



General Environmental Hazards in Agriculture

Agricultural Health and Safety Course
for Medical and Safety Professionals

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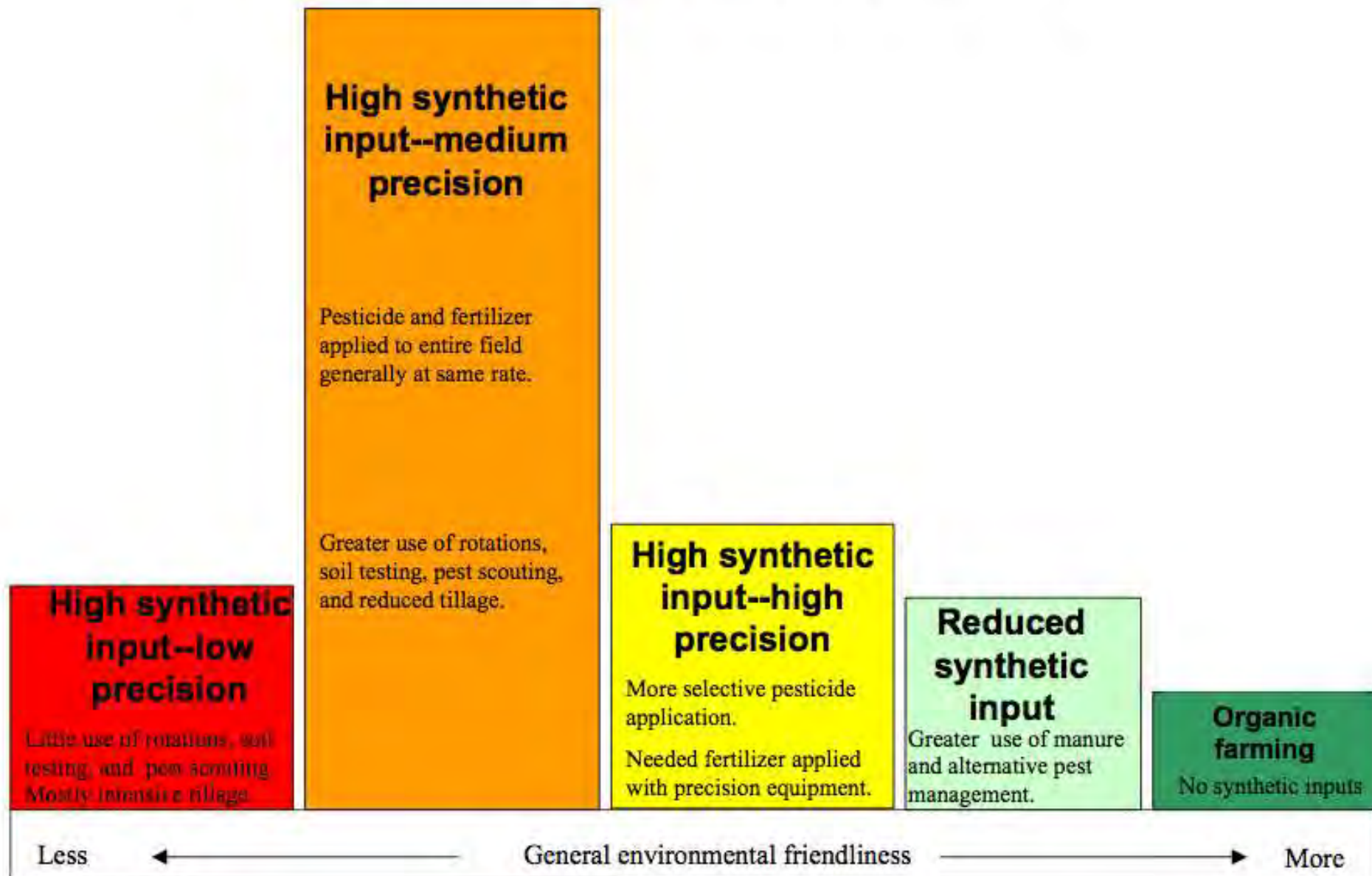
Learning objectives

- Define major environmental health hazards and their sources in the rural and agricultural environment
- Characterize contaminants in air and water and the suspected health hazards of these contaminants
- Examine health concerns for people living in the vicinity of large livestock confinement facilities



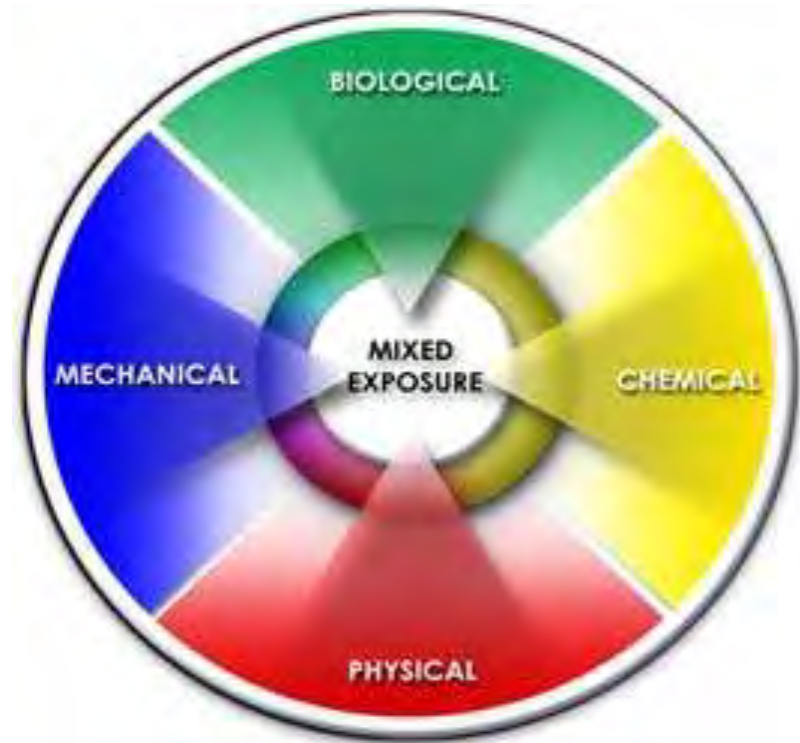
Figure 4.1.1--Major farming systems in U.S. agriculture

(Height of bar grossly indicates the relative acreage in that system)



Types of environmental health hazards

- Chemical
- Physical
- Mechanical
- Biological
- Psychosocial



<http://www.cdc.gov/niosh/topics/skin/>



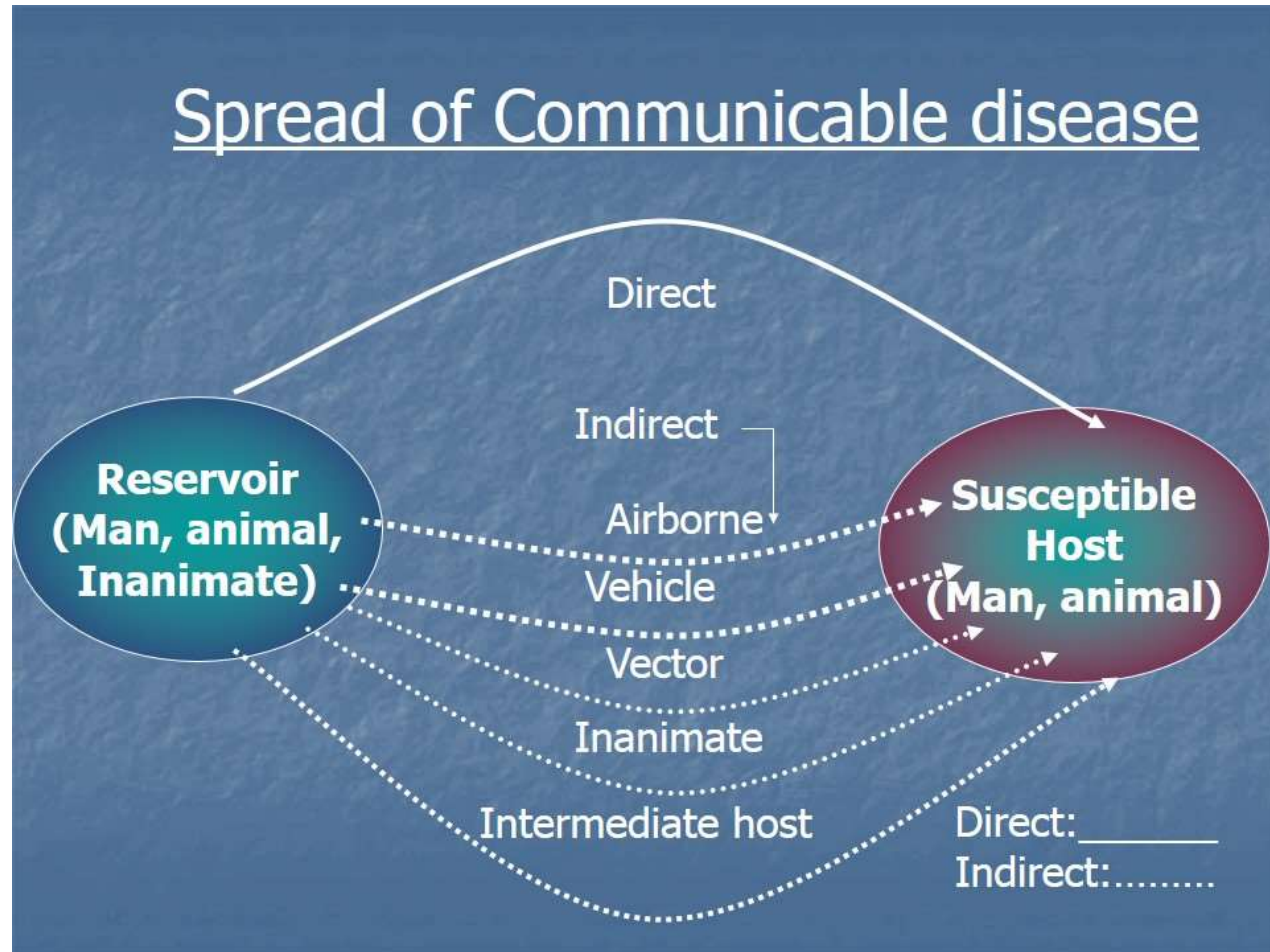
Routes of exposure

- Water
- Air
 - Indoor
 - Outdoor
- Soil
- Food
- Penetrating skin



Infectious or communicable disease

- Direct
 - Touching
 - Fluids
- Vehicles
 - Food
 - Soil
 - Water
 - Air
- Vectors
 - Animals
 - Insects



Bacteria

- *Bacillus anthracis*
 - Anthrax
- *Bordetella pertussis*
 - Whooping cough
- *Borrelia burgdorferi*
 - Lyme disease
- *Campylobacter* spp.
 - *C.jejuni*, *C.coli* (from poultry)
- *Clostridium* spp.
 - Botulism
- *Escherichia coli*
 - Food poisoning
- *Francisella tularensis*
 - Tularemia (from rodents)
- *Mycobacterium* spp.
 - Tuberculosis, leprocy
- *Salmonella*
 - Typhoid fever, food poisoning
- *Shigella* spp.
 - Shigellosis, diarrhea
- *Vibrio cholerae*
 - Cholera, diarrhea
- *Yersinia pestis*
 - Bubonic plague, black death



Viruses

- Adenovirus
- Coxsackievirus
- Flavivirus
- Hantavirus
- Hepatitis A and E Viruses
- HIV
- Influenza (incl. bird flu)
- Norwalk-like viruses
- Rhabdovirus
- Rotavirus
- West Nile Virus
- Corona virus



Parasites

- *Cryptosporidium parvum*
- *Cyclospora*
- *Entamoeba histolytica*
- *Giardia lamblia*
- *Leishmania* spp.
- *Plasmodium* spp.
- *Schistosoma* spp.
- *Taenia* spp.
- *Trichinella spiralis*



Other sources

Prions (protein particle)

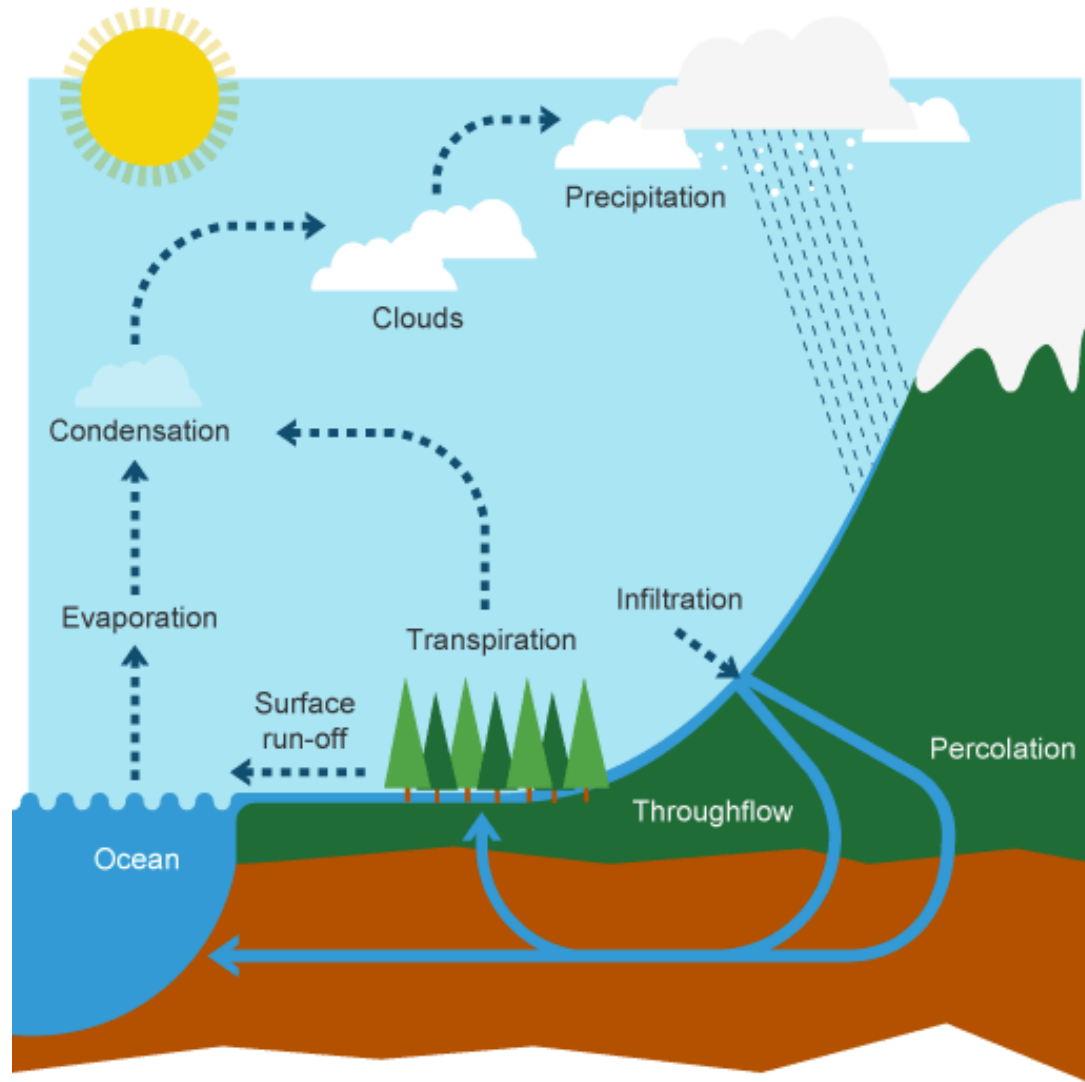
- Creutzfeldt-Jacob (“mad cow”) disease

Rickettsia (very small bacteria)

- *Coxiella burnetii* (Q Fever)
- *Rickettsia rickettsii* (Rocky Mountain Spotted Fever)

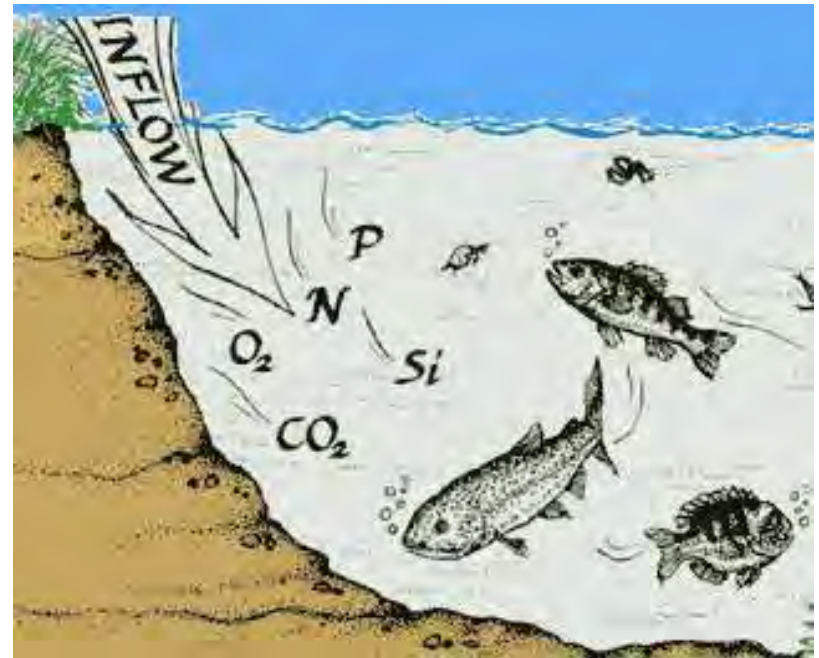


Water cycle



Water quality

- Contamination vs. pollution
- Biological, chemical, physical
- Point source vs. Non-point source



<http://water.epa.gov/scitech/datait/models/aquatox/index.cfm>



Sources of water pollution in rural areas

- Animal wastes
- Fertilizers
- Pesticides
- Urban sources
- Rural industrial sources
- Inappropriate land management
- Natural sources



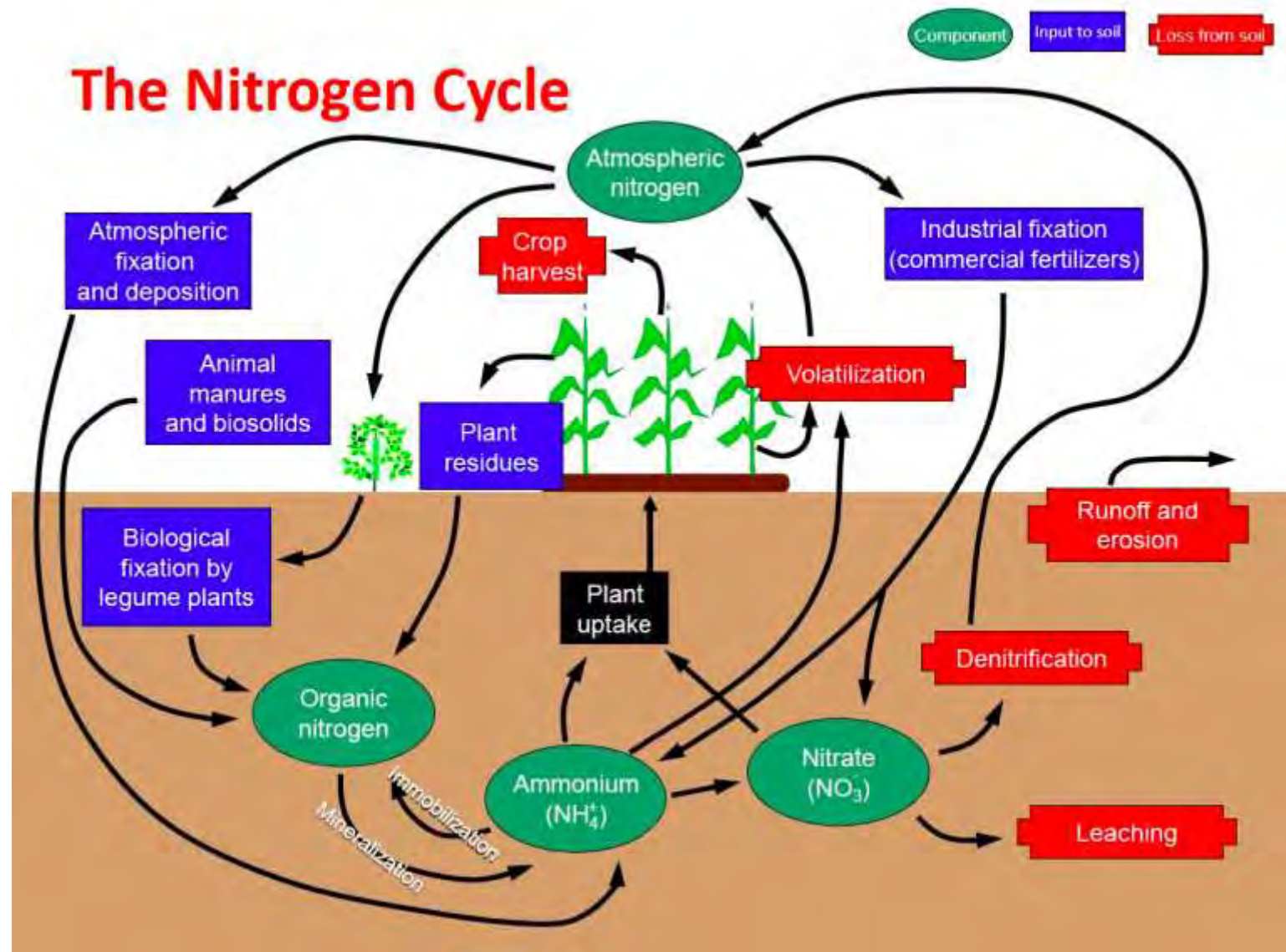
Water pollutants associated with agriculture

- Nitrogen
- Phosphorus
- Trace elements
- Particles, sediment
- Microbes and antibiotics
- Veterinary pharmaceuticals



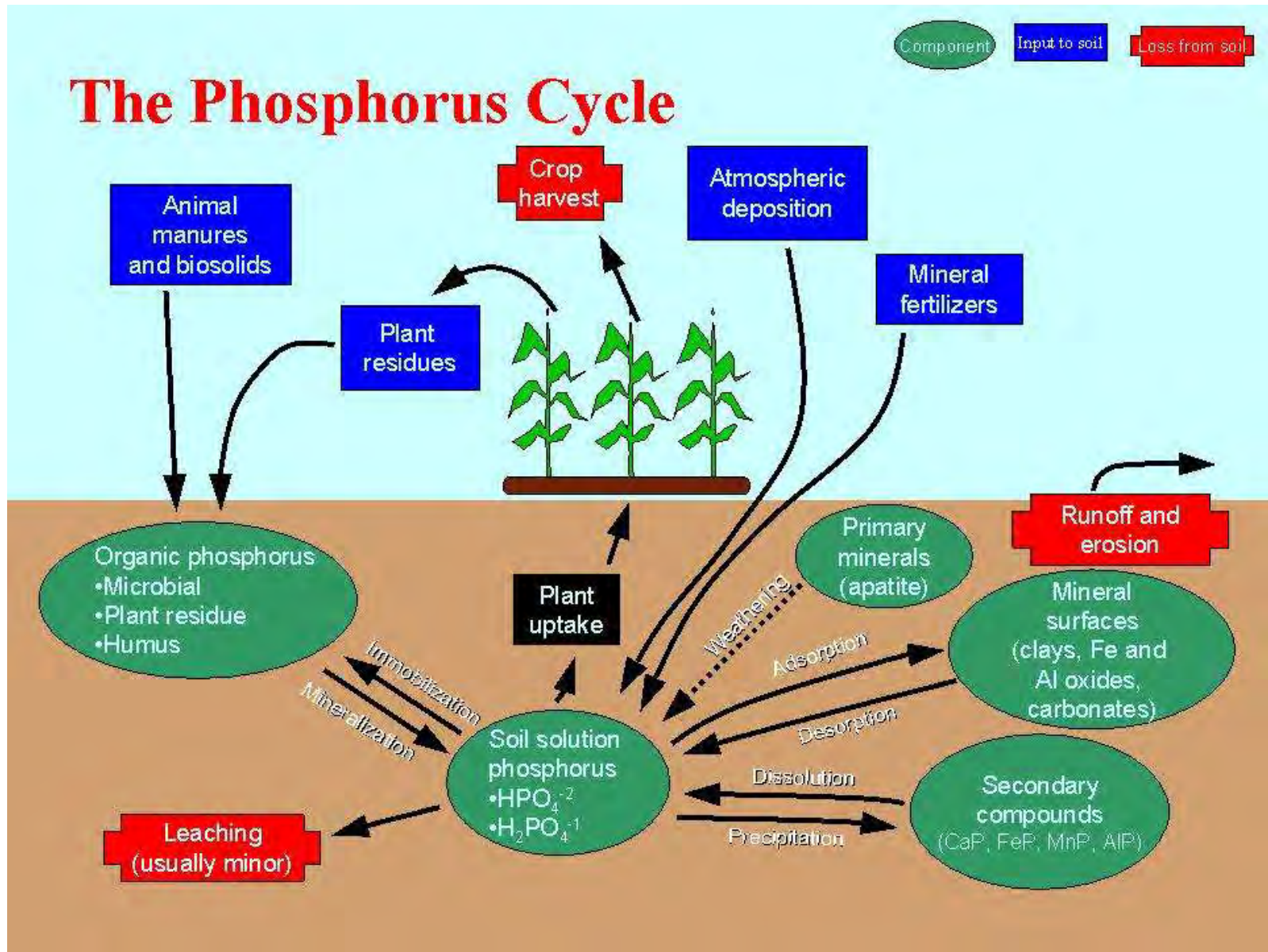
Nitrogen cycle

<http://faculty.engineering.asu.edu/landis/research/nutrient-flow-analysis/>



Phosphorous cycle

<http://faculty.engineering.asu.edu/landis/research/nutrient-flow-analysis/>



Control of water pollution

- Regulatory:
 - Main regulatory body EPA
 - <http://water.epa.gov/scitech/swguidance/standards/wqsregs.cfm>
- Voluntary:
 - 2012 National Water quality Initiative; USDA, EPA, state water quality agencies
 - Reduce nonpoint sources of nutrients, sediment, pathogens in high-priority watersheds in each state
 - Voluntary efforts to avoid, trap, control run-off
 - <https://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/water/?cid=stelprdb1047761>



Table 3-1. NRCS conservation practices, pollutants potentially controlled, and sources of pollutants (USDA-NRCS, 1977).

	RESOURCE CONCERNS	Pesticides	Nutrients & Organic	Salinity	Heavy Metals	Pathogens	Pesticides	Nutrients & Organic	Salinity	Heavy Metals	Pathogens	Temperature	Low Dissolved Oxygen	Suspended Sediments & Turbidity	Aquatic Habitat Suitability
NRCS Code	CONSERVATION PRACTICES	Ground Water					Surface Water								
322	Channel Vegetation				B	B	B	B	B	B	B	B		B	B
327	Conservation Cover	D	B	B	B	B	B	B		B	B	B	B	B	B
656	Constructed Wetland						B	B	B	B	B		B		B
332	Contour Buffer Strips	D	D	D	D	D	B	B	B	B			B	B	B
342	Critical Area Planting	D	B	B	B	B	B	B	B	B	B	B	B	B	B
400	Floodwater Diversion	B	B				B	B	B	B	B	B	B	B	
490	Forest Site Preparation							D					D	D	D
412	Grassed Waterway						B	B					B	B	B
561	Heavy Use Area Protection						B	D						B	
422	Hedgerow Planting						B	B			B		B	B	
441	Irrigation System - Micro	B	B		B	B	B	B		B	B	B	B	B	B
442	Irrigation System - Sprinkler	D	D	D	D	D	B	B		B	B	B	B	B	B
634	Manure Transfer		B	B				B	B		B	B	B	B	
484	Mulching	D	D	D	D	D	B	B	B	B	B		B	B	
590	Nutrient Management		B	B	B	B		B	B	B			B		B
528A	Prescribed Grazing		B				B	B			B	B		B	B
344	Residue Management, Seasonal	D	D	D	D	D	B	B	B	B	B	B	B	B	B
391	Riparian Forest Buffer	B	B	B	B	B		B	B	B	B	B		B	B
350	Sediment Basin	D	D	B	D	D	B	B	B	B	B			B	B
351	Well Decommissioning	B	B	B	B	B									
657	Wetland Restoration						B	B			B		B	B	B
	B - Beneficial effects expected	National Management Measures to Control Nonpoint Pollution from Agriculture http://water.epa.gov/polwaste/nps/agriculture/upload/2003_09_24_NPS_agmm_ch													
	D - Detrimental effects expected														
	Blank - Not Rated														

Drinking water quality

Testing, Private wells

- <http://www.cdc.gov/healthywater/drinking/public/drinking-water-faq.html>
- <https://www.epa.gov/privatewells>
- <http://deq.ne.gov/NDEQProg.nsf/OnWeb/Water>

Clean water act and agriculture

- Clean water act: <https://www.epa.gov/laws-regulations/summary-clean-water-act>
- Agriculture sector:
<https://www.epa.gov/regulatory-information-sector/agriculture-sectors-crop-naics-111-and-animal-naics-112>
- 2015 Waters of the United States (WOTUS) rule - Farm Bureau site:
<https://www.fb.org/issues/regulatory-reform/clean-water-act/>



Rural air quality

- Indoor and outdoor contaminants
- Natural sources
 - Wild fires, volcanic eruptions, dust storms
 - Pollens, moulds, particulates
- Human activity sources:
 - Manure, fertilizers, pesticides
 - Animal confinements
 - Emissions from storage facilities
 - Incomplete combustion from engines, burning materials



Air pollution from agriculture

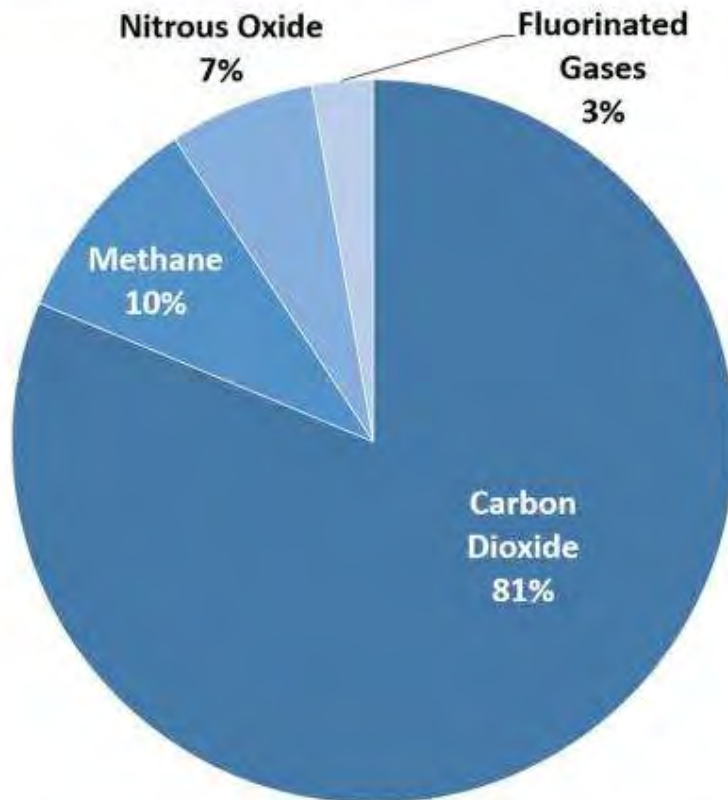
- Particulates (incl. organic dust, silica)
- Gasses (inc. CO², methane, H²S, ammonia)
- Odors
- Microbes
- Endotoxin and glucans
- Antibiotics
- Agricultural chemicals



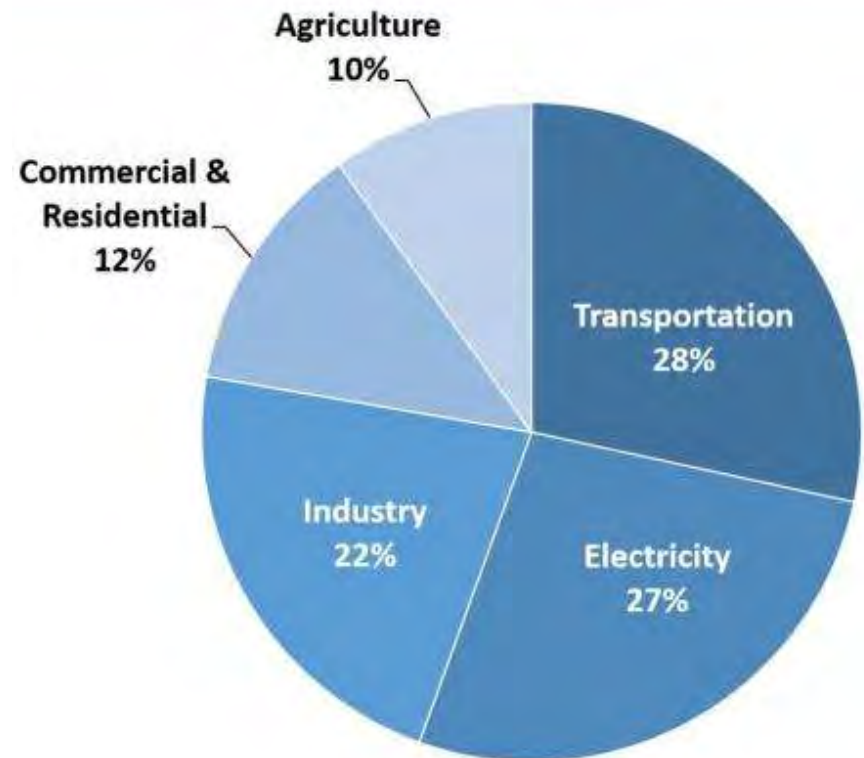
Greenhouse gasses

<https://www.epa.gov/ghgemissions/inventory-us-greenhouse-gas-emissions-and-sinks>

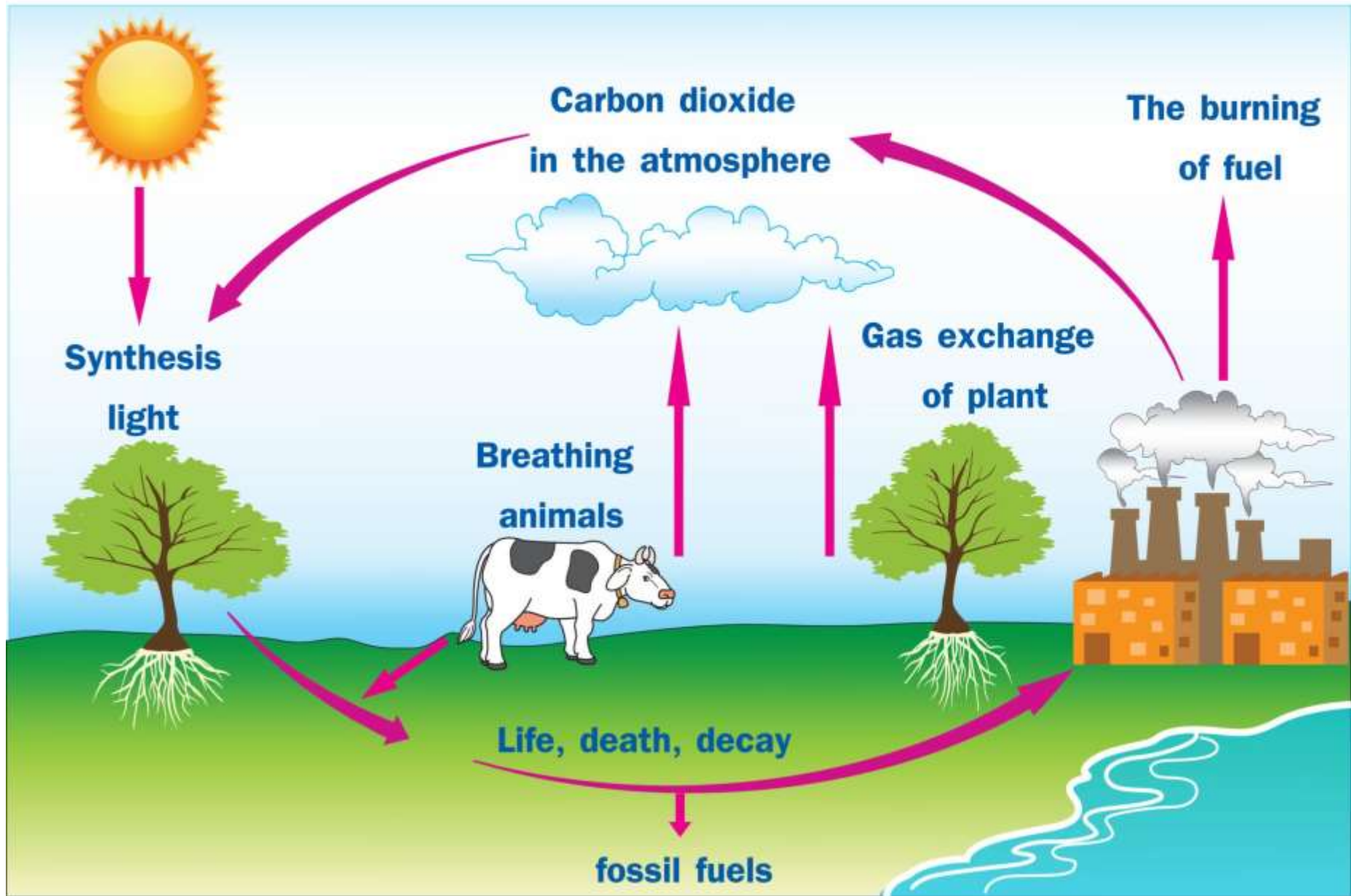
Overview of Greenhouse Gas Emissions in 2018



Sources of Greenhouse Gas Emissions in 2018

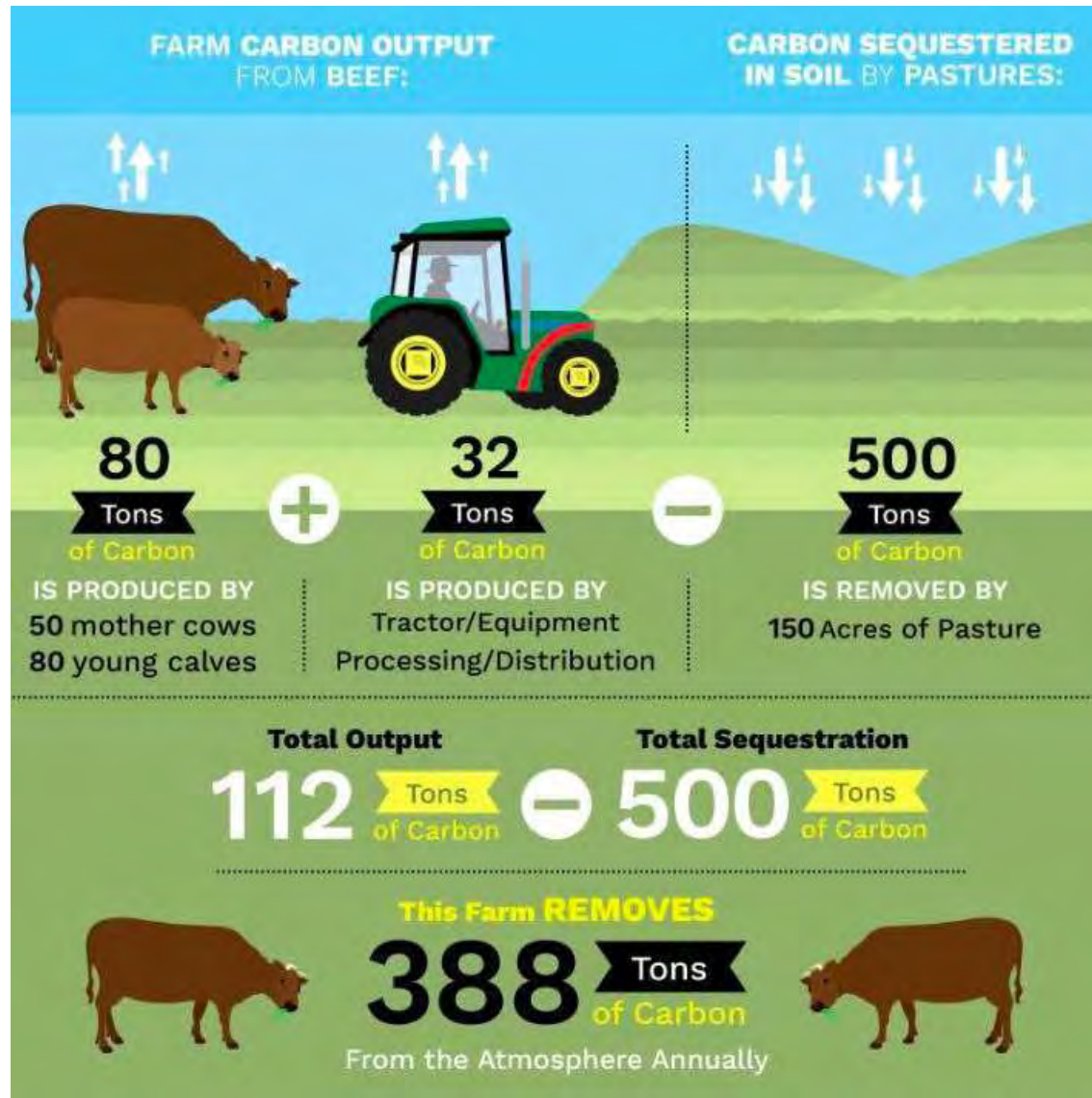


Carbon cycle



Greenhouse gas emissions from cattle

Source: <https://www.facebook.com/defendingbeef/>



Control of air pollution from manure

- Direct injection; 90% less odor compared to surface application
- Incorporation (tilling) into soil during surface application
- Biogas production
- No application on frozen ground



Control of agricultural air pollutants

http://www.nrcs.usda.gov/Internet/FSE_DOCUMENTS/stelprdb1049502.pdf

- Maintain soil surface cover
- In-field pass reductions
- Soil conditioning, timing of operations
- Maintenance of unpaved roads, traffic areas
- Wind barriers
- Equipment modifications
- Fire, smoke reductions
- Precision delivery of inputs





Natural Resources Conservation Service

United States Department of Agriculture

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NRCS Practice Standards for Greenhouse Gas Emission Reduction and Carbon Sequestration

Qualitative Ranking N = Neutral	Practice Code	Practice Standard and Associated Information Sheet	Beneficial Attributes
GHG Benefits of this Practice Standard	327	Conservation Cover	Establishing perennial vegetation on land retired from agriculture production increases soil carbon and increases biomass carbon stocks.
	329	Residue and Tillage Management, No-Till/Strip-Till/Direct Seed	Limiting soil-disturbing activities improves soil carbon retention and minimizes carbon emissions from soils.
	366	Anaerobic Digester	Biogas capture reduces CH ₄ emissions to the atmosphere and provides a viable gas stream that is used for electricity generation or as a natural gas energy stream.
	367	Roofs and Covers	Capture of biogas from waste management facilities reduces CH ₄ emissions to the atmosphere and captures biogas for energy production. CH ₄

Health effects associated with pesticides include:

- Eye, nose, throat irritation
- Skin rashes, stomach cramps, nausea
- Central nervous system damage
- Kidney damage
- Increased risk of cancers



<http://npic.orst.edu/health/minexp.html>



Insecticides

- Organophosphate
- Carbamate
- Organochlorine
- Pyrethroid



http://www.peer.eu/news_events/news_archive/?tx_list_pi1%5Bcat2%5D=2009&tx_list_pi1%5Bcat0%5D=2



Re-classification of Glyphosate (Roundup)

<http://www.iarc.fr/en/media-centre/iarcnews/pdf/MonographVolume112.pdf>

International Agency for Research on Cancer



20 March 2015

IARC Monographs Volume 112: evaluation of five organophosphate insecticides and herbicides

Lyon, France, 20 March 2015 – The International Agency for Research on Cancer (IARC), the specialized cancer agency of the World Health Organization, has assessed the carcinogenicity of **five organophosphate pesticides**. A summary of the final evaluations together with a short rationale have now been published online in *The Lancet Oncology*, and the detailed assessments will be published as Volume 112 of the IARC Monographs.

What were the results of the IARC evaluations?

The herbicide **glyphosate** and the insecticides **malathion** and **diazinon** were classified as *probably carcinogenic to humans* (Group 2A).

The insecticides **tetrachlorvinphos** and **parathion** were classified as *possibly carcinogenic to humans* (Group 2B).



http://agr.wa.gov/Pestfert/Pesticides/WastePhotoGallery_storage.aspx

Storage, transportation, disposal of pesticides

- Containers or equipment should not be stored, handled, emptied, disposed of, or left unattended in such a manner that they may present a hazard to persons, animals, food, feed, crops, or property.
- Pesticides should not be placed into a container used for food, drink, household products, or feed.
 - Soda, water, and milk bottles
 - Mason jars
 - Ziploc bags sold for food storage





Disposal of surplus pesticides

- Keep in original containers
- Return to registrant/manufacture
- Dispose of as hazardous waste



http://agr.wa.gov/Pestfert/Pesticides/WastePhotoGallery_storage.aspx



Animal feeding operations (AFOs)



Confined Animal Feeding Operations (CAFOs)

http://www.epa.gov/npdes/pubs/sector_table.pdf

Animal Sector	Size Thresholds (number of animals)		
	Large CAFOs	Medium CAFOs ¹	Small CAFOs ²
cattle or cow/calf pairs	1,000 or more	300 - 999	less than 300
mature dairy cattle	700 or more	200 - 699	less than 200
veal calves	1,000 or more	300 - 999	less than 300
swine (weighing over 55 pounds)	2,500 or more	750 - 2,499	less than 750
swine (weighing less than 55 pounds)	10,000 or more	3,000 - 9,999	less than 3,000
horses	500 or more	150 - 499	less than 150
sheep or lambs	10,000 or more	3,000 - 9,999	less than 3,000
turkeys	55,000 or more	16,500 - 54,999	less than 16,500
laying hens or broilers (liquid manure handling systems)	30,000 or more	9,000 - 29,999	less than 9,000
chickens other than laying hens (other than a liquid manure handling systems)	125,000 or more	37,500 - 124,999	less than 37,500
laying hens (other than a liquid manure handling systems)	82,000 or more	25,000 - 81,999	less than 25,000
ducks (other than a liquid manure handling systems)	30,000 or more	10,000 - 29,999	less than 10,000
ducks (liquid manure handling systems)	5,000 or more	1,500 - 4,999	less than 1,500

¹Must also meet one of two "method of discharge" criteria to be defined as a CAFO or may be designated.

²Never a CAFO by regulatory definition, but may be designated as a CAFO on a case-by-case basis.

Federal CAFO regulations

- The National Pollutant Discharge Elimination System (NPDES) Permit Regulation for CAFOs (40 CFR Part 122).
- The Effluent Limitations Guidelines and Standards (ELGs) for CAFOs (40 CFR Part 412).



§ 412.4 Best management practices (BMPs) for land application of manure, litter, and process wastewater.

- “Setback Requirements means a specified distance from surface waters...”
- “Vegetated buffer means a narrow...”
- “Multi-year phosphorus application means...”
- “Nutrient management plan....”
- “Determination of application rates....”
- “Manure and soil sampling...”



Public health issues with CAFOs

- Concerns:
 - Large size of the operation ->
 - can become a point source for water, air and solid waste pollution
 - managing feed, manure, dead animals, flies, particulates, gases, odors, odorants, infectious diseases
 - Air quality:
 - Human health concern: ammonia, H₂S
 - Greenhouse gases: Methane, CO₂
 - Odor: mix of numerous compounds



Air quality concerns from CAFOs

- Nearly 200 compounds emitted from manure
- Some have low odor thresholds
- Ammonia and H₂S main human health risks
- Methane and CO₂ – greenhouse gases
- Particulates; may contain bioactive materials, smallest particles travel far
- Particles + gases; synergistic effects
- Minimum separation distances, HEV, HES



H2S Concentration – estimated effect of distance

<http://ir.uiowa.edu/cgi/viewcontent.cgi?article=2708&context=etd>

Figure 4. Largest Swine CAFO Average Estimated Hydrogen Sulfide Concentrations and Distance Away from the Source

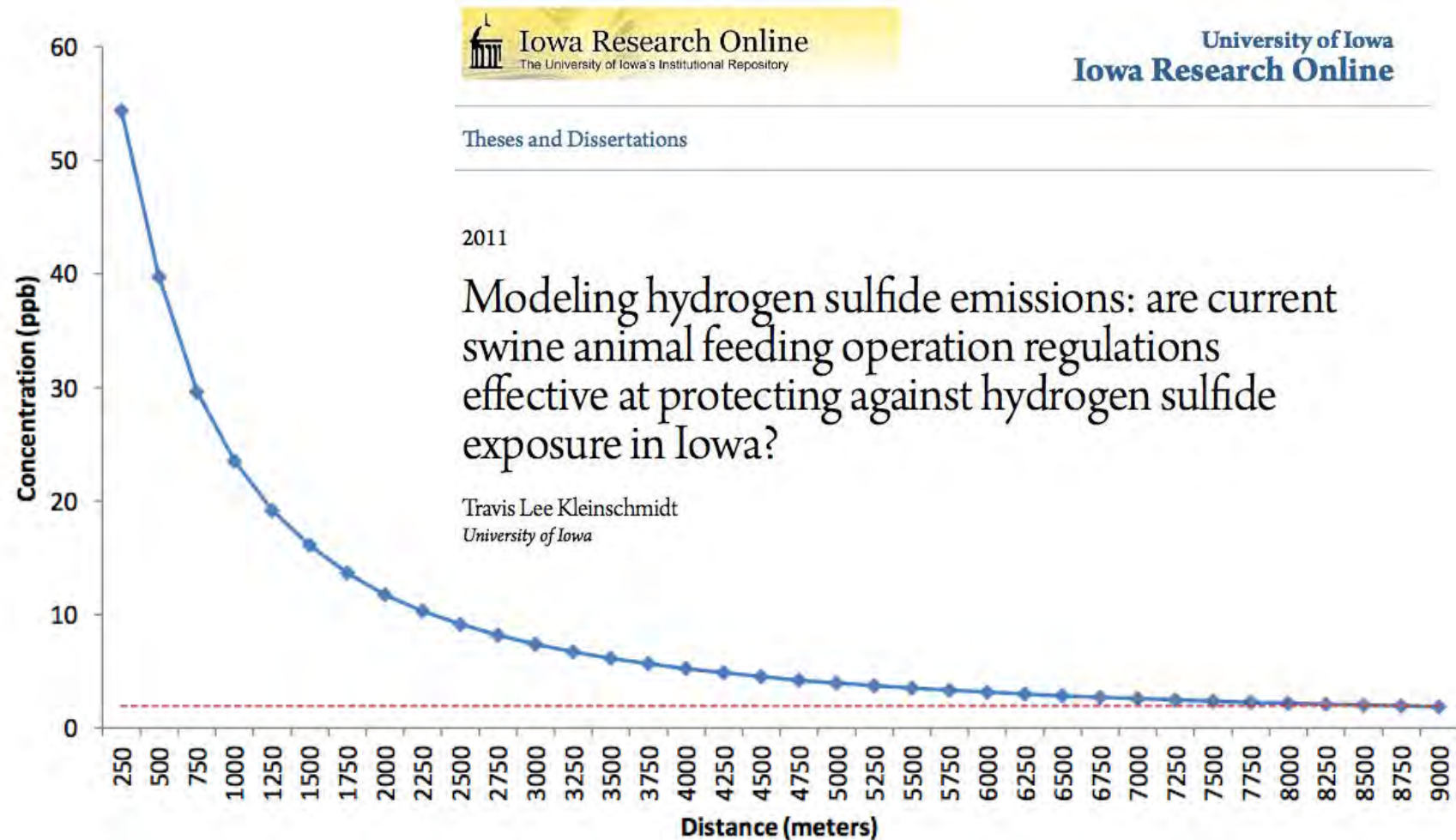
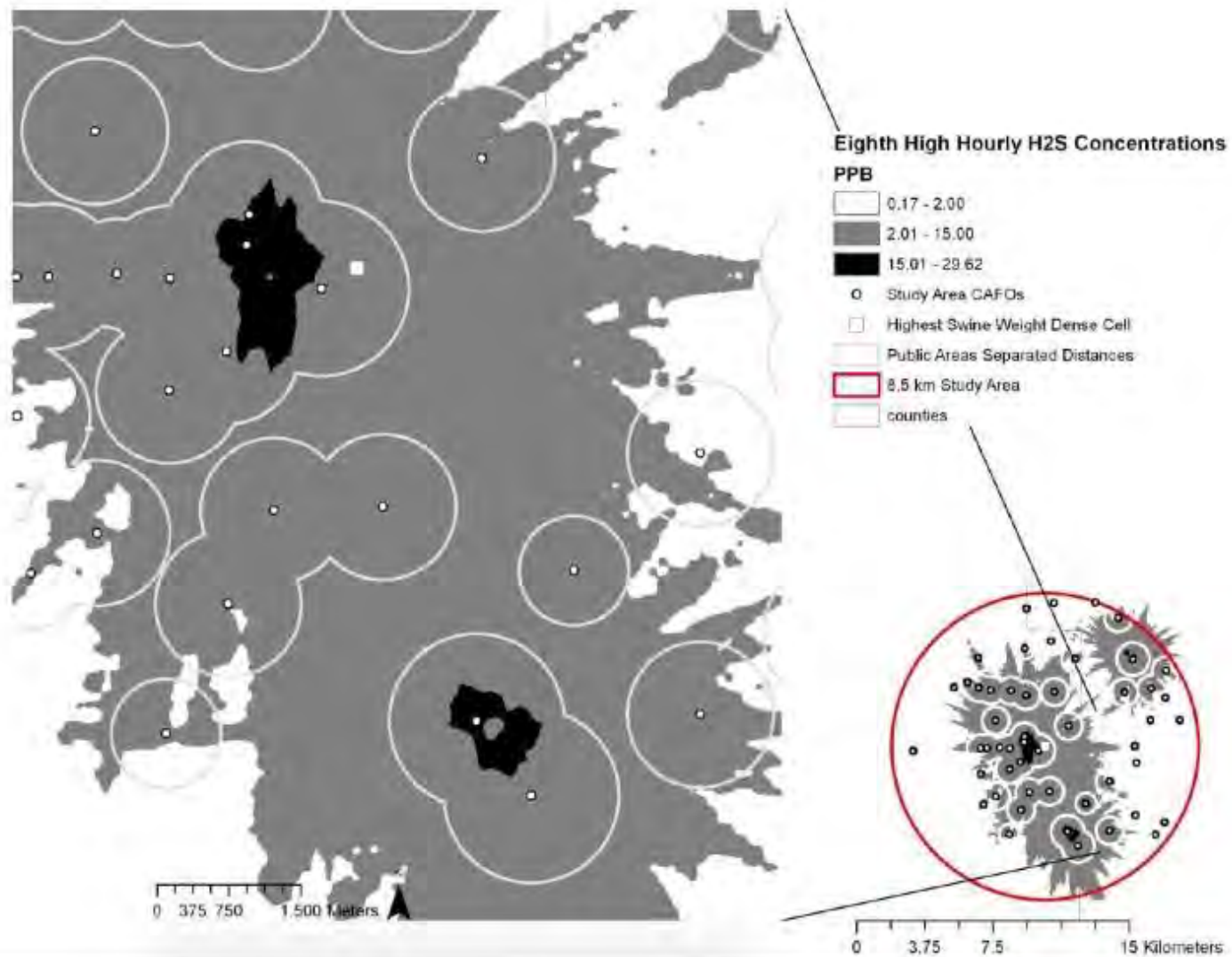


Figure 14. Swine Weight Dense Area. Eighth-Highest, Hourly, Hydrogen Sulfide Concentrations and Public Use Separated Distances



Community health issues

- Measured concentrations of pollutants from CAFOs in the vicinity are much lower than occupational threshold limit values (TLV)
- Longer low level exposures to H₂S may have neurological effects
- Mental health concerns; loss of property value; quality of life



Community concerns (cont.)

- Extra-Toxic mechanisms
 - low level emissions, absence of objective data
 - physical, mental, emotional, social effects
- Somatization of adverse odors
 - Irritation, pungency may trigger protective behavioral responses to odors
 - Avoiding odors, underlying conditions, susceptibility differences, stress





Questions

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