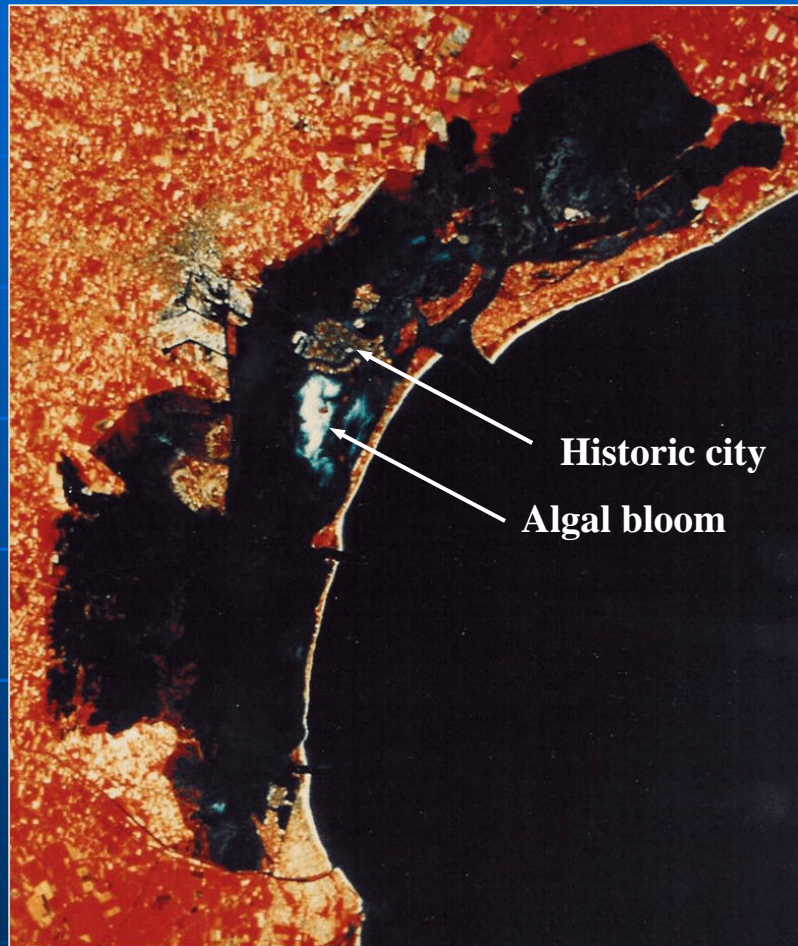


Diffuse Pollution from Agriculture in the World (II)

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Historic city

Algal bloom

IWA Diffuse Pollution Group

Conference "Agriculture and Environment" in Venice 1984

(Giorgini and Zingales

Workshop on Agricultural Diffuse Pollution in Teolo (Veneto) 1997

(Bendoricchio, 1999)

IWA Leading Edge Conference on Managing Rural Diffuse Pollution, Edinburgh – April 2006

(Contact Brian D'Arcy, SEPA)

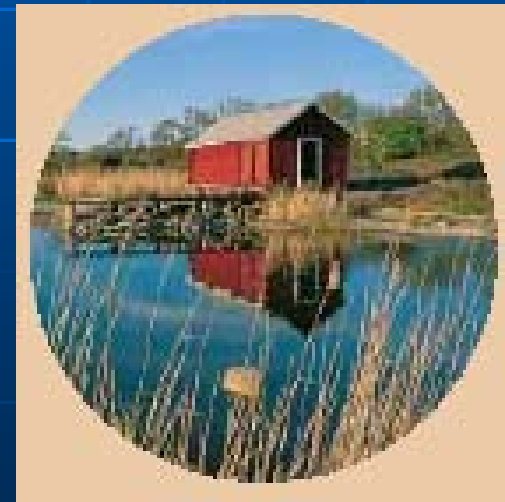
Lagoon of Venice Problems



- Drainage of wetlands
- Intensive agriculture industrial fertilizers and pesticides
- Urbanization and transportation
- Tide barrier ?

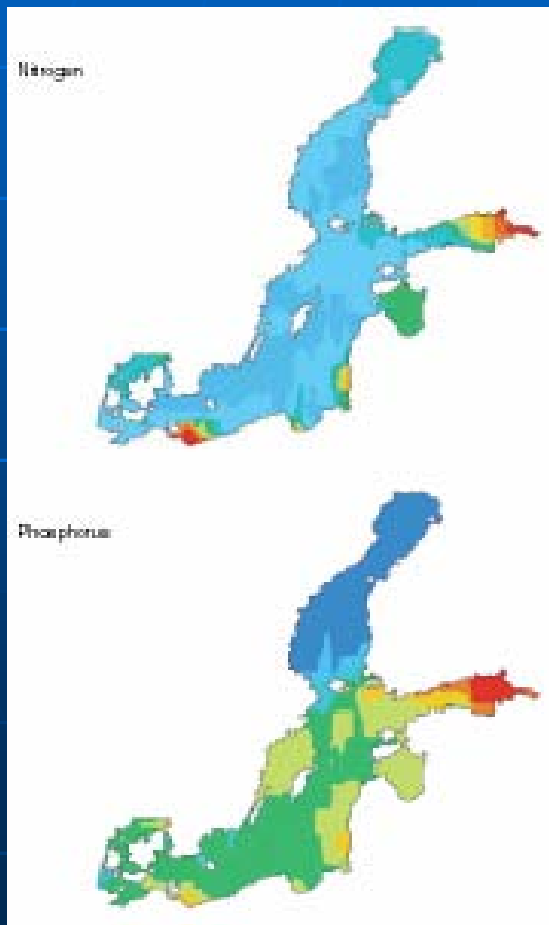
Problems of the Baltic Sea

- **Nutrients (N and P)**
- **Eutrophication**
- **Excessive algae growth**
- **Oxygen depletion**



Problems of the Baltic Sea - Algae blooms

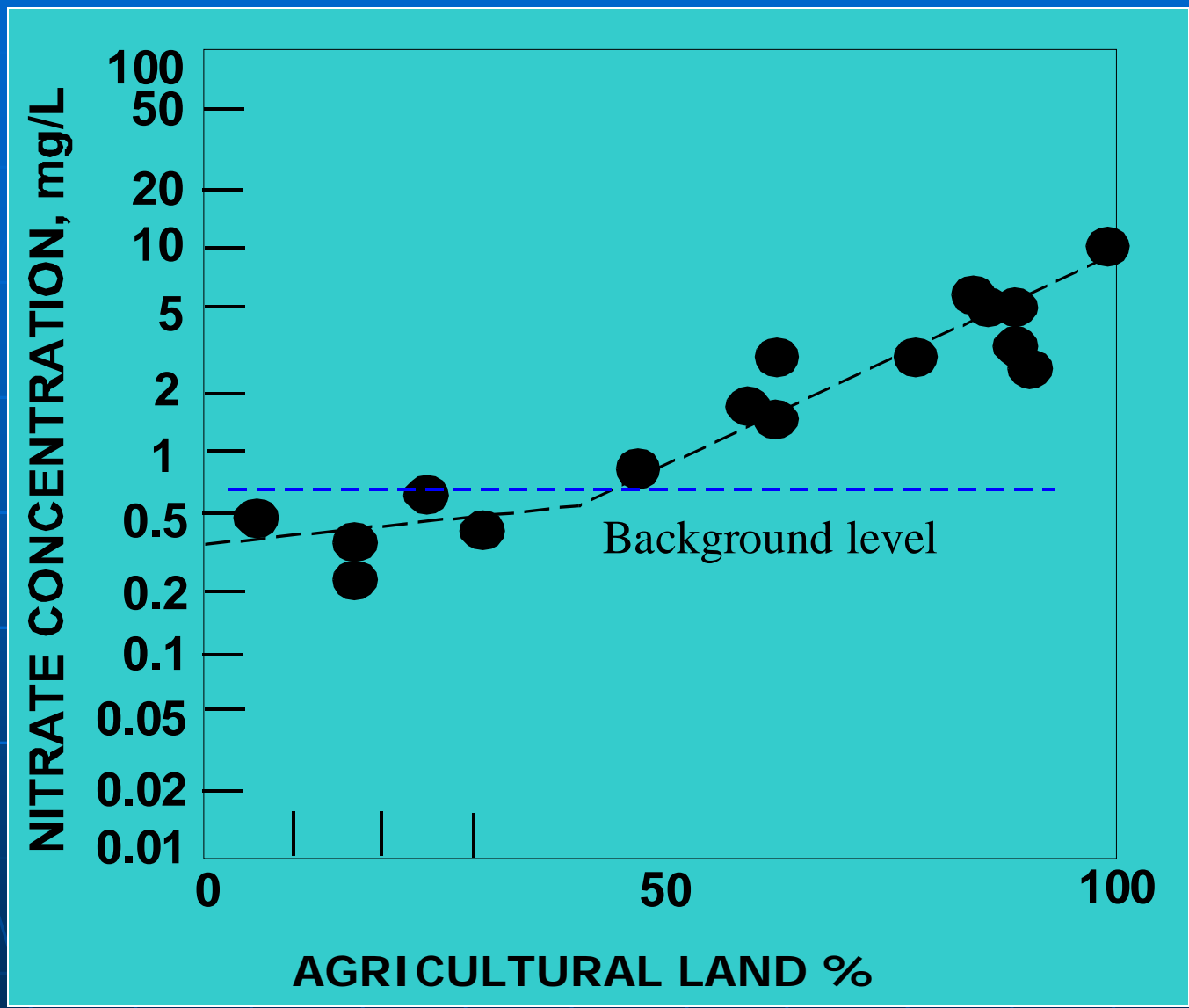
Blue-greens
Oxygen depletion



Source:
Claus Hagebro
Professional Secretary, M.Sc.
Helsinki Commission

Other areas of large scale problems

- Chesapeake Bay
 - Susquehanna River
- Gulf of Mexico
 - Mississippi River
- Black Sea
 - Danube River
- North Sea
 - Elbe



Remaining land use is mostly forest

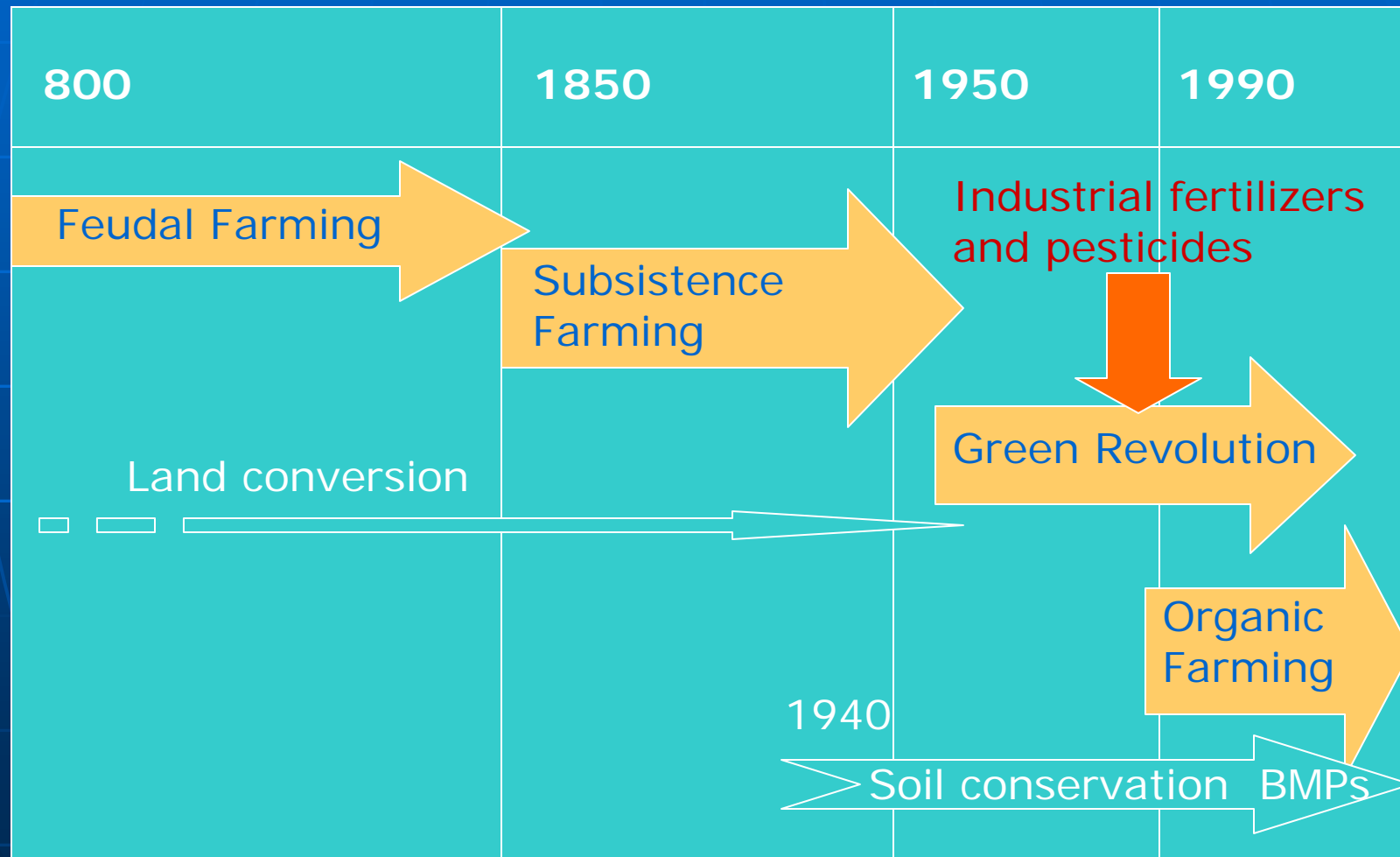
Willamette River Basin, OR

Source USGS

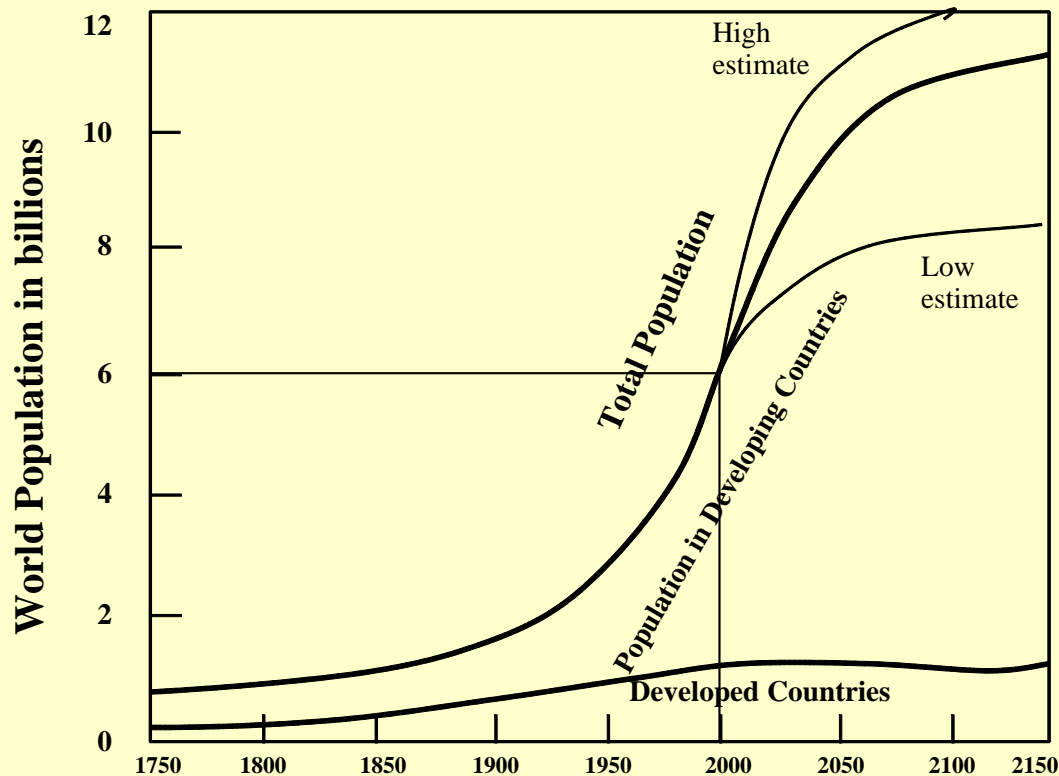
Problems

- Eutrophication
 - Dissolved oxygen, turbidity
 - Algal toxins, taste and odor
 - Increased cost of treatment
 - Impairment of swimming (aesthetic, rash, gastrointestinal diseases)
- Disappearance of sea grasses
- Loss of diversity
- Fish, shell fish and marine mammals kills, aquatic life impairment

Important Periods of Change of Agriculture



Root Causes of Diffuse Pollution



Population Growth and Increased Standard of Living

Need for food can be satisfied by

- Converting more land to agriculture
- Intensification of agriculture

Green Revolution

(Intensive Agriculture)

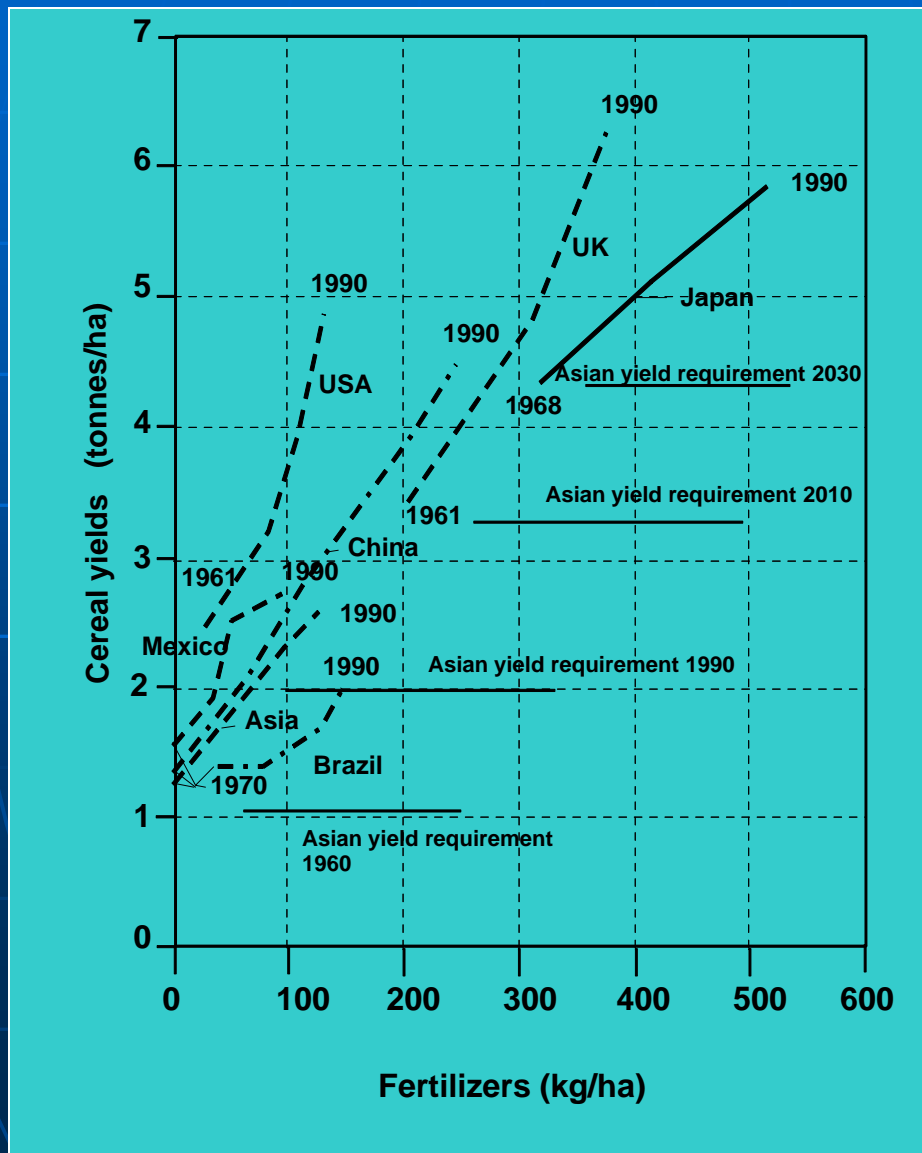
N.E. Borland

- New crop cultivation methods
- Developing new crop varieties
- Irrigation
- Dramatically increased chemical fertilizer and pesticide applications
- Mechanization

Green revolution

- Has dramatically increased crop yields
 - More land would have to be converted to agriculture without green revolution
 - It brought increased standard of living
- Made traditional family farms economically unsustainable
- Diffuse pollution dramatically got worse
- Farm subsidies encourage large intensive operations

Worldwide increases in fertilizer use



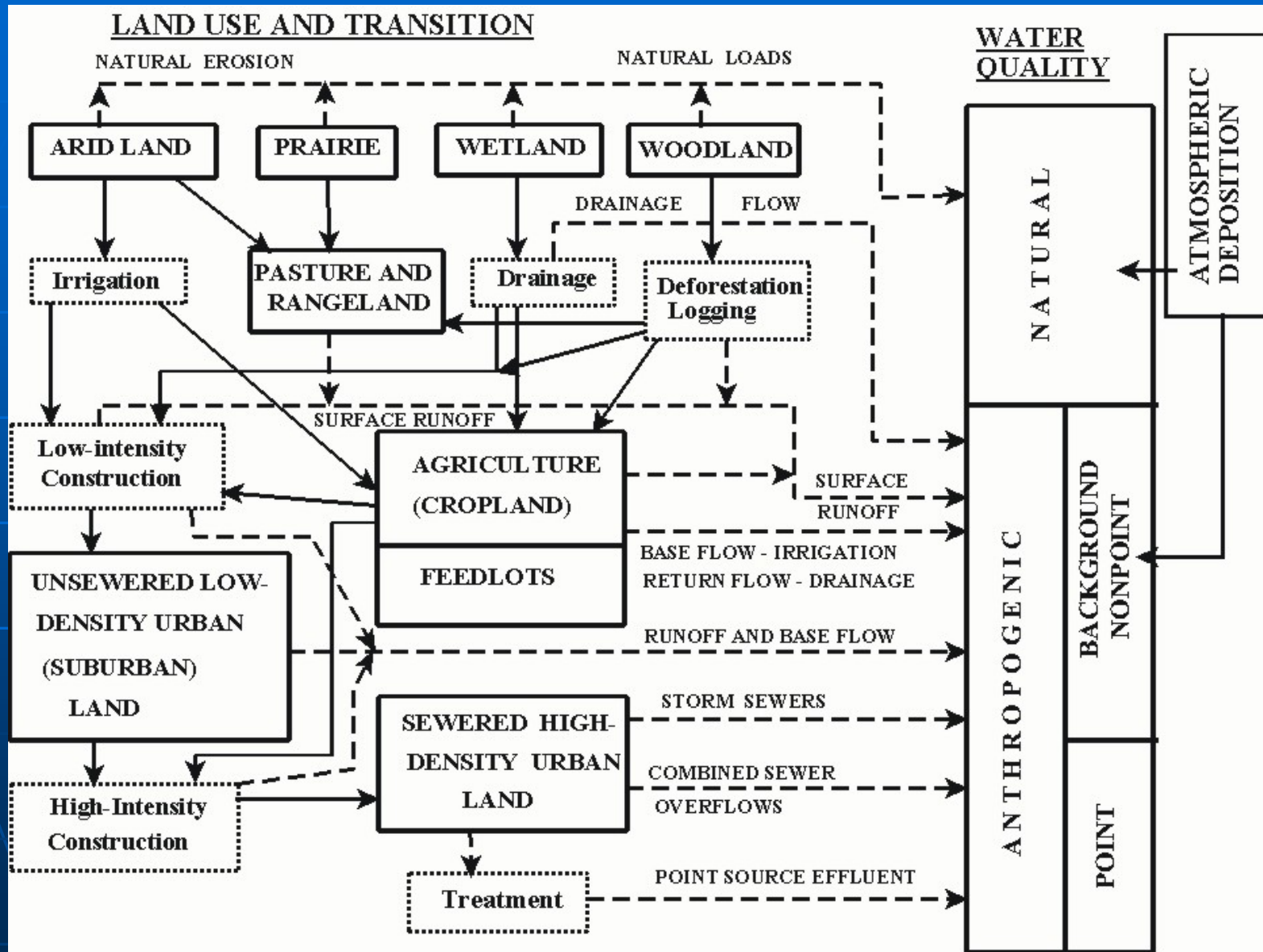
Source : Ongley

Pollution from animal operations

- Change of animal operations from small scale family animal husbandry and pasture to concentrated feedlots made possible by green revolution with hundreds (cattle) or thousands (pigs, chickens, turkeys) animals in a small space
- Consequences:
 - Large increase of diffuse pollution on top of the nutrient losses from fields
 - Poor disposal into soils
 - Soil overloading, disposal on frozen soils

Pollution from land use changes

- Deforestation to subsistence farming
- Wetland drainage
- Irrigation of dry lands and irrigation return flow
- Cultivation of prairies
- Conversion of range land and pasture
- Conversion to aquaculture in tropical countries and elimination of mangrove wetlands



- Borlaug estimated that if green revolution had not occurred then additional 1.8 billion hectares would have been needed to satisfy the current needs of population
- This “new” agricultural land would come from converted rain forest (tropical humid countries) or from marginal more erosive lands (China)

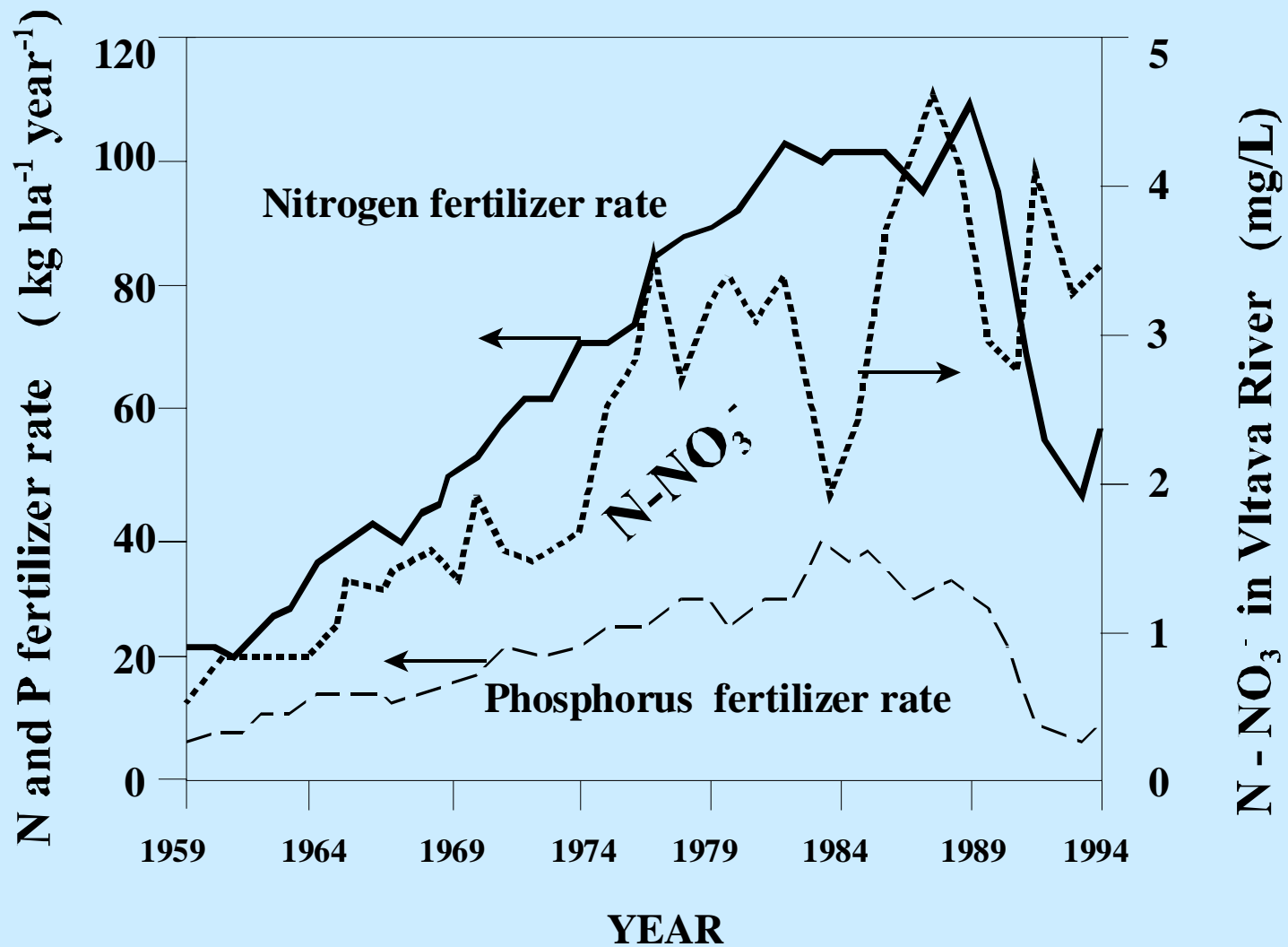
Nutrient Balance on a World Basis and for the European Community

	World		European Community	
	N	P	N	P
<i>Addition of Nutrients (10⁶ tonnes)</i>				
Fertilizer	70	14.4	9.3	2.0
Waste products	58	12	7.1	1.4
Atmosphere	89	-	1.3	-
Total (Kg/ha)	13	5.6	96	26.8
<i>Extraction of Nutrients (10⁶ tonnes)</i>				
Crop production	60	12	10	1.9
Denitrification	157	-	4.3	-
Total (Kg/ha)	13	2.5	78	15
<i>Net addition (Kg/ha)</i>	<i>0</i>	<i>+3.1</i>	<i>+18</i>	<i>+1.8</i>

Accumulation in soils and aquatic systems

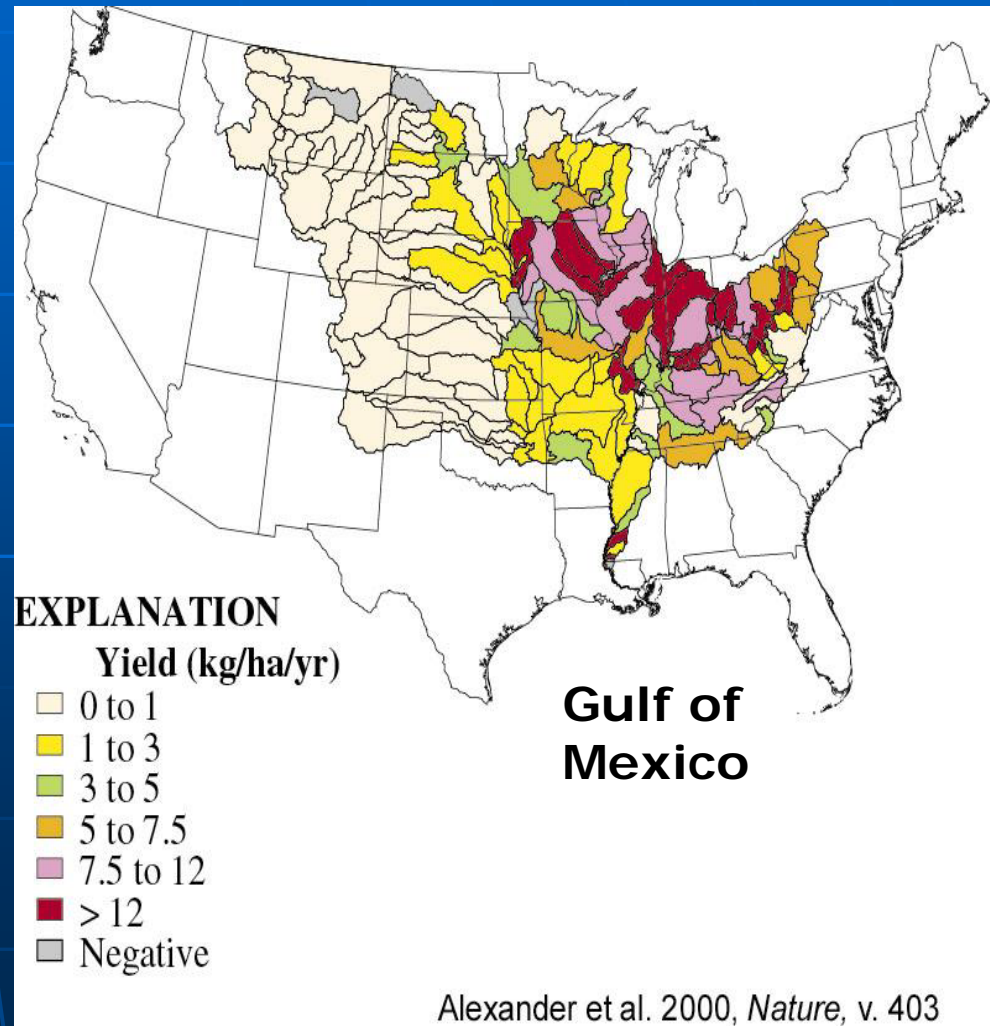
- 20% of applied phosphorus and 50% of applied nitrogen to land reach receiving waters (NAWQA)
- Accumulation rate of phosphorus ranges 3 to 18 kg ha⁻¹ year⁻¹
- Highest accumulations of nutrients from fertilizers and waste application
 - Japan
 - EC Community
 - US
- Fertilizer use on suburban lawns in the US is several times larger (per unit area) than that of farms

Nutrient balance and content of Vltava River in Czech Republic (Slapy Reservoir)

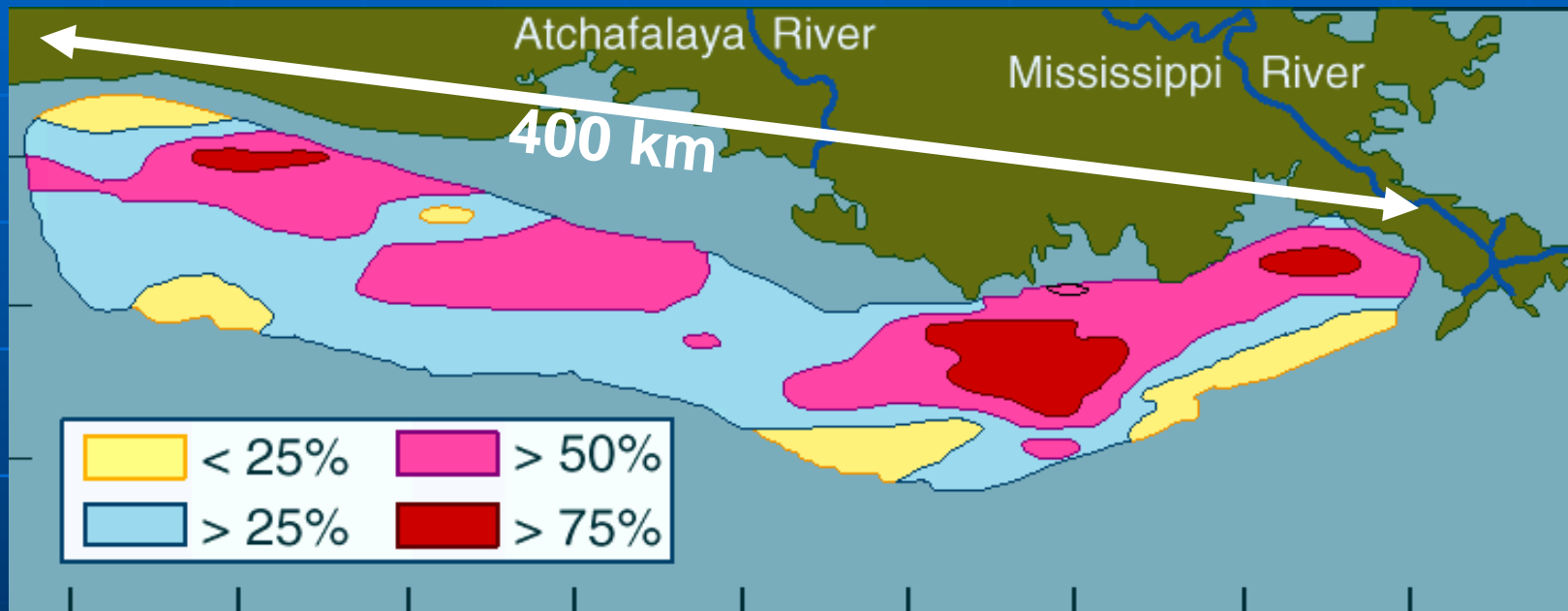


IMPACT OF AGRICULTURE

- Intensive agriculture in the “Bread/Corn basket of America”
- High nutrient loads to the river and the Gulf of Mexico
- Nitrogen is the limiting factor for the eutrophication problems in the Gulf of Mexico



Extent of Hypoxia in the Gulf

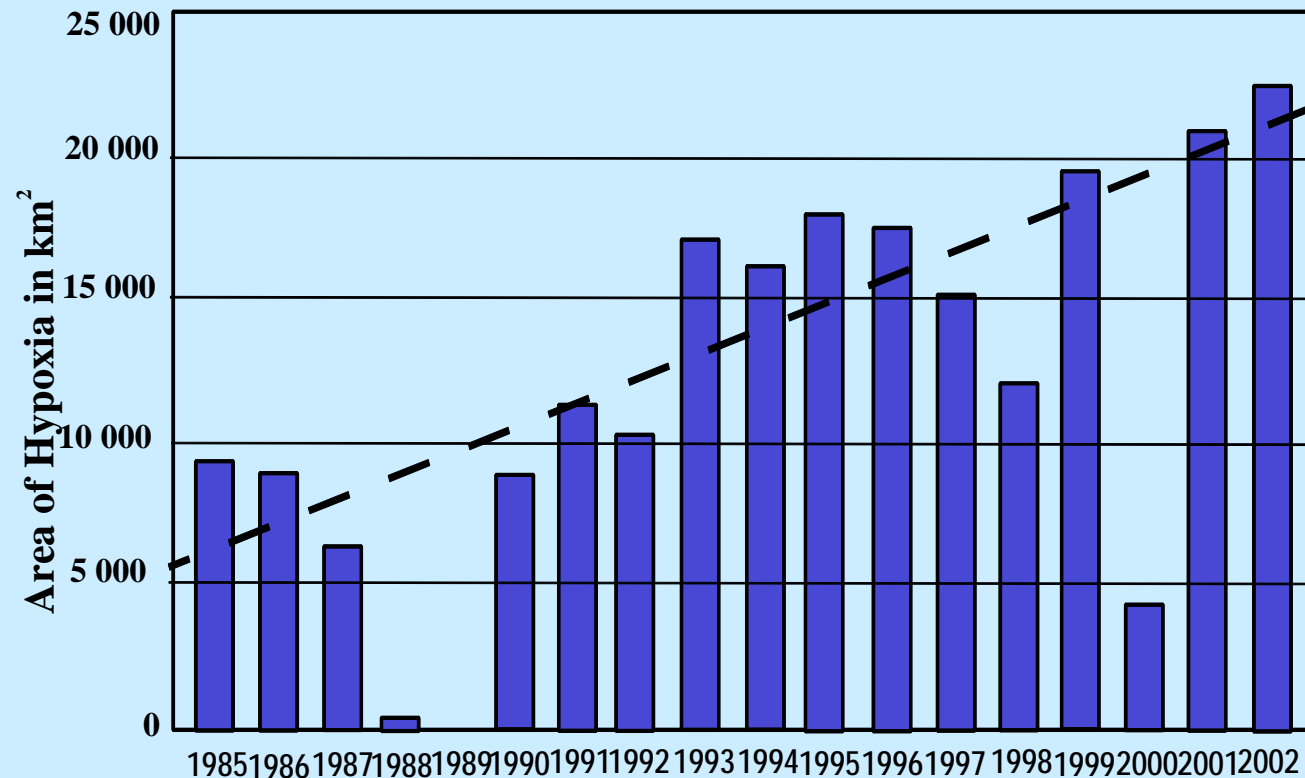


Frequency of Occurrence 1985 - 1999

Rabalais, et al.

Distance Paris to London = 490 km

Area of hypoxic zone 1985 - 2002

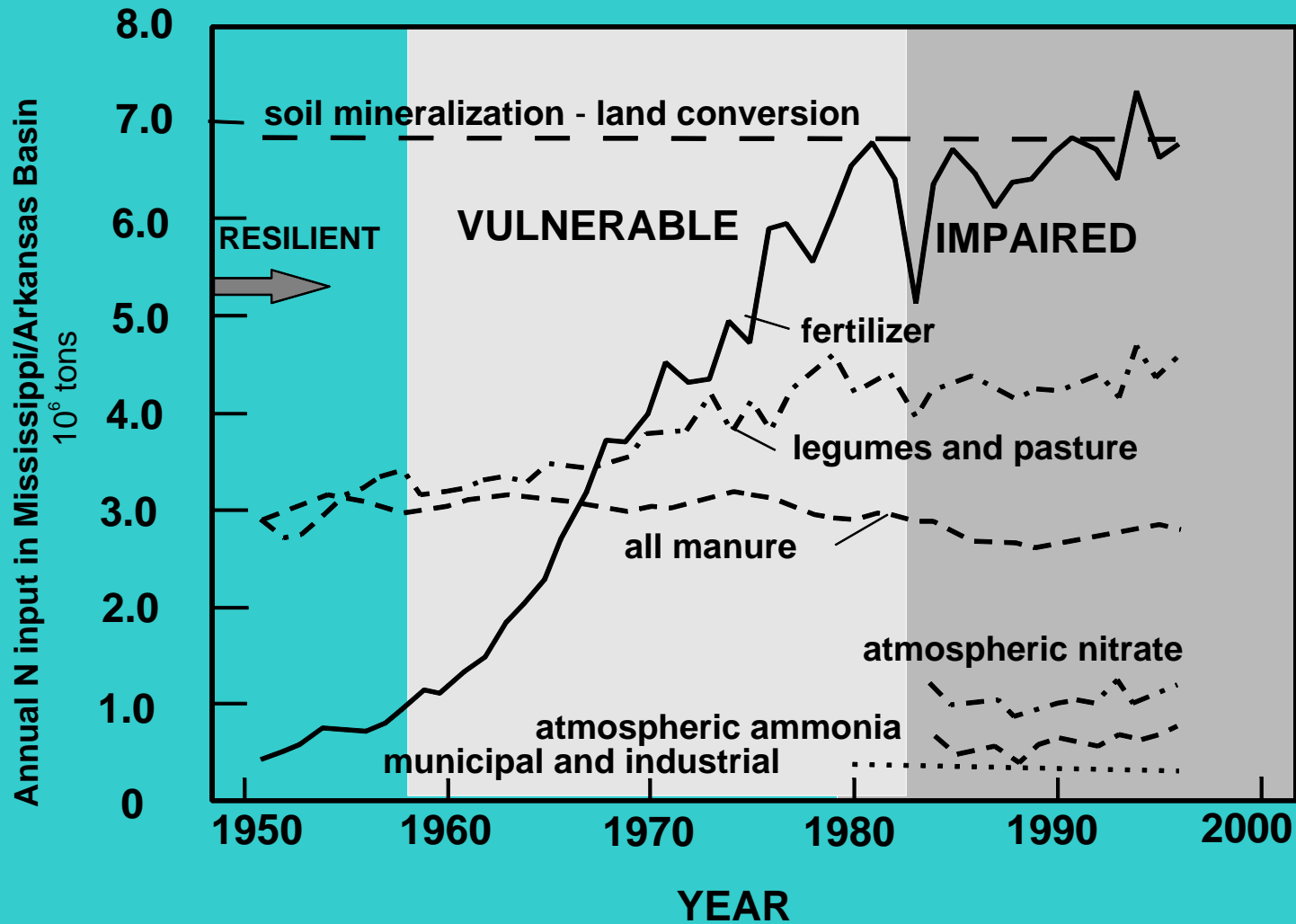


Note: Hypoxia in the Gulf is defined as less than 2 mg/L of DO

Source Rabalais et al.

By interpolation, hypoxia problems started around 1960

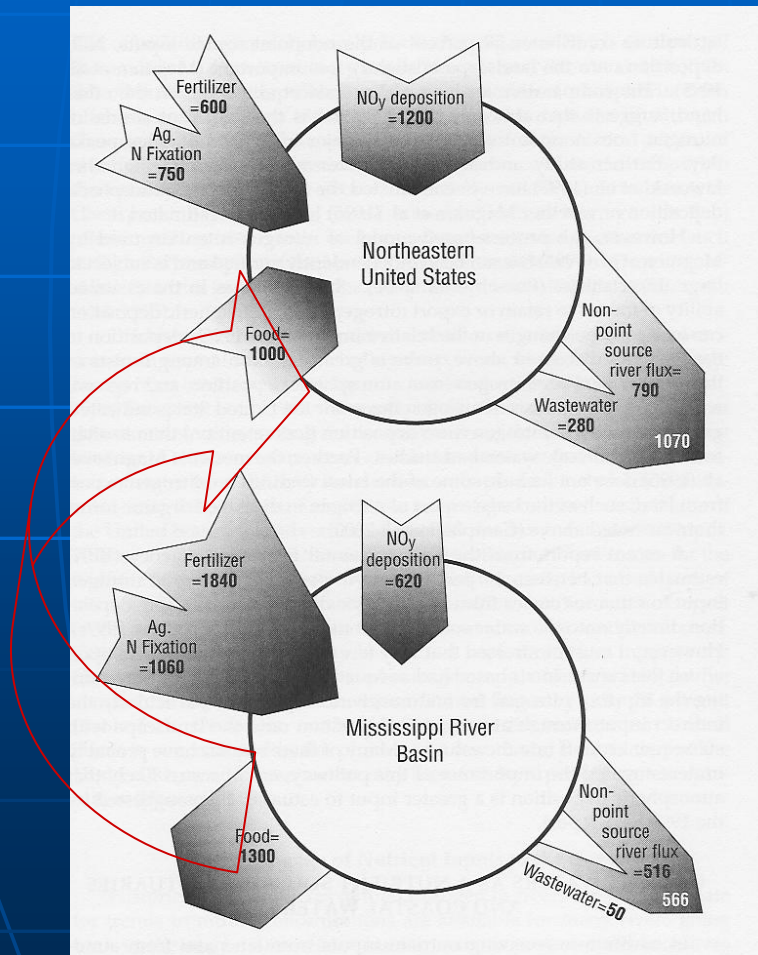
Overall balance of nitrogen



Phases of hypoxia

- Conversion of prairies and subsistence farming - late 1800 -1950 steady state – period of resilience
- Introduction of commercial fertilizers after 1950 upset the steady. Hypoxia might have started around 1960 but was not observed until 1985 – period of vulnerability
- Hypoxia appeared after 1980 with concurrent diminishing of shellfish population – period of impairment

Subglobal transport of nitrogen



Source:

National Research
Council

Diffuse pollution is related to or a consequence of the use or misuse of land

Agricultural Diffuse Pollution is caused mostly by misuse and overuse of land

Community response

- Intensive research and development of BMPs
 - Soil conservation (since mid 1930s)
 - Integrated pest management
 - Buffer strips and field borders
 - Animal feedlot management
 - Targeting fertilizer needs of crops
 - Incorporation and restoration of wetlands
- Grass root movement to organic farming
- Taking polluting agricultural lands out of production

Three types of farming

- Subsistence (mostly small family farms)
 - Expanded by land conversion
 - Without education and some incentives hardly environmentally sustainable (slash, burn, farm and move away)
 - Subsistence farmers in developing countries often may not reason beyond providing food for their families
- Commercial (Large industrial farms and animal operations)
 - High reliance on fertilizers and pesticides, mostly monocultural
 - Large increase of nutrient inputs into receiving waters

Organic Farming

- Ecologically manageable systems
- Still relatively small
- Dramatic growth in Europe and US
- Is it sustainable and/or less polluting?

Converting the entire agriculture sector to organic farming is a challenge and only a long term goal

Sustainable Agriculture?

Shortest definition of sustainability:

A sustainable agriculture is one that, over a long term, (1) enhances environmental quality and the resource base on which agriculture depends, (2) provides for basic human food and fiber needs, (3) is economically viable, and (4) enhances the quality of life for farmers and the society as whole

American Society of Agronomy

Dream, Conflicting or Achievable?

Three Types of Farming

Parameter	Subsistence	Commercial	Sustainable (organic)
Social identity	Family	Corporation	Family or Community
Nature of change	Uncontrolled	Controlled	Planned and anticipated
Government support	Education and grants for BMPs	Subsidies for production and set-aside land	Same as subsistence
Relation to environment	Vulnerable	Control over	Anticipatory
Natural resources	Finite; consume; relocate when exhausted	Develop and consume	Finite; conserve and preserve
Role of government	Undeveloped and unstable	Coordination, protect rights and needs of land owners	Regulate
Knowledge base	Tradition	Science and technology	Science and technology
Impact on diffuse pollution	Localized, could be significant over long term	Significant and widespread	Small, often none
Cost of externalities	Medium	Large	None

From Novotny (2003) and Padgitt and Petrzela (1994)

Conclusions

- Over the last 50 years there has been a dramatic shift from subsistence family farming to commercial large scale farms and feedlots with a consequence of large losses of fertilizers into receiving waters (diffuse pollution)
- More environmentally sustainable farming is emerging
- Ecologically sustainable (minimum diffuse pollution) farming may emerge by a conversion of large farm operations to more sustainable farming. This can only be achieved by regulation and rethinking or eliminating subsidies

In memoriam

Professor
Giuseppe
Bendoricchio

1950-2003

Founder of the IWA
Diffuse Pollution Group

