

## EUTROPHICATION

- This is a problem for both ocean (the hydrosphere including lakes, rivers) and land (soil -> plants).
- Yes, in fact can occur naturally in lakes as they age (take limnology if interested); they accumulate nitrates ( $\text{NO}_3^-$ ) and phosphates ( $\text{PO}_4^{3-}$ ). The process is VERY slow.
- Currently, human induced eutrophication is one of the rapidly growing issues and has been recognized as pollution since mid-20<sup>th</sup> century.  
Non-point source  
Fertilizers:
  - come from petroleum; takes petroleum to get petroleum, takes petroleum to make fertilizers from petroleum.
  - agricultural practices are not ethical (considerate of the environment -> run-offs)Point source
  - waste waters
  - industry
  - sewage + detergents

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Species lost in both water and land:

- Phytoplankton is favoured in eutrophic waters -> algae bloom -> light penetrating water in the area is lowered by much (?) -> oxygen depletion -> hypoxia -> fish and mollusk literally suffocate -> die off of phytoplankton -> methane producing bacteria in the water (and land?)
- Naturally many trees -> VOC's production -> ozone production AND ozone reduction in troposphere -> ozone (cleanser) -> destruction of CO & CH<sub>4</sub> (hydrocarbons) -> ozone sink = a balanced ratio of one to the other  
Unintended land conversion:
  - Eutrophication favors bushes, faster growing species, over trees; this, in turn, converts forests into thickets. Those do not produce as much VOC's, do not cause O<sub>3</sub> production to the same degree as slower growing (but bigger in the end) trees. Therefore the amount of hydrocarbons increases.
  - Effects of Ammonia: stress withstanding abilities are decreased; reduced flowering -> impoverishing seed-bank, gene pool, and potentially reduces resilience to climate change
  - Rain depends on rainforests. Not the other way around. Most VOC's lead to formation of particles (aerosols) – pp107 (“smoke” in the Smoky Mountains isn't the same as London smog?)
  - Trees are a larger sink of CO<sub>2</sub> than bushes.

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- Grassland soils and Vegetation responses to Nitrogen saturation in UK -> in an acidic areas increased ammonium concentration... (?)
  - pH of the soil decreases with excessive N depositions (?)
  - Currently in many European areas soil's fixed N concentration is double the pre-industrial
  - N deposition rates increased between 3 and more than 10-fold (???) compared to preindustrial times
  - Critical load for acidification are exceeded in ~7-17% of the globally – critical load for eutrophication ~7-19% (combine the numbers? Correlation=causation?)

National Institute for Public Health and Environment (RIVM, Netherlands)

Natural Environment Research Council (UK)

City of Boulder: Municipal Tree Resource Analysis

Our textbook: Holloway, Atmospheric Chemistry

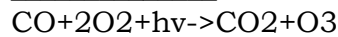
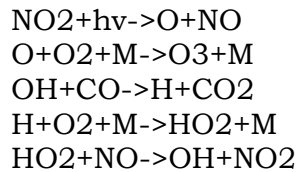
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pp 77: N from fertilizers -> ammonium  $\text{NH}_4^+$  -> nitrification into  $\text{NO}_2^-$  &  $\text{NO}_3^-$  -> plant consumption  
-> denitrification  $\text{N}_2$  &  $\text{N}_2\text{O}$

It is unclear how much is consumed and how much is denitrified, but I would assume if more fixed N available both processes must increase (?)

pp 102-103  
Figure 8.3 pp108

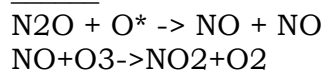
Photolysis of  $\text{NO}_2$  = the only known way of producing  $\text{O}_3$  in the troposphere:



Below a certain critical value of ratio  $[\text{NO}]/[\text{O}_3]$   $\text{HO}_2$  reacts primarily with  $\text{O}_3$  and not  $\text{NO}$  -> ozone loss dominates over generation  
In troposphere that should be good, right?..

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Nope! Tropospheric ozone determines oxidizing capacity of the troposphere (cleansing). Too much isn't good, too little either. Tropospheric ozone is a greenhouse gas and initiates the chemical removal of methane and other hydrocarbons from the atmosphere. Thus, its concentration affects how long these compounds remain in the air.



Non-methane hydrocarbons NMHCs, partially oxidized VOCs are very reactive and are produced and emitted by plants

Alkanes & alkenes (also from trees):

