Overview of Nitrogen and Groundwater Quality Issues

Section 1

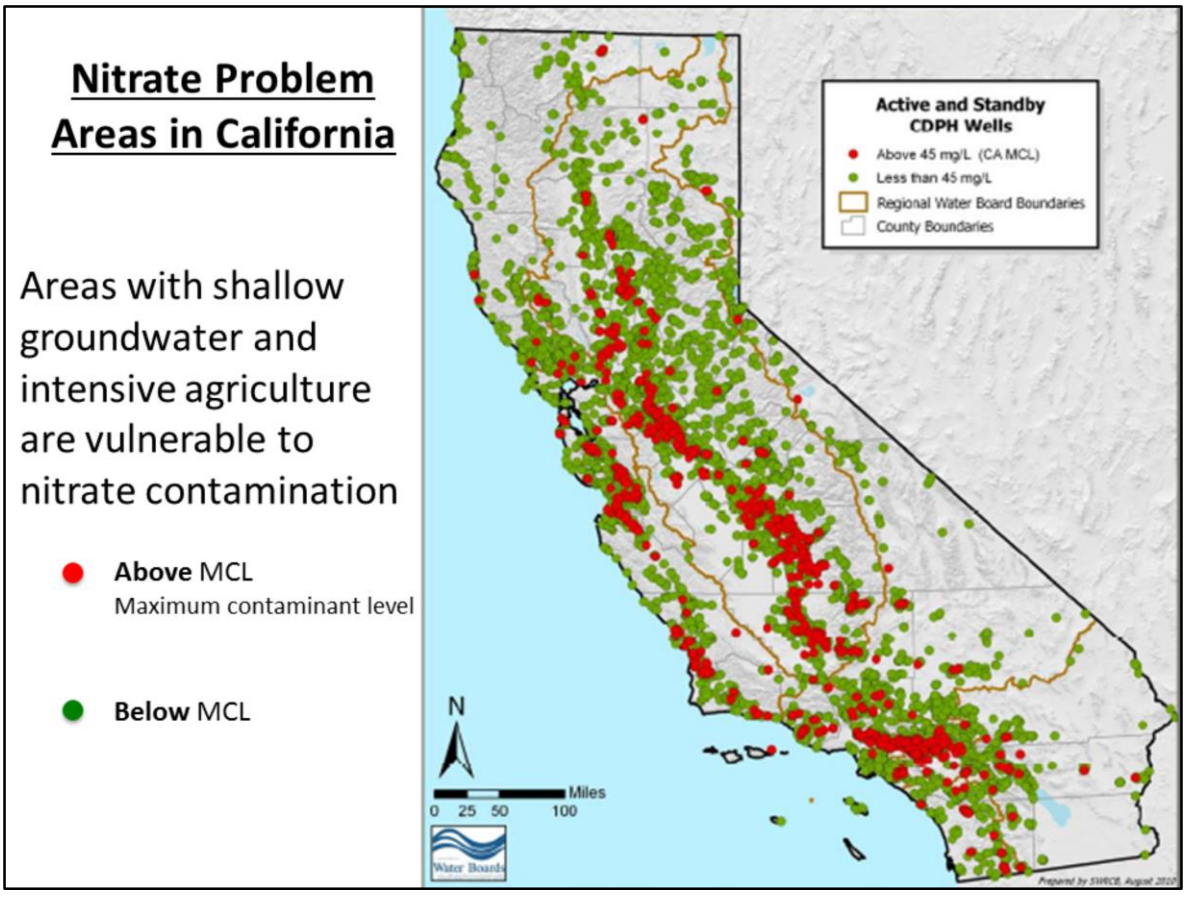
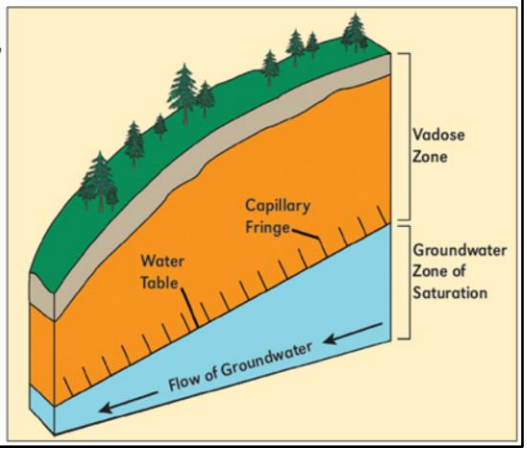


Figure: From the State Water Resources Control Board, this image shows red dots as active and standby California Department of Public Health (CDPH) wells that are in excess of the 45 ppm nitrate MCL as of June 2010. The main areas of concern are the Coast, the Delta, the Tulare Lake Bottom and the East Side of the San Joaquin Valley. All these areas have shallow depth to ground water combined with intensive agriculture.

Why is Shallow Groundwater Most Affected?

- Nitrate (NO_3^-) is an anion (negatively charged) and is not retained by soil. It moves with the wetting front.
- Water moving below the root zone carries nitrate with it.

- After years of downward flow with water, nitrate eventually reaches the aquifer.
- The farther from the source, the longer nitrate takes to reach the groundwater.



Ground water may become polluted more quickly where soils are layered (eg. alluvial soils) and exhibit preferential flow that can shorten the time it takes for nitrate to reach the groundwater.

How Did Nitrate Become a Problem?

- In nature, nitrogen cycles through soil, water, and plants at low concentrations.
- California agriculture has a long history of N use, with cropped acreage, N fertilization rates, dairy production, and irrigated land increasing in the last 50 years.
- Agriculture requires high N input to produce profitable crops.
- **Inefficiency** of irrigation and N application leads to nitrate leaching losses.

Note: The natural background concentration of nitrogen cycling though soil, water, and plants is about 2 ppm (2mg/L).

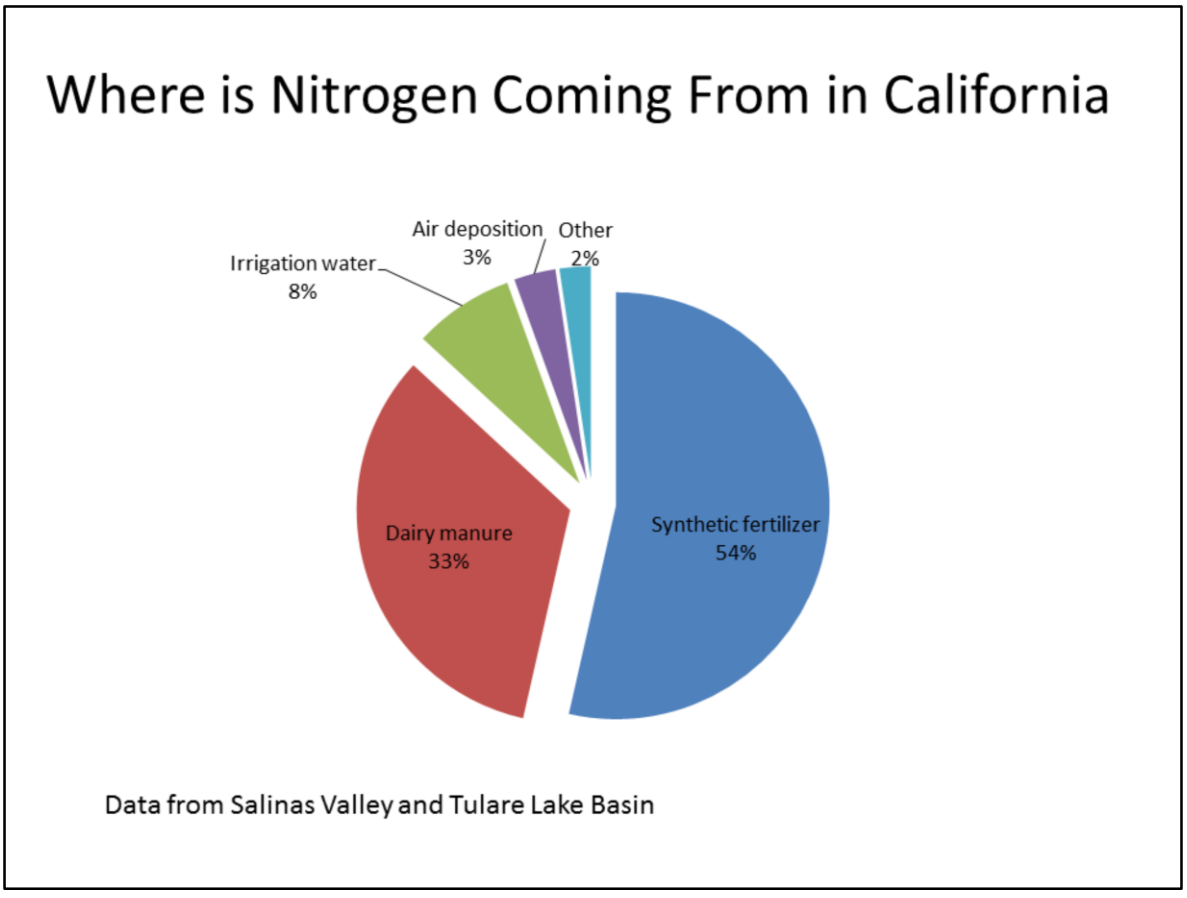


Figure: This information is from "Addressing Nitrate in California's Drinking Water," linked below. The researchers determined the sources and fates of cropland-applied nitrogen in the Salinas Valley and Tulare Lake Basin. They accounted for all the sources of nitrogen inputs applied in one year in the study areas. More than half of the inputs by mass are from synthetic fertilizer, plus a third from dairy manure, accounting for 86% of total nitrogen inputs.

Addressing Nitrate in California's Drinking Water:
http://groundwaternitrate.ucdavis.edu/files/138956.pdf

Please note theses data are from Salinas and Tulare Lake Basin and are not necessarily representative of all California.

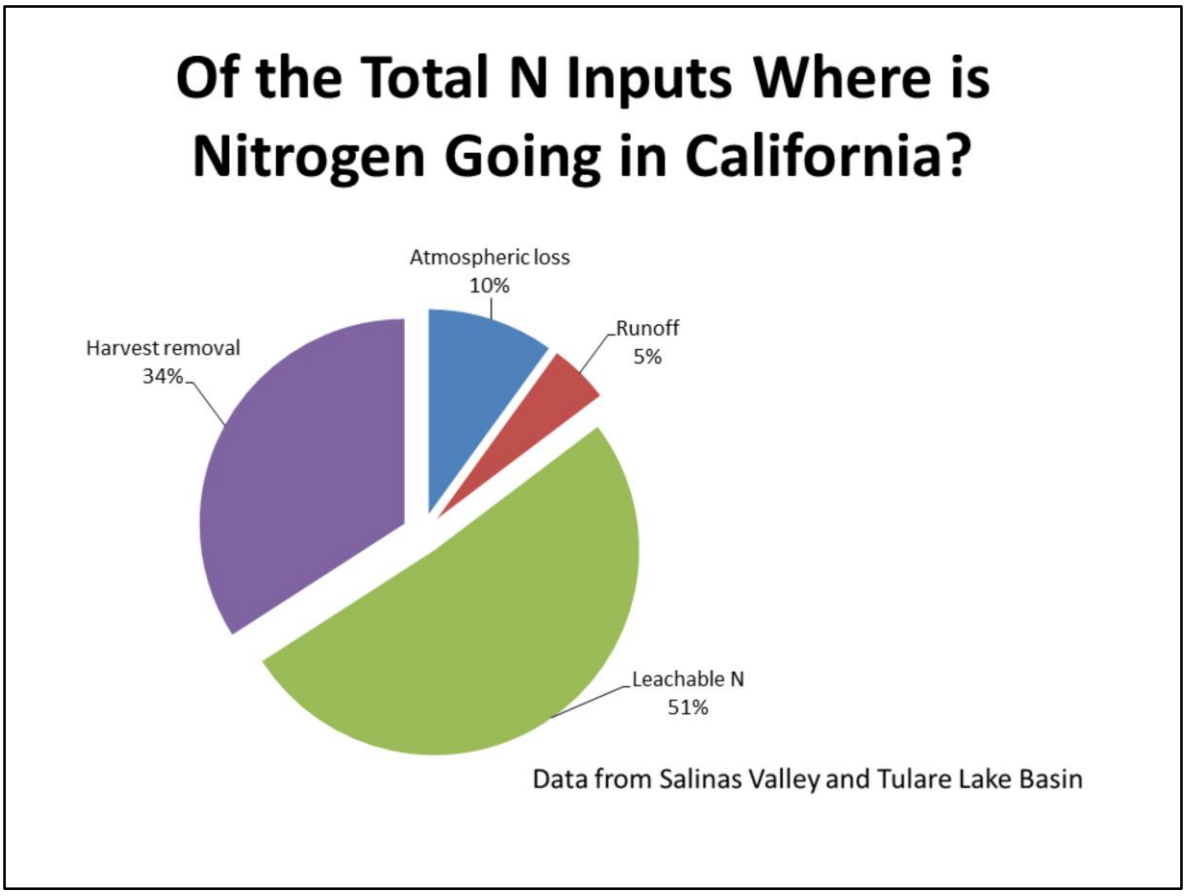


Figure: In a mass balance model, the mass of the inputs must equal the mass of the outputs. By estimating the amount of total nitrogen exported in the harvested portion of the crop as well as nitrogen lost to the atmosphere by denitrification, volatilization, and surface runoff, the remaining nitrogen is assumed to have leached below the crop root zone. In these cases, 51% of nitrogen was available to leach to groundwater.

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Dealing with Nitrate Pollution

- No inexpensive method exists to remove nitrate once it is in water
- Source control: More efficient use of fertilizers and fertilizer products
    - By accounting for all the sources of nitrogen in the system leads to more efficient use of nitrogen and fertilizer products.
        - Mineralization
        - Residual nitrogen
        - Nitrogen in irrigation water
        - Nitrogen fertilizers

Nitrate -----What is the Problem?

- Nitrate in Drinking Water
  - Federal/CA Maximum Contaminant Level is 45 ppm NO_3 (10 ppm NO_3–N).
  - Concentrations in drinking water of some CA aquifers exceed this level.
  - CA State Water Resources Control Board noted that 8% of drinking water wells exceed the nitrate threshold.

Note: The Maximum Contaminant Level (MCL) amount was determined by US EPA to "…to prevent methemoglobinemia in infants, the most sensitive health endpoint in children."

Measuring Nitrate and Nitrate-N Concentrations

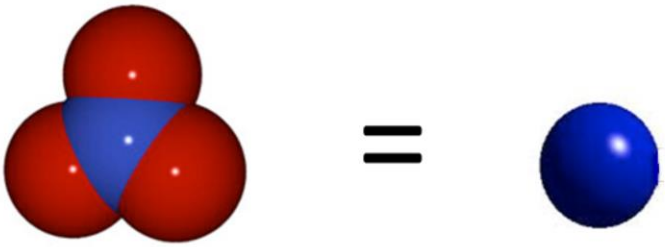
Maximum contaminant levels

Measuring **Nitrate**:

45 ppm NO_3 (measure **N + O**)

Measuring **Nitrate-N**:

10 ppm NO_3^--N/ (measure **N** only)



When Nitrate concentration is measured in nitrate-N (NO3--N), only the nitrogen is measured.

When Nitrate concentration is measured in nitrate (NO3-), nitrogen and oxygen are both measured.

Note 1 : The two maximum contaminant levels are the same – only difference is the mg/L is the weight on N and O3 versus N .
A factor of about 4.5
62.0049 / 14.0067 = 4.427