


Computing Agricultural PM_{10} Fugitive Dust Emissions

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Agricultural Emission Estimates

- Field & orchard operations
- Unpaved roads
- Farm equipment exhaust
- Agricultural burning
- Processing & handling facilities
- Pesticides
- Livestock
- Windblown dust

Agricultural Air Emissions are Complex

- Agricultural emissions vary substantially
  - By type of operation
  - By time of year
  - By other conditions (humidity, soil, speed, etc.)
- Emission estimates rely on approximations and simplifications
- Stakeholder expertise helps us work with imperfect information

Computing Land Preparation and Harvest Agricultural Emissions

- Input Data
  - Crop acreage
  - Crop calendars
  - Operation specific emission factors
- Compute emission factors for each crop based on types and number of operations
- Incorporate geographic information for spatial resolution

Crop Acreage

- Compiled by California Department of Food and Agriculture
- Data generated annually by crop and by county
- Over 200 crops included
- Over 30 million acres grown statewide

Crop Calendars

- Crop calendars list types and number of farming operations and when they occur for each crop
- Developed for California with agricultural experts

Farming Operations	Crop Cycles Per Year	Passes Per Crop Cycle	Fraction of Acreage Per Cycle	Passes During Month											
				Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Land Preparation															
Stubble Disc	1	1	1.0												
Finish Disc	1	1	1.0												
List & Fertilize	1	1	1.0												
Mulch Beds	1	1	1.0												
Planting	1	1	1.0												
Cultivation	1	2	1.0												
Harvesting	1	1	1.0												

Land Preparation and Harvest Emission Factors

- Operation and crop specific emission factors
- Based on recent upwind/downwind field measurements by UC Davis
- Based on averages of multiple tests

Activity	**Emission Factor** (lbs PM_{10}/acre-pass)
Land Preparation	
Root cutting	0.3
Discing, Tilling, Chiseling	1.2
Ripping, Subsoiling	4.6
Land Planing & Floating	12.5
Weeding	0.8
EPA AP-42 Tilling (old)	*4.0*
Harvest	
Cotton Harvest	3.4
Almond Harvest	40.8
Wheat Harvest	5.8

Land Preparation Operation Emission Factor Assignments

- Emission factors assigned to all crop calendar operations
- Assign best-fit
- Stakeholder involvement very important for assignments

Land Preparation Operation	Emissions Category	Emission Factor (lbs PM_{10}/ acre-pass)
List	Weeding	0.8
List & Fertilize	Weeding	0.8
Roll	Weeding	0.8
Spring Tooth	Weeding	0.8
Seed Bed Preparation	Weeding	0.8
Terrace	Weeding	0.8
Chisel	Discing	1.2
Plow	Discing	1.2
Mulch Beds	Discing	1.2
Disc & Stubble Disc	Discing	1.2
Disc & Furrow-out	Discing	1.2
Finish or Harrow Disc	Discing	1.2
Post Burn/Harvest Disc	Discing	1.2
Unspecified Operation	Discing	1.2
Land Preparation, Gen.	Discing	1.2
Subsoil-deep chisel	Ripping	4.6
Float	Land planing	12.5
Land Plane	Land planing	12.5
Laser Level & Leveling	Land planing	12.5

*Not complete list

Harvest Emission Factor Assignments

Harvested Crop	Base EFs (lbs/PM10/acre-pass)
Cotton	3.4
Almond	40.8
Wheat	5.8

- Assign base EF to each crop
- If not clear match, apply EF division factor
- Assignments made with guidance of ag experts

Crop Name	Crop Calendar Profile	Harvest EF Base Factor	Harvest EF Division Factor
Almonds	Almonds	Almonds	1
Beans, Dry	Dry Beans	Cotton	2
Corn, Grain	Corn	Cotton	2
Corn, Silage	Corn	Cotton	20
Cotton	Cotton	Cotton	1
Grapes, Wine	Grapes-Wine	Cotton	20
Alfalfa	Alfalfa	Zero	1
Oranges	Citrus	Cotton	40
Pistachios	Almonds	Almonds	10
Rice	Rice	Cotton	2
Safflower	Safflower	Wheat	1
Tomatoes	Tomatoes	Cotton	20
Wheat	Wheat	Wheat	1

*Not complete list

Estimating Emissions
Bringing It All Together

① - Crop acreage data
② - Activity specific emission factors
③ - Assign EFs to crop activities
④ - Compute activity emission rates
⑤ - Summarize emissions
⑥ - Temporally Allocate emissions

① **Crop Acres**
- Crop 1
- Crop 2
- Crop 3
- Crop...

③ **Crop Calendars**

Farming Operations	Crop Cycles Per Year	Passes Per Crop Cycle	Fraction of Acreage Per Cycle	Passes During Month											
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Land Preparation															
Stubble Disc	1	1	1.0												
Finish Disc	1	1	1.0												
List & Fertilize	1	1	1.0												
Mulch Beds	1	1	1.0												
Planting	1	1	1.0												
Cultivation	1	2	1.0												
Harvesting	1	1	1.0												

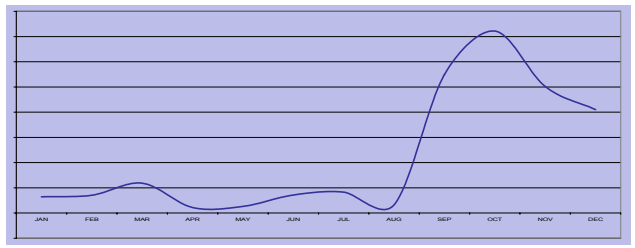
④ **Compute Emissions by Activity**

⑤
- Summarize Land Preparation Emissions
- Summarize Harvest Emissions

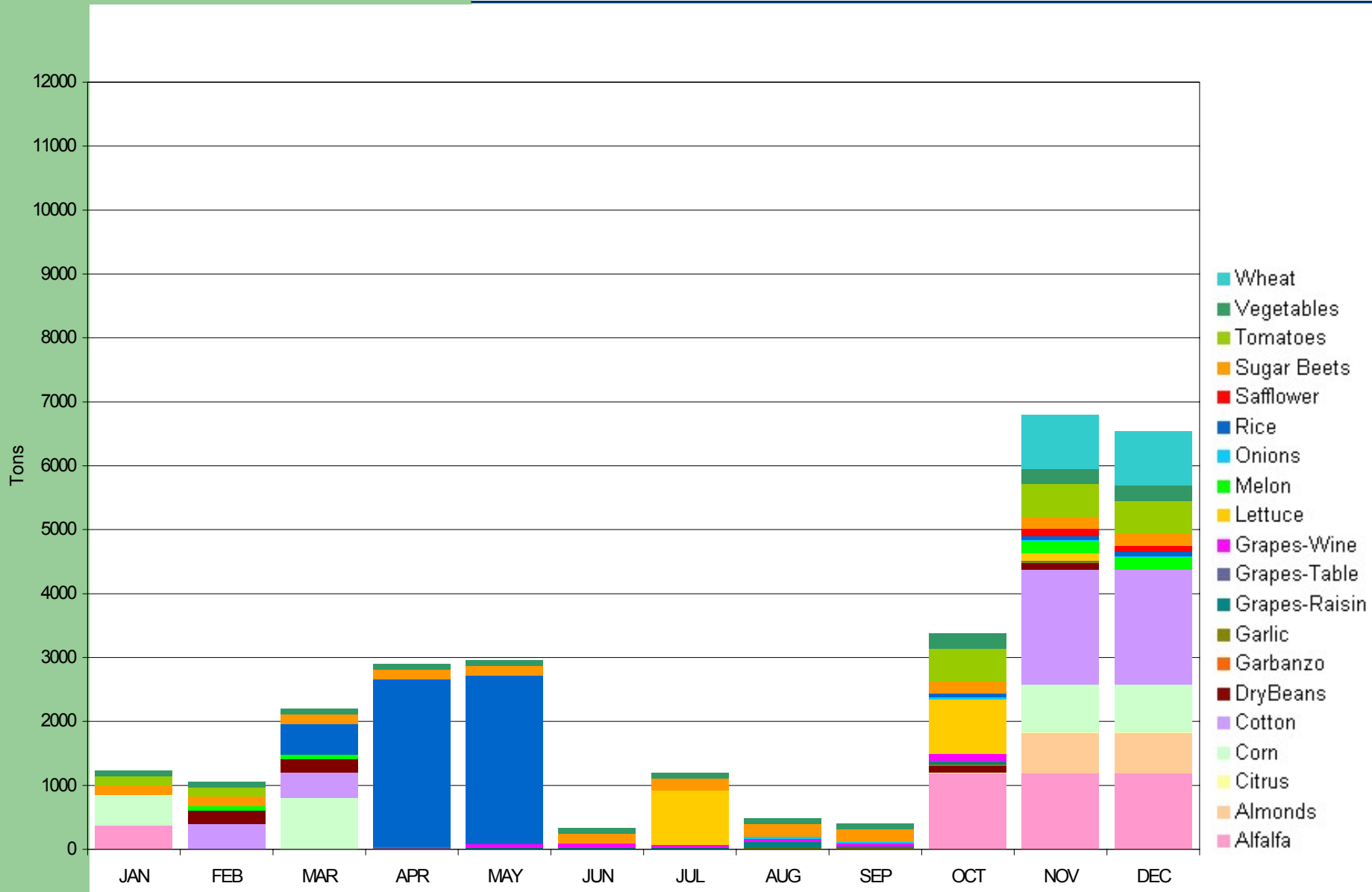
② **Land Preparation and Harvest Emission Factors**

Land Preparation Activity	Emission Factor (lbs PM_{10}/acre-pass)
Root cutting	0.3
Discing, Tilling, Chiseling	1.2
Ripping, Subsoiling	4.6
Land Planing & Floating	12.5
Weeding	0.8
Tilling (from AP-42)	4.0
Cotton Harvest	3.4
Almond Harvest	40.8
Wheat Harvest	5.8

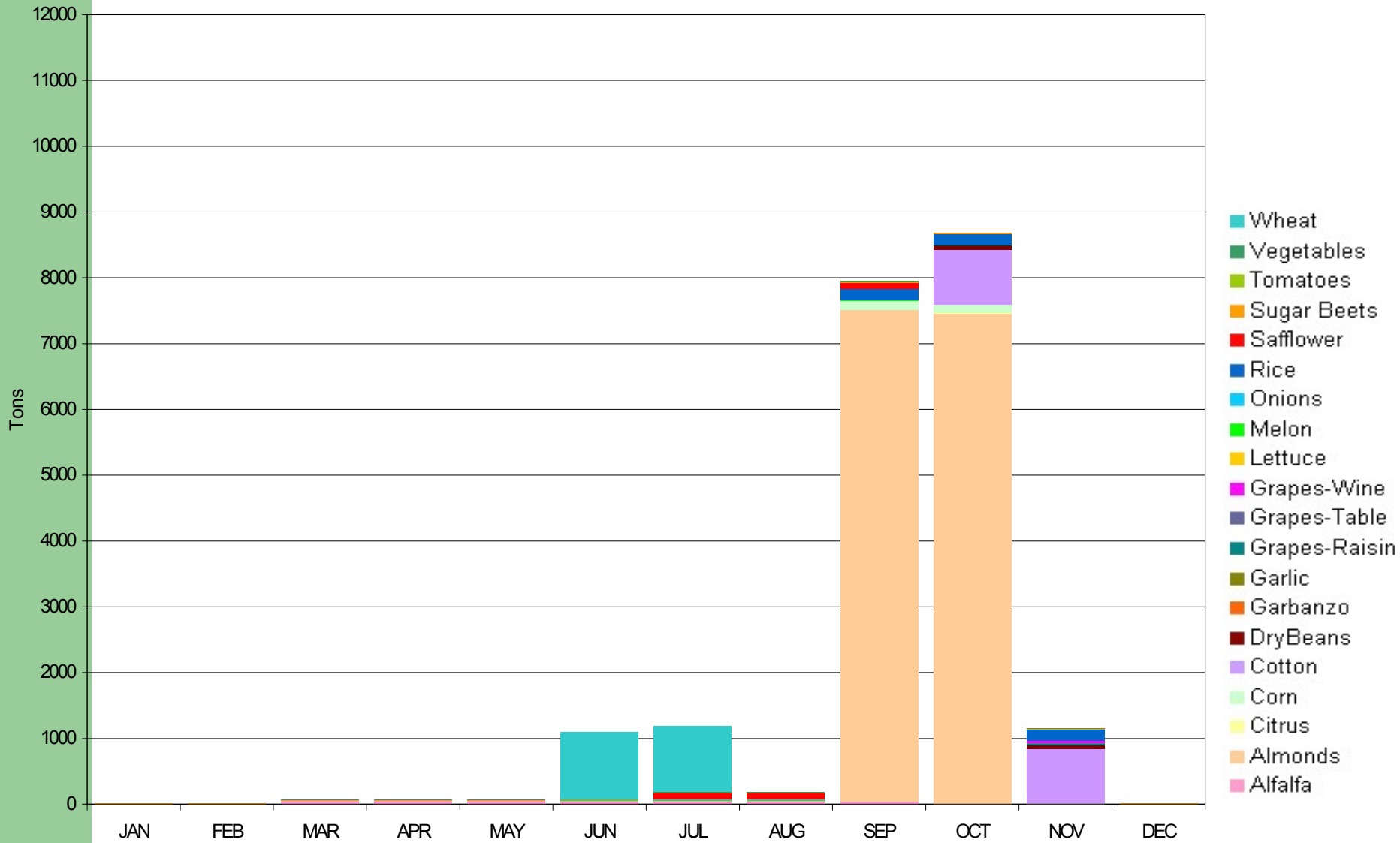
⑥ **Use Crop Calendars to Temporally Allocate Emissions**



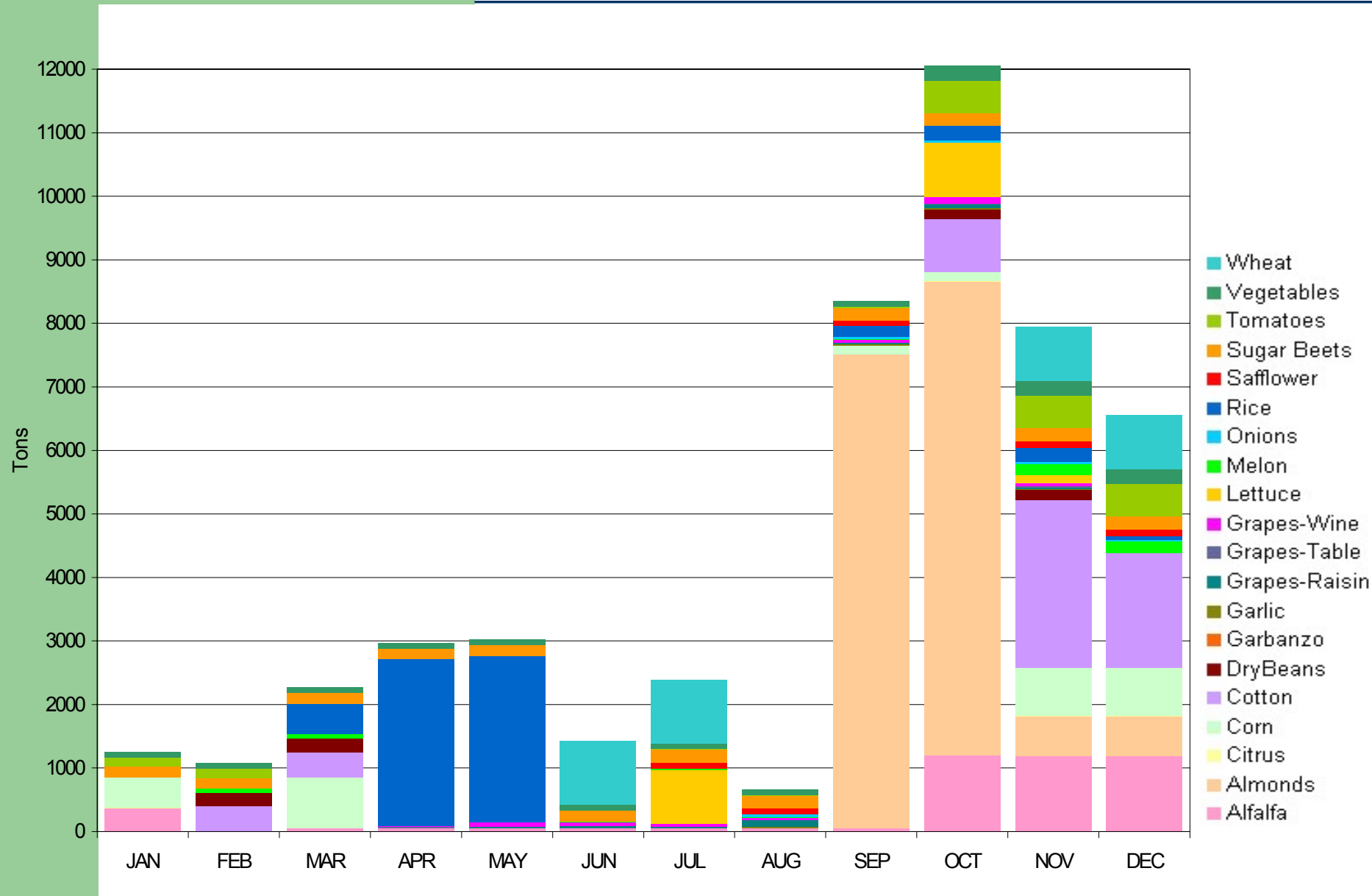
Land Preparation Emissions



Harvest Emissions

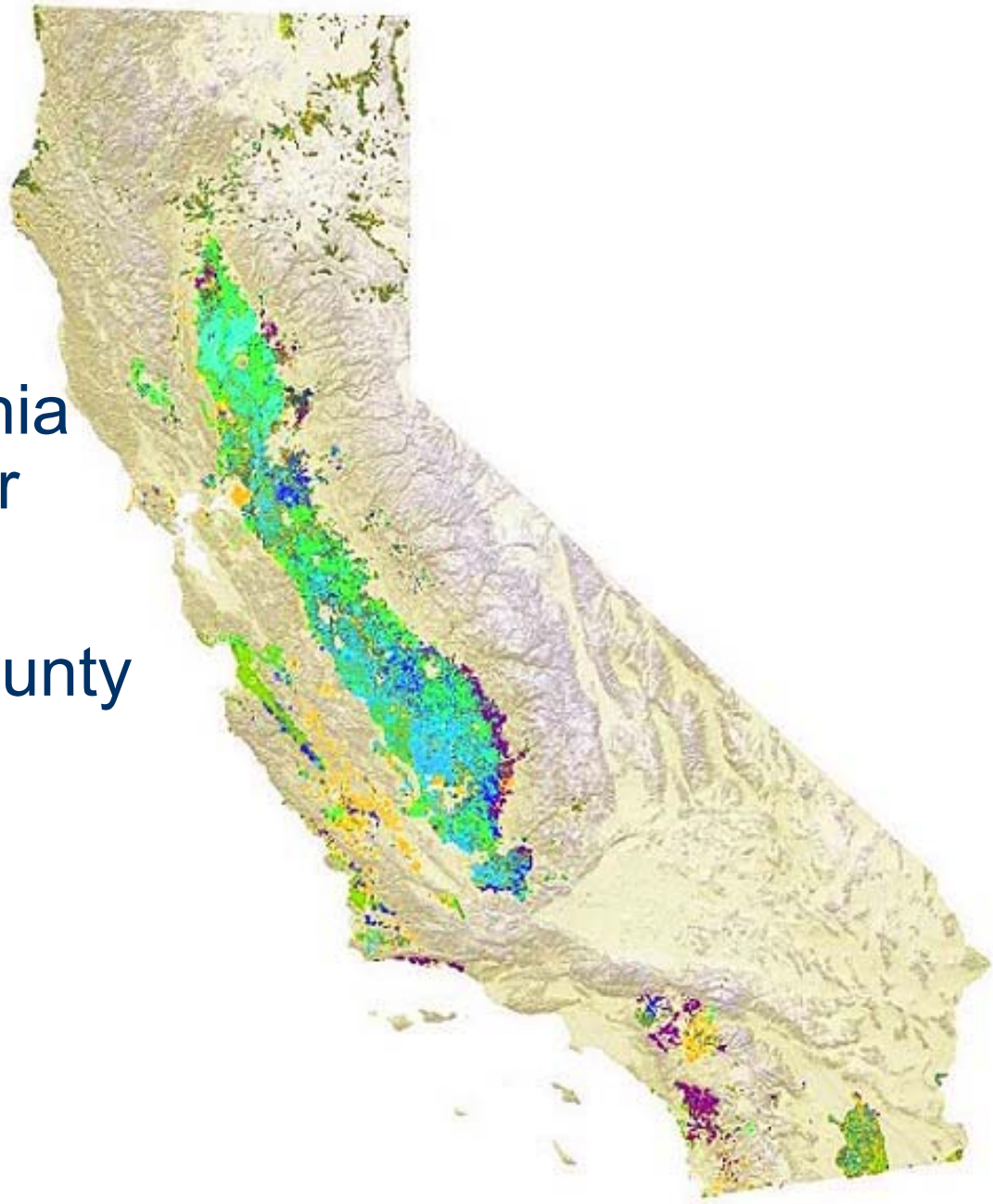


Land Preparation and Harvest Emissions



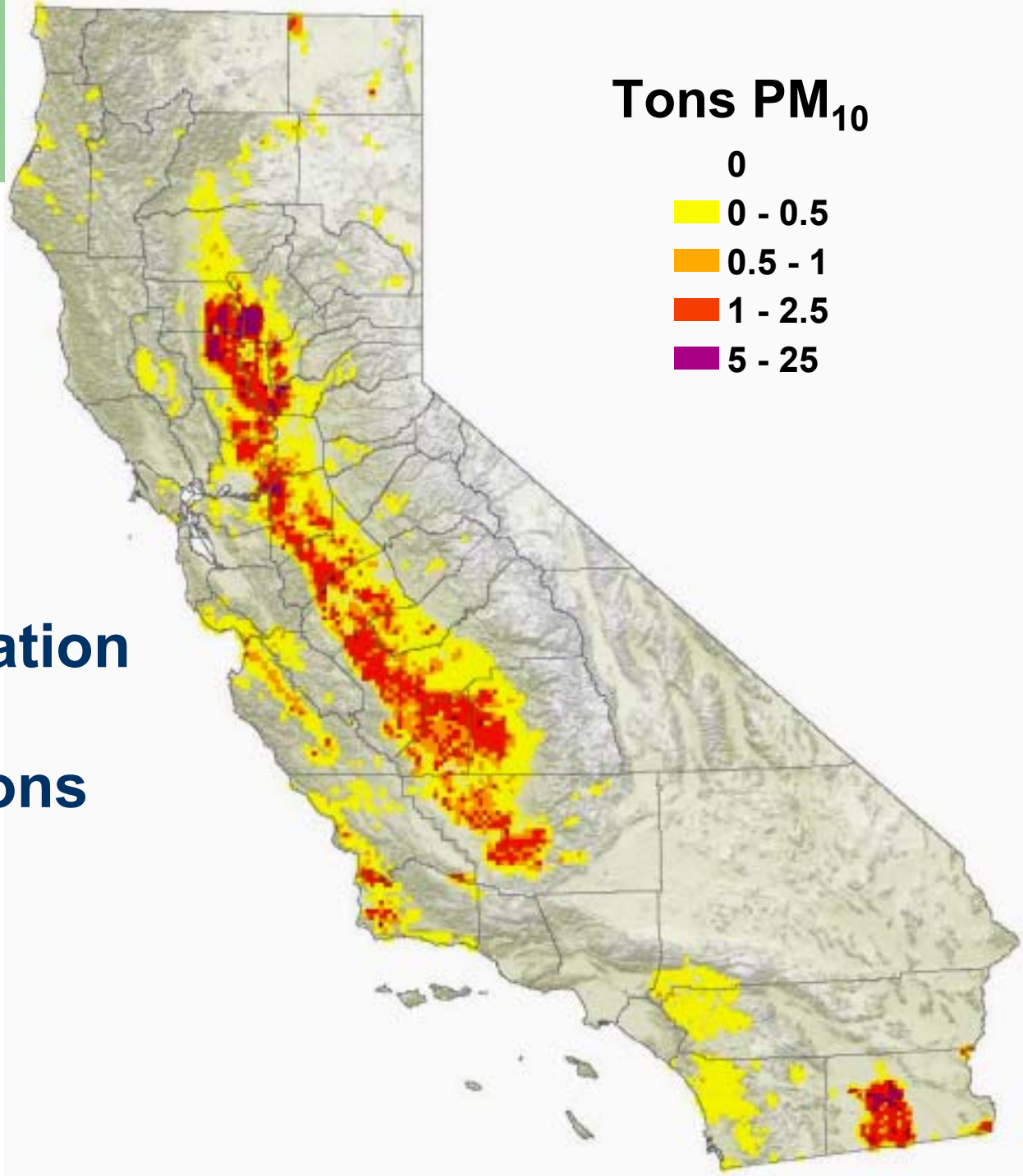
GIS Crop Data

- Collected by California Department of Water Resources
- Updated for each county once every 7 years
- Based on digitized aerial photographs
- High resolution field verified data



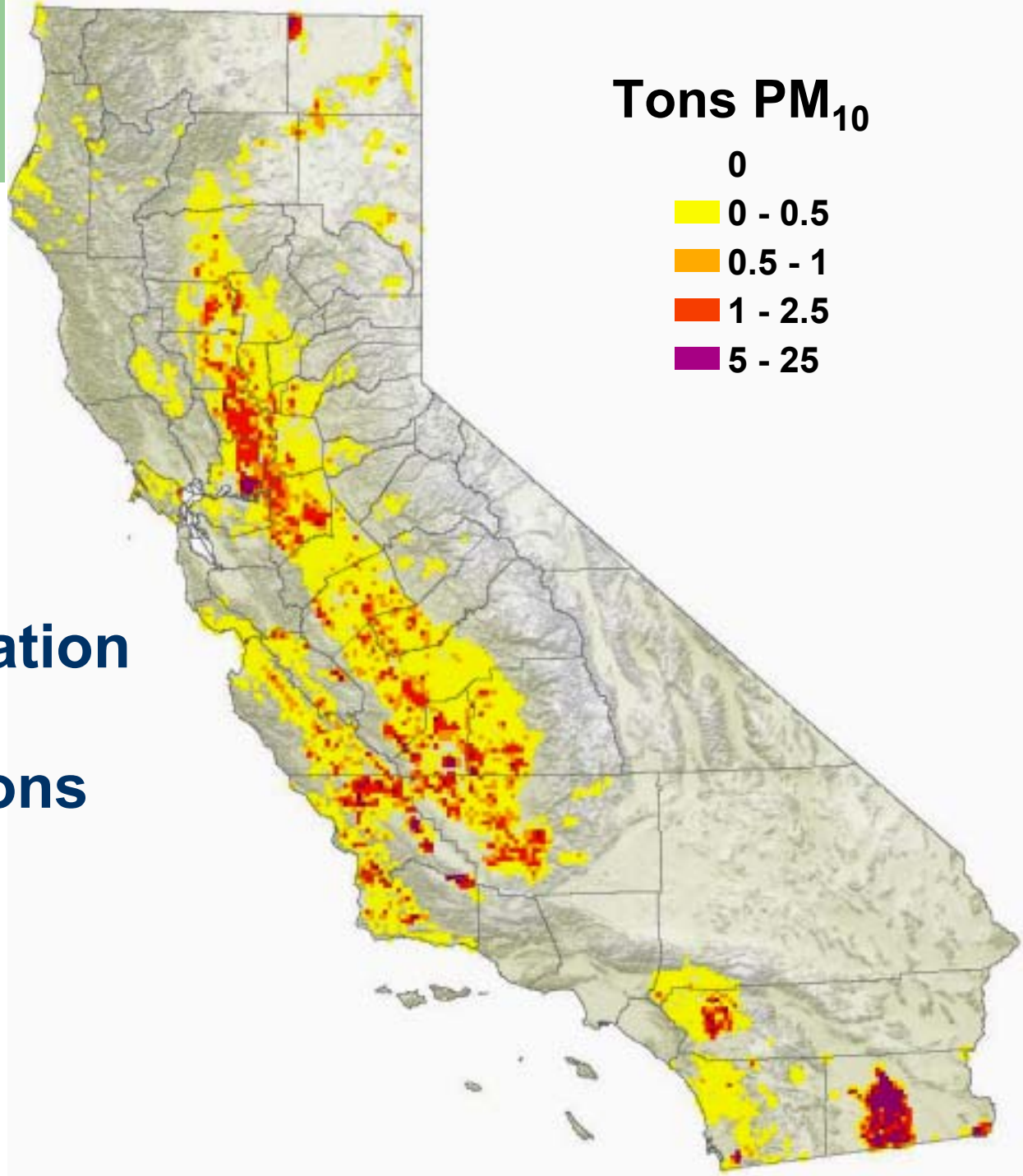
Land Preparation and Harvest PM_{10} Emissions

March



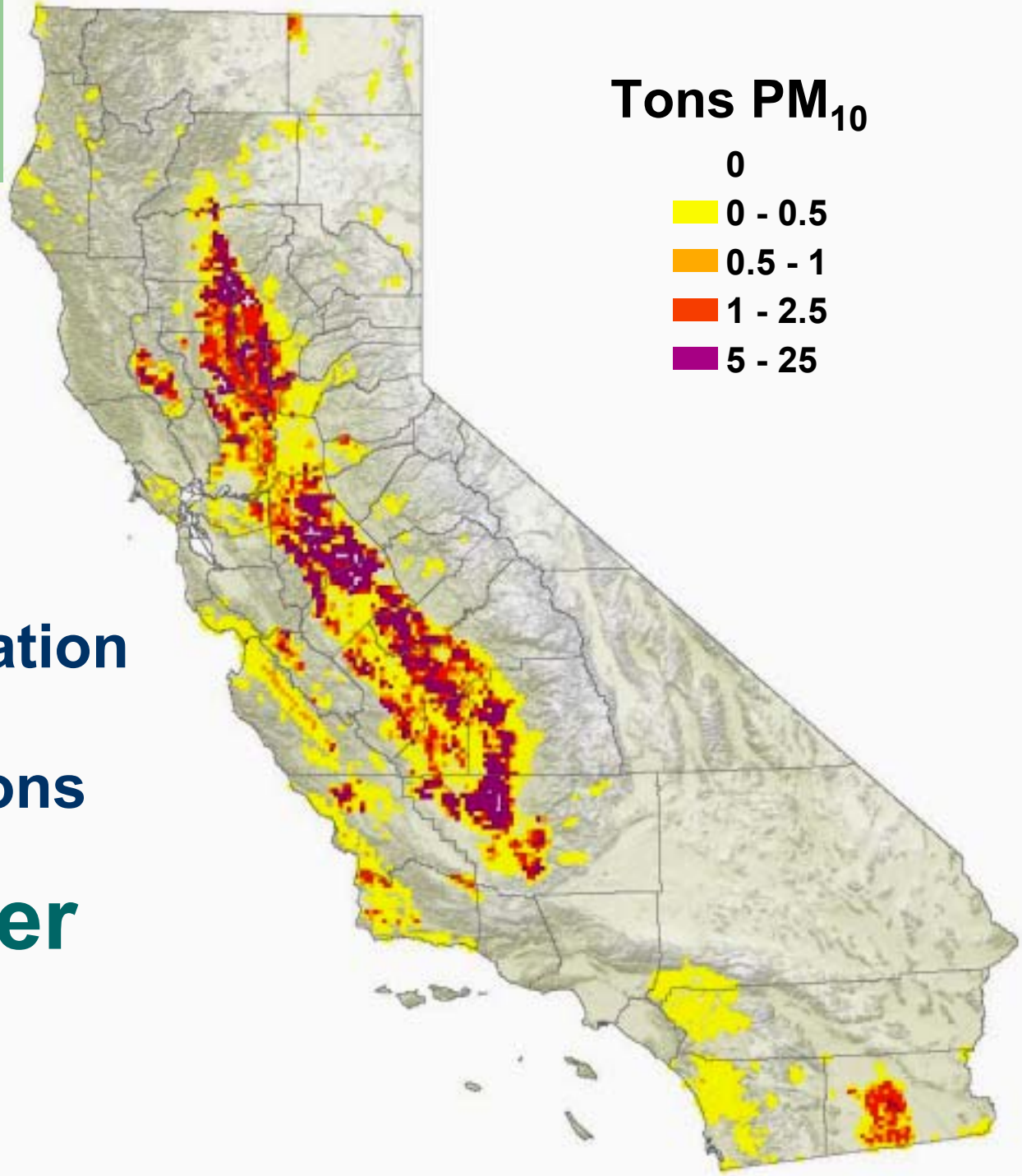
Land Preparation and Harvest PM_{10} Emissions

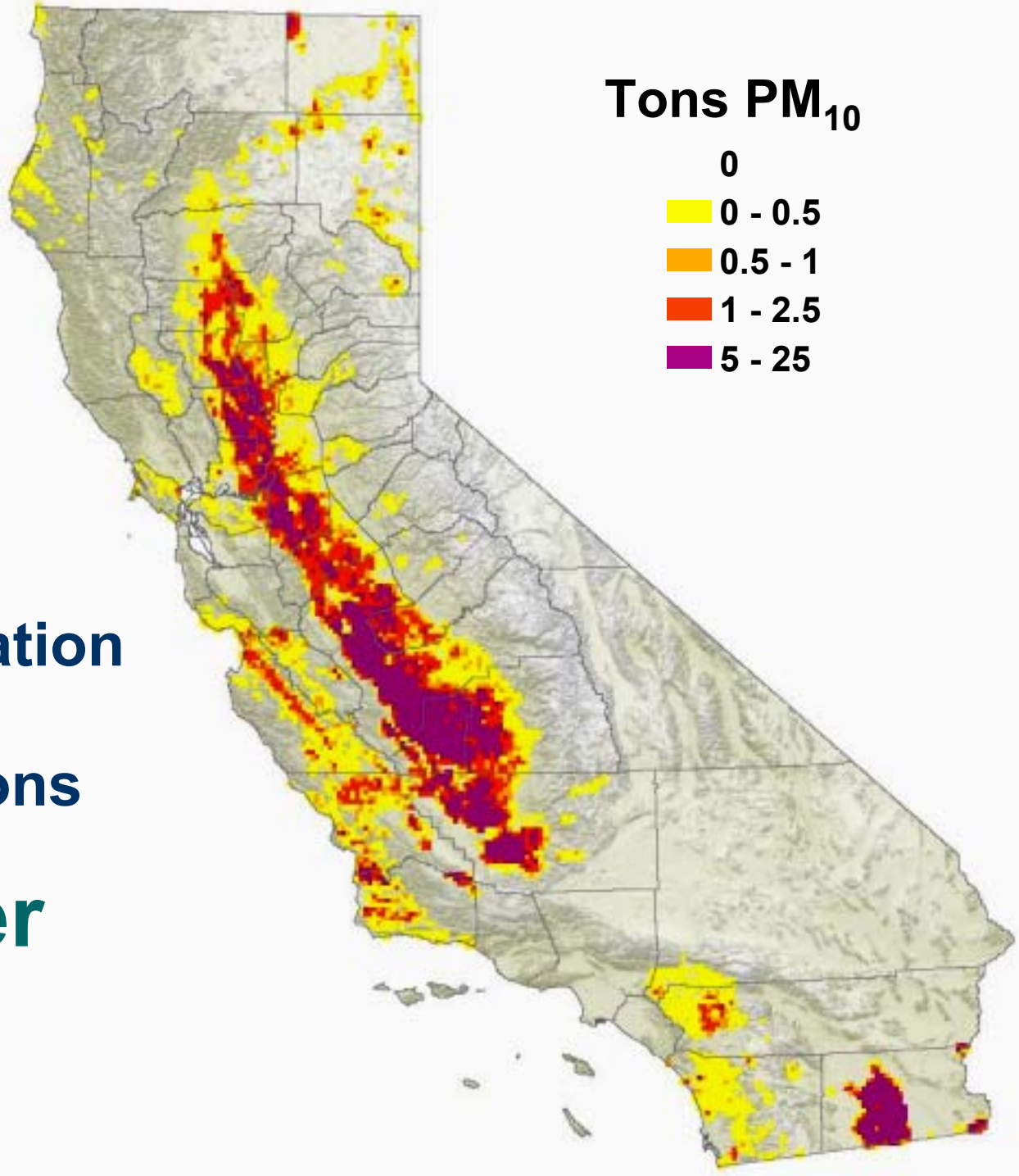
June



Land Preparation and Harvest PM_{10} Emissions

September





Land Preparation and Harvest PM_{10} Emissions

December

Land Preparation and Harvest PM_{10} Emissions

Tons PM_{10}

0

0 - 0.5

0.5 - 1

1 - 2.5

5 - 25

March

June

September

December

Conclusions
Harvest & Land Preparation

- PM estimates now include:
  - Crop & operation specific emission factors
  - Crop calendar based temporal data
  - GIS based spatial data
- Provides more credible and defensible emission estimates
- Partnerships strengthened with agricultural community
- Allows evaluation of more focused and effective PM reduction approaches

Contact Information

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