Agriculture's Contribution to Nitrogen Deposition in Rocky Mountain National Park

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Fate of Ammonia

- **Ammonia combines with sulfuric and nitric acids in the atmosphere (from urban sources) to form ammonium sulfate and ammonium nitrate droplets known as fine particulate matter ($PM_{2.5}$)**
- **This conversion increases residence time and transport distances (estimated at over 1000 miles)**

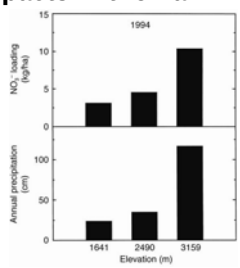
Outline

- **1) Impacts in the Park**
- **2) Sources of Nitrogen Deposition**
- **3) Political Response**
- **4) CSU's Role**

1) Environmental Impacts

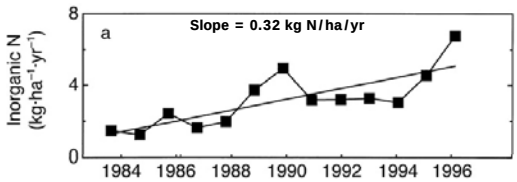
- **Deposition in Rocky Mountain National Park**
  - **Dry deposition**
  - **Wet deposition**
    - **Ammonium salts are hydroscopic and act as cloud condensation nuclei, facilitating wet deposition**

1) Impacts in the Park



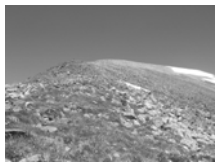
- **Higher elevations have**
  - **More precipitation, and subsequently**
  - **Higher N loads**
    - **Williams and Tonnessen (2000)**

1) Impacts in the Park



- **Background is considered to be 0.2 kg/ha/yr, but wet deposition has averaged 2.6 kg N/ha/yr (2.4 lbs/acre/yr).**
- **Dry deposition wasn't measured but is estimated to be 50% of wet deposition, for a total of 3.9 kg N/ha/yr (3.6 lbs/acre/yr).**
  - **Williams and Tonnessen (2000)**

1) Impacts in the Park



- **Alpine areas are particularly sensitive to small increases in N deposition due to:**
  - **Exposed bedrock**
  - **Steep slopes**
  - **Limited extent of soils and vegetation**
  - **Short growing seasons**
  - **Rapid hydrologic flushing during snowmelt**

1) Impacts in the Park

- **Surface water NO_3-N levels have been increasing (especially on east side of Continental Divide).**
- **Vegetation affects lake NO_3-N levels.**
  - **Rocky, unvegetated slopes have higher concentrations.**

1) Impacts in the Park

- **Pine needles at higher elevation have increased N:P ratios.**
- **Trees on east side of the Continental Divide have higher foliar N concentration and lower soil C:N than on the west side.**

2) Sources of Ammonia

- Wet deposition of inorganic N consists of 55% NO_3^- and 45% NH_4^+.
- The Colorado Department of Public Health and Environment has developed an inventory of ammonia sources in Colorado including:
  - Wildlife
  - Native soils
  - Human perspiration
  - Industry
  - Livestock
  - Fertilizer

2) Sources of Ammonia

- After removing the "uncontrollable ammonia sources," CDPHE estimates that:
  - 40% of controllable ammonia emissions in Colorado come from livestock
  - And 20% come from fertilizer
- There are some gaps in the database and assumptions that are being questioned.

3) Political Response

- The Park Service
  - The National Park Service released a report stating that N deposition in RMNP is causing ecosystem changes
- The Public
  - Citizens living near Rocky Mountain National Park became concerned about nitrogen (including ammonia) deposition in the park and voiced their concerns

3) Political Response

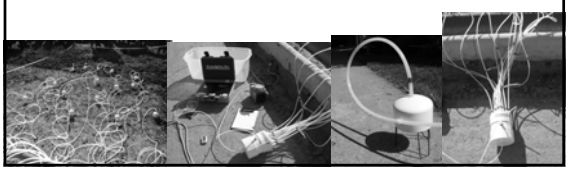
- **Colorado Air Quality Control Commission**
  - Ammonia is an unregulated pollutant
  - Formed a Rocky Mountain National Park sub-committee in 2005 to evaluate sources of nitrogen deposition and to develop potential solutions.
  - **Nitrogen Deposition Reduction Plan – Final August 16, 2007**
    - **"promoting development and implementation of voluntary BMPs for ammonia emission reductions from ag"**
    - **Every 5 years, they will evaluate whether voluntary BMPs are achieving the necessary reductions.**

3) Political Response

- **The Agricultural Community**
  - **Very pro-active in creation of the Plan**
  - **RMNP Ag Team created an Ag Strategy around research, identification of gaps in inventory, modeling, and education**

4) CSU's Role: BMP Testing

- **Testing BMPs on dairies and feedlots in 2007 and 2008**
- **Real-time ammonia analyzer and surface samplers**
- **Evaluate ammonia reduction potential, practicality, and cost efficiency of the technologies**

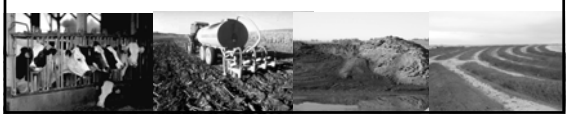


4) CSU's Role: Producer Survey

- **Sent out a survey to dairy and feedlot producers in Colorado, Iowa, Kansas, and Nebraska**
- **Help us understand what BMPs are already in use and constraints to further BMP adoption**
- **Current practices, profitability, ease of use, perceived cost of implementation, water and air quality impacts**


4) CSU's Role: Extension

- **Comprehensive ammonia reduction strategy based on the most effective BMPs:**
  - **online factsheet series**
  - **photo gallery**
  - **ammonia reduction and implementation cost-estimator**
- **Website: www.AmmoniaBMP.info**



Questions?

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