	Drill or airseeder, double disk	Oats, spring	0	<input checked="" type="checkbox"/>	60	bu/ac	14
Aug 05, 01	Harvest, killing crop 50pct standing stubble						
Nov 01, 01	Chisel, st. pt.		0				

**Dates, Operations, & Crops**

# WEPS 1.0 Outputs

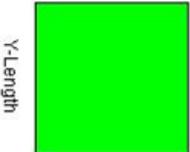
Run : 2x1 CT cotton 325 lb Am LFS Lubbock Lbb Int cal LC\_3.wjr

**Run Summary** 

2x1 CT cotton 325 lb Am LFS Lubbock Lbb Int cal LC\_3

Run Date: null  
 Client Name: ---  
 Farm No: --- Tract No: --- Field No: ---  
 Run Location: TX Issues  
 Management: Cotton,Stripper2x1;CT,FC,CZM19\_test.man  
 Soil: Amarillo\_4\_100\_LFS.ifc

**Simulation & Site Information**



X-Length: 5280 ft  
 Y-Length: 5280 ft  
 Area: 639.97 ac  
 Elevation: 3238 ft  
 Orientation: 0.00 °

Mode: NRCS  
 Soil Loss T: 5.0 tn/ac/yr  
 Site: UNITED STATES  
 TEXAS  
 LUBBOCK  
 Location: 33.61° N, 101.83° W  
 Cligen: LUBBOCK WB AP  
 Windgen: Interpolated Station

**Erosion**

Period	Crop/Residue	Gross Loss tn/ac	Net Soil Loss From Field ( tn/ac )	
			Total Creep/Salt.	Suspension
Rot. year: 1	Cotton, stripper skip 1 row	54.9	54.9	8.3 46.5
Ave. Annual		54.9	54.9	8.3 46.5

**Crop Rotation Erosion**

Date Range	Crop	Gross Loss tn/ac	Net Soil Loss From Field ( tn/ac )	
			Total Creep/Salt.	Suspension
Nov 02, 01 - Nov 01, 01	Cotton, stripper skip 1 row	54.9	54.9	8.3 46.5

- ▶ **Run Summary**
  - ▶ **Simulation & Site Infor**
  - ▶ **Erosion**
  - ▶ **Crop Rot. Erosion**
  - ▶ **Harvest**
  - ▶ **SCI**
  - Summary**
  - ▶ **Rot. Stir Energy**
  - ▶ **Crop Rot. Stir Energy**

# WEPS 1.0 Outputs (cont.)

Detail Reports - Cotton CT 40 stripper bio\_1.wjr

Select Report: Output Details

Client: Wind Erosion  
 Fm: Tr: Fld:  
 Management: Cotton,Stripper,CT,FC,CMZ19 bio  
 Soil: Amarillo\_AfB\_100\_FSL

Date	Operation	Crop	Average Total Gross Soil Loss	Net Soil Loss from Field		
				Average Total	Average Creep and Saltation	Average Suspension
tons/acre						
May 20-31, 01	Planter, double disk opnr	Cotton, stripper	1.2	1.2	0.56	0.63
Jun 1-14, 01			6.0	6.0	2.80	3.20
Jun 15-19, 01			1.5	1.5	0.70	0.84
Jun 20-30, 01	Cultivator, row 1 in ridge		2.2	2.2	1.09	1.10
Jul 1-14, 01			0.0	0.0	0.00	0.00

▶ **Detail Output**  
 Net soil loss by period

Net soil loss by type  
 Creep & Saltation,  
 Suspension, and  
 PM10

Detail Reports - Cotton CT 40 stripper bio\_1.wjr

Select Report: Output Details

Client: PM10  
 Fm: Tr: Fld:  
 Management: Cotton,Stripper,CT,FC,CMZ19 bio  
 Soil: Amarillo\_AfB\_100\_FSL

Date	Operation	Crop	PM10			
			tons/1000ft			
May 20-31, 01	Planter, double disk opnr	Cotton, stripper	0.0	0.9	0.0	0.0
Jun 1-14, 01			0.0	0.2	1.6	2.8
Jun 15-19, 01			0.0	0.0	1.2	0.0
Jun 20-30, 01	Cultivator, row 1 in ridge		0.0	0.0	1.4	0.2

▶ **Detail Output**  
 PM10 loss each side of  
 the field

PM10 loss by period per  
 1000 ft of field edge

# WEPS 1.0 Outputs (cont.)

Detail Reports - Cotton CT 40 stripper bio\_1.wjr

Select Report : Erosion & Crop Veg, Res & Biomass (details)

Client:			Erosion						
Fm: Tr: Fld:			Average Total Gross Soil Loss	Crop Vegetation					
Management: Cotton,Stripper;CT,FC,CMZ19 bio				Canopy Cover	Effective Standing Silhouette	Leaf and Stem Mass	Root Mass	Crop Height	Number Crop Stems
Soil: Amarillo_A1B_100_FSL			tons/acre	fraction	ft <sup>2</sup> /ft <sup>2</sup>	lbs/acre	lbs/acre	in	#/ac
May 20-31, 01	Planter, double disk opnr	Cotton, stripper	1.2	0.01	0.00	4	4	8	20001
Jun 1-14, 01			6.0	0.05	0.00	34	21	1	20001
Jun 15-19, 01			1.5	0.10	0.01	69	41	1	20001
Jun 20-30, 01	Cultivator, row 1 in ridge		2.2	0.38	0.05	267	176	3	20001

► Detail Output

Crop Growth

Canopy Cover

Detail Reports - Cotton CT 40 stripper bio\_1.wjr

Select Report : Erosion & Crop Veg, Res & Biomass (details)

Client:			Average Biomass Surface Conditions on Date							
Fm: Tr: Fld:			Crop Residue							
Management: Cotton,Stripper;CT,FC,CMZ19 bio			Surface Cover	Effective Standing Silhouette	Flat Mass	Standing Mass	Buried Mass	Buried Root Mass	Weighted Residue Height	Number Residue Stems
Soil: Amarillo_A1B_100_FSL			fraction	ft <sup>2</sup> /ft <sup>2</sup>	lbs/acre	lbs/acre	lbs/acre	lbs/acre	in	#/ac
May 20-31, 01	Planter, double disk opnr	Cotton, stripper	0.12	0.00	376	1	733	261	4	3
Jun 1-14, 01			0.11	0.00	351	0	668	237	4	1
Jun 15-19, 01			0.11	0.00	343	0	649	229	4	1
Jun 20-30, 01	Cultivator, row 1 in ridge		0.06	0.00	190	0	732	222	4	

► Detail Output

Crop Residue Flat Mass

Crop Residue Standing

# WEPS Database Needs

- ▶ **Climate Data**
  - ▷ Wind (Windgen)
  - ▷ Weather (Cligen)
- ▶ **Management Practices Data**
  - ▷ Management
  - ▷ Operations
  - ▷ Crop
  - ▷ Wind Barrier Data
- ▶ **Soils Data**





# WEPS 1.0 Databases

## Climate Data (Windgen & Cligen)

### ▶ Databases

- ▷ Compact & national in coverage

### ▶ Generators

- ▷ Hourly speed and daily direction from Windgen
- ▷ Daily weather data from Cligen

### ▶ More information

- ▷ Windgen - <http://www.weru.ksu.edu/weps>
- ▷ Cligen - <http://www.ars.usda.gov/Research/docs.htm?docid=18094>



# WEPS 1.0 Databases

## Management Practices Data

- ▶ **Crop and Operation Databases**
  - ▷ The WEPS User Manual has a “How to” section
  - ▷ NRCS has matched all crop and operation files with RUSLE files
- ▶ **Wind Barrier Database**
  - ▷ The WEPS User Manual has a “How to” section
  - ▷ Bruce Wight, NRCS has revised the Barrier data
- ▶ **Management Database**
  - ▷ “How to” Power Point explains file conversions from RUSLE files



# WEPS 1.0 Databases

## Management Practices Data

- ▶ **Management Database**
  - ▷ **23000 RUSLE files are available on the WEB by Conservation Management Zones (CMZs)**
  - ▷ **Each FO will only download the zones they need**



# WEPS 1.0 Databases

## Soils Data

- ▶ **NRCS “SSURGO” database**
  - ▷ **National soil database (MS Access format)**
    - <http://soildatamart.nrcs.usda.gov>
  - ▷ **Populated from NRCS “NASIS” database**
    - <http://soils.usda.gov/>
    - WEPS will run on the same file as Toolkit does in the FO
- ▶ **WEPS soils data input requirements**
  - ▷ **“IFC” file format (WEPS User Manual)**
    - <http://www.weru.ksu.edu/weps>



# WEPS 1.0

## Current Status and Work

- ▶ **April 4, 2005**
  - ▷ Released to NRCS for Testing/Evaluation
- ▶ **NRCS Testing/Implementation**
  - ▷ Testing has been completed in 10 regional locations
  - ▷ Train the trainer sessions scheduled for June-August, 2010
  - ▷ NRCS Ver 1.0 released May 2010



# Benefits of WEPS 1.0

- ▶ **Allows for future WEPS releases that will:**
  - ▷ **Use the same erosion technology**
  - ▷ **Use same databases**
  - ▷ **Use compatible inputs**
  - ▷ **Build upon user's current knowledge and experience with WEPS 1.0**
  - ▷ **Provide additional capabilities**

# Future Versions of WEPS will include

- ▶ **Plant damage**
- ▶ **Integration with WEPP**
- ▶ **Non-cropped lands**
- ▶ **Visibility & PM<sub>2.5</sub>**
- ▶ **“DEPAWS”**
- ▶ **Complex fields**
- ▶ **Barrier Growth**
- ▶ **Multiple soils**





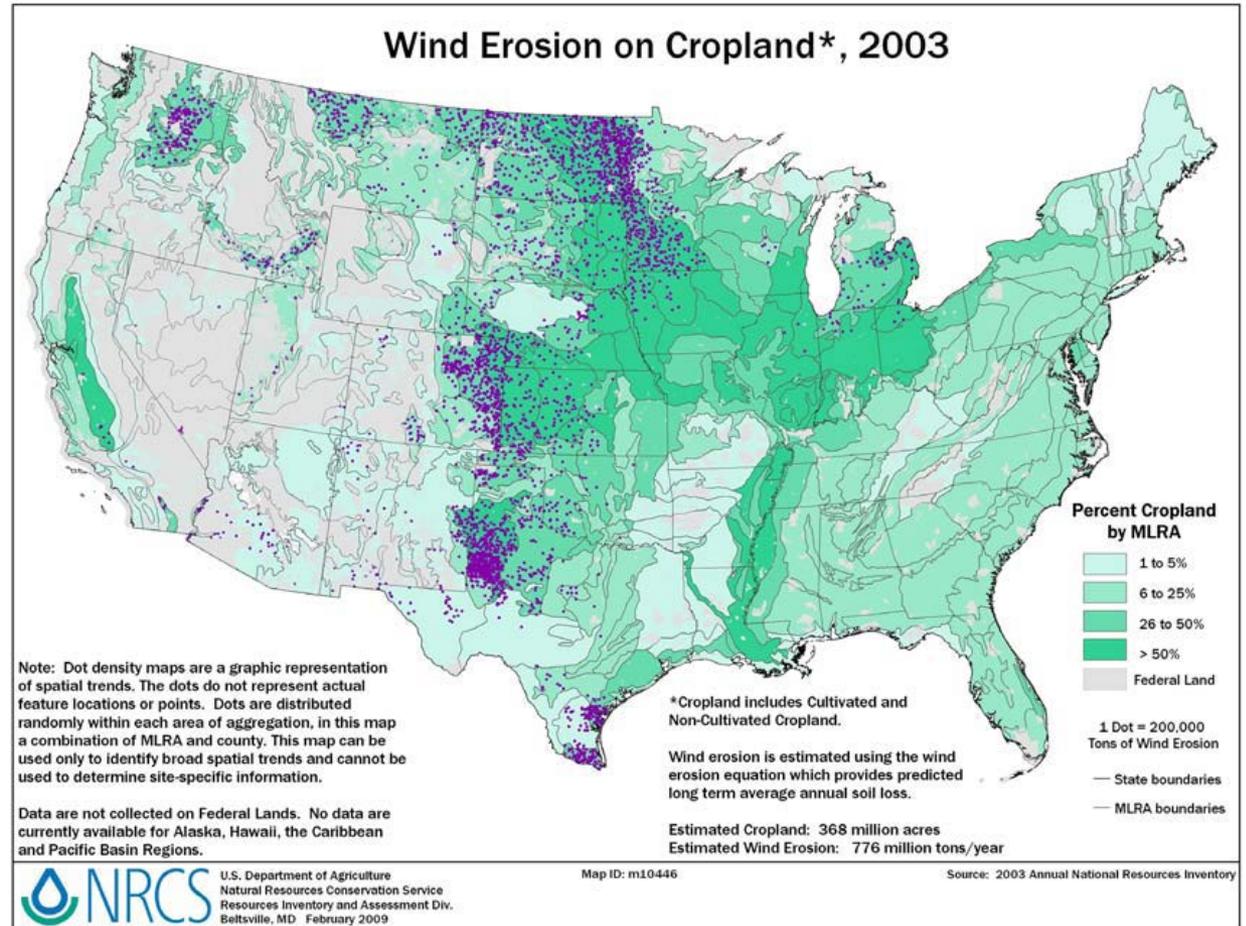
# WEPS Summary

## Providing needed erosion prediction technology

- ▶ **Process based model**
- ▶ **Weather/database driven**
- ▶ **Simulation on a daily time step**
- ▶ **Reflects effects of cultural practices**
- ▶ **Computes erosion in 2-D space**
- ▶ **Estimates soil loss by direction and size**

# The Problem

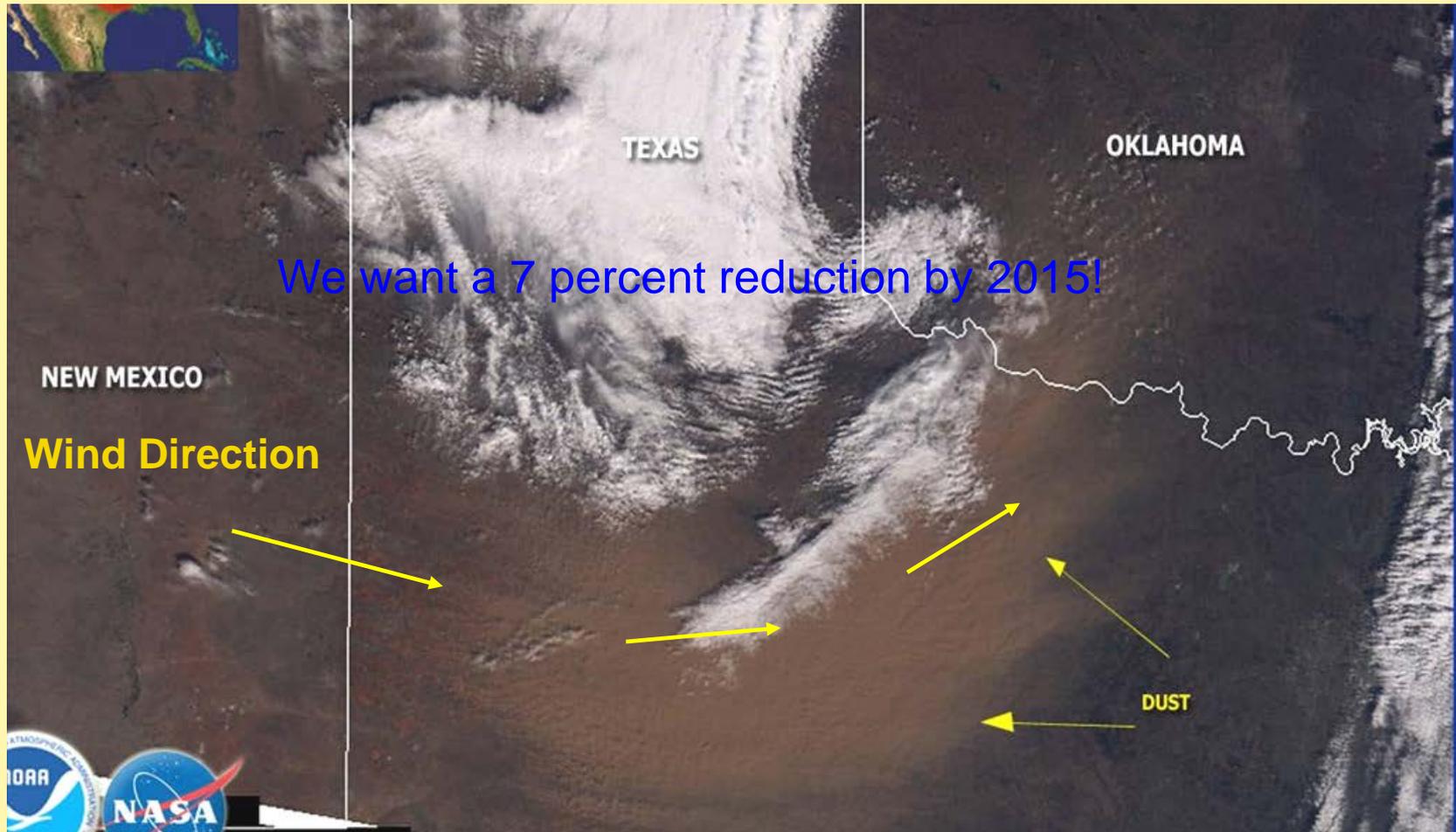
- NRI has identified wind erosion as a problem on more acres than water erosion.
- In 2003, wind erosion accounted for more than 776 million tons of soil loss from cropland



# West Texas 2-24-07

Major problems still occur.

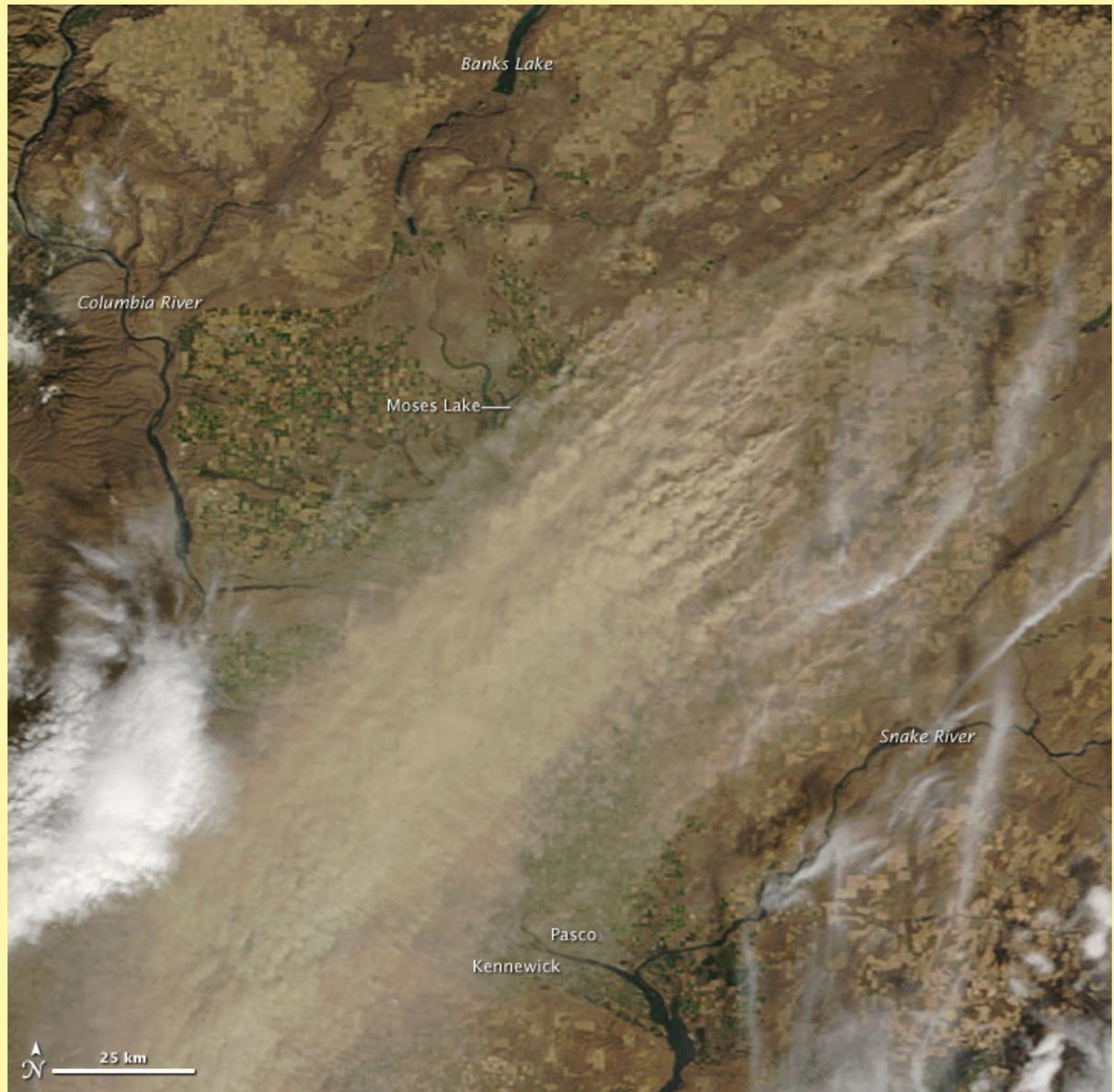
This was mostly Cotton cropland with residue shredded



# This is Eastern WA

10/3/09

- 40+ mph blowing from the NE (not normal)
- SE Lincoln and Adams Co.
- WW-SF
- The WW was just planted and had not come up yet.



# Resource Evaluation is People

“If we don’t continue spending as much time in the field as possible, face to face with the people and the resources, then our databases are as good as they are ever going to be.”

Larry Butler 3/1/07  
Retired TX State  
Conservationist





*Wind Erosion Prediction  
Systems*