Factors Affecting Water-Quality Response in the Chesapeake Bay and Watershed

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and many others

U.S. Department of the Interior
U.S. Geological Survey

University of Maryland
Center for Environmental Science

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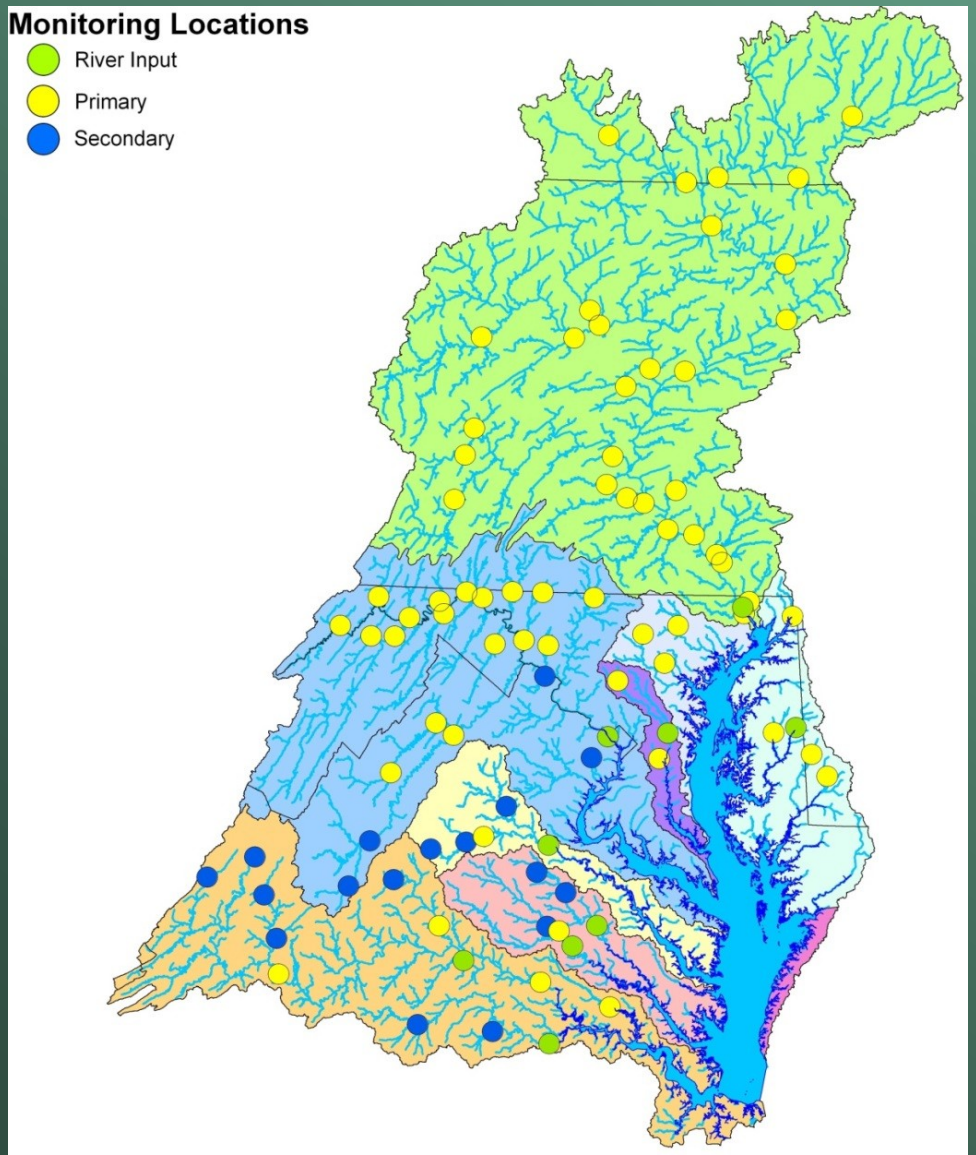
Outline

- Water-quality changes
  - Watershed
  - Estuary
- Factors affecting changes
  - “New Insights” report
- Thoughts on OECD scoping papers

Chesapeake Networks



Estuary:

- Nutrients
- DO, clarity
- 150 sites
- SAV

Nontidal

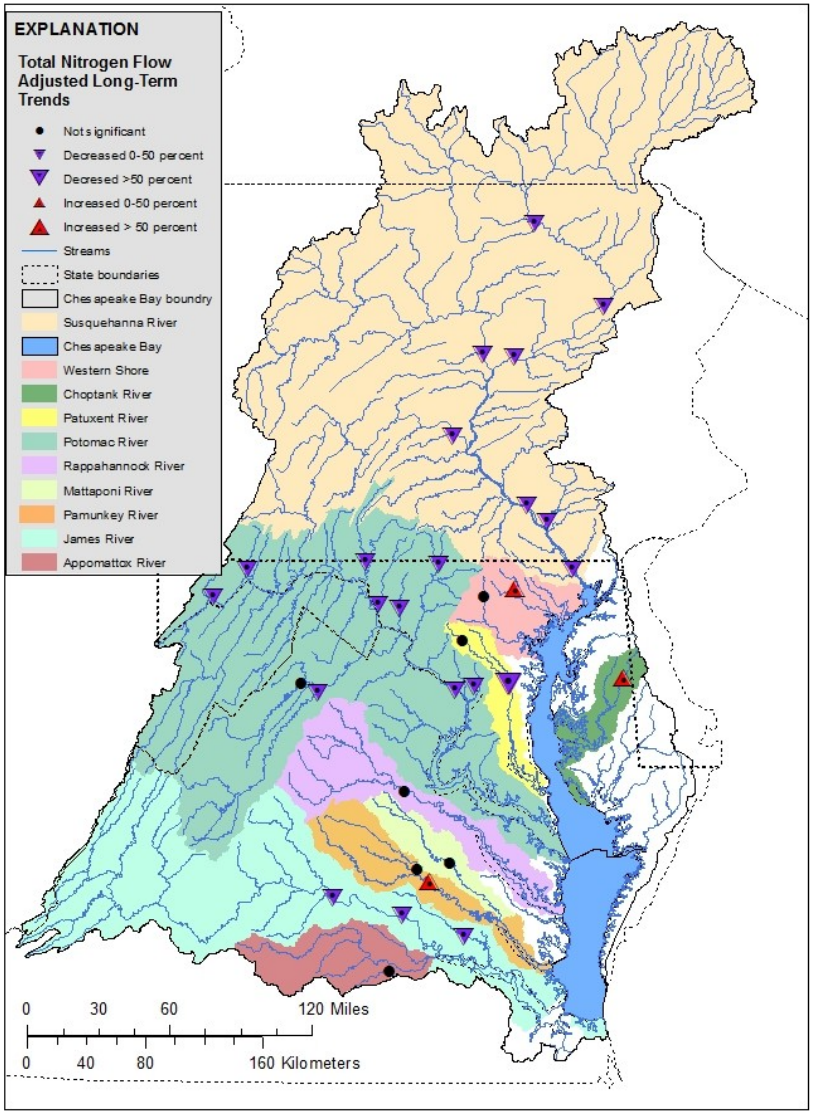
- Nutrients
- sediment
- Streamflow
- 125 sites

Annual updates:

- Status and trends

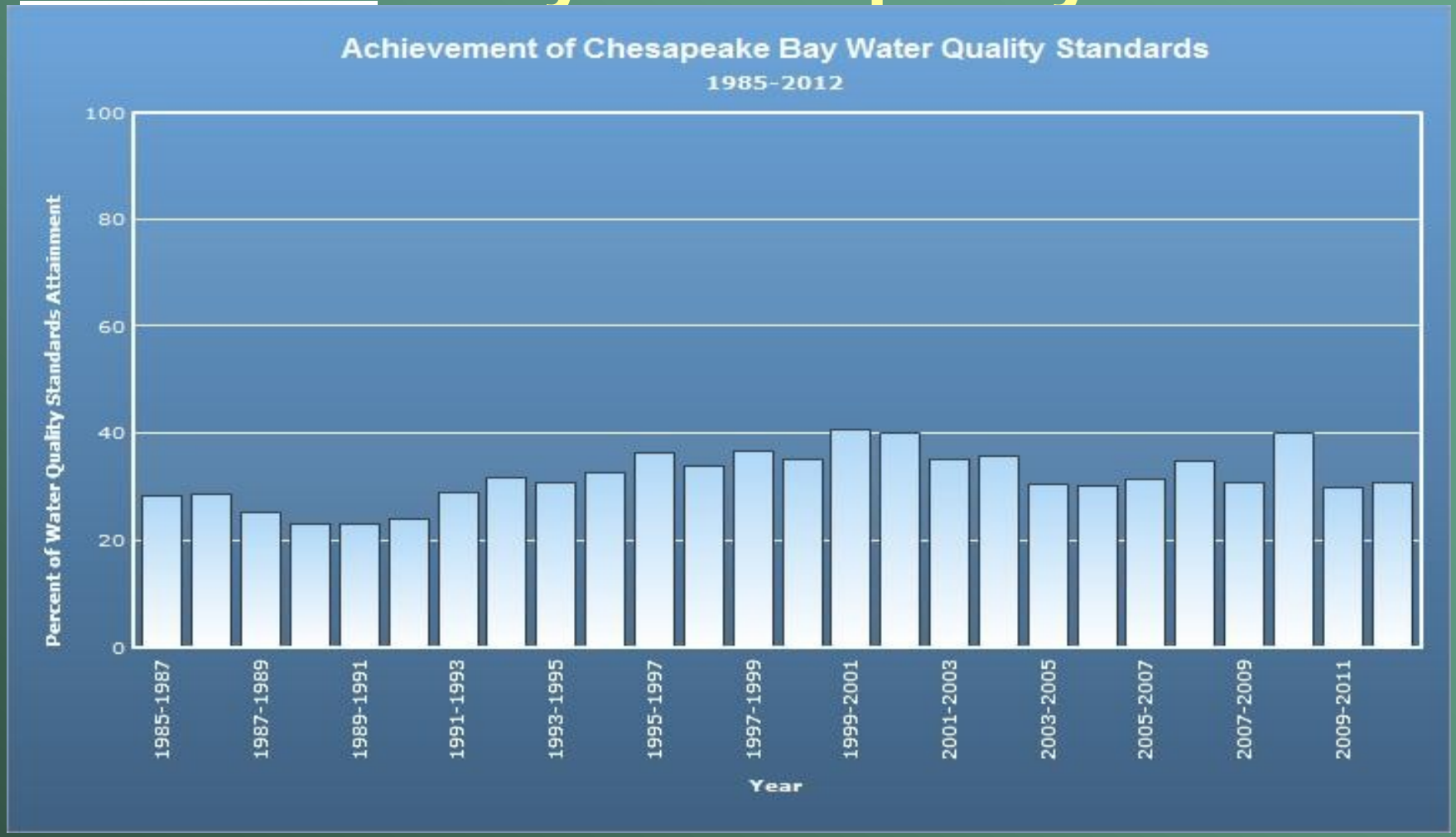
Watershed Trends

- Nutrients and sediment
  - LT: 1980s to now
  - ST: Past 10 years
  - Flow adjusted
- TN
  - LT: 70% improving
  - ST: 54% improving
- TP
  - LT: 73 % improving
  - ST: 21% improving, most NS



Flow-adjusted trends for total nitrogen for 31 sites in the Chesapeake Bay Watershed, 1985-2011.

Estuary water quality



- 31% of waters achieved standards
  - DO, clarity/SAV, chl.

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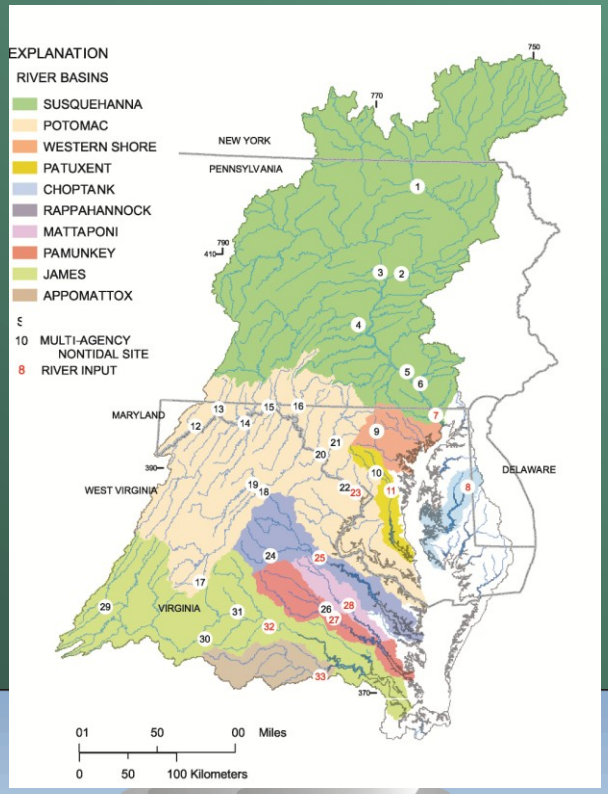
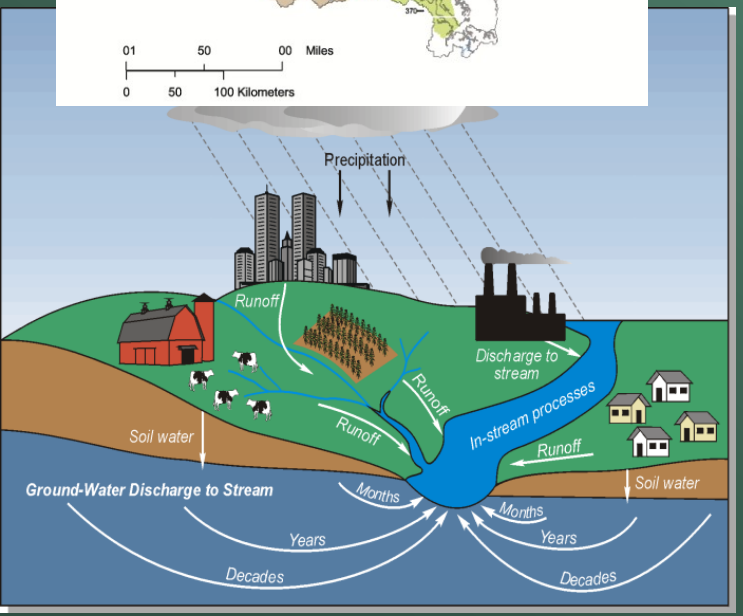
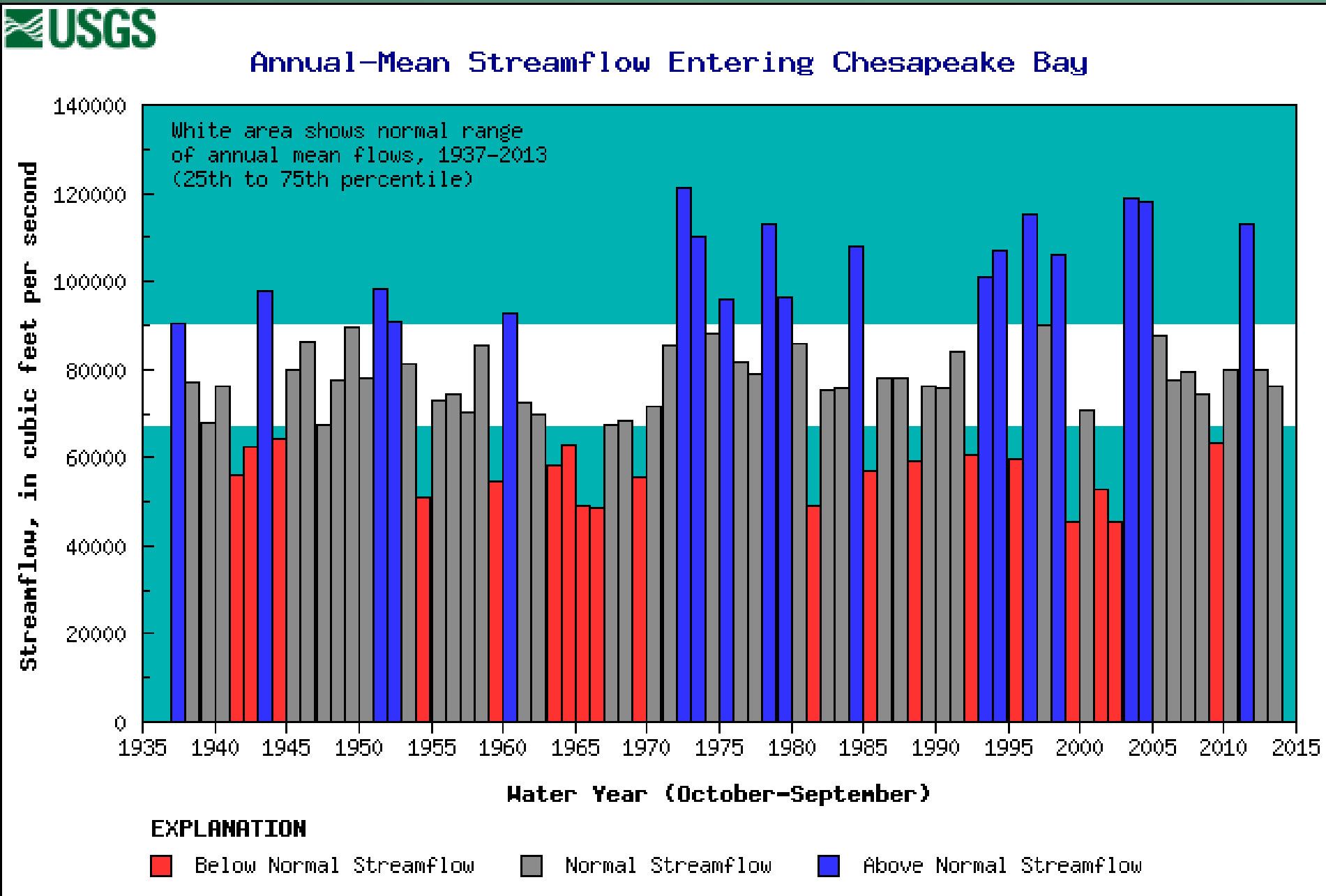
Explain Trends





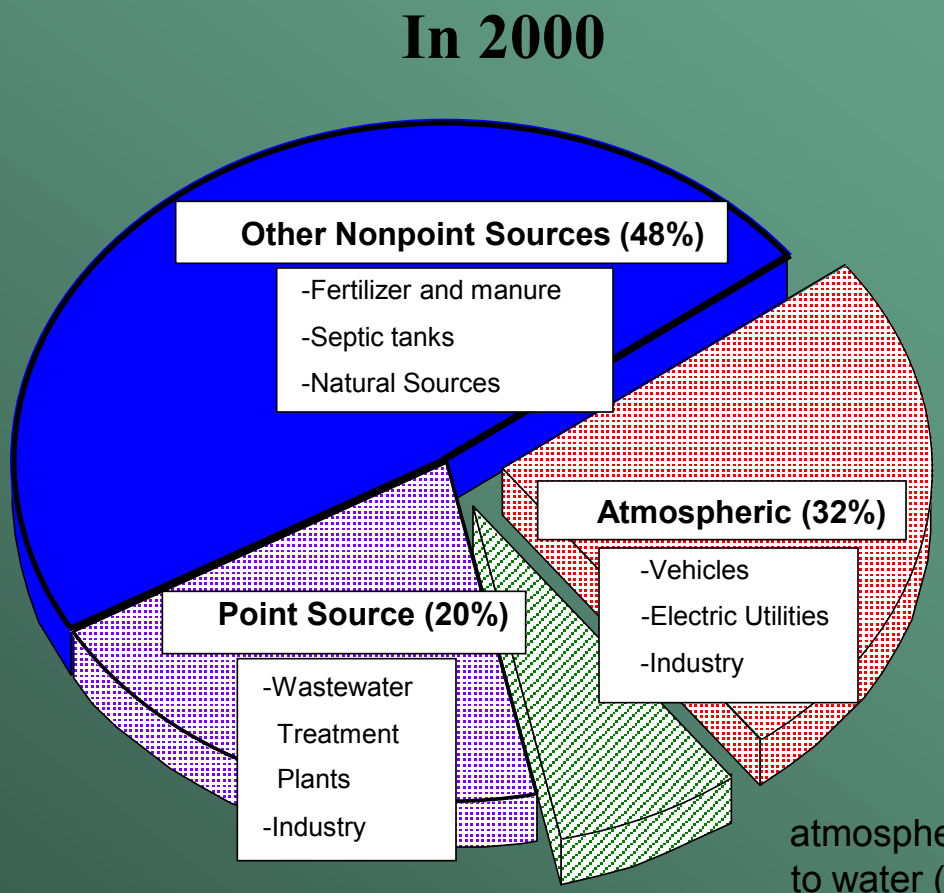
- Regional and small watershed s
- Factors
  - Climate Variability
  - Land use and sources
  - BMP implementation
  - Watershed properties
    - Fate, transport, storage
    - “Lag times”

Climate Variability: River Flow



Nutrient Sources

- Point sources
  - 25% reduction since 1985
- Non-point source dominated
  - Air
  - Agricultural
  - Urban



Source: Chesapeake Bay Program Phase 4.3 Watershed Model, 2000 progress scenario

New Insights from Chesapeake Bay Restoration Efforts

- Review of over 40 case studies
- Seven lessons under three broad categories:
  1. What Works
  2. Challenges
  3. What We Need

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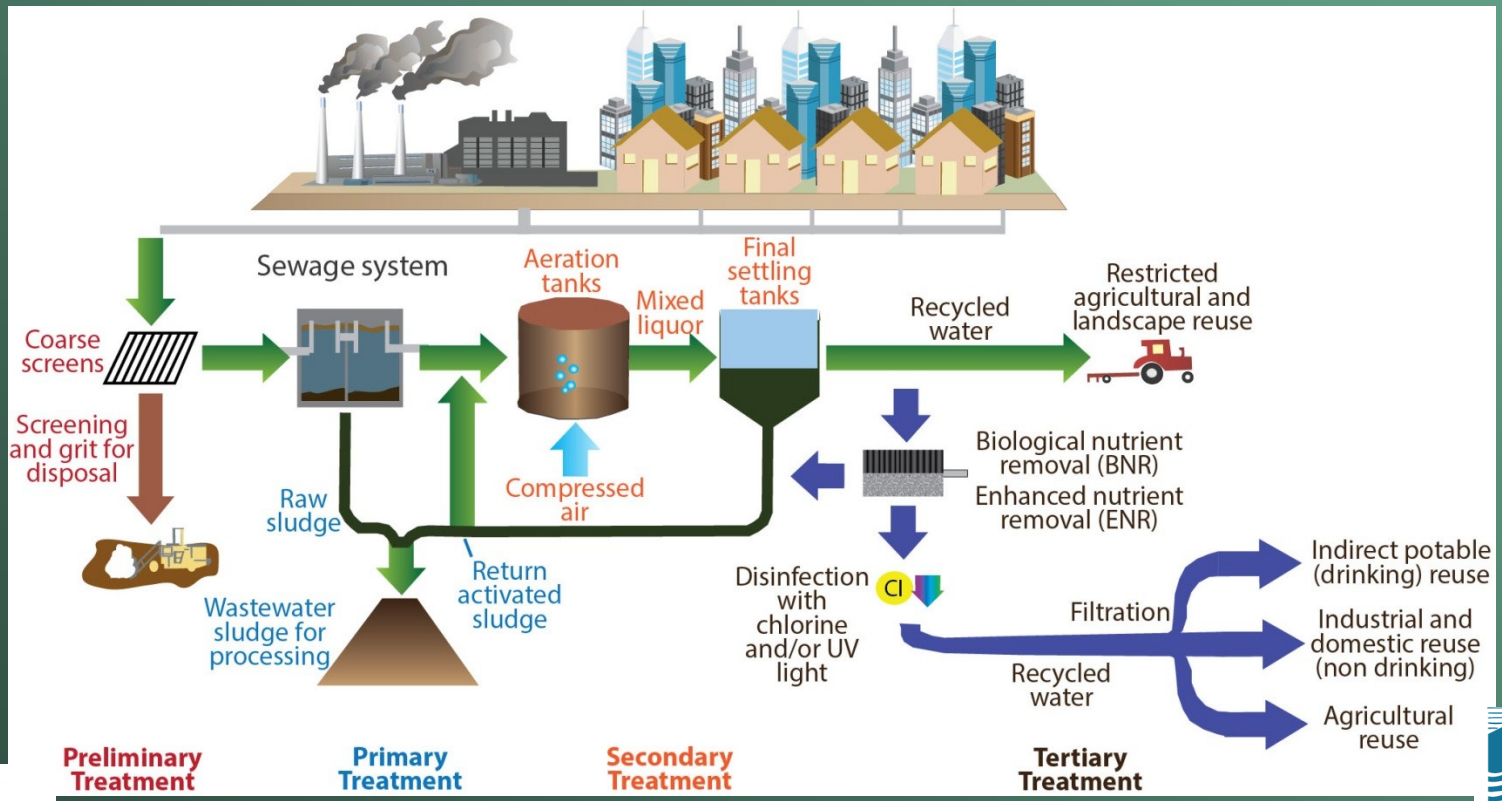
Lesson 1

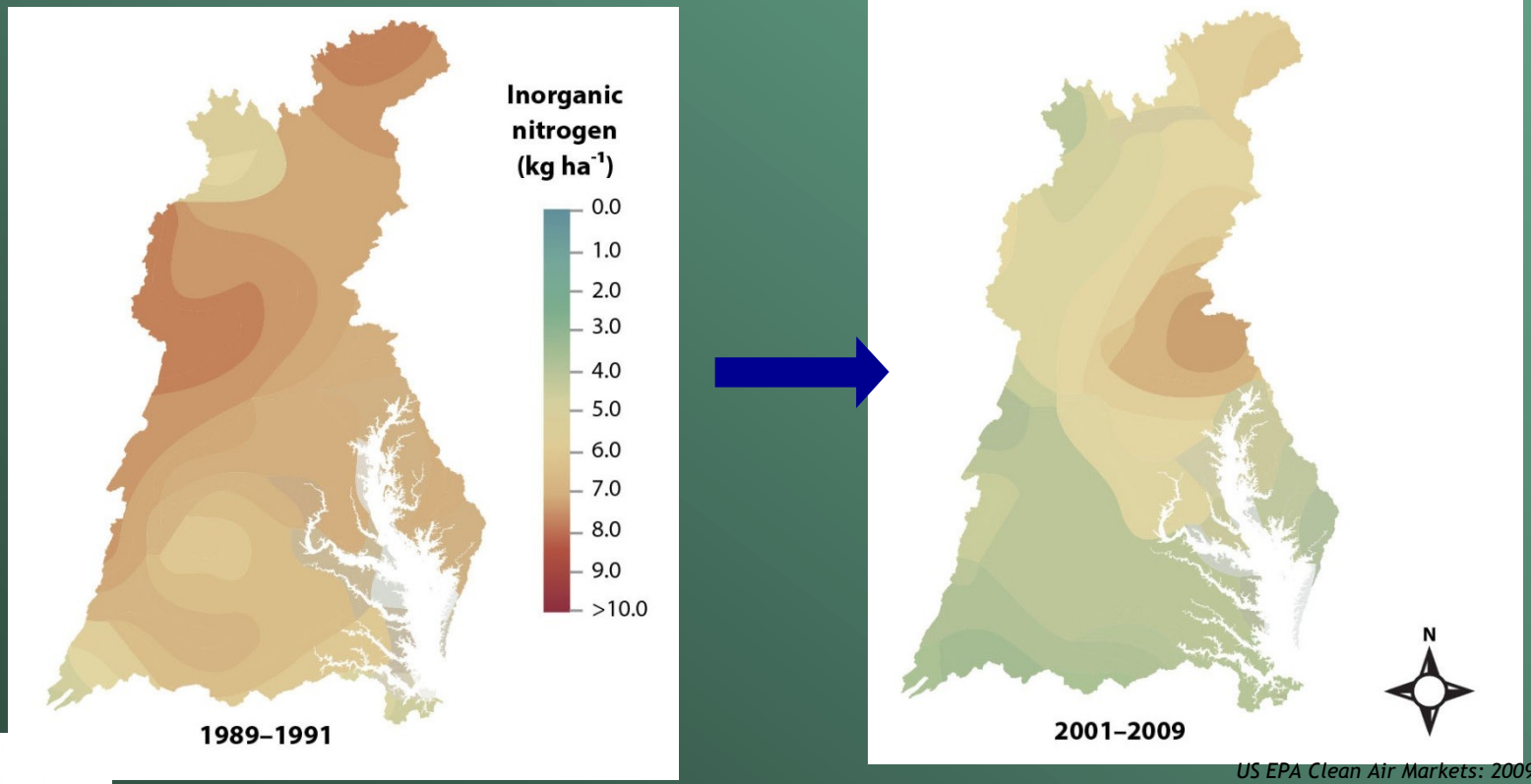
- Upgrades in both nitrogen and phosphorus wastewater treatment result in rapid local water quality improvements



Lesson 2

- Improvements in air quality lead to reductions in atmospheric nitrogen deposition

Annual mean wet inorganic nitrogen deposition



US EPA Clean Air Markets: 2009 Results

Lesson 3

- **Reductions of agricultural nutrient sources result in improved local stream quality**

Cover crops

Livestock exclusion

Waste management

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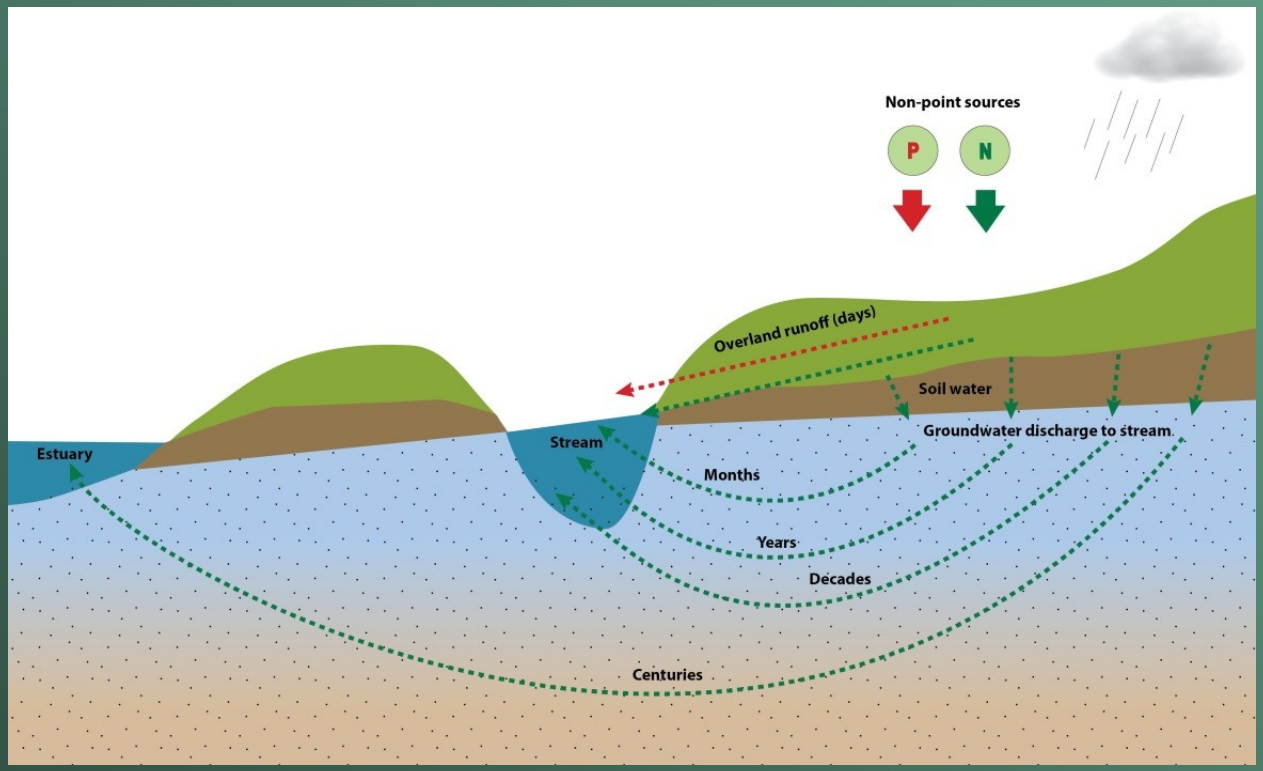
Lesson 4

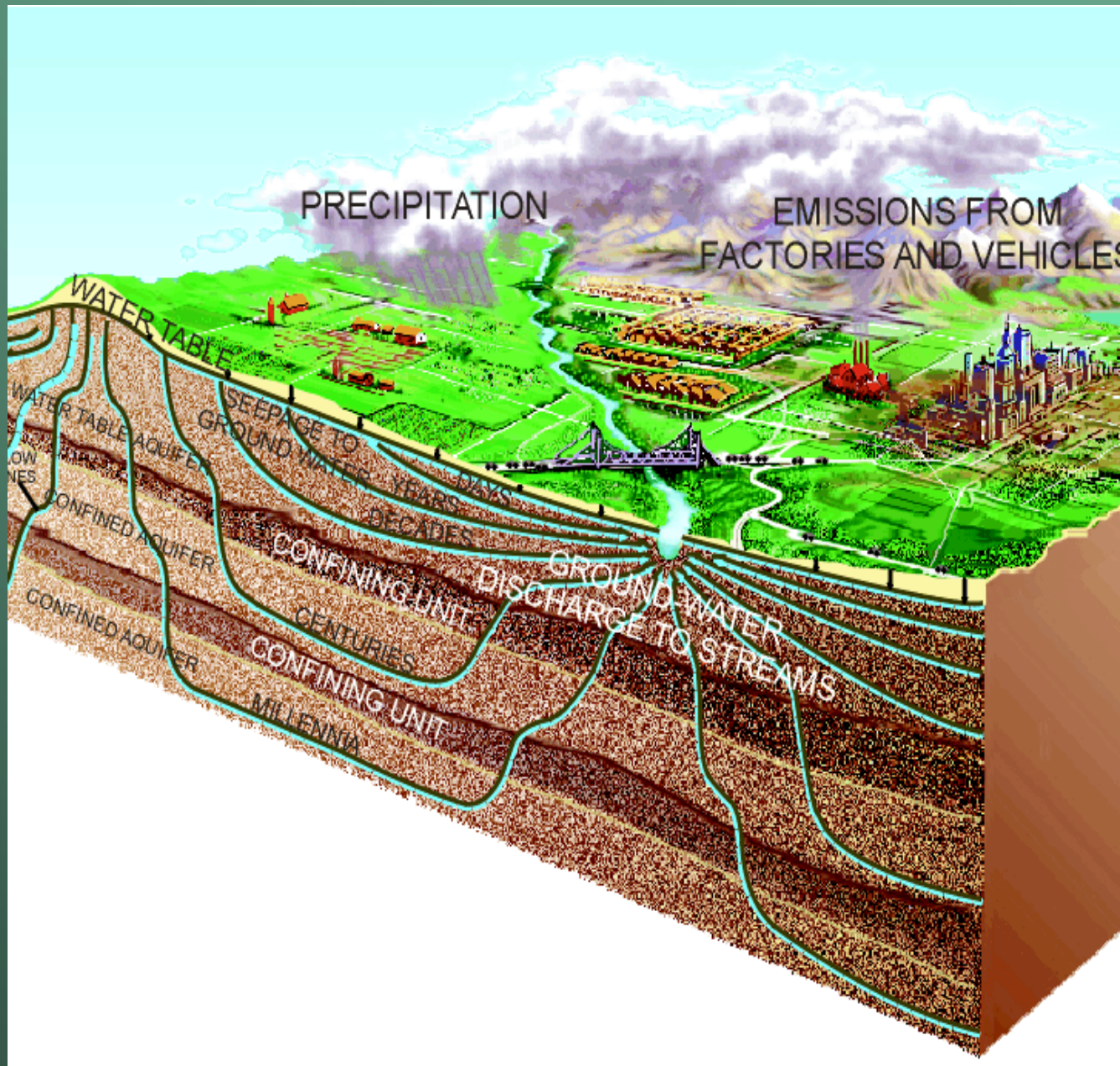
- Many practices provide initial water quality improvements in runoff; however, full benefits to stream conditions can be delayed



Sanford et al., 2012

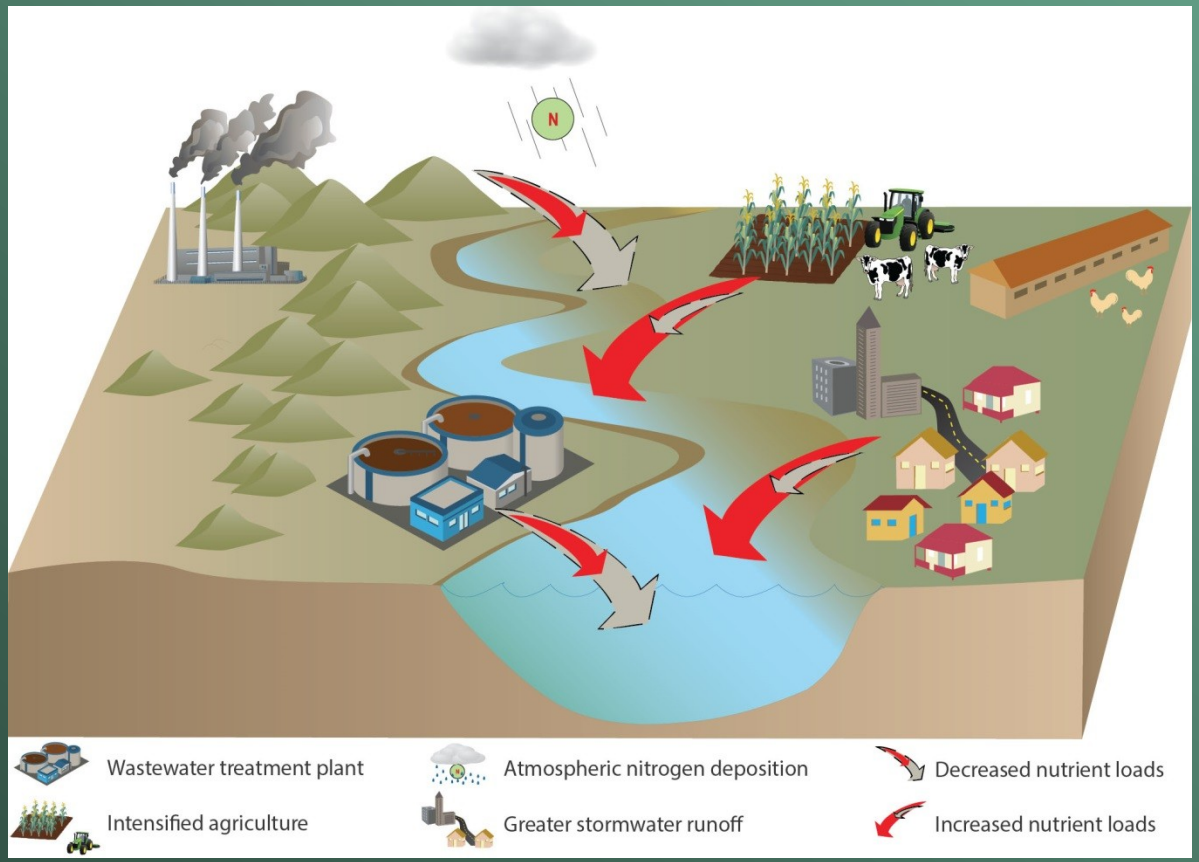
Ground Water and Residence Times

- Ground water contribution to stream flow
  - About 50%
  - Range of 16 to 92%
- Nitrogen load in stream from GW
  - Varies from 17 to 80 %
- Residence time
  - Modern to hundreds of years

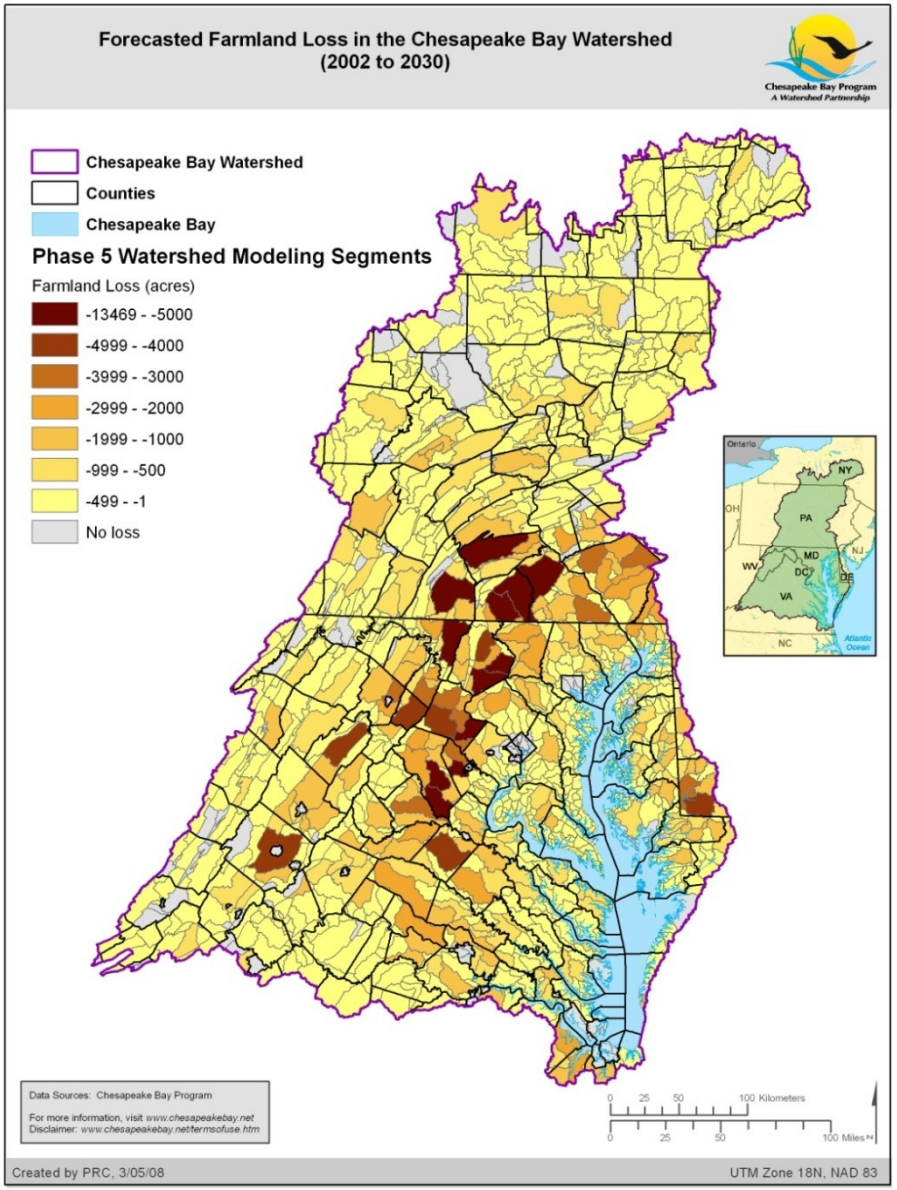


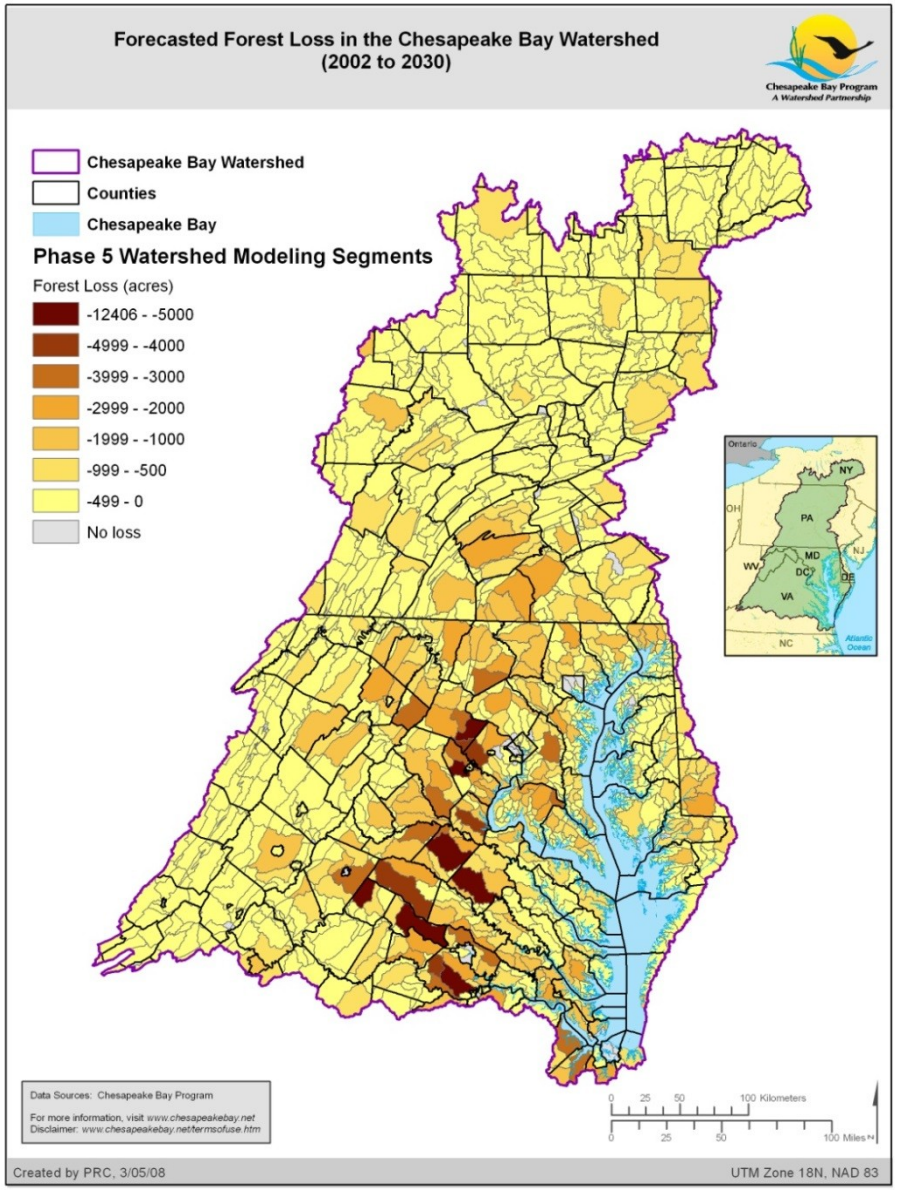
Lesson 5

- Improvements in water quality can be counteracted by changes in nutrient sources and land-use practices



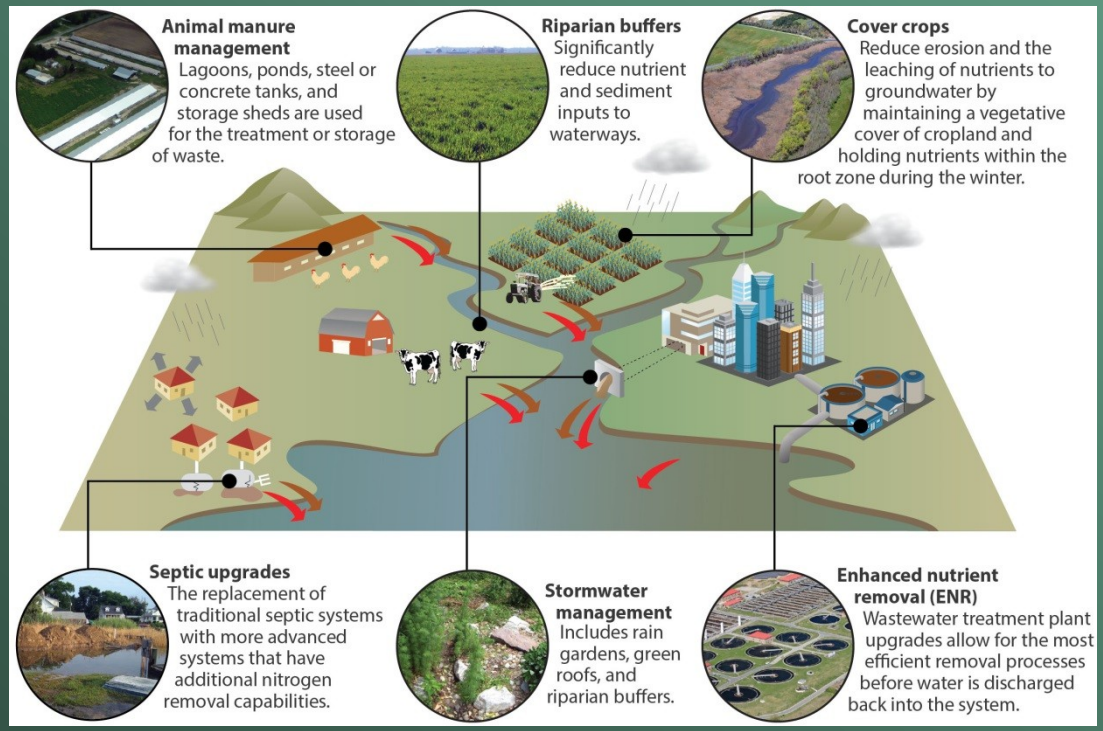
Land Change Forecasts





Lesson 6

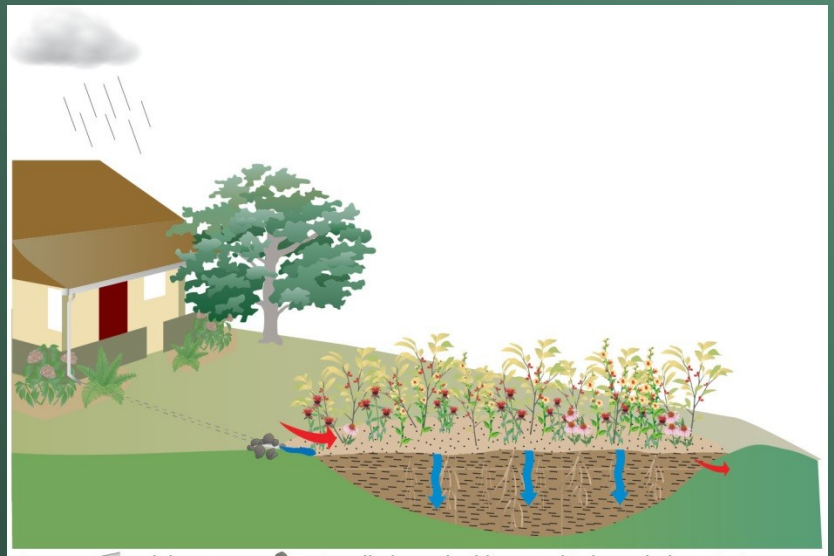
- Enhanced targeting is needed to guide restoration and monitoring to evaluate effectiveness



Lesson 7

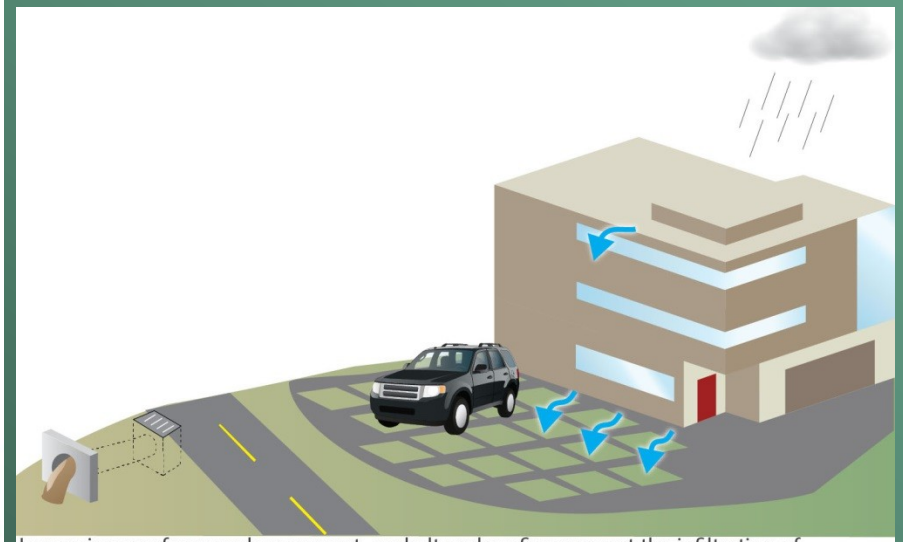
- **Innovative practices and testing are needed**

Rain gardens



Gutters and downspouts installed onto buildings and in lawns help assist in directing rain water from the roof to the garden. A landscape of native, drought resistant plants is well adapted to local conditions and easily maintained. Plants with deep root systems encourage stormwater infiltration and help absorb excess nutrient runoff. Additionally, a berm on the downward slope of a rain garden will help hold water in the garden during heavy rains, further improving its filtering capacity.

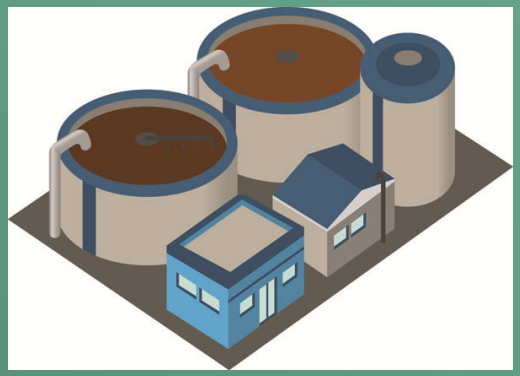
Pervious surfaces

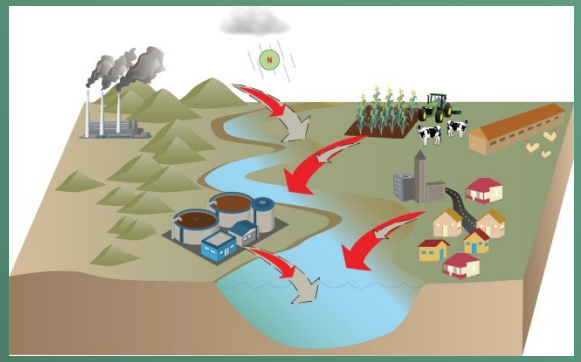


Impervious surfaces such as cement, asphalt and roofing prevent the infiltration of stormwater, increasing the volume and velocity of surface runoff which carries nutrients and sediments with it. Pervious surfaces, such as pervious pavement or pavers, allow for stormwater to filter through the surface and into the ground, rather than into nearby streams and storm drains.

Conclusions

1. **Long-term efforts led to local improvements**
   - Sewage upgrades
   - Air reductions
   - Some agricultural practices
2. **Progress affected by lag times and land change**
   - Delays in improvements necessitates patience and persistence
   - Expanding population
3. **Diligent and innovative**
   - Location should guide restoration efforts and monitoring
   - Innovative practices and testing





Implications for OECD paper

- Focus on just a “few” sources and practices
- Expanding population
  - Suburban and urban practices
- Intensifying agricultural
- Types and locations of practices
  - Reductions
  - Time for improvements
  - Costs