Overview and Update on the California Nitrogen Assessment

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What is an assessment?

An assessment is a critical evaluation of information for purposes of guiding decisions on a complex, public issue.

Stakeholders, who typically are decision-makers, define the topics.

An assessment is <u>not</u> …

- **a research project**
- **a review paper**
- **an advocacy piece**

Source: Millennium Ecosystem Assessment

California Nitrogen Assessment Goals

Gain a **comprehensive view of N flows in the state**, with emphasis on agriculture's roles.

Provide useful insights for stakeholders into the **balance between the benefits of agricultural nitrogen and the effects of surplus nitrogen** in the environment.

Compare options, including practices and policies.

Move beyond "academic business as usual" to more effectively **link science with action** and to produce information that informs both policy and field-level practice.

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California Nitrogen Assessment

The CNA is based on stakeholder-driven questions and concerns

- What are the big sources of nitrogen pollution in California?
- What practices are most effective in mitigating nitrogen pollution?
- What are the policy challenges and opportunities?

Policy challenges and opportunities

Nitrogen may be a good candidate to pioneer the next generation of integrated environmental policies and regulatory re-organization.

"One size fits all" won't work for nitrogen.

Some opportunities are problem-specific and locally-important:

- **Crop management for groundwater quality**
- **Manure management for air and water quality**

But even technological solutions require an integrated approach to develop appropriate practices combined with policy support

Complexity + diversity + spatial dispersion → high transaction costs

How policy is designed and implemented is as important as what policy targets.

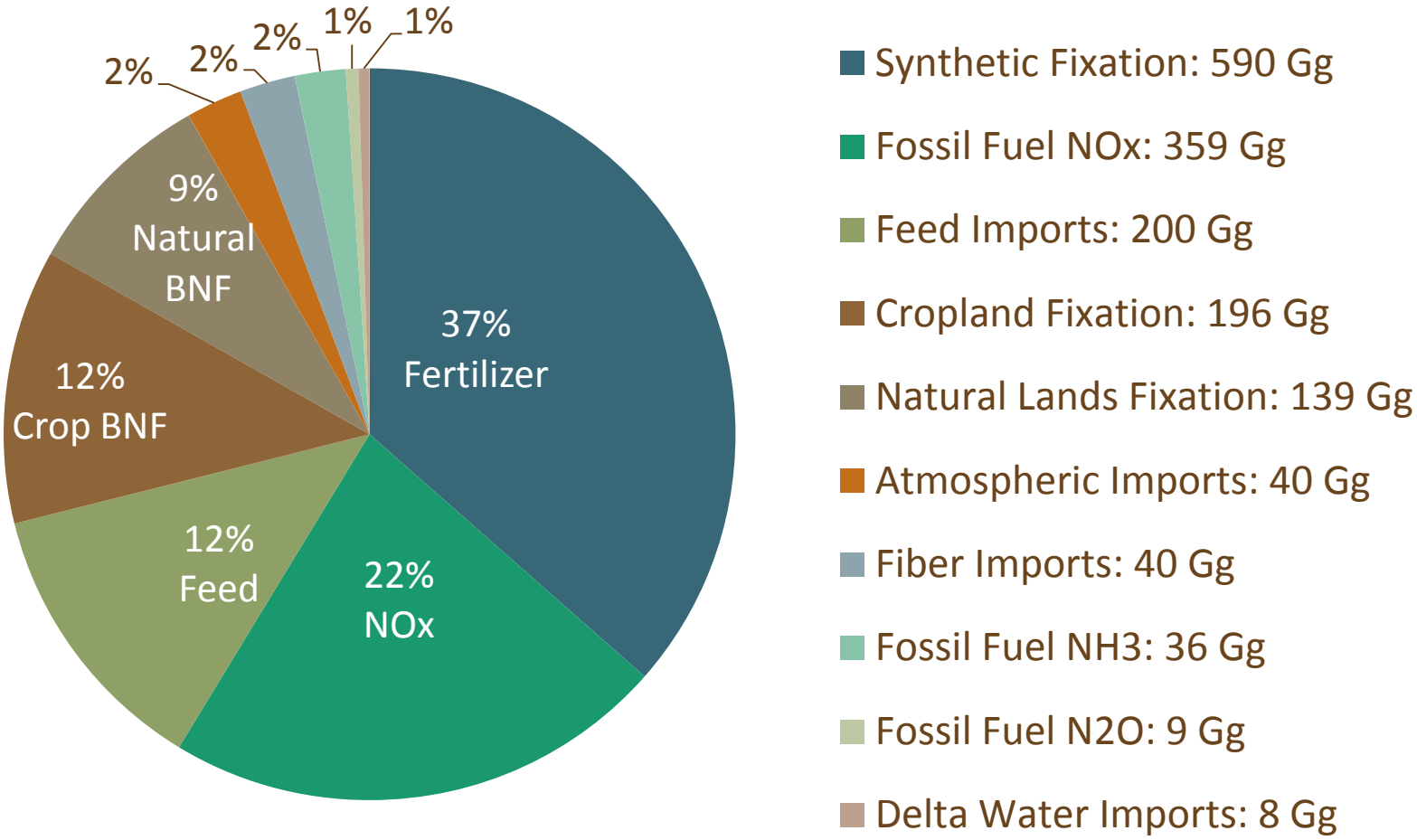
N “solutions” typically also involve tradeoffs

Increasing fertilizer use efficiency is a win-win for farmers <u>and</u> the environment.

Statewide N inputs:

≈1.78 million tons N per year

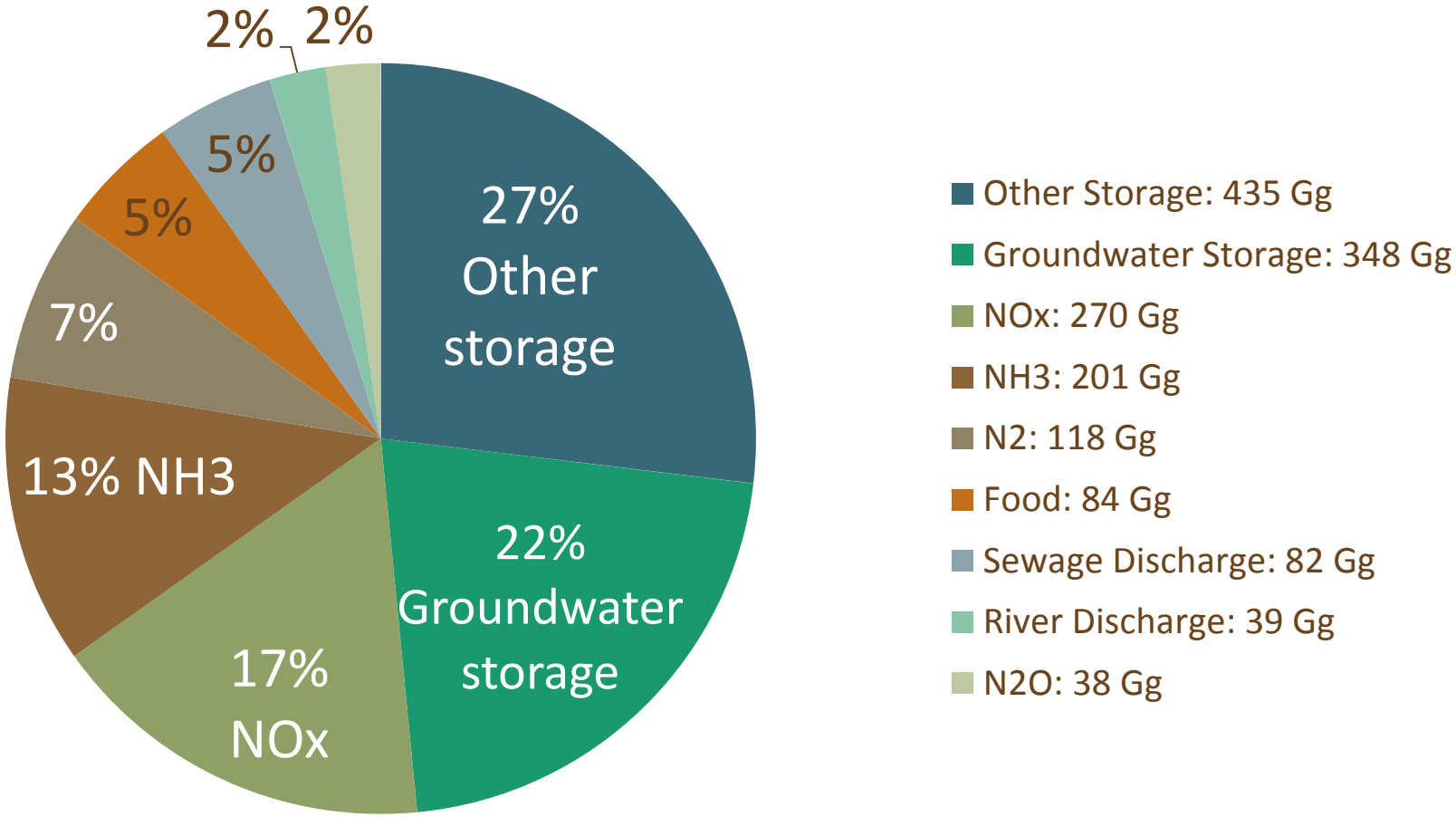
(1618 Gg N yr^{-1} , roughly 1% of global human N inputs)



BNF = biological nitrogen fixation

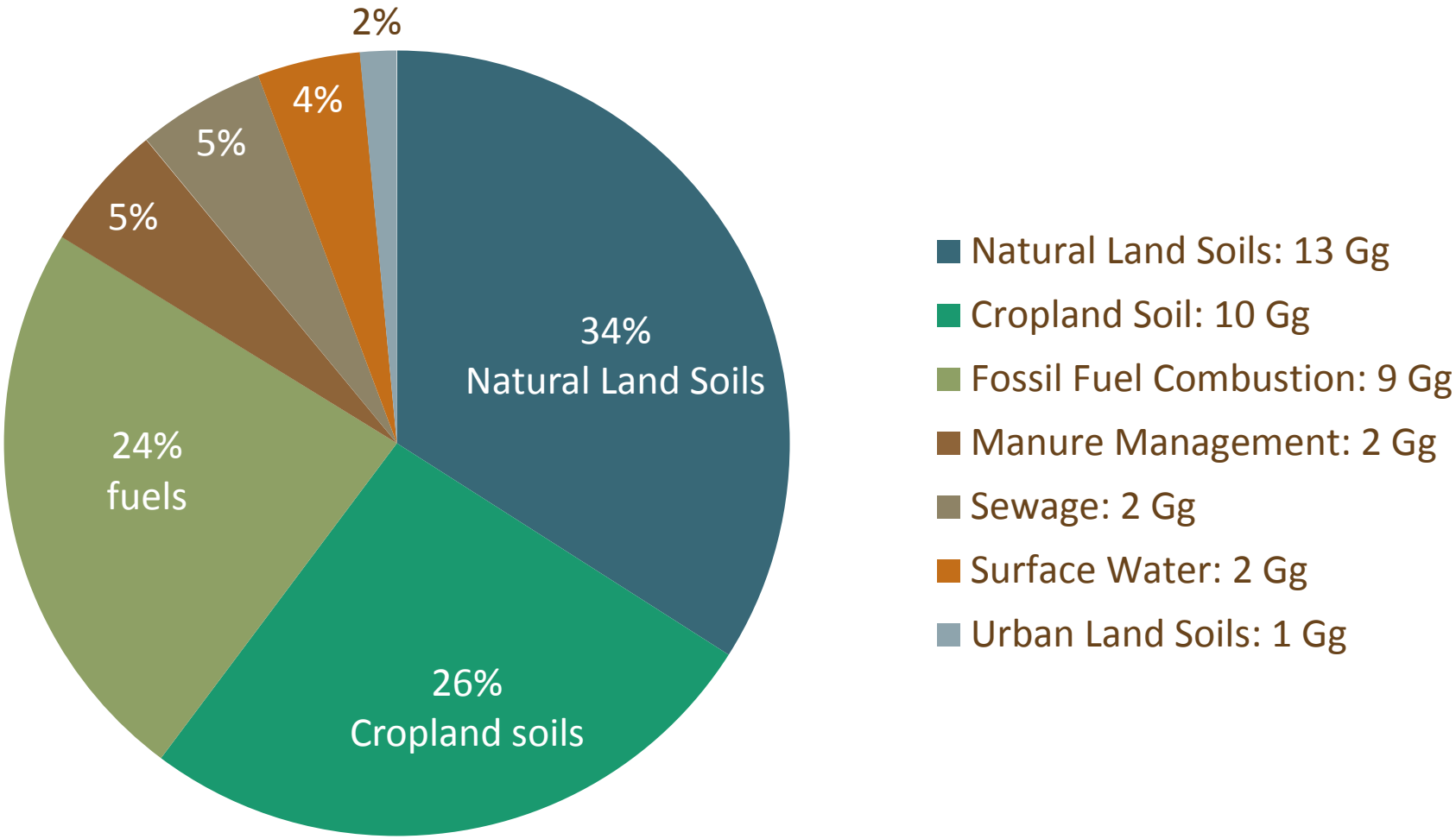
Statewide N Outputs and Storage:

≈1.78 million tons (1615 Gg N yr^{-1})

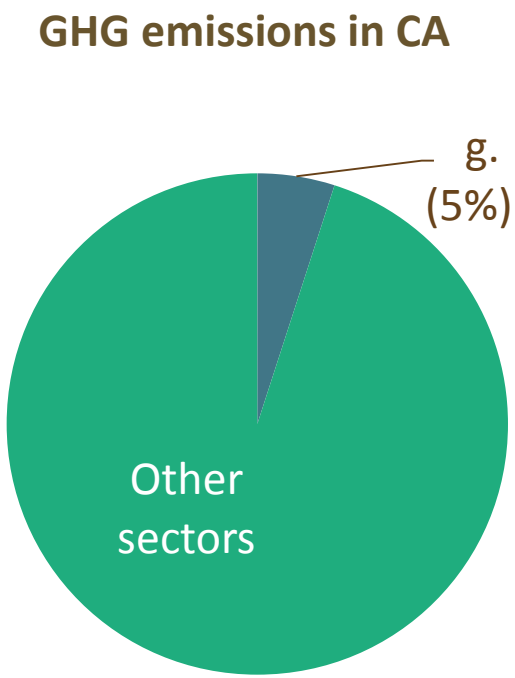


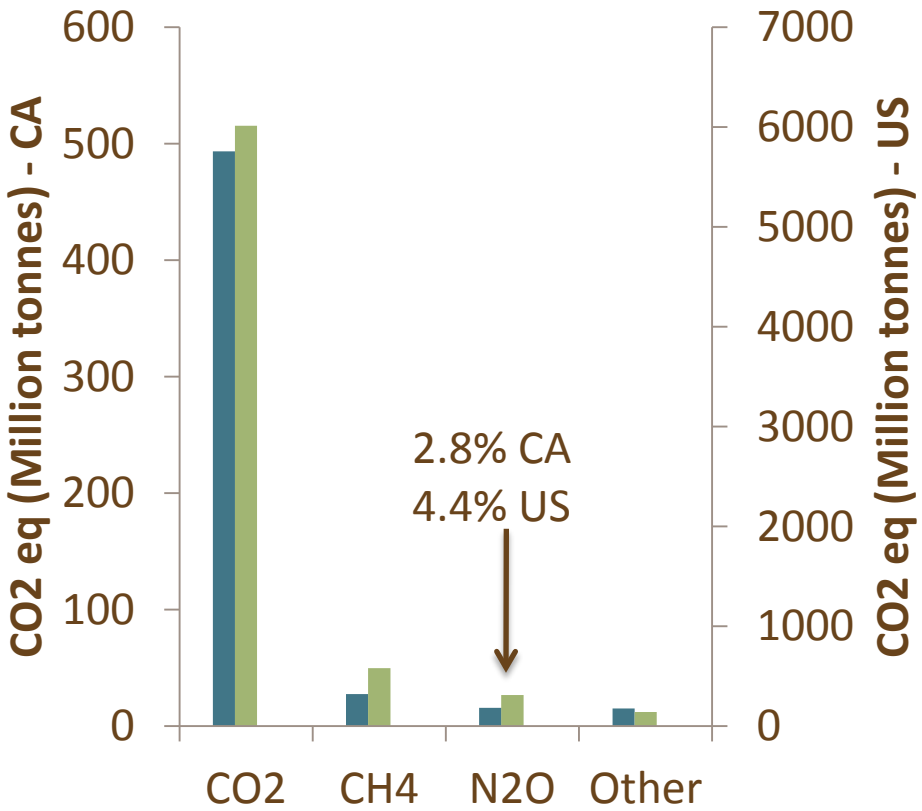
N_2O Emissions:
42 thousand tons (38 Gg) N per year

(Nitrous oxide emissions = about 2% of total statewide N inputs)



Inventory of human-caused GHG emissions in California, 2005



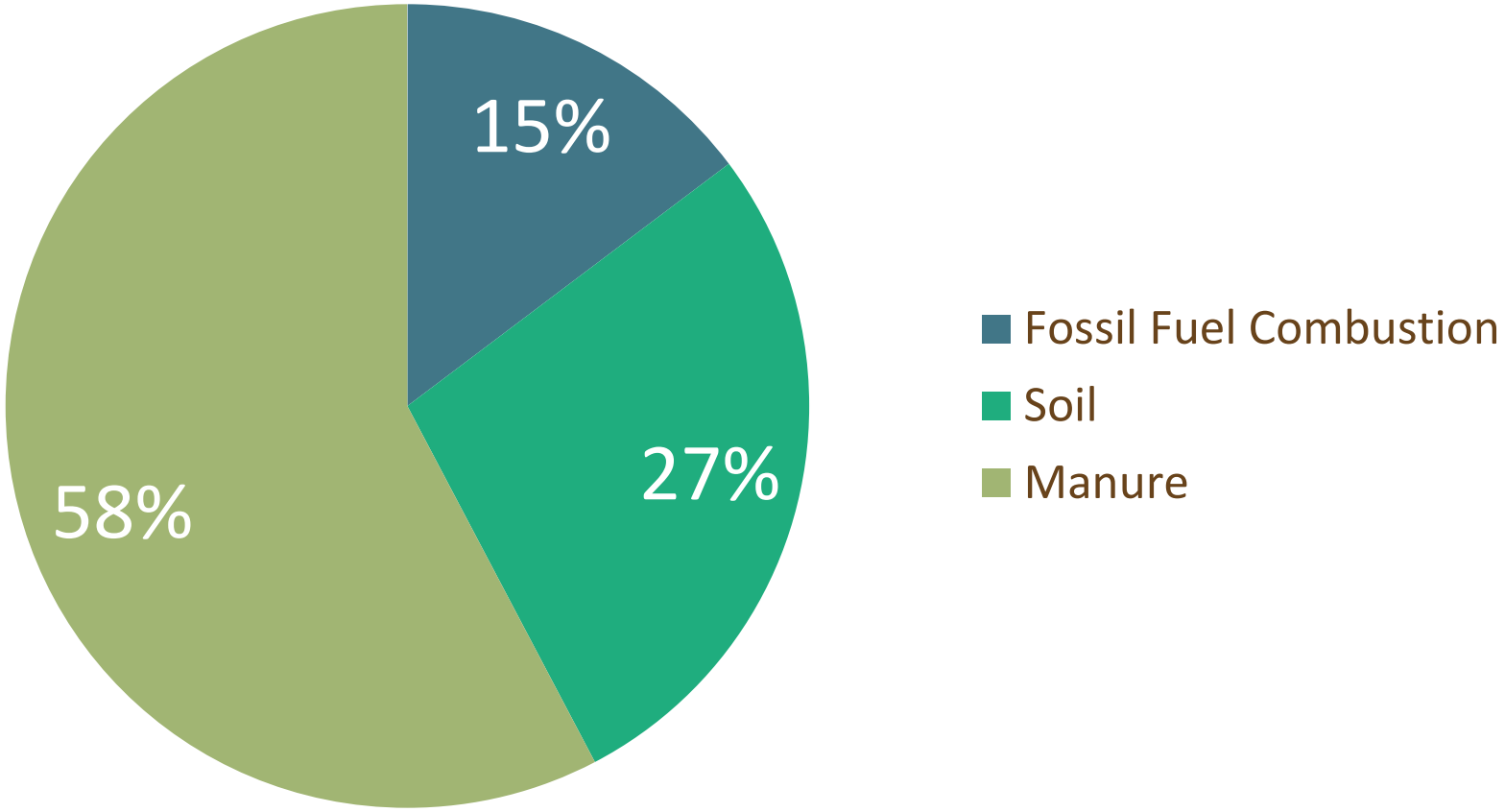


Source: California Air Resources Board

NH_3 Emissions:

221 thousand tons (201 Gg) N per year

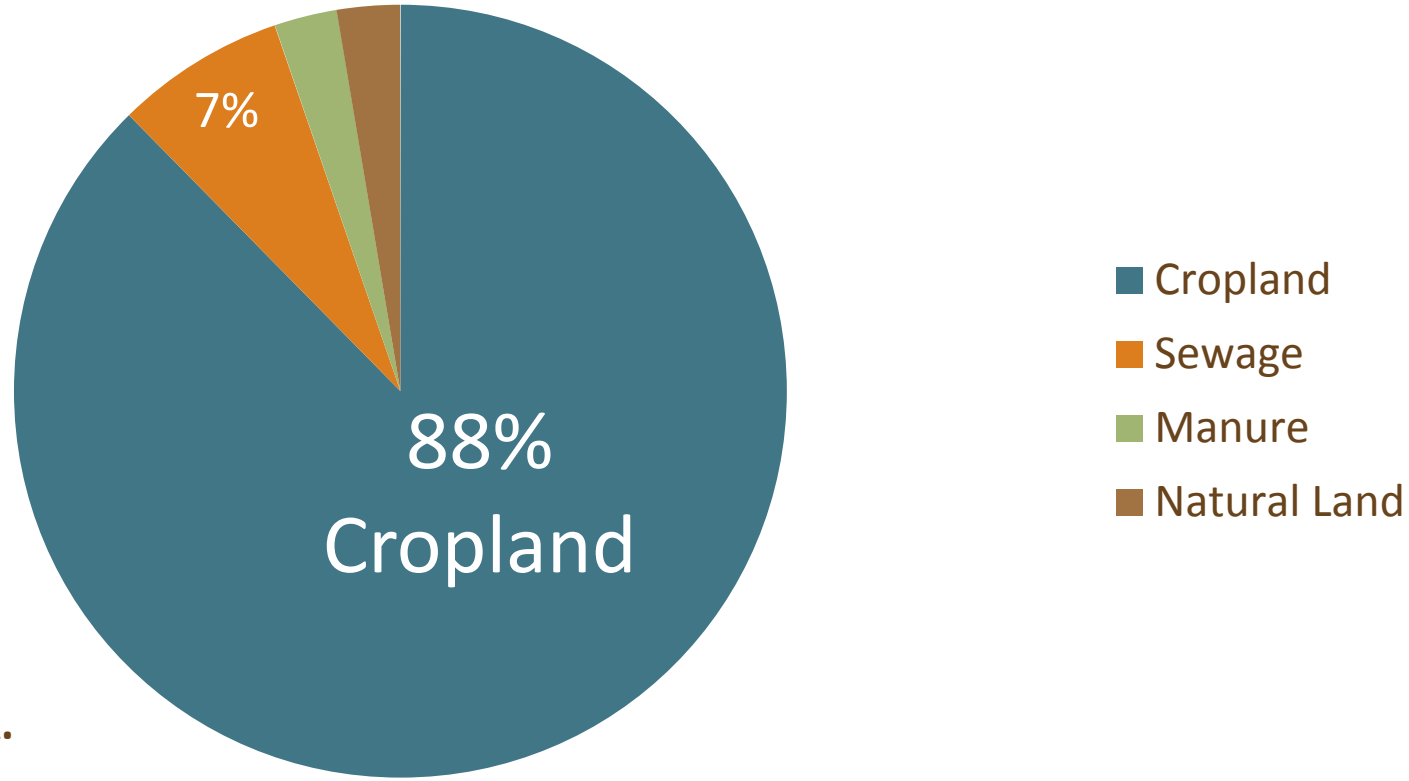
(Ammonia emissions = < 13% of total statewide N inputs)



NO_3 to Groundwater:

383 thousand tons (348 Gg) N per year

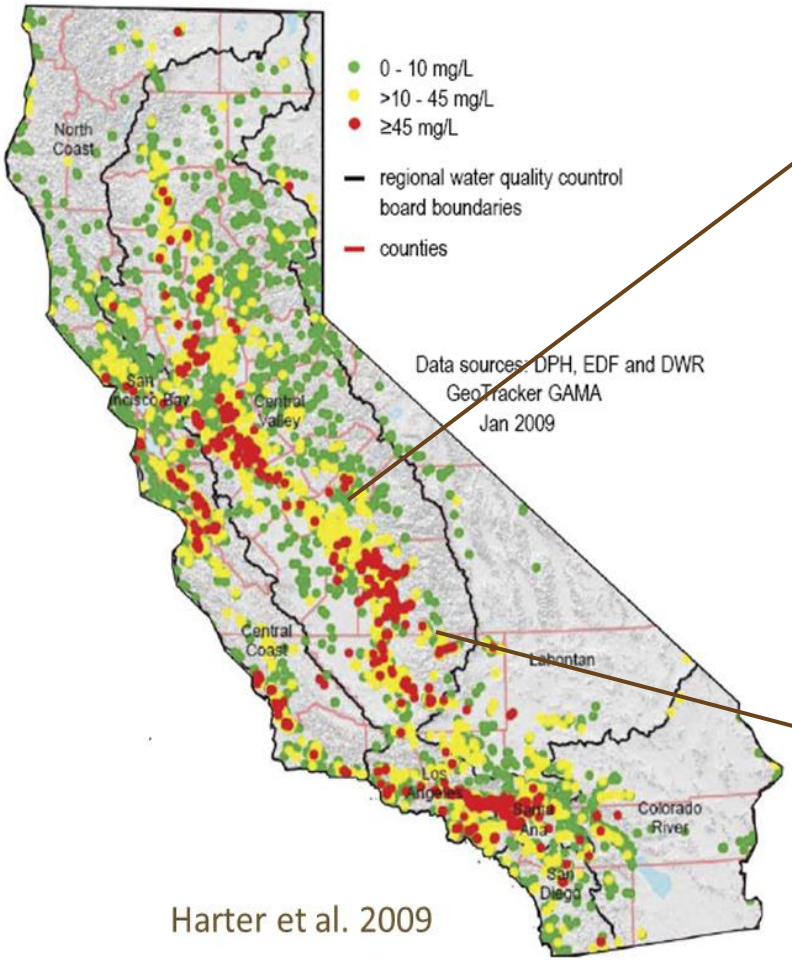
(Nitrate to groundwater = > 20% of total statewide N inputs)



Cropland dominates, although this is linked to livestock.

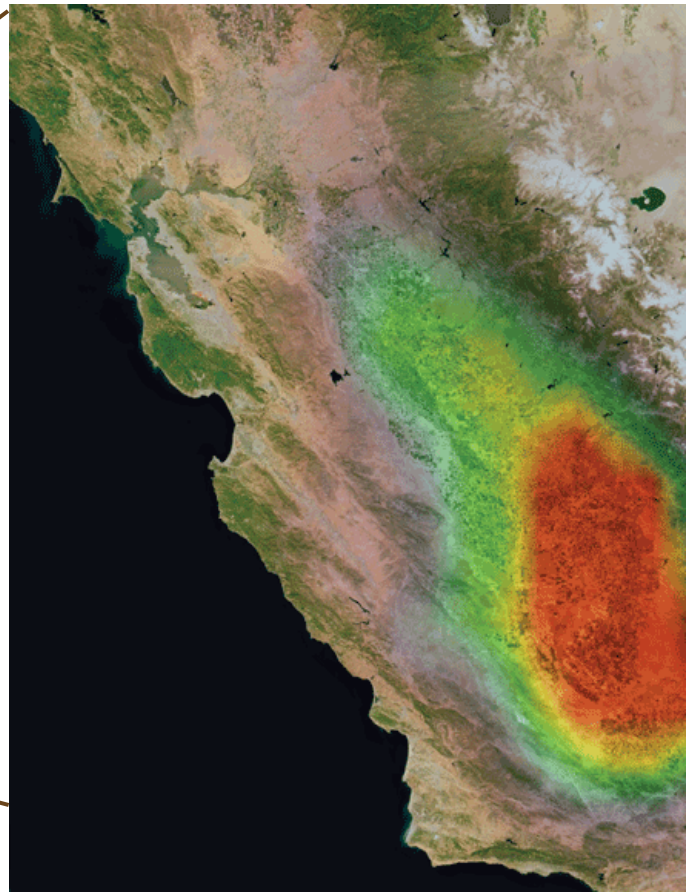
Co-location of air and groundwater pollution

Nitrate in groundwater



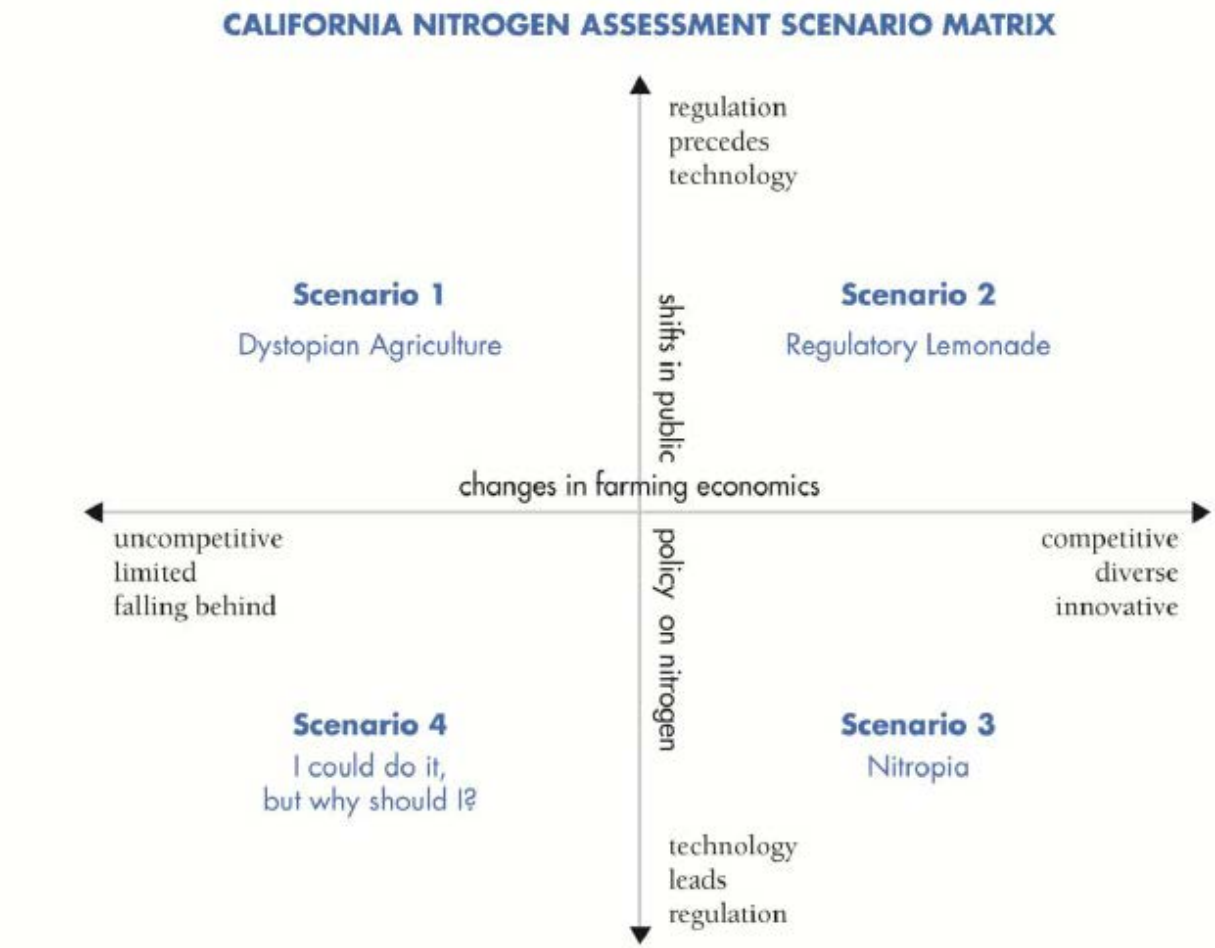
Harter et al. 2009

Ammonia in the air



Clarisse et al. 2010

How will nitrogen be managed in California agriculture 20 years from now?



Which future will best allow us to feed 9 billion people and meet goals of sustainability?

Practical approaches to mitigation?

Underlined = technology "on the shelf"

N efficiency

- **Precision feeding for livestock** (addresses air, water, and climate)
- **Improved manure management,** handling practices, integrated crop-livestock systems (air, water, climate)
- **Nutrient use efficiency in cropping,** including nutrient budgeting and monitoring, precision farming, irrigation management, integrated nutrient management, fertilizer formulation, crop breeding, soil ecology (water, climate?)

Ammonia synthesis in fertilizer manufacturing (climate)

Practical approaches to mitigation?

Underlined = technology "on the shelf"

N switching

- Synthetic fertilizer to organic fertilizer (problems, limited gains)
- **Imports of feed to imports of livestock products from other states** (air and water, but largely a climate "leakage")

- **"Pump and Trade": N-contaminated groundwater to irrigation, instead of domestic use**

N Removal

- **Drinking water purification: "ounce of cure" vs "pound of prevention"**

- **N + C sinks in soils and vegetation** (landscape management for adaptation)

We will need your input

Scientific review of the California Nitrogen Assessment is ongoing.

The next step will be a stakeholder review, and we are seeking to broaden input from stakeholders like yourselves.

To get involved, please go to nitrogen.ucdavis.edu and click "contact us".

Thank you!
I look forward to your comments and questions.