National Academies Workshop
"Measuring Food Insecurity and Assessing the Sustainability of Global Food Systems"
February 16-17 Washington, DC

SUSTAINABILITY CONSORTIUM

Metrics for Agricultural Sustainability:
A Brief Introduction

Greg Thoma

The Sustainability Consortium, University of Arkansas

Sustainable Agriculture

1. Meeting the needs of the present while enhancing the ability of future generations to meet their needs
2. Increasing productivity to meet future food demands
3. Decreasing impacts on the environment
4. Improving human health
5. Improving the social and economic well-being of agricultural communities

We manage what we measure

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Category	Emissions	Drivers
Water Quality	Nutrients Ammonia Sediments Metals Pesticides Hormones Antibiotics Pathogens	Livestock: Manure management & application Storm water management Land management (tillage, etc) Crop protection and fertilization
Water Use	Groundwater scarcity Reduced stream flows impact aquatic habitats	Livestock: drinking water and facility maintenance Irrigation
Air Quality	Particulate matter (1^0 & 2^0) Odor Ozone precursors Greenhouse gasses	Manure management Animal emissions Combustion
Land Use / Biodiversity	Land occupation and conversion Habitat degradation / fragmentation	Land management (Tillage, riparian zone management, etc.)

EPA, Region 9 Animal Waste, http://www.epa.gov/region09/animalwaste/problem.html (accessed April 16, 2009).

Life Cycle Assessment:
One measurement tool

- Think broadly: Life cycle, cradle-to-next-life
- Think deeply: Impacts, endpoints
- Think quantitatively: data; how much of x?
- Think comparatively: what if we change y?

Linked Unit Processes:

Complex Systems of Material and Energy Flows

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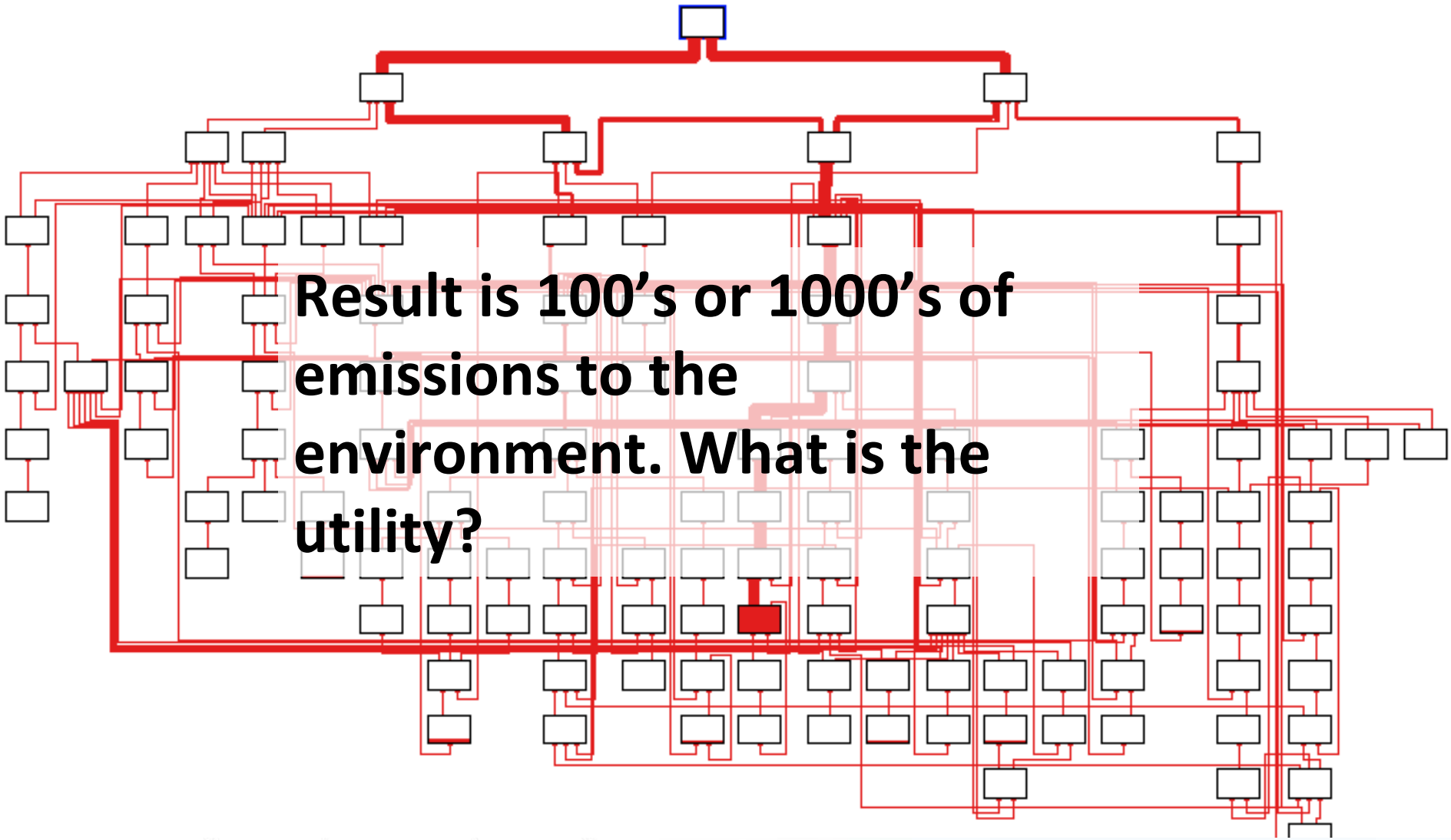

Life Cycle Impact Assessment:

Making sense of the emission inventory

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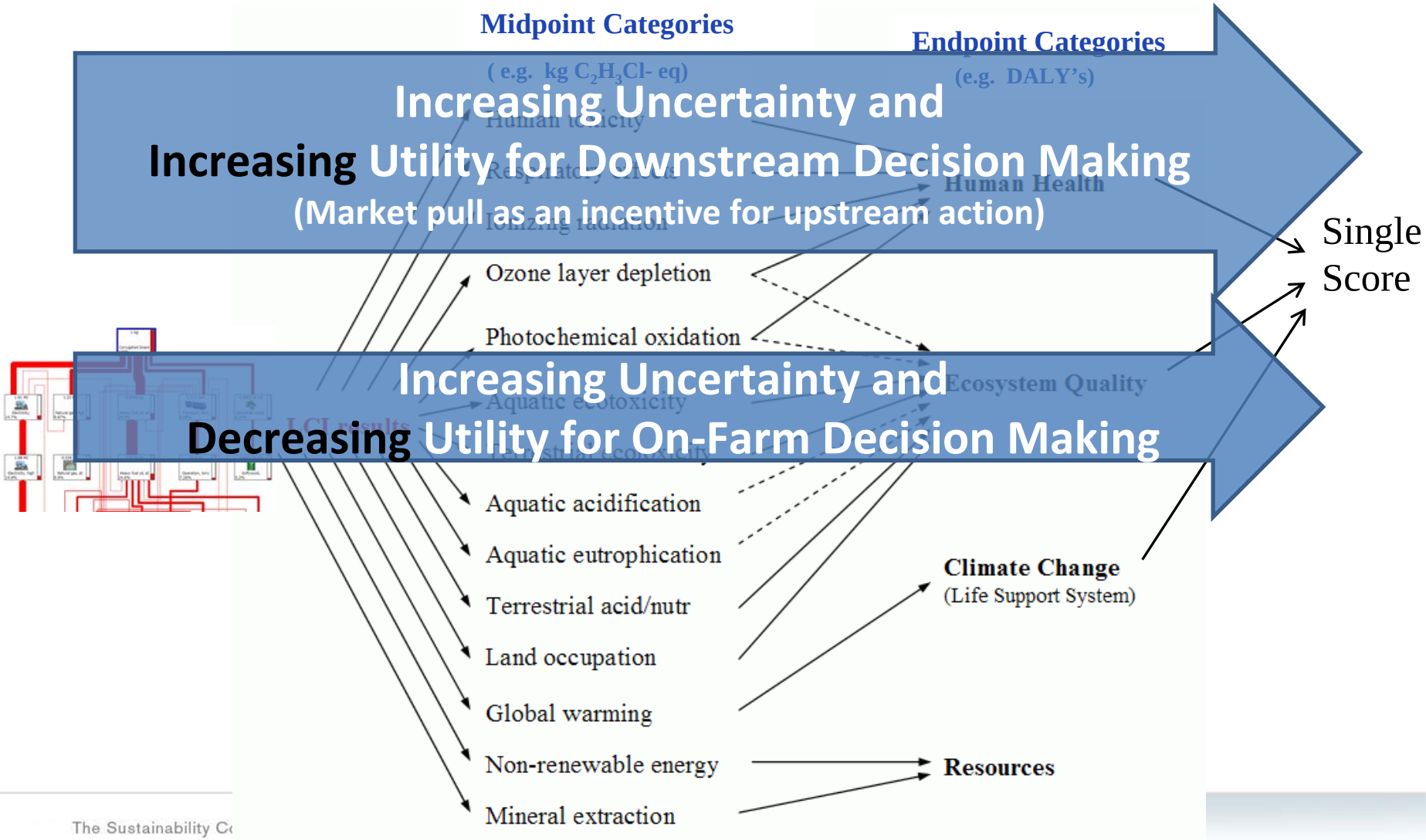
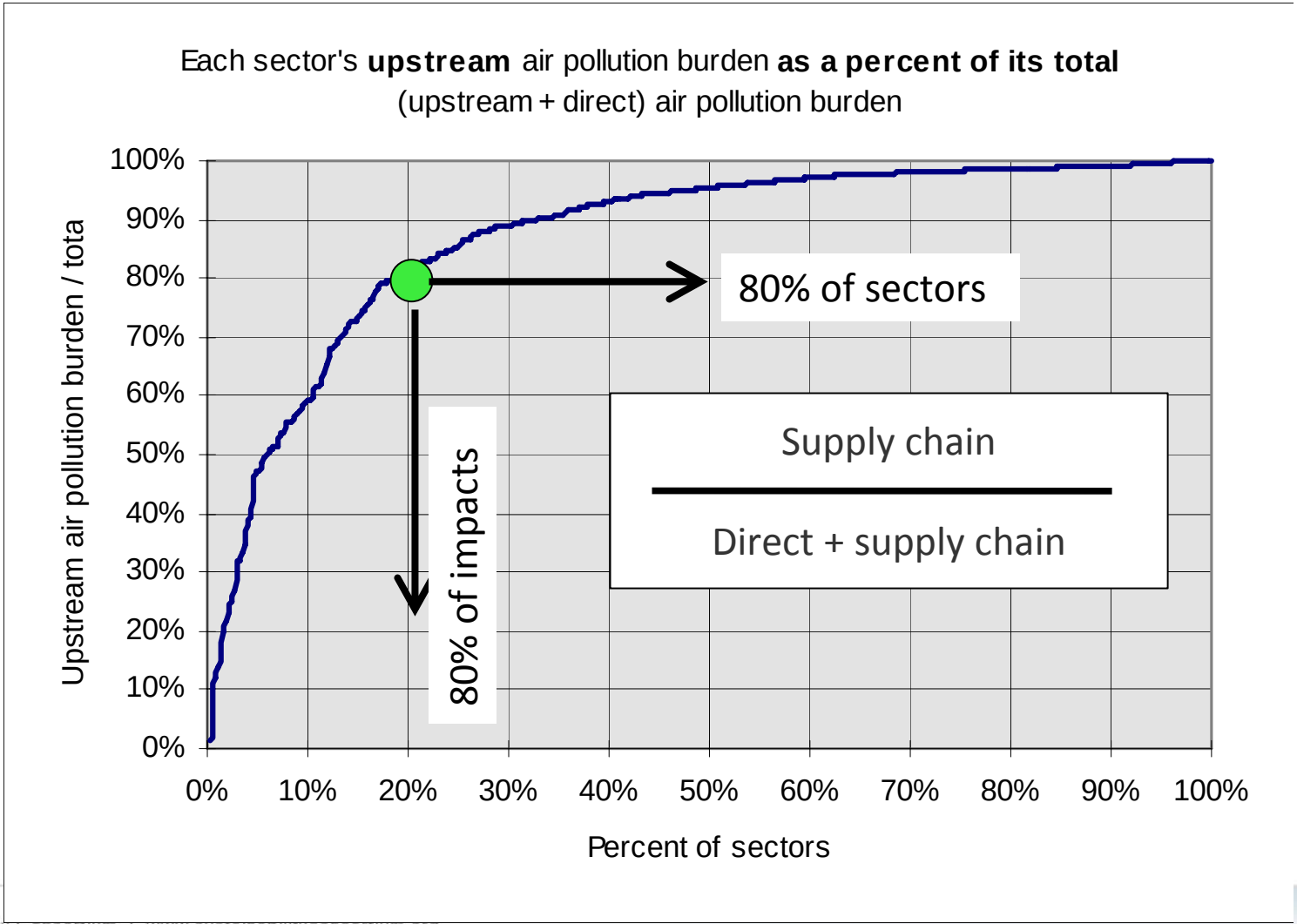


Buyer power: the 80-80 Rule



Combined Metrics

- Combined metrics may also mask trade offs:
- Upland tank fisheries vs. ocean cage fisheries
  - Carbon footprint vs. local aquatic impact
- Sustainability decisions should not be made on the basis of a single metric or indicator
  - If you can't make a living, it is not sustainable

Assessing Uncertainty

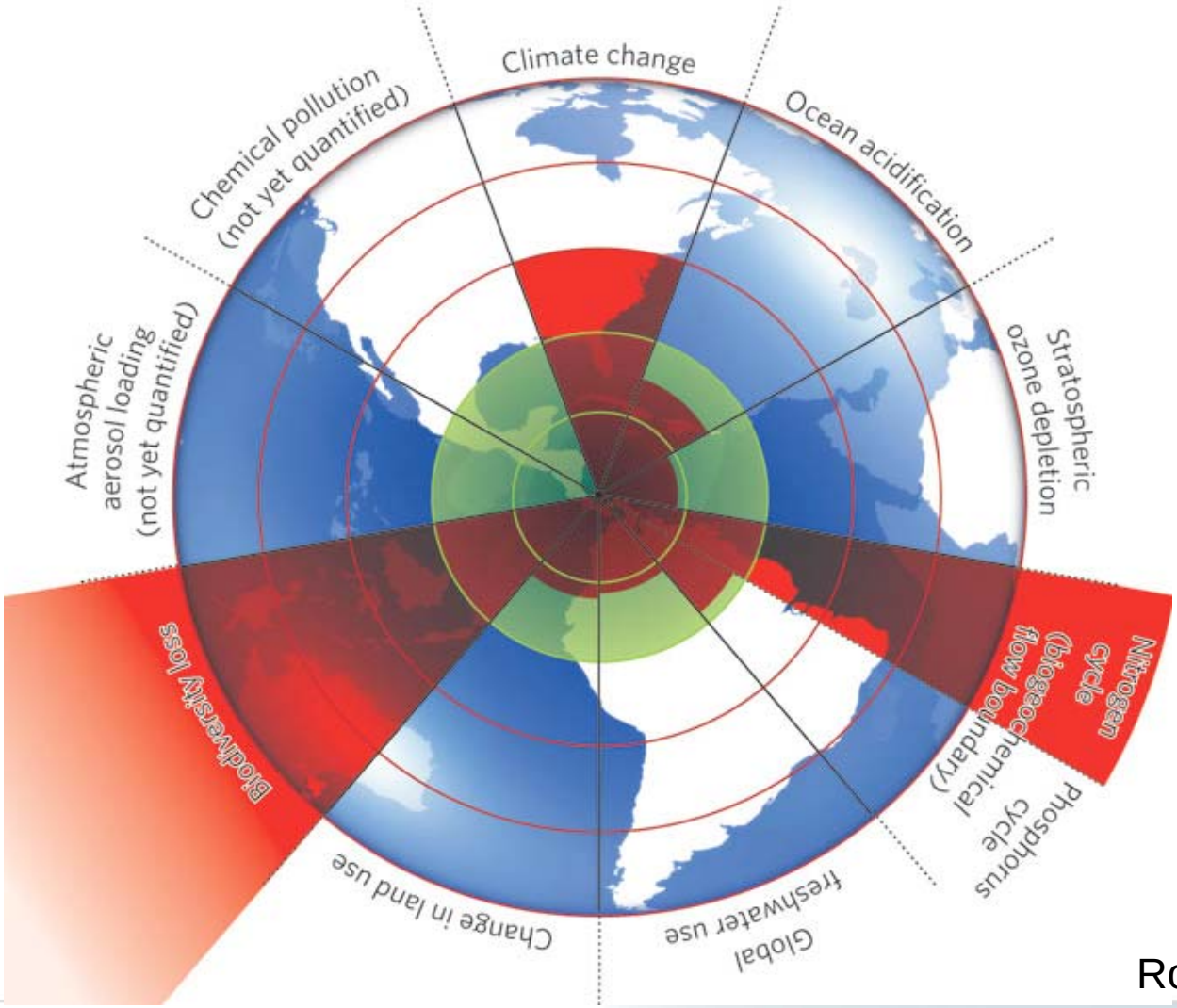
- Background unit process database should specify uncertainty for all LCI parameters
- Quantify uncertainty in foreground data
- Run Monte Carlo simulation to identify important points of uncertainty that should be reduced.
- *What is the minimum degree of certainty necessary for decision support?*

- *Communicating uncertainty to decision makers is also very important*

What's Missing?

- Spatial and Temporal dynamics
- Impact methodologies for:
  - Water
    - Quantity, Quality, Scarcity
    - Competing methodologies
  - Ecosystem Services
    - Methods in development (ETH, UNEP, WRI)
    - InVest & Natural Capital project
- Thresholds

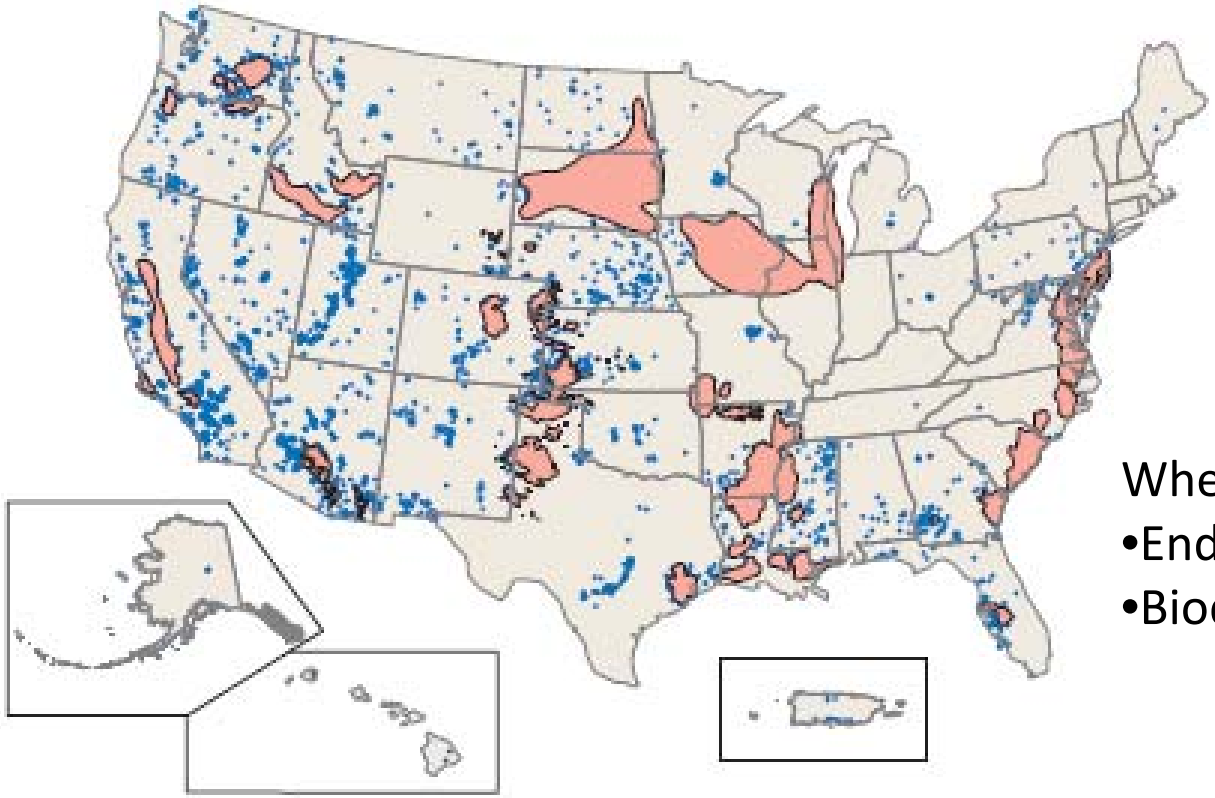
Thresholds & Combined Metris



Natural systems, not humans, determine the capacity for renewal.

Rockström et al., *Nature* 2009

Groundwater depletion



When do we say “stop”?
- Endangered species
- Biodiversity loss

Water-level declines Red regions indicate areas in excess of 500 square miles that have water-level declines in excess of 40 feet in at least one confined aquifer since predevelopment, or in excess of 25 feet of decline in unconfined aquifers since predevelopment. Blue dots are wells in the USGS National Water Information System database where the measured water-level difference over time is equal to or greater than 40 feet.

Source: Reilly, T.E., Dennehy, K.F., Alley, W.M., and Cunningham, W.L., 2008, Ground-Water Availability in the United States: U.S. Geological Survey Circular 1323, 70 p., also available online at *http://pubs.usgs.gov/circ/1323/*

Sustainability Metrics

(Quantitative)

Field to Market – The Keystone Alliance

- Commodity agriculture
- Metrics are outcomes based, technology neutral
- National and regional in scale

Stewardship Index for Specialty Crops

- Specialty crops
- Metrics are outcomes based, technology neutral
- Regional and local in scale

Solutions from the Land (UN Foundation, CI, TNC)

- Linking crop, forestry and conservation land management
- Harmonization of metrics and management practices effort

ANSI Standard – Leonardo Academy

- Stagnated at present

Sustainability Indicators

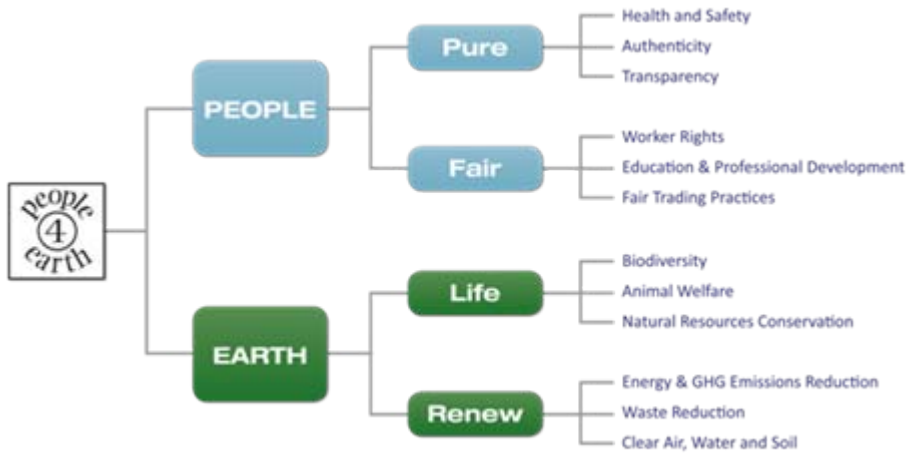
(Qualitative)

Unilever Sustainable Agriculture Code

- Mandatory program for Unilever suppliers
- Record keeping for pest and nutrient management, etc
- Some simple metrics included

People 4 Earth

- 300+ qualitative questions
  - Eco-labels – Organic; Fair Trade, …
  - Energy plans; nutrient management plans



SAI Platform

- Best Management Practices Guidance
- Principles focusing on
  - Farming systems
  - Economic viability
  - Social sustainability
  - Environmental sustainability

Software Tools

- BASF Eco-Efficiency
- SALCA – Swiss Agricultural Life Cycle Assessment
- Carbon footprint calculators galore (e.g., Cool Farm Tool)
- Field to Market
- Global Water Tool
- InVest
- HarvestChoice

The FARMSMART Concept

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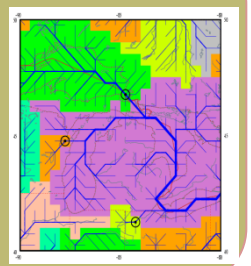
Pilot farm from NAEMS
Common input
data set

GIS interface

GEOS+ NEWS
Database
watershed and
airshed model



DNDC, IFSM,
Dairy GHG
models

LC carbon footprint
and inventory

Life cycle impact
assessment

Local emissions NH_3,

CH4, NO_3, P, water use

NAEMS
monitoring

Joint project of Purdue, Michigan, Arkansas, New Hampshire and DRI to put decision support tools in the hands of producers

GHG

Human and ecotox

Land and water use

Eutrophication
Acidification

Expected tool output: Position a farm in the US distribution: move farm to left with scenario analysis

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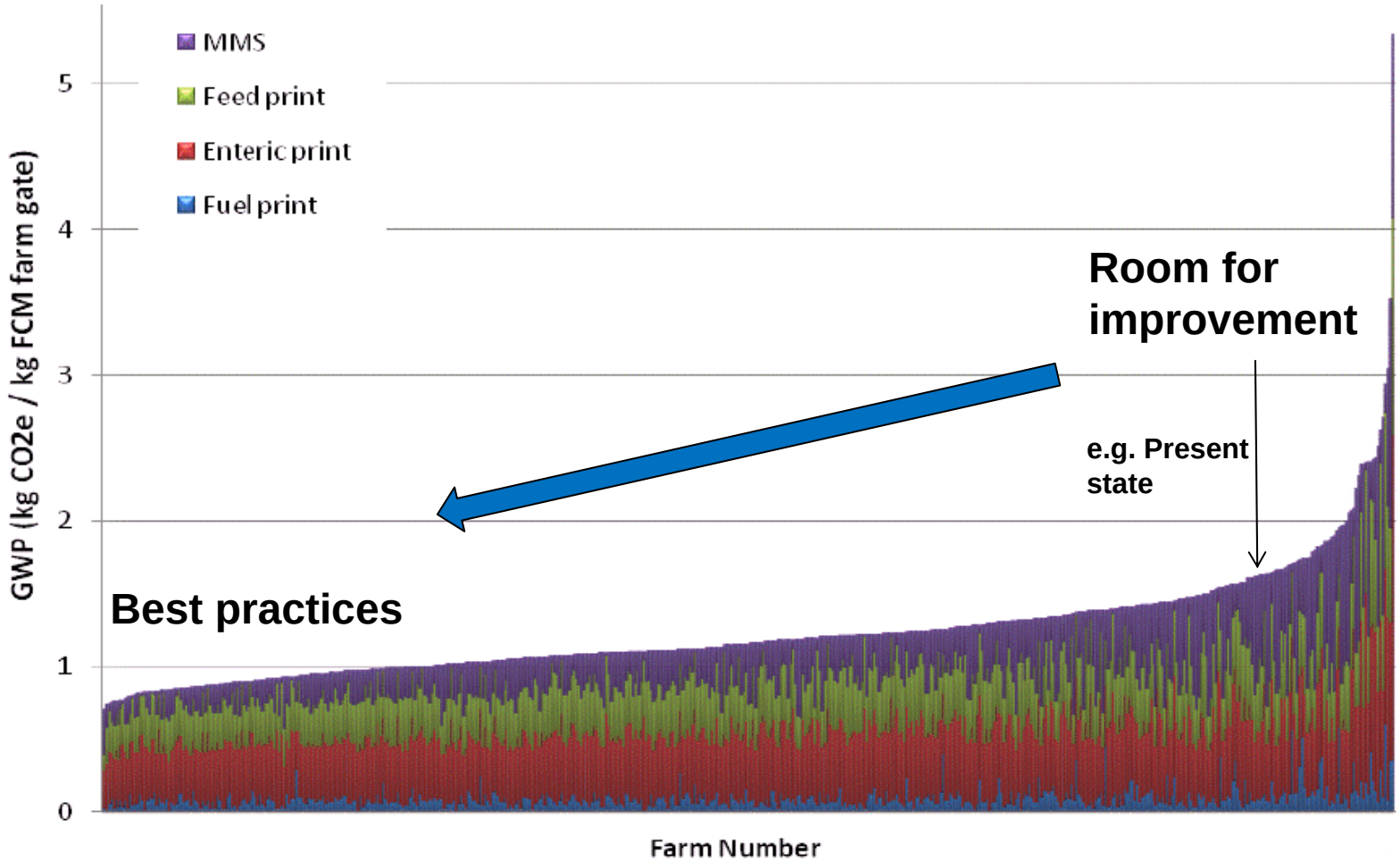

Figure 4-10. Farm gate GWP for all respondents.

Summary

- Metrics – manage what's measured
  - Outcome based – technology neutral
- Indicators –
  - Best Practices, generally good, but not quantitative, so improvement harder to document
- LCA
  - Systems Approach
  - Mechanism to engage procurement officers and consumers

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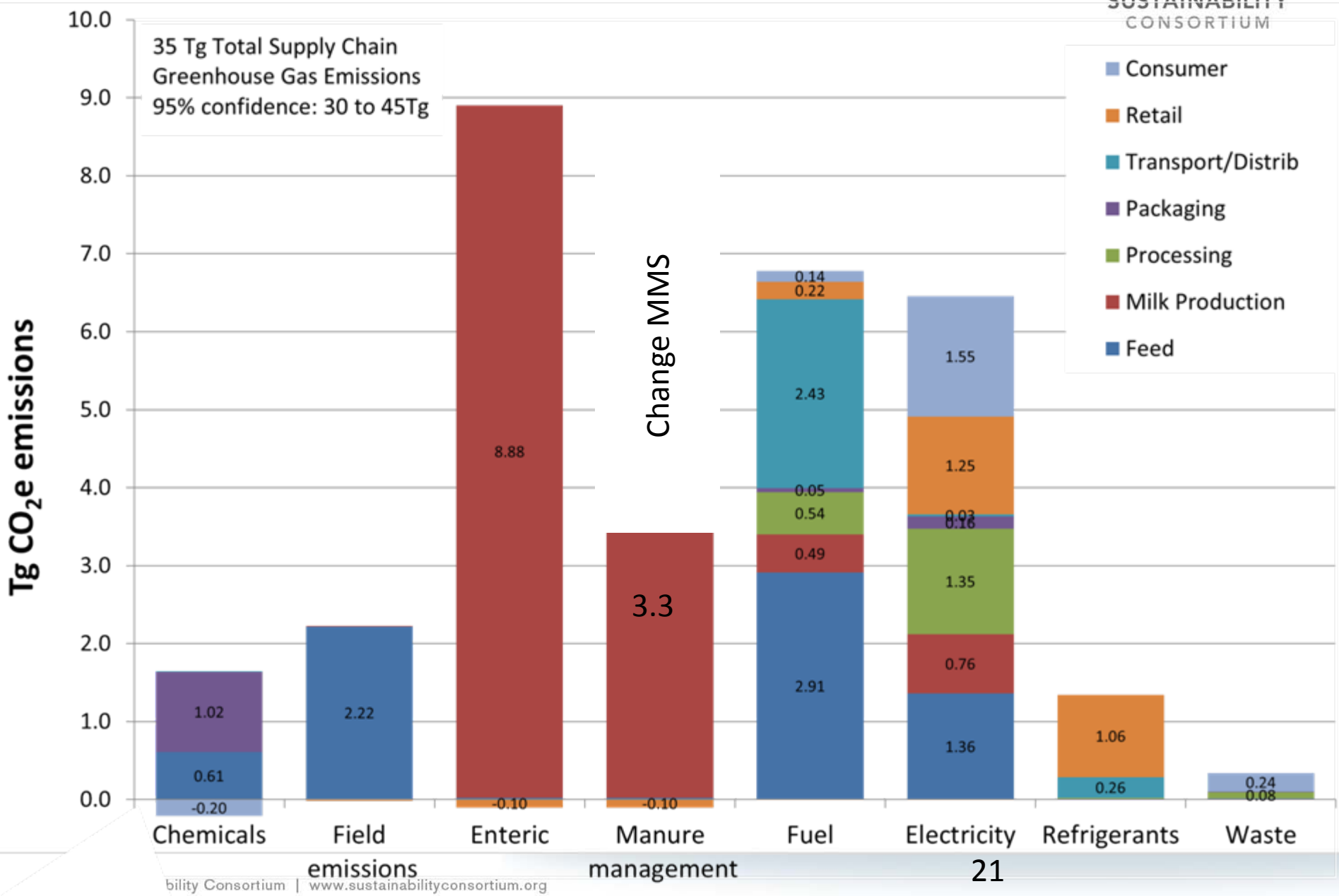
Thanks

Current Challenges in LCA

- Data Availability – proxy & substitution
- Spatially extensive – integrated supply chain
- Dynamic Systems – static model
- Standardization of methodology
- Scale and IT infrastructure

Fluid Milk Supply Chain GHG emissions



Social LCA

- Life Cycle Attribute Assessment
  - Linked to economic activity (e.g. GTAP model)
  - Answers questions like:
    - what % of my coffee is fair trade certified?
    - What % of my supply chain is child labor free?
- What actions should be taken?
  - DON'T make it worse.

Social Hotspots

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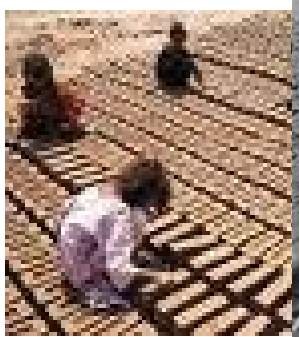
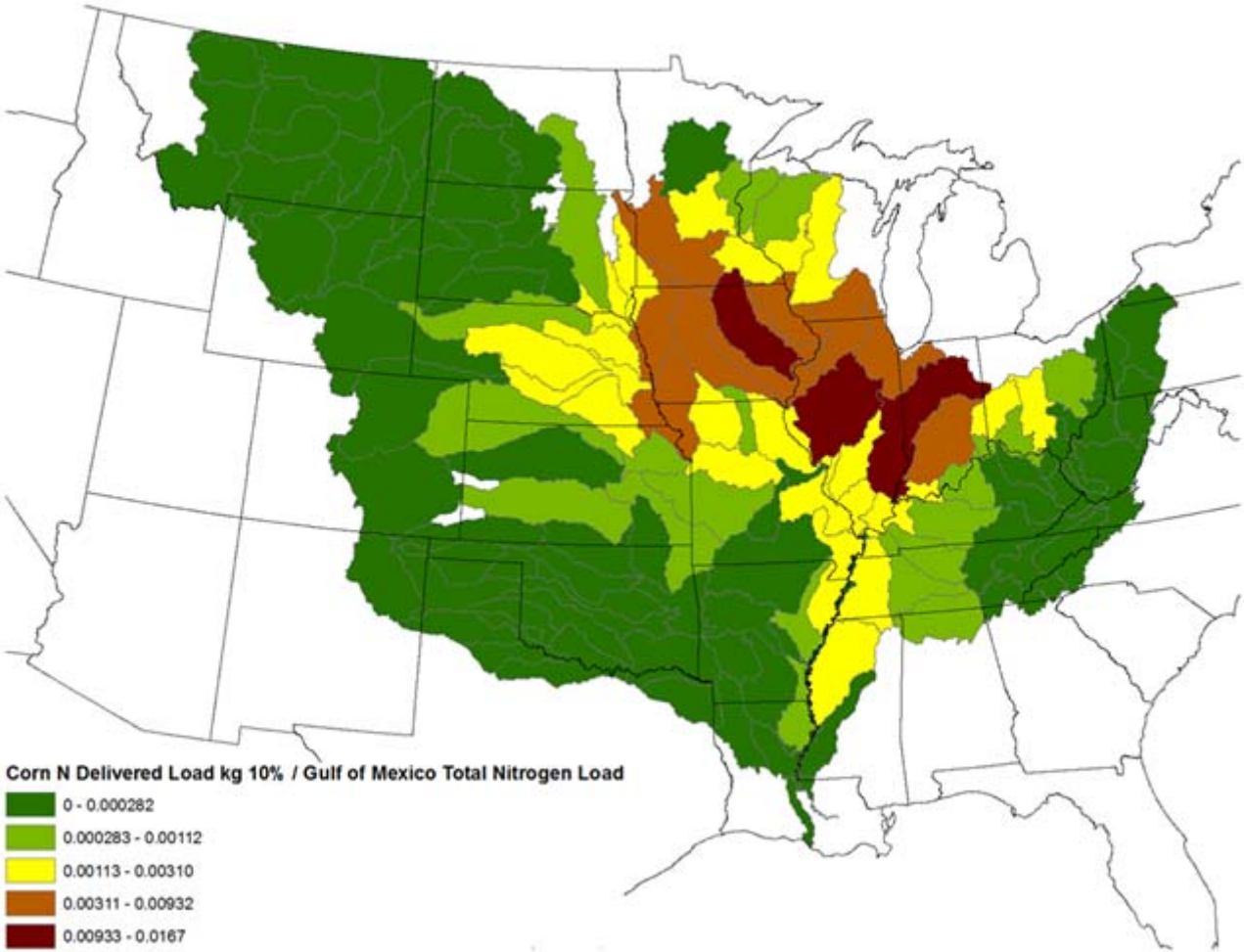
What are hotspots?

They are processes in the life cycle providing higher opportunity to address issues of concern –risks --

- **Risks of violations**
- **Risks of reputations**
- **Issues that need to be considered when doing business in a certain sector in a certain region/country**

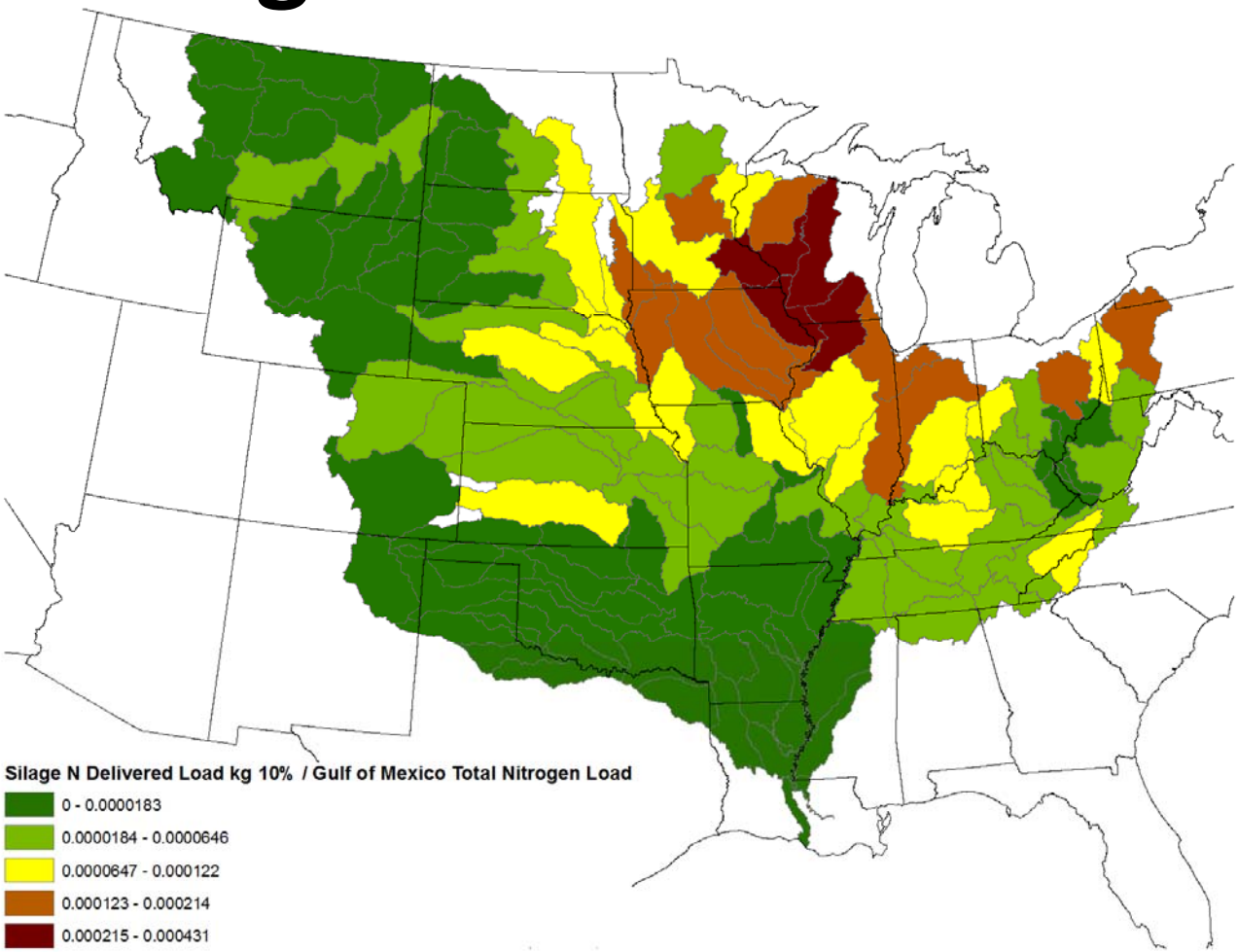


Local Emission, Non Local Impact
US Corn Production



Proportion of SPARROW Model Nitrogen Delivered to the Gulf of Mexico from Corn Production

Local Emission, Non Local Impact
US Corn Silage Production



Proportion of SPARROW Model Nitrogen Delivered to the Gulf of Mexico from Silage Production