

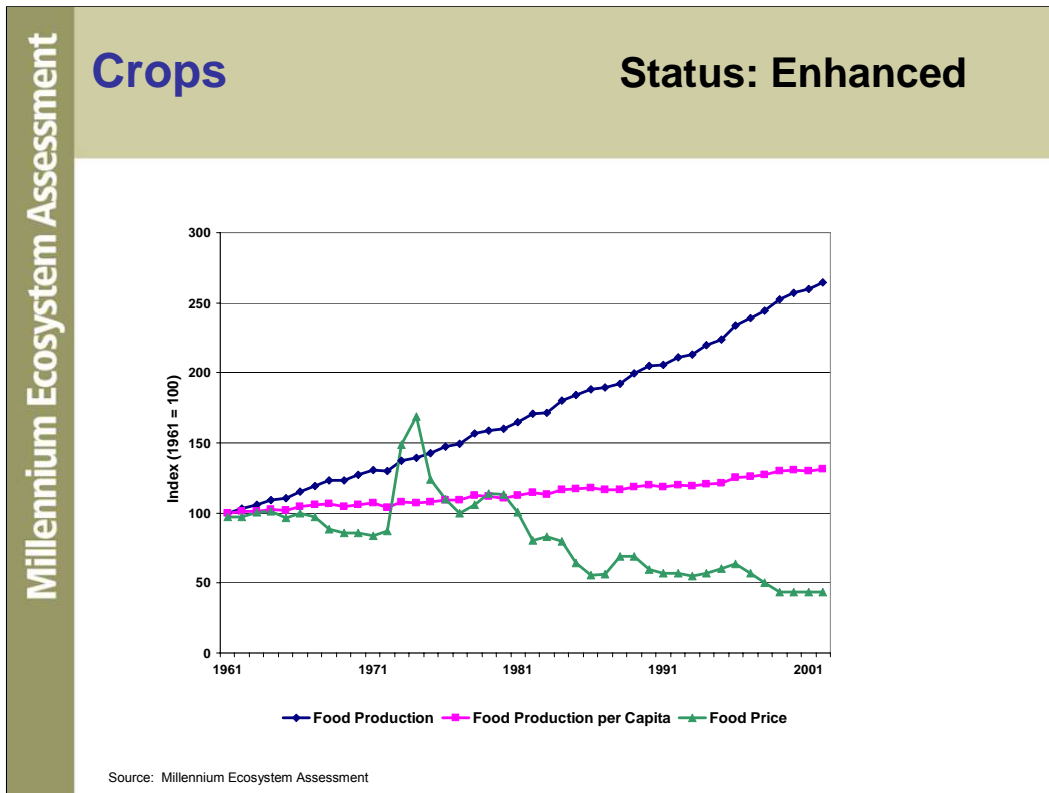
The MA focused on population growth in last 50 years. From MA Synthesis: “Between 1960 and 2000, the demand for ecosystem services grew significantly as world population doubled to 6 billion people ...” This figure (not from the MA) illustrates that recent growth but in the context of the longer term trends. Sources are listed below.

1 billion in about 1804, 2 billion in 1927 (123 years to double), 4 billion in 1974 (54 yrs to double); 6.5 billion in July 2005. In the last 45 years (since 1960) more people have been added to the planet (3.4 billion) than lived on the planet in 1960.

Source (1950 to 2050): Population Division of the Department of Economic and Social Affairs of the United Nations Secretariat, World Population Prospects: The 2004 Revision and World Urbanization Prospects: The 2003 Revision, <http://esa.un.org/unpp>, 06 July 2005; 1:30:16 PM.

Source (1700-1900): Ronald Lee, “The Demographic Transition: Three Centuries of Fundamental Change”, Journal of Economics Perspectives, Volume 17, Number 4—Fall 2003—Pages 167–190.

Source (pre 1700): Population Reference Bureau: "World population expanded to about 300 million by A.D. 1 and continued to grow at a moderate rate. But after the start of the Industrial Revolution in the 18th century, living standards rose and widespread famines and epidemics diminished in some regions. Population growth accelerated. The population climbed to about 760 million in 1750 and reached 1 billion around 1800"

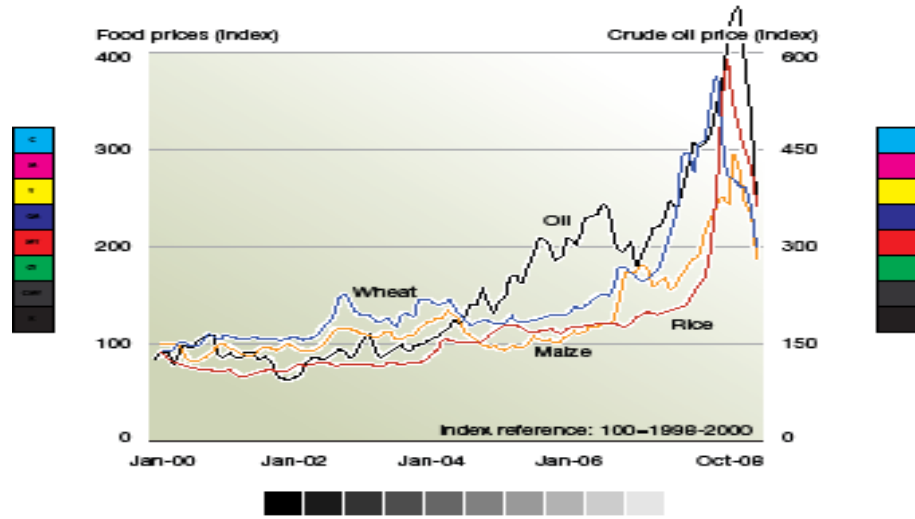


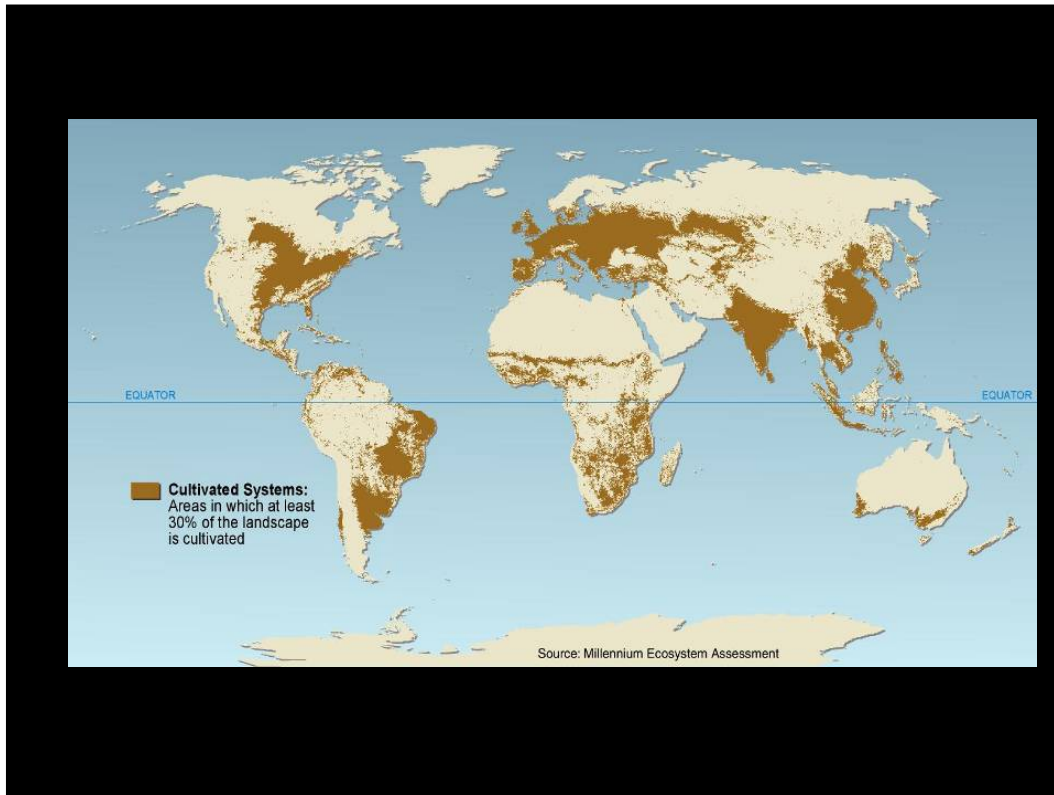
**From MA Synthesis Appendix A.:** “Food production more than doubled (an increase of over 160%) from 1961 to 2003 (C8.1). (See Appendix Figure A.1.) Over this period, production of cereals—the major energy component of human diets—has increased almost two and a half times, beef and sheep production increased by 40%, pork production by nearly 60%, and poultry production doubled (C8.ES).

**Figure is adapted from MA Synthesis Appendix Figure A.1.** Trends in Key Indicators of Food Provision: 1961–2003 (C8 Figure 8.1) Global Production, Prices, and Undernourishment

From MA Synthesis SDM p. 6: “Agriculture, including fisheries and forestry, has been the mainstay of strategies for the development of countries for centuries, providing revenues that have enabled investments in industrialization and poverty alleviation. Although the value of food production in 2000 was only about 3% of gross world product, the agricultural labor force accounts for approximately 22% of the world’s population, half the world’s total labor force, and 24% of GDP in countries with per capita incomes of less than \$765 (the low-income developing countries, as defined by the World Bank).”

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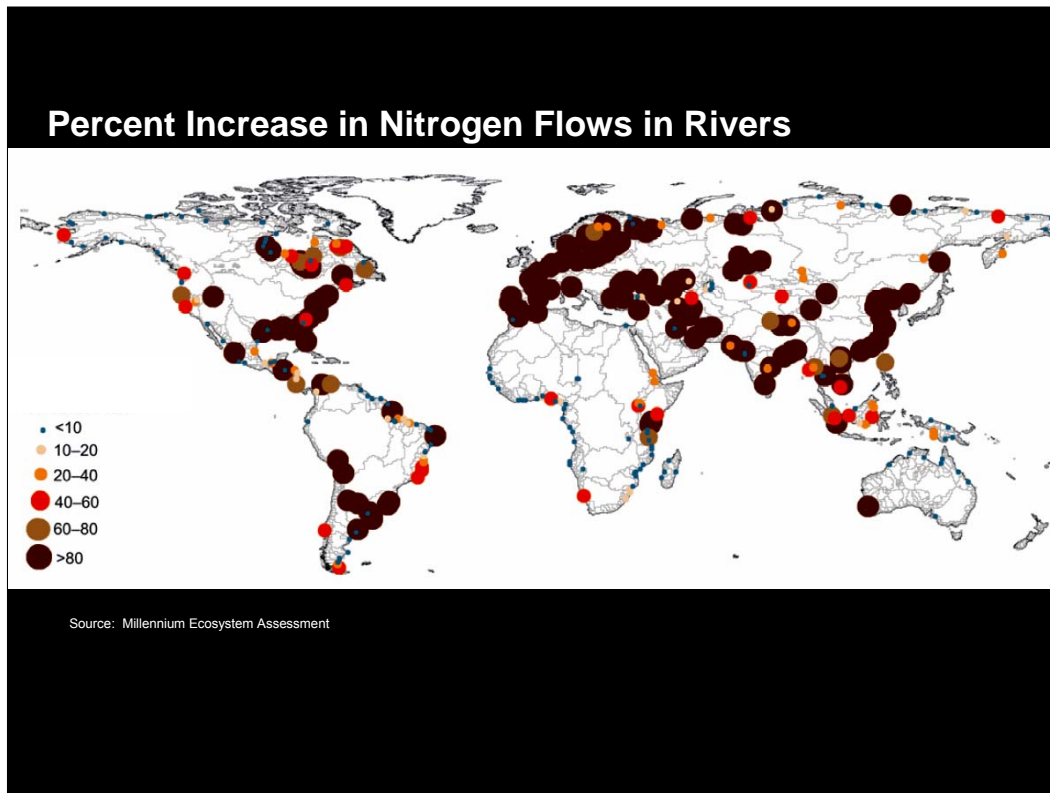




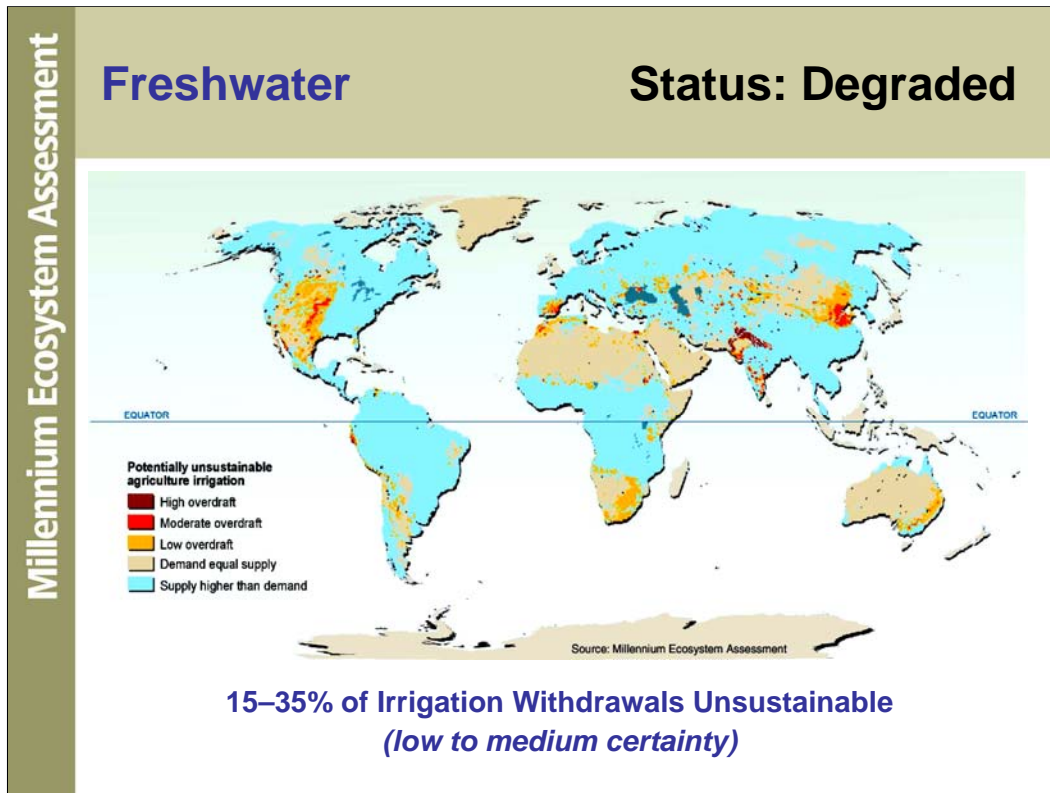
**MA Synthesis Figure 1. Extent of Cultivated Systems, 2000.** Cultivated systems cover 24% of the terrestrial surface.

The structure and functioning of the world’s ecosystems changed more rapidly in the second half of the twentieth century than at any time in human history.

- More land was converted to cropland in the 30 years after 1950 than in the 150 years between 1700 and 1850. Cultivated systems (areas where at least 30% of the landscape is in croplands, shifting cultivation, confined livestock production, or freshwater aquaculture) now cover one quarter of Earth’s terrestrial surface.



**MA State and Trends Figure 12.3 Geography of Relative Increases in Riverborne Nitrogen Fluxes Resulting from Anthropogenic Acceleration of Cycle.** Contemporary time is from the mid-1990s. While the peculiarities of individual pollutants, rivers, and governance define the specific character of water pollution, the general patterns observed for nitrogen are representative of anthropogenic changes to the transport of waterborne constituents. Elevated contemporary loadings to one part of the system (e.g., to croplands) often reverberate to other parts of the system (e.g., coastal zones), exceeding the capacity of natural systems to assimilate additional constituents. (Green et al. 2004)



**From MA Synthesis Appendix Figure A.3. Unsustainable Water Withdrawals for Irrigation (C7 Fig 7.3)**

Globally, roughly 15–35% of irrigation withdrawals are estimated to be unsustainable (*low to medium certainty*) (C7.2.2). The map indicates where there is insufficient fresh water to fully satisfy irrigated crop demands. The imbalance in long-term water budgets necessitates diversion of surface water or the tapping of groundwater resources. The areas shown with moderate-to-high levels of unsustainable use occur over each continent and are known to be areas of aquifer mining or major water transfer schemes. Key: high overdraft, > 1 cubic kilometer per year; moderate, 0.1–1 cubic kilometer per year; low, 0–0.1 cubic kilometer per year. All estimates made on about 50-kilometer resolution. Though difficult to generalize, the imbalances translate into water table drawdowns >1.6 meters per year or more for the high overdraft case and <0.1 meter per year for low, assuming water deficits are met by pumping unconfined aquifers with typical dewatering potentials (specific yield = 0.2).

**Freshwater use expanding 20% per decade**

**5-25% of water use exceeds sustainable supply**

**Water scarcity affects 1-2 billion people**

## What was unique?

# Ecosystem services



Photo credits (left to right, top to bottom): Purdue University, WomenAid.org, LSUP, NASA, unknown, CEH Wallingford, unknown, W. Reid, Staffan Widstrand

The assessment focuses on the linkages between ecosystems and human well-being and, in particular, on “ecosystem services.” An ecosystem is a dynamic complex of plant, animal, and microorganism communities and the nonliving environment interacting as a functional unit. The MA deals with the full range of ecosystems—from those relatively undisturbed, such as natural forests, to landscapes with mixed patterns of human use, to ecosystems intensively managed and modified by humans, such as agricultural land and urban areas. Ecosystem services are the benefits people obtain from ecosystems. These include *provisioning services* such as food, water, timber, and fiber; *regulating services* that affect climate, floods, disease, wastes, and water quality; *cultural services* that provide recreational, aesthetic, and spiritual benefits; and *supporting services* such as soil formation, photosynthesis, and nutrient cycling. The human species, while buffered against environmental changes by culture and technology, is fundamentally dependent on the flow of ecosystem services. Original version of this slide was prepared by Karen Bennett, WRI.



## The Balance Sheet

| Enhanced             | Degraded                            | Mixed                   |
|----------------------|-------------------------------------|-------------------------|
| Crops                | Capture fisheries                   | Timber                  |
| Livestock            | Wild foods                          | Fiber                   |
| Aquaculture          | Wood fuel                           | Water regulation        |
| Carbon sequestration | Genetic resources                   | Disease regulation      |
|                      | Biochemicals                        | Recreation & ecotourism |
|                      | Fresh Water                         |                         |
|                      | Air quality regulation              |                         |
|                      | Regional & local climate regulation |                         |
|                      | Erosion regulation                  |                         |
|                      | Water purification                  |                         |
|                      | Pest regulation                     |                         |
|                      | Pollination                         |                         |
|                      | Natural Hazard regulation           |                         |
|                      | Spiritual & religious               |                         |
|                      | Aesthetic values                    |                         |

**Bottom Line: 60% of Ecosystem Services are Degraded**

**MA Synthesis SDM (p. 6):** “Approximately 60% (15 out of 24) of the ecosystem services evaluated in this assessment (including 70% of regulating and cultural services) are being degraded or used unsustainably. Ecosystem services that have been degraded over the past 50 years include capture fisheries, water supply, waste treatment and detoxification, water purification, natural hazard protection, regulation of air quality, regulation of regional and local climate, regulation of erosion, spiritual fulfillment, and aesthetic enjoyment. The use of two ecosystem services—capture

fisheries and fresh water—is now well beyond levels that can be sustained even at current demands, much less future ones. At least one quarter of important commercial fish stocks are overharvested (*high certainty*). (See Figures 5, 6, and 7.) From 5% to possibly 25% of global freshwater use exceeds long-term accessible supplies and is now met either through engineered water transfers or overdraft of groundwater supplies (*low to medium certainty*). Some 15–35% of irrigation withdrawals exceed supply rates and are therefore unsustainable (*low to medium certainty*). While 15

services have been degraded, only 4 have been enhanced in the past 50 years, three of which involve food production: crops, livestock, and aquaculture. Terrestrial ecosystems were on average a net source of CO<sub>2</sub> emissions during the nineteenth and early twentieth centuries, but became a net sink around the middle of the last century, and thus in the last 50 years the role of ecosystems in regulating global climate through carbon

sequestration has also been enhanced.”



## Main Findings

1. Humans have radically altered ecosystems in last 50 years.
2. Changes have brought gains but at growing costs that threaten achievement of development goals.
3. Degradation of ecosystems could grow worse but can be reversed.
4. Workable solutions will require significant changes in policy







Millennium Ecosystem Assessment





