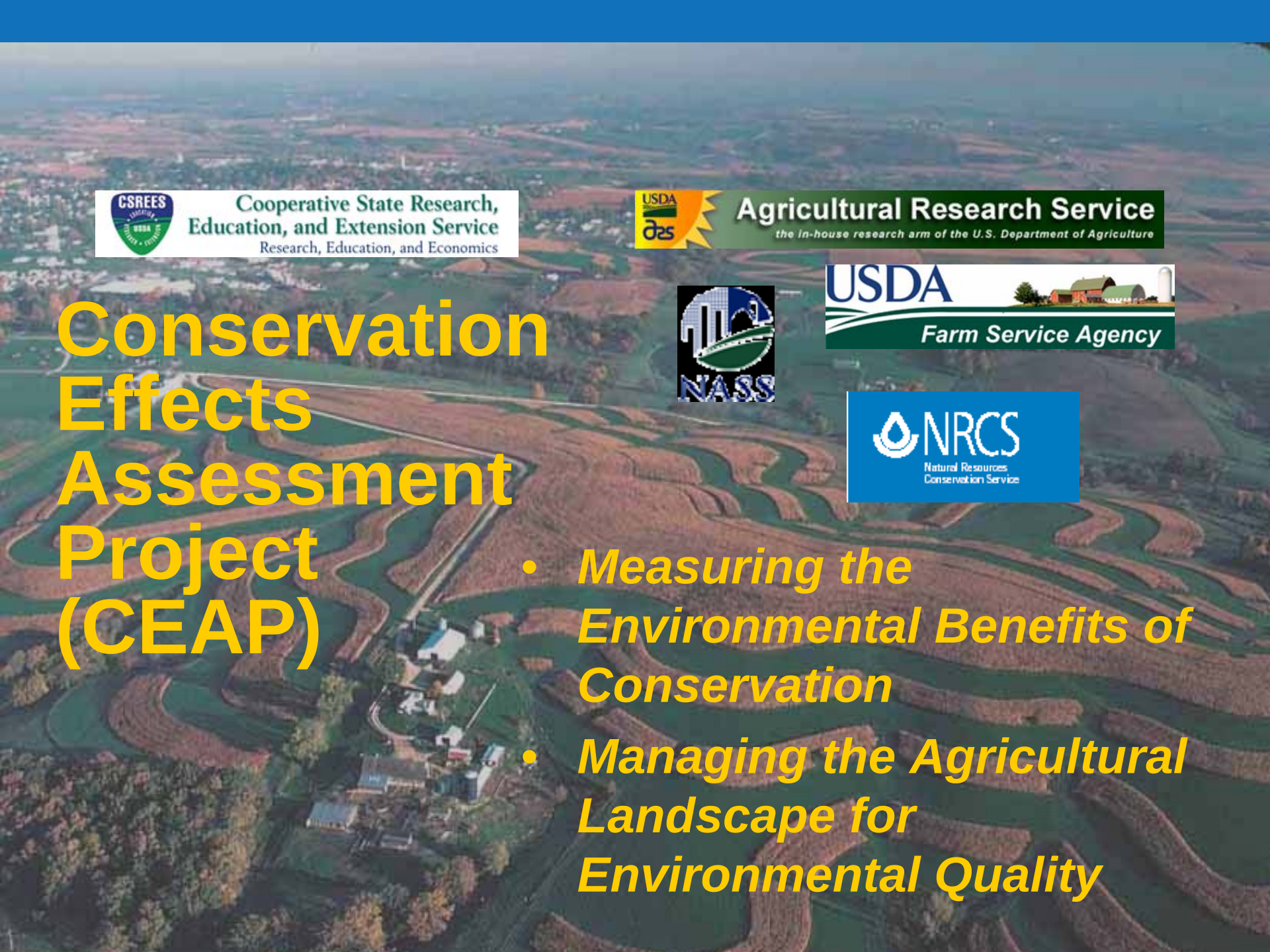
Challenges in Applying the APEX Model for the CEAP National Cropland Assessment

Acknowledgement - Many of these slides were developed by:

Dr. Robert Kellogg, CEAP National Cropland Assessment Leader, USDA, NRCS, Resource Inventory and Assessment Division


CSREES
Cooperative State Research, Education, and Extension Service
Research, Education, and Economics
USDA ars
Agricultural Research Service
the in-house research arm of the U.S. Department of Agriculture
NASS
USDA
Farm Service Agency
NRCS
Natural Resources Conservation Service
Conservation Effects Assessment Project (CEAP)
• Measuring the Environmental Benefits of Conservation
• Managing the Agricultural Landscape for Environmental Quality

CEAP—Conservation Effects Assessment Project

National / Regional Assessments of the Effects of Conservation Practices on Cropland

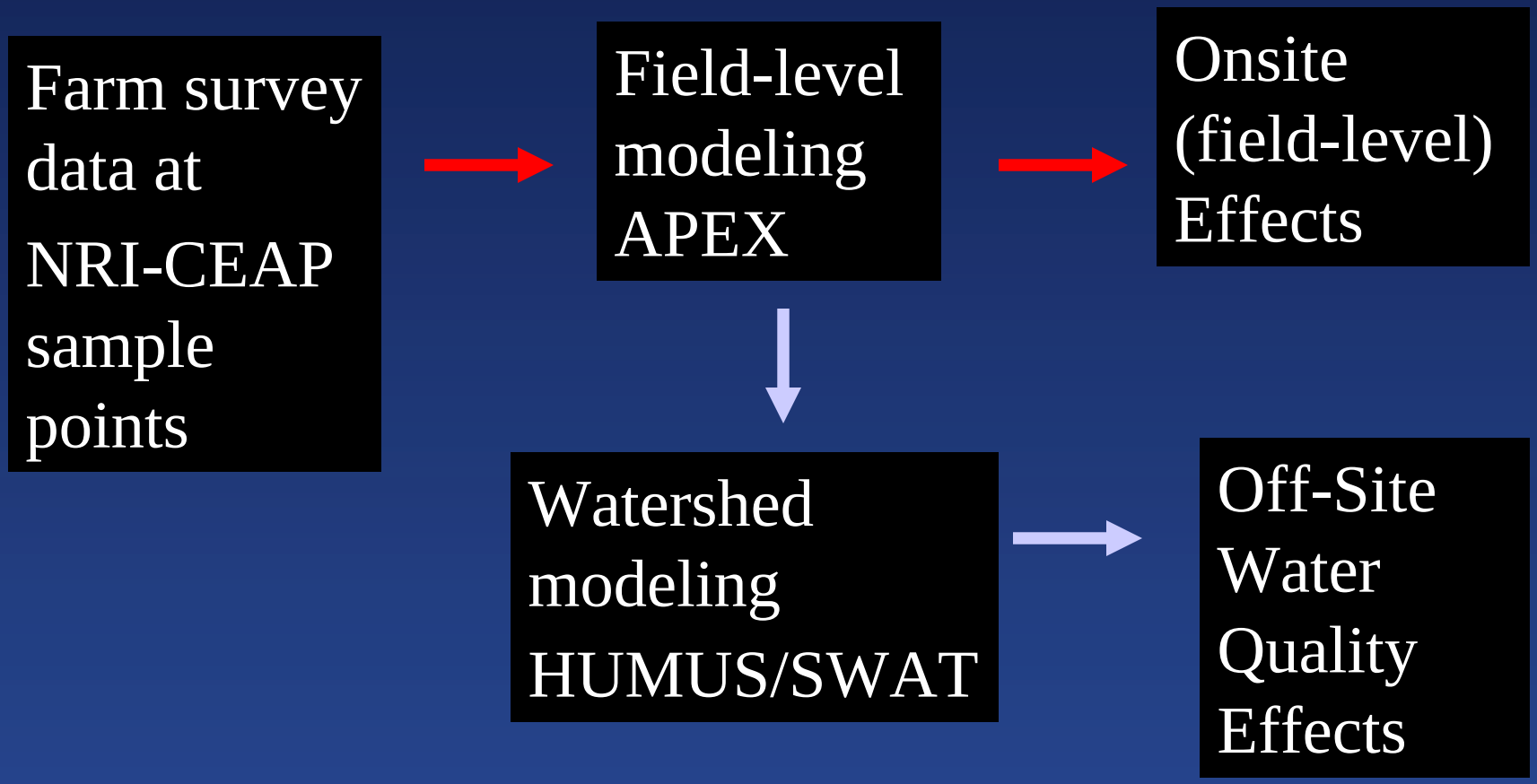
Goals

1. **Estimate the benefits of conservation practices currently present on the landscape**

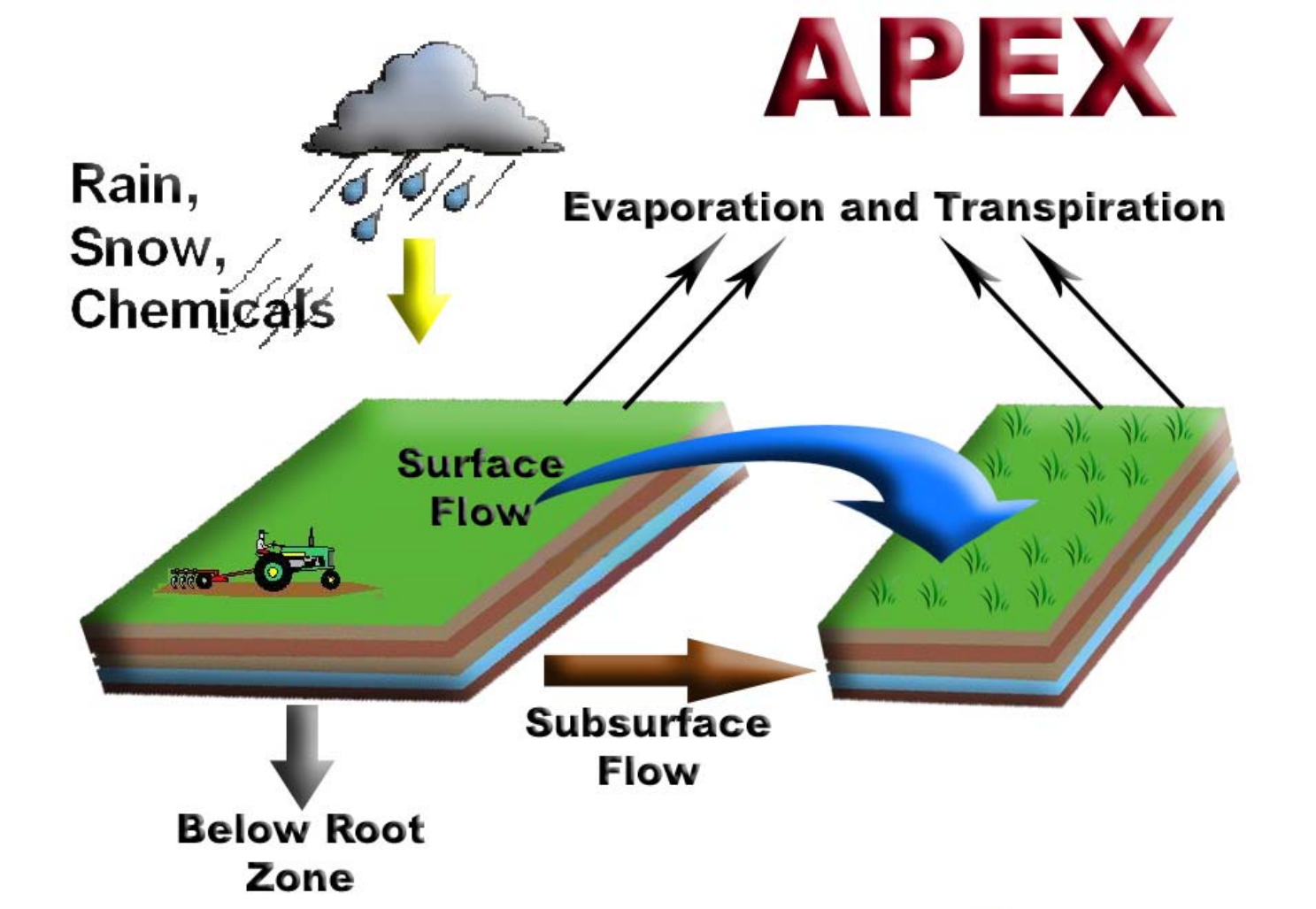
2. **Estimate the need for conservation practices and the benefits that could be realized under "full treatment"**

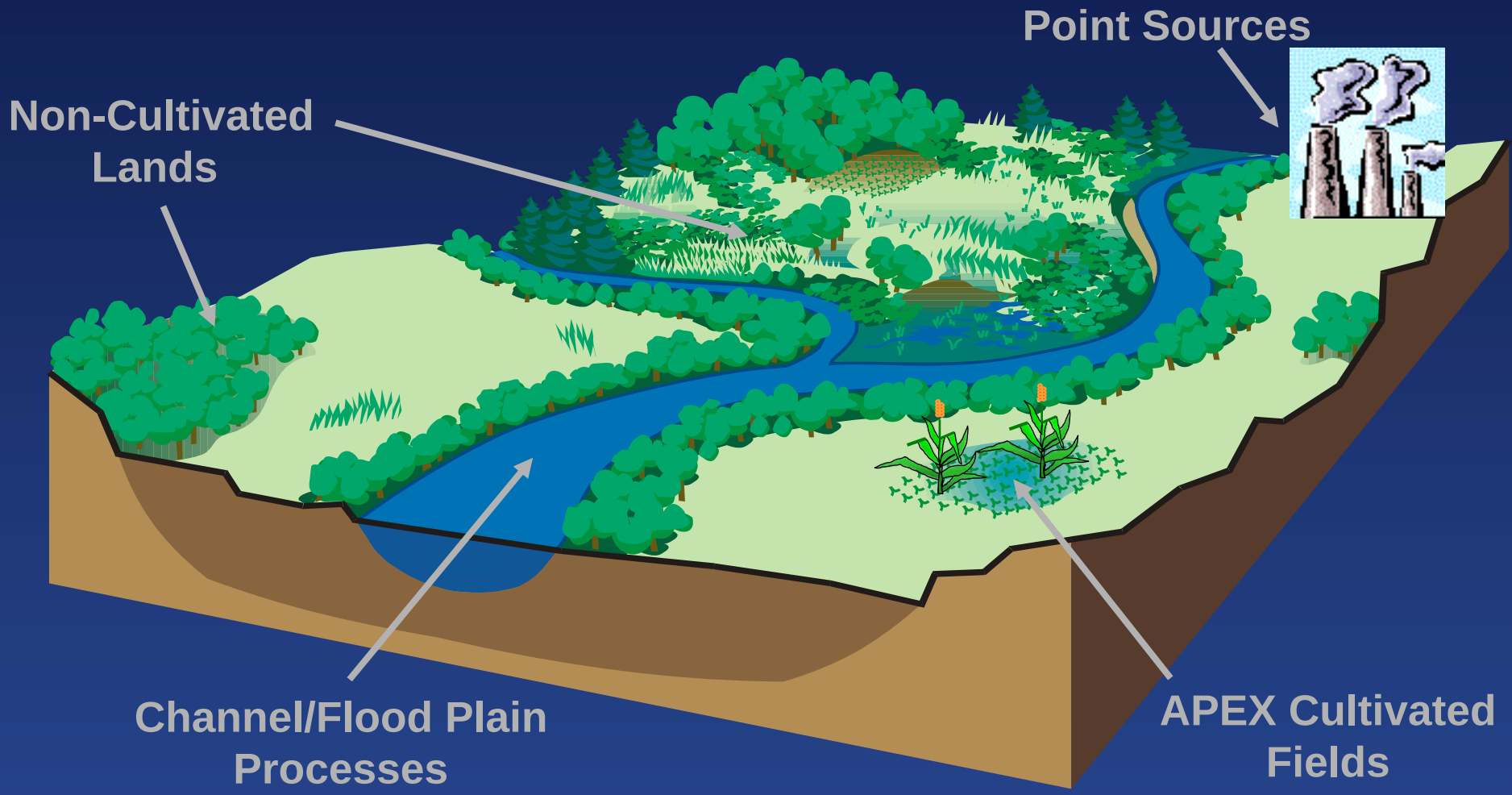
3. **Simulate alternative options for implementing conservation programs on cropland**

Sampling and Modeling Approach

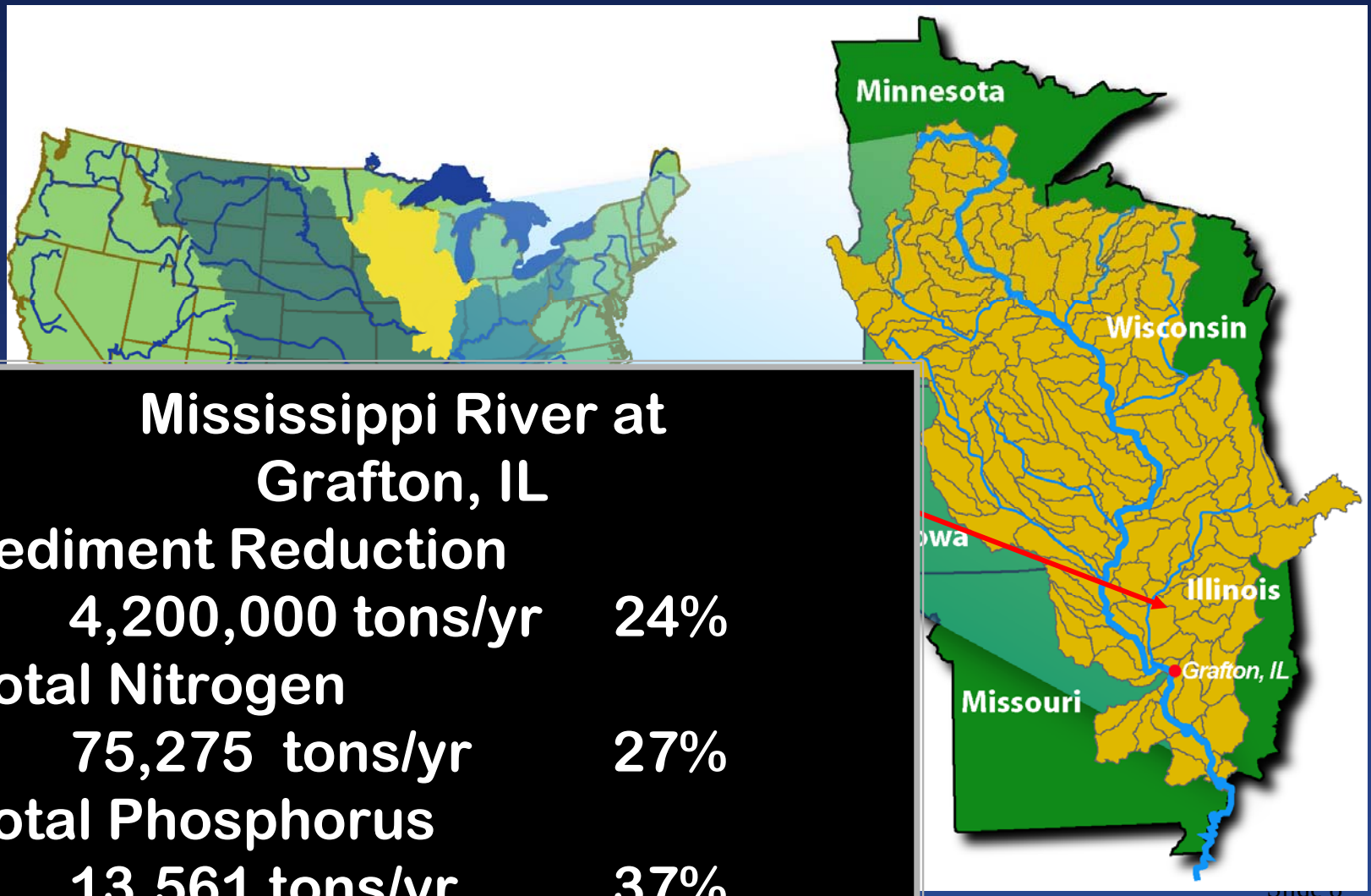


Agricultural Policy Environmental eXtender Model




Point Sources
Non-Cultivated Lands
Channel/Flood Plain Processes
APEX Cultivated Fields

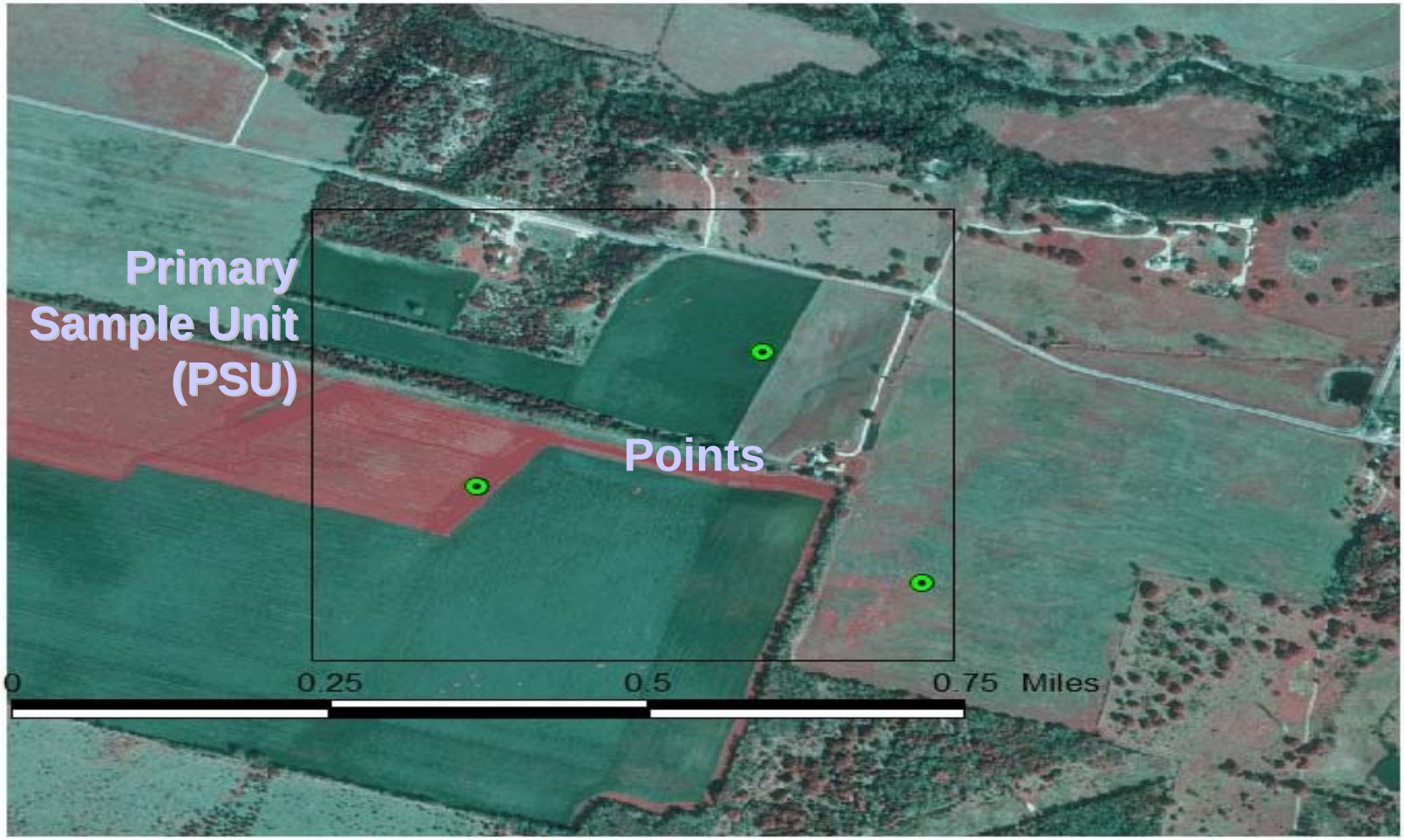
Preliminary Reduction Results



Mississippi River at Grafton, IL

- **Sediment Reduction**
  - 4,200,000 tons/yr 24%
- **Total Nitrogen**
  - 75,275 tons/yr 27%
- **Total Phosphorus**
  - 13,561 tons/yr 37%

Statistical Design



Approximate Count of Usable Surveys

18,722 model-able farm samples out of 33,249 selected NRI points

Plus APEX simulations for each of the 13,178 NRI points classified as CRP in 2003

NRI-CEAP Cropland Survey

The survey obtains for each sample point:

- Three years of crop and cropping practice information
  - Crops grown, seeding rates, etc.
  - Nutrient applications, including manure
  - Pesticide applications and pest management practices
  - Field operations, including tillage
  - Irrigation practices
- Conservation practices
- Conservation Program participation

Modeling Strategy

1. **Estimate a CEAP Baseline using farmer survey information at NRI sample points**

2. **Construct an alternative scenario assuming "no practices"**

Difference between these two scenarios represents the benefits of the accumulation of conservation practices currently in place on the landscape.

Conservation Treated Acres

Treatment	Percent of acres treated
None	11%
Structural practices only	8%
Residue management practices only	50%
Both residue management and structural practices	31%

Residue Management Practices

	Average annual STIR	% acres
Continuous conventional	130	19%
Continuous no-till	5	20%
Mulch till	60	30%
Seasonal no-till	38	20%
Seasonal mulch till	99	11%

Characteristics of Simulations

- 46 years with actual weather 1961-2006
- 15 year pre-run period
- Standardized field size and orientation
- Practices represented by changes in USLE-P factor or with sub-basins set up as buffers, grassed water ways, etc.
- Site specific soils, weather, atmospheric deposition, landscape characteristics
- A single national set of coefficients in the Crops, Operations, and Parameter tables

Data Edit Steps

1. Determine rotation
2. Assign specific species (e.g., winter or spring wheat)
3. Check existence of plant and harvest operations
4. Resolve schedule overlap and operations from previous fall
5. Resolve missing dates
6. Resolve quantity and unit issues
7. Augment or adjust field operations in special cases
8. Build special hay, idle/fallow only, other perennial rotations
9. Trouble shoot actual APEX simulation

Where possible, mark and save original data rather than discard.

Rotation Determination Issues

1. Possibly a 3 – year snapshot of longer, complex rotation?
2. Multiple crops reported for 1 or more years
    a. Crop abandonment
    b. Cover crop
    c. Partitioned management of field
    d. Inter-cropping, over-seeding, and “nurse” crop
    e. Double/Triple/Quadruple cropping
3. Hay or other perennial extending beyond 3-year survey period
4. Samples with fallow/idle only reported
5. Grazing of crop (with and without later harvest)

Evolving Management Within Survey Period?

1. Is reduced tillage adoption occurring during survey period?
2. Or occasional use of tillage like deep ripper?
3. Or abnormal weather, pest outbreaks, or other circumstances?
4. Temporary response to market conditions?

Species Assignment (Crop Label ID)

1. Determine Winter or Spring wheat by planting date
2. Silage, hay or grain type according to harvest method
3. Assign specie for “other hay”, “pastured cropland”, “grass silage”, etc.
4. Other vegetable, grass seed, etc.

Check for Plant and Harvest Operations

1. Harvest operation of final year not reported if after survey collection date
2. Occasional miss-coding of operations
3. If two crops seeded with same machine, planter reported only once, but APEX needs an operation for each crop
4. For missing field operations in “NoTill” samples, simply add planter and harvester
5. Add harvest operation if crop abandoned but intent was grain or forage harvest

Date Issues

1. Overlapping management schedules from year to year
2. Tillage operations reported for late fall previous to 1st survey year
3. Most missing dates or “bad” dates were easily corrected

N Fertilizer Adjustments

- Reporting options
  - actual N, P, and K in lbs/acre;
  - or elemental analysis (N-P-K) and total lbs fertilizer material with various units (lbs, tons, gallons, …)
  - Resulted in e.g., 180 bu of corn from 18 lbs N, 46 lbs P, and 0 lbs K
  - Similar reporting issue for manure nutrient units
- Address cases of obvious “low” reporting errors
- Objective is to adjust appropriately – how much?
- Modeling approach based on potential yields versus reported yields for “good” surveys

Field Operation Augmentation

1. Replace “hand harvest” with crop specific harvest operations
2. Appropriate machines for forage harvest
3. Add “grazing” operation for grazed fields
4. Planter, mower, etc for cover crops
5. Crop residue removal
6. Exclude machines not traversing field and/or not interacting with soil or biomass

Diverse Management Systems – Stretching APEX Capability

- Corn (and soybeans) seeded 1 – 2 months prior to wheat harvest
- Clover seeded into winter wheat, then kept as cover crop
- Baling of peanut vines and soybean residue
- NoTill Planting operation preceded by “In-Row-Sub-soiler”
- Three or four vegetable crops per year
- Rare crops (Emmer and Spelt, Guar, Hops, Kenaf, Mint, Teff, Triticale)
- Various vegetable, seed, and ornamental crops in rotation
- Multiple diverse harvest of same crop – forage, roots, seed, residue

CRP Simulation Procedures

1. All except 50 of the 13,178 CRP points in 2003 NRI
2. CRP practice data from FSA for points linked to contract records
3. Procedures:
   a. Assignment of each CRP point to one of 6 vegetative cover types based on dominant practice according to FSA or NRI data
   b. Species mix by LRR for each cover type
   c. Field operation management data set development
   d. Development of site data (soils, slope, weather, etc.)
   e. Inclusion of legume to provide N for reasonable growth?
4. Selection of corresponding cropping samples for No-Practice scenario (or for grain or ethanol production)

Modeling Challenges

- Delivery ratio to convert APEX edge-of-field output to SWAT point source input
- Drainage
- Adequacy of N fertilizer (crops and CRP)
- Over lapping crops and reported out of “range” planting and harvesting operations
- Varietal and regional differences in crop growth characteristics
- Variation in planting and harvesting dates across samples within regions
- Multiple harvest operations for partial, repeat, or differing components of crop