Processing Agricultural Fertilizer Data for CAST

Background

- Chemical fertilizer[*] in the Chesapeake Bay Watershed is a large source of nutrients that leads to low dissolved oxygen and increased chlorophyll *a*.
  - [*]Inorganic fertilizer available for application to crops

- Modeling chemical fertilizer application rates is important for management decisions.

- Jurisdictions are concerned with the accuracy of chemical fertilizer data used in modeling efforts.
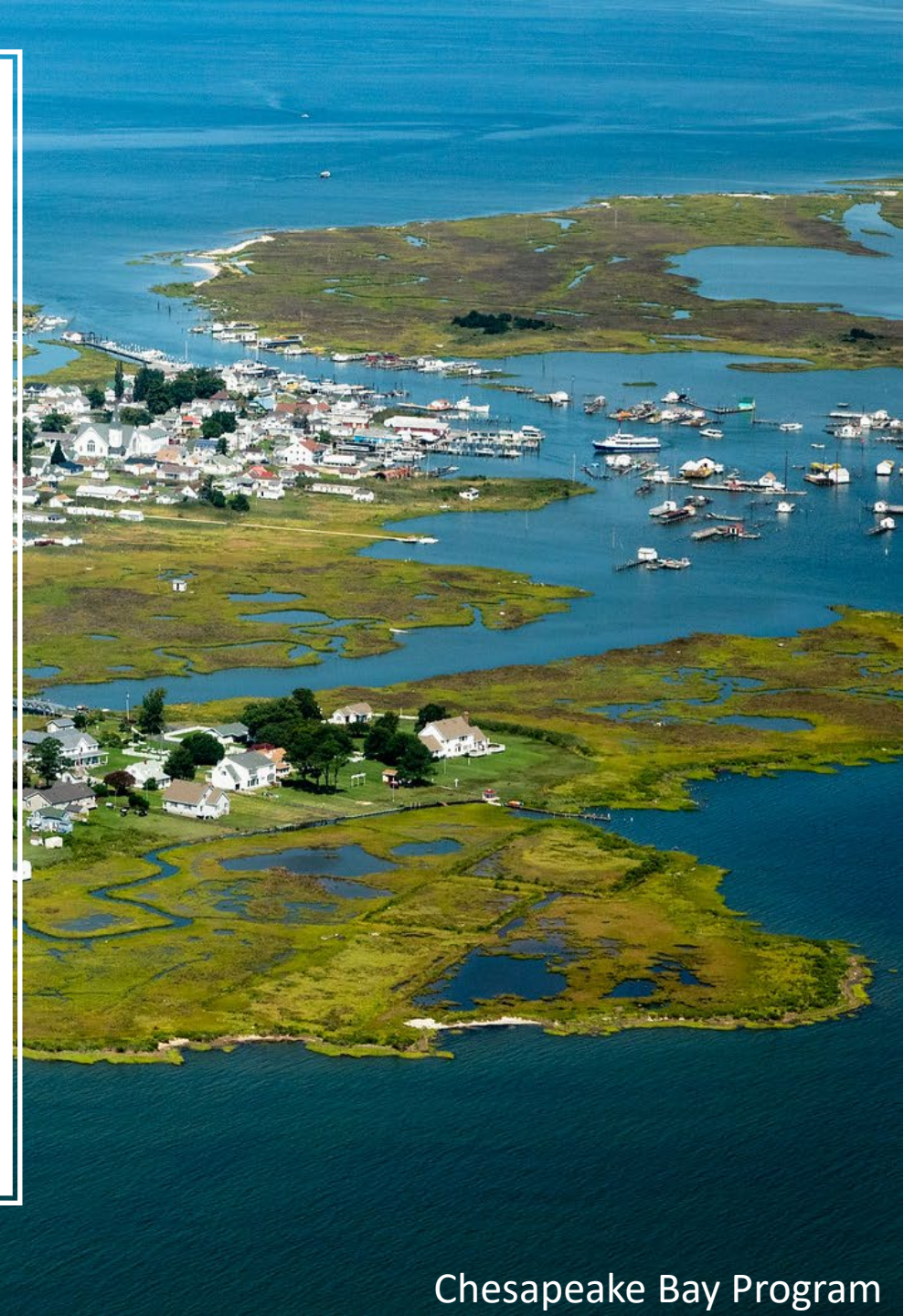
Chesapeake Bay Program

Brief History of Chemical Fertilizer Data

Chemical fertilizers are manufactured and applied differently to urban and agricultural lands.

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Workshops were held in 2007 & 2013 examining alternative chemical fertilizer model inputs. Suggestions included:

| Regulation/Policy changes | Bay wide farm surveys describing fertilizer applications | Using data from the International Plant Nutrition Institute (CAN) | Utilize Association of American Plant Food Control Officials (AAPFCO) sales data |

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In 2017 the Partnership utilized AAPFCO data (with additional data streams) in the model.

| Best dataset available in 2017 | Single, consistent data source across the watershed | Data originate from state regulatory reports |

In 2023 Moved to utilize data directly from states where available

Working with the Data

Agricultural fertilizer data are summed for the entirety of the six CBW states and redistributed at county-level

Fertilizer can be transported across state lines after sale

Calculate a regionwide fertilizer amount by summing all states

Determine watershed counties' crop application goals with Ag Census and reported nutrient management data

Distribute regional fertilizer to counties based on crop application goal and available manure and biosolids

Agricultural Fertilizer Data Sources

American Association of Plant Food Control Officials (AAPFCO)

- County-level commercial fertilizer sales (mass of N and P)
- Updated annually but takes time to release (most recent release is for 2017 data)

State departments of agriculture

- County-level commercial fertilizer sales (mass of N and P)
- Updated annually with reduced latency vs AAPFCO

United States Department of Agriculture (USDA) National Agricultural Statistics Service (NASS)

- Census of Agriculture
  - Fertilizer expenditures on 60+ crops produced in the region (US Dollars)
  - Updated every five years (County and State levels)
- Annual Surveys
  - Major crop production and livestock production (State level only)

Land Grant Universities and State Extension Agencies

- Agronomic application rates (fertilizer mass/ crop yield / acre)
- Updates based on the availability of research data

Why AAPFCO data?

- State reported, single data source

- Consistent standard data reporting requirements

- Publicly available data for deriving countywide inorganic fertilizer application
  - When investigating fertilizer inputs for Phase 6, AAPFCO provided full spatial coverage of CB watershed counties, was regularly published (although delayed), and included necessary information (e.g., farm vs. non-farm, nutrient masses) from a single source

- Ag Modeling Subcommittee (AMS) developed a Partnership-approved fertilizer use estimation procedure for agricultural fertilizer in CAST
  - Process utilizes AAPFCO data, NASS datasets, and application rates from states

Organizations Using AAPFCO

- The Fertilizer Institute and Plant Nutrition (Canada)
  - Nutrient Use Geographic Information System (NuGIS)

- United States Geological Survey (USGS)
  - Spatially Referenced Regression On Watershed (SPARROW) attributes model
  - National Water-Quality Assessment (NAWQA)
  - Develop turfgrass application estimates

- USDA Economic Research Service
  - Fertilizer Use and Price

- USDA Natural Resources Conservation Service (NRCS)
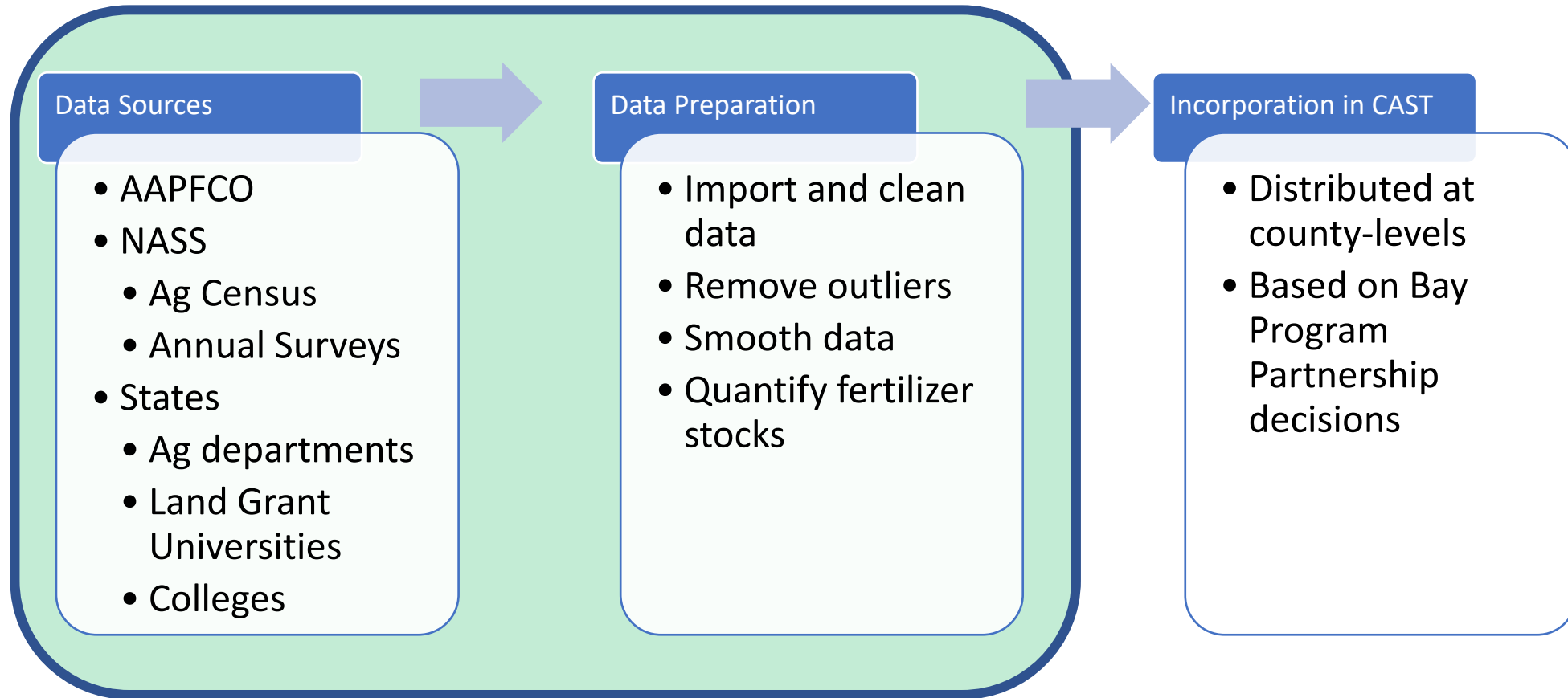 - Conservation Effects Assessment Project (CEAP)

Why the move to states?

- Same data as AAPFCO

- No middleman

- Reduced latency

Data Processing Steps

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Ag Fertilizer Data Processing Overview

Data Sources
- AAPFCO
- NASS
  - Ag Census
  - Annual Surveys
- States
  - Ag departments
  - Land Grant Universities
  - Colleges

Data Preparation
- Import and clean data
- Remove outliers
- Smooth data
- Quantify fertilizer stocks

Incorporation in CAST
- Distributed at county-levels
- Based on Bay Program Partnership decisions

1. County Level

AAPFCO/State

1. AAPFCO data are obtained by the Chesapeake Bay Program at the **county level**.
     a. These data contain the annual mass (tons) of fertilizer sold (% TN and P205).

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2. State Level — AAPFCO/State

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    a. These data contain the annual mass (tons) of fertilizer sold (% TN and P205)
2. These data are converted to pounds of fertilizer sold then summed at the **state level**.
    a. Outlier removal occurs.
    b. Farm fertilizer fraction is determined.
    c. Smoothing with a 3-year rolling averge.

1. County Level

2. State Level

NY

PA

MD

DE

WV

VA

3. Six State Level

AAPFCO/State

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3. Summed for the **six state level** per year for TN and P205.

Notes on State data *

- The same information is gathered from states as AAPFCO.
- Data after 2016 and up to 2020 were provided directly by states.
  - DE, PA, MD, VA
- Remaining states used the trend of fertilizer increase from those who reported.
  - Trend was applied from last reported data.

4. County Level

Ag Census

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4. County Level

Ag Census

5. Six State Level

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5. These data are then summed to the **six state level**.

4. County Level — Ag Census

5. Six State Level — Ag Census

5a. CBW Counties — Ag Census

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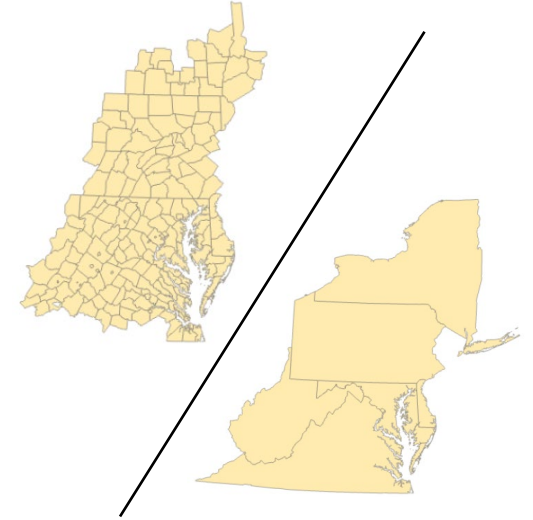
4. County Level — Ag Census

5. Six-State Level — Ag Census

**5a. CBW Counties** — Ag Census

6. Expenditures Fraction — Ag Census

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5. These data are then summed to the **six-state level**.

    a. Soil amendment expenditures are summed for **CBW counties**.

6. The **expenditures fraction** spent on agricultural fertilizer within the CBW is determined.

    a. Ratio of CBW Counties to the Six-State Level (unitless) per year.
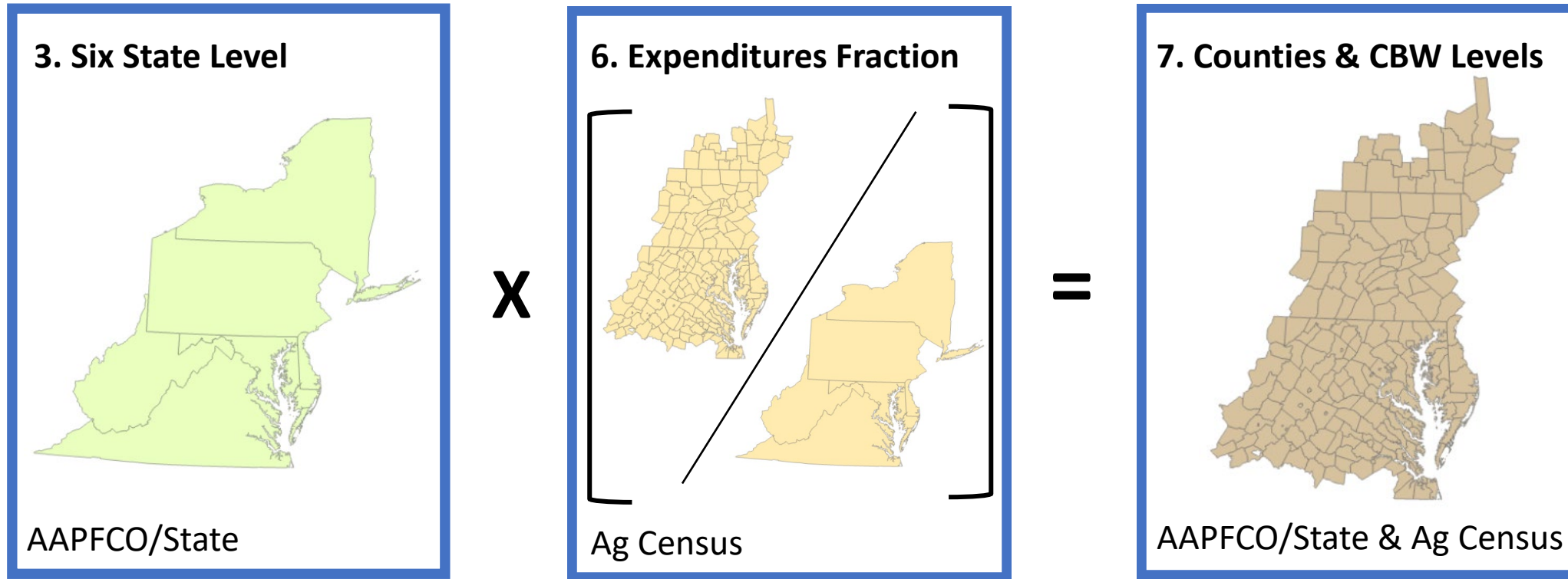
3. Six State Level

AAPFCO/State

X

6. Expenditures Fraction

Ag Census

=

7. Counties & CBW Levels

AAPFCO/State & Ag Census

7. Quantify the pounds of agricultural fertilizer used annually in the **CBW**.

a. Six state agricultural fertilizer mass (pounds; AAPFCO) is multiplied by the CBW expenditures fraction (unitless; Ag Census).

3. Six State Level

AAPFCO/State

X

6. Expenditures Fraction

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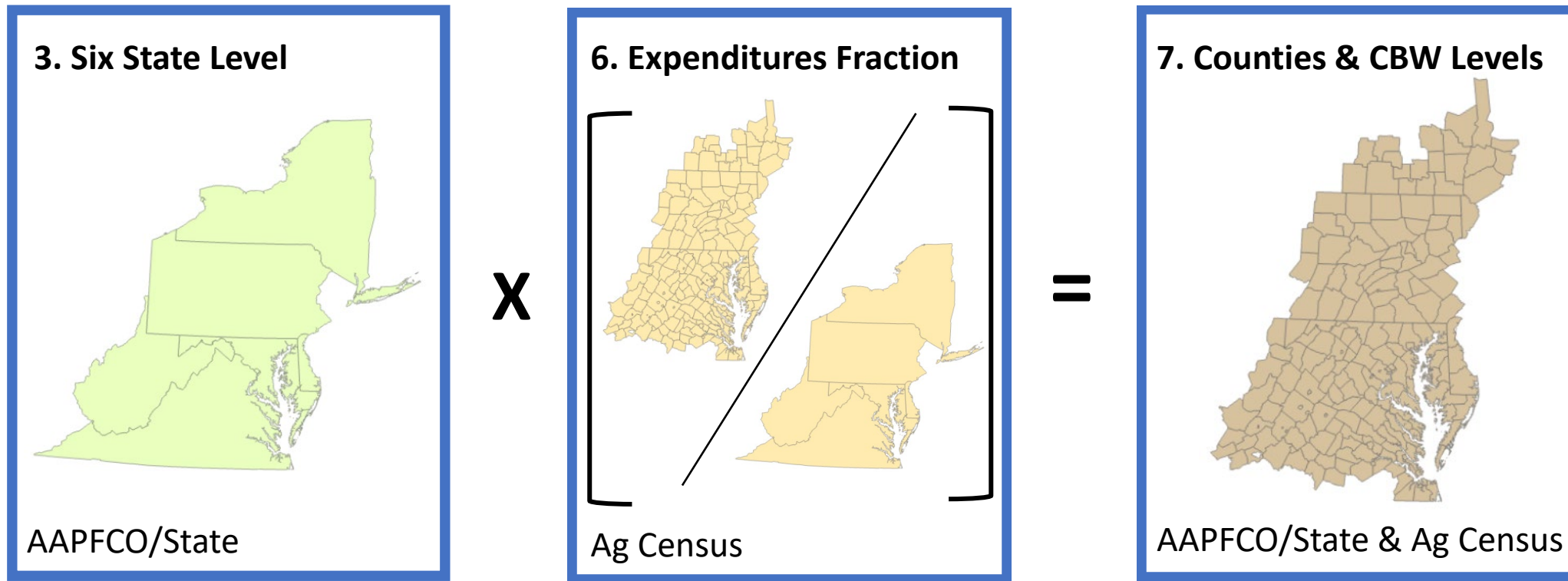
7. Quantify the pounds of agricultural fertilizer used annually in the **CBW**.

a. Six state agricultural fertilizer mass (pounds; AAPFCO) is multiplied by the CBW expenditures fraction (unitless; Ag Census).

b. Results in annual fertilizer mass _available for application_ (pounds of TN and P205 [multiplied by 0.4362 for farm fertilizer]), which is a calculated fertilizer stock for the entirety of CBW **counties.**

Some quick Terminology

- **Expected Application (pounds)**
  - Indicates the amount of nitrogen a crop or set of crops is expected to receive for an entire county. It is calculated for each crop type using this equation: **#acres of crop x yield/acre (NASS Annual data C-23) x *Expected Application Rate**

- **Expected Application Rate (pounds/acre)**
  - The ***Recommended Application Rate** is adjusted for a factor to account for acres **not** under nutrient management

- **Recommended Application (pounds)**
  - Indicates the amount of nitrogen a crop or set of crops is expected to receive for an entire county under 100% nutrient management. It is calculated for each crop type using this equation: #acres of crop x yield/acre x ***Recommended Application Rate**

- **Recommended Application Rate (pounds/acre)**
  - The Nutrient Management Application Goal per Acre supplied by the jurisdictional land grant university (LGU)- it describes the amount of nitrogen needed per yield unit or acre for each crop type and assumes nutrient management is practiced.

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b. All fertilizer is distributed to counties based on their remaining **expected application** after manure and biosolids are applied.

c. Fertilizer is distributed to available crops within counties based on a set of distribution curves developed by the Ag Modeling Subcommittee.

Summary

We need fertilizer data to estimate N and P applications to the land.

We use state and federally reported data sets.

Data are processed to remove outliers, location issues, and timing of use.

Processed data are applied at the county level, based on the reported crop types and yields in addition to applied organic nutrients.

Questions?