



SVENSKA ARALSJÖSÄLLSKAPET

Swedish Aral Sea Society



5. Ecosystems

Lars Rydén
Professor Emeritus
Uppsala University
Uppsala, Sweden

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A scenic mountain landscape with a hiker in the foreground. The hiker is wearing a red hat and a backpack, standing on a grassy slope. The background features steep, rocky mountains under a cloudy sky. The text "Ecosystems are built of resources" is overlaid in large blue letters.

Ecosystems are built of resources

- 1. Soil - abiotic**
- 2. Water - abiotic**
- 3. Vegetation/animals – biotic**
- 4. Atmosphere**

Ecosystems provide services

- Soil formation
- Photosynthesis and carbon dioxide fixation
- Water cycles
- Nutrient cycles
- Home and living conditions for all living species

Ecosystems are crucial for our survival but are today severely destroyed

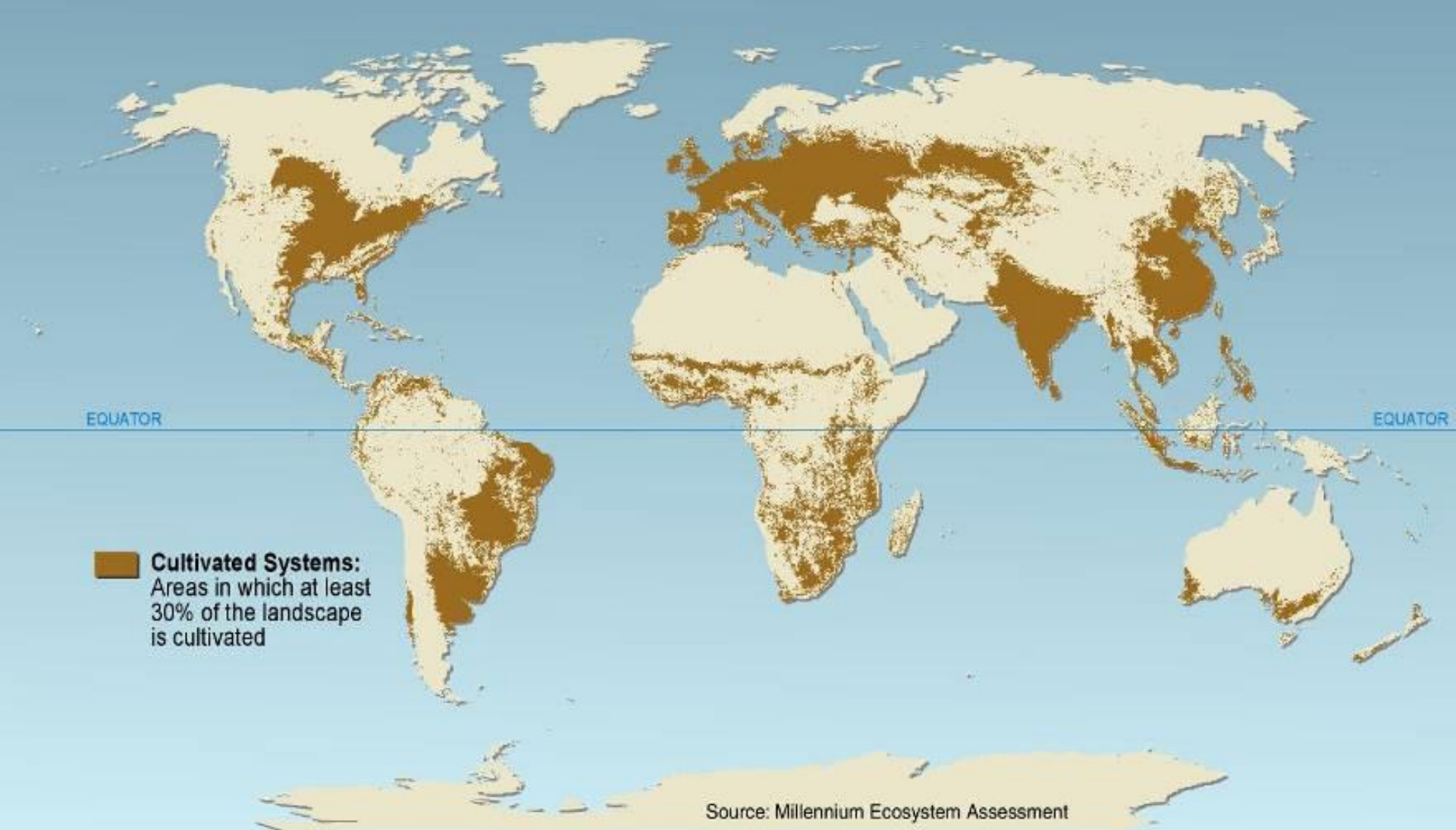
Land Area

The **Land Area** of the World is 13,003 million ha. 4,889 million ha are classified as 'agricultural **area**' by the FAO (this is 37.6% of the **Land Area**).

Society has caused tremendous changes in the land surface area of the planet

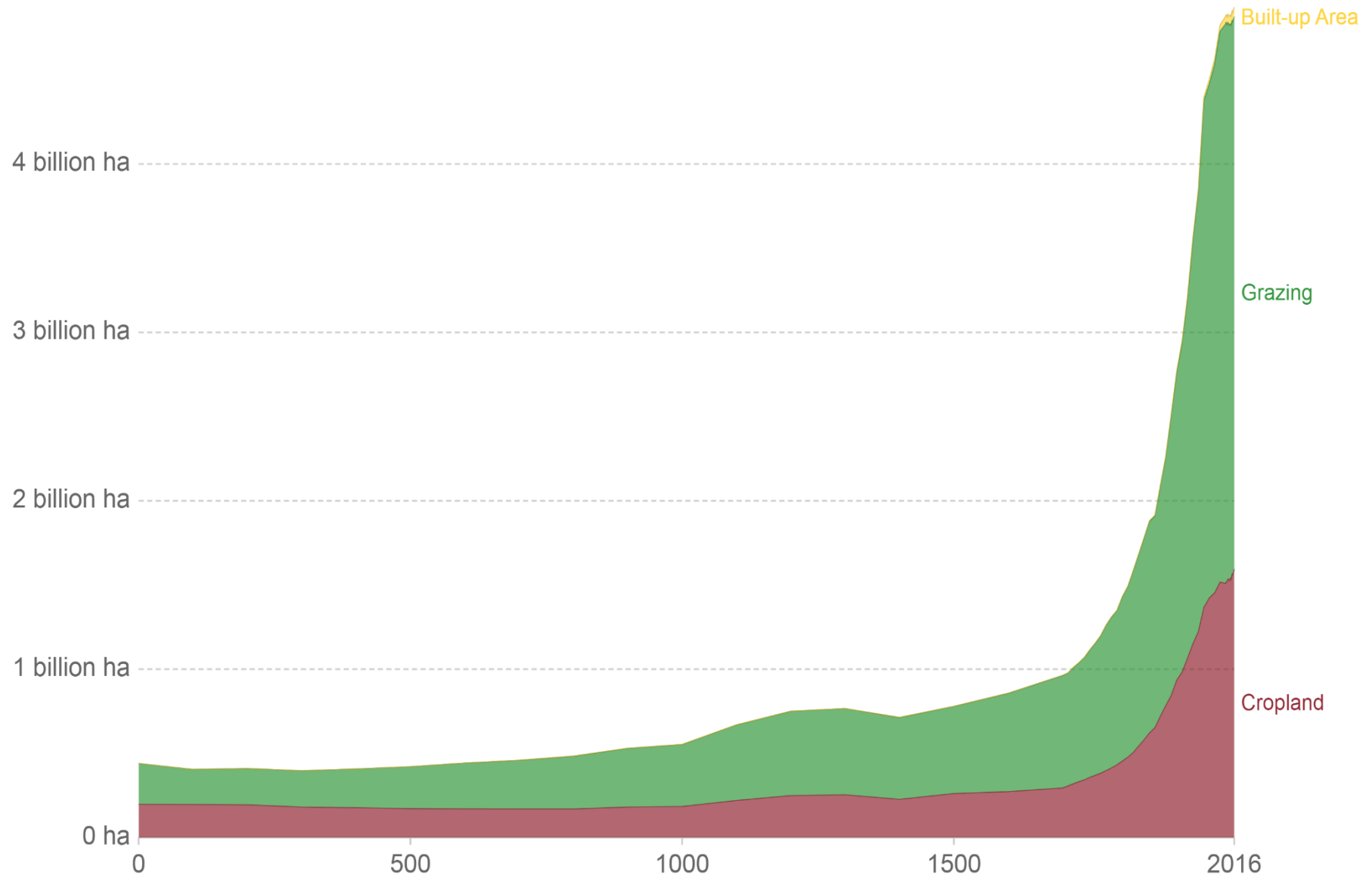
[Land Use - Our World in Data](https://ourworldindata.org/land-use)

[https://ourworldindata.org › land-use](https://ourworldindata.org/land-use)

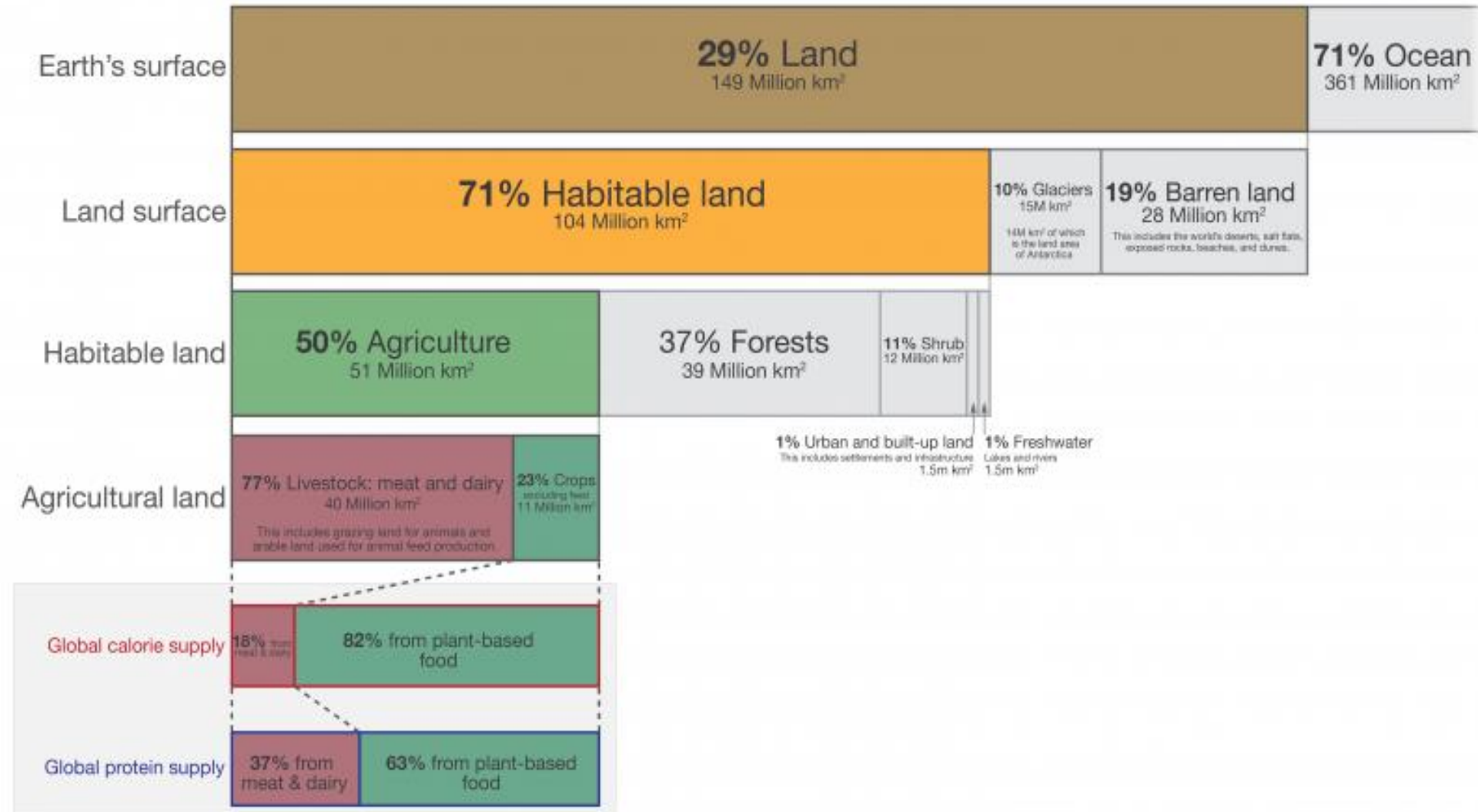


Land use over the long-term, World, 0 to 2016

Total land area used for cropland, grazing land and built-up areas (villages, cities, towns and human infrastructure).



Global land use for food production



Data source: UN Food and Agriculture Organization (FAO)
 OurWorldinData.org - Research and data to make progress against the world's largest problems.

Licensed under CC-BY by the authors Hannah Ritchie and Max Roser in 2019.

The soil

Ancient civilizations indirectly mined soil to fuel the growth as agricultural practice accelerated soil erosion well beyond the rate of soil production. ...

Soil abuse remains a threat to modern society: we see environmental refugees, the dust bowl in the 1930s US, the African Sahel in the 1970s and the Amazon basin today. The world's population increases while the amount of productive farmland began declining in the 1970s..

David Montgomery. The erosion of civilisations, 2007

What can we do to preserve and build soil?

Technically (some examples)


- Minimum tillage or no-tillage farming
- Agro-forestry
- Compost
- Biochar

Economically

- Include soil in carbon funding

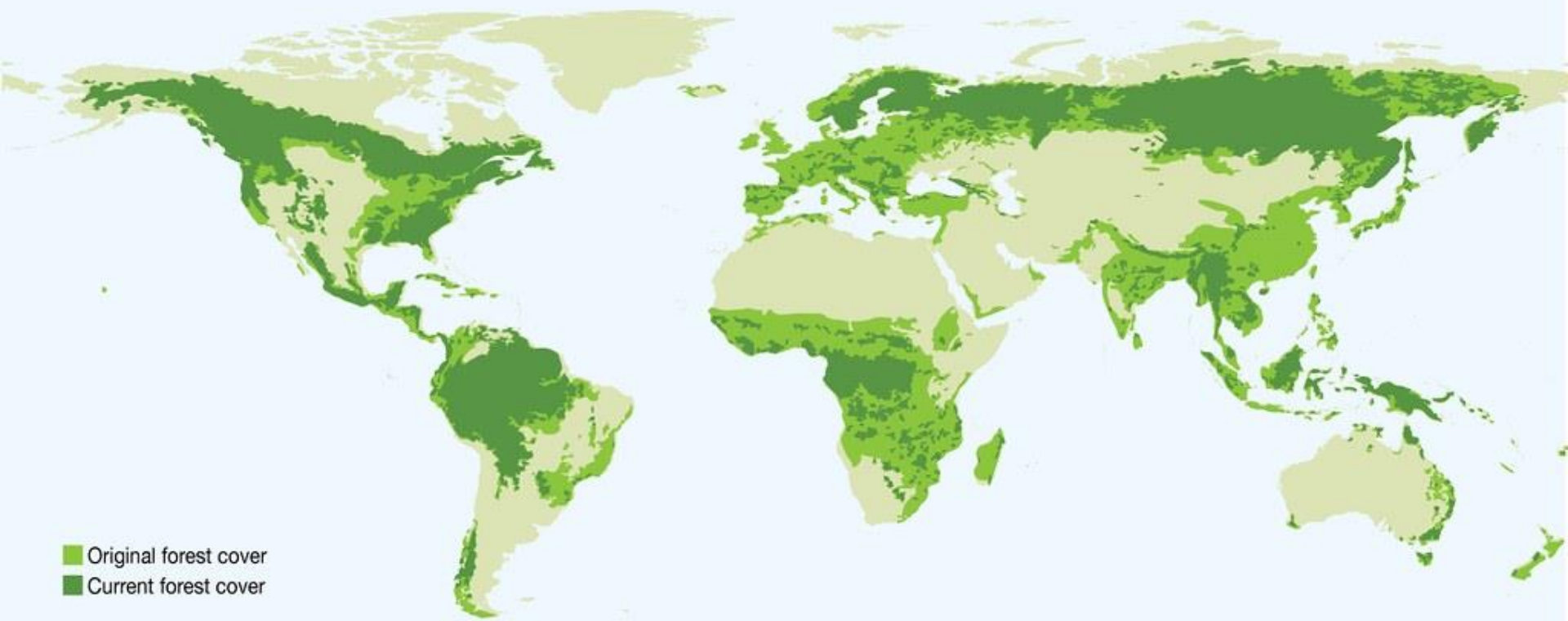
Legally

- Protect soil

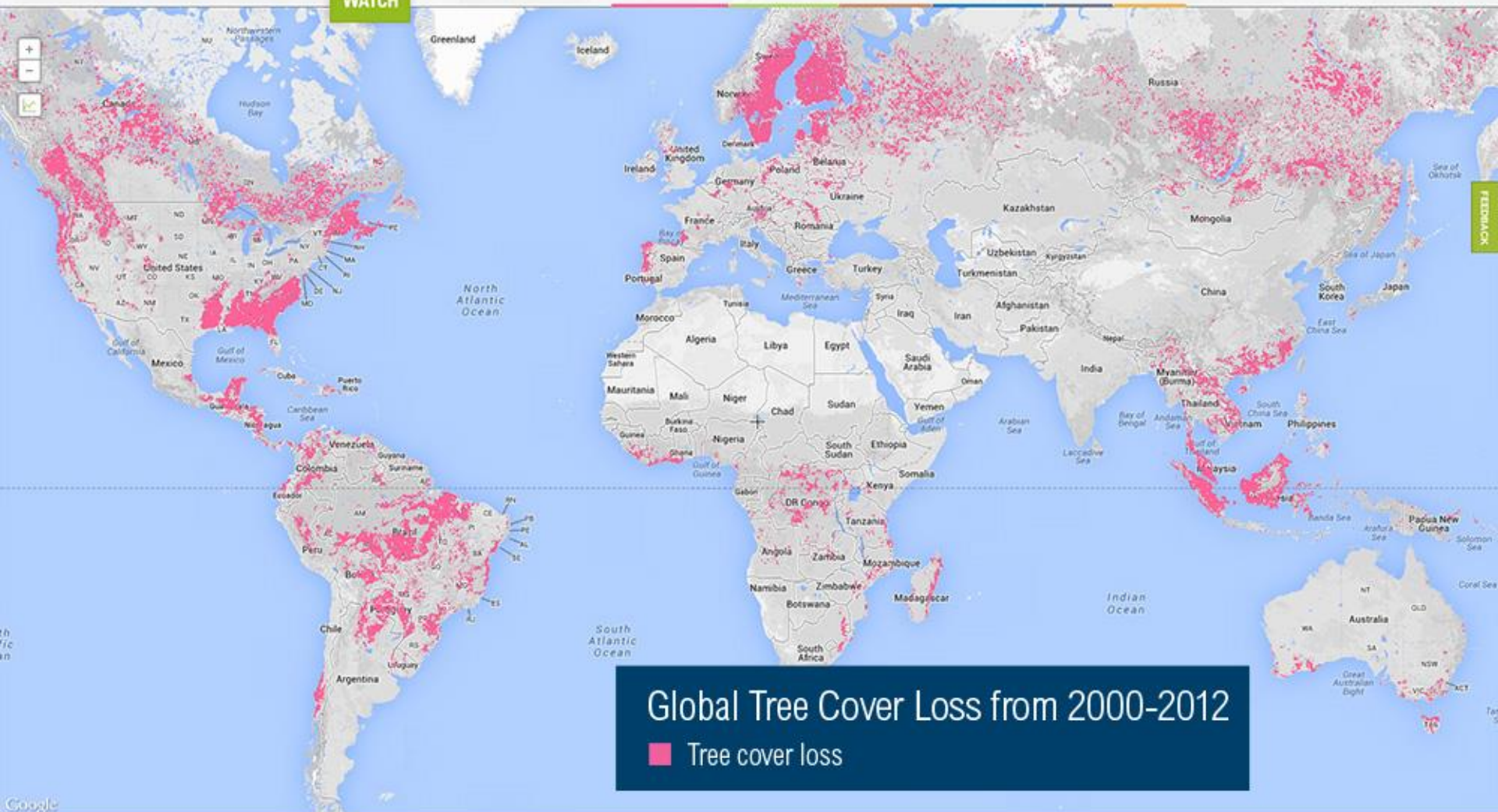
A photograph of a dense tropical forest. The foreground is filled with lush green foliage, including large-leafed plants and ferns. The background shows a thick canopy of tall trees with green leaves, extending to the horizon under a bright sky. The overall scene is a vibrant, natural landscape.

Half of the original forests of our planet are gone, and the land used for other purposes. Half of the rest is foreseen to be cut down during the 21st century.

Global forest cover



Source: WCMC online database, accessed August 2014



Critical concerns:

1. Deforestation
2. Desertification
3. Wetland decrease
4. Insufficient nature protection

Waterscape

**From the beginning of the industrial area
we have major impacts on the waterscape**

- 1. Wetlands have been drained**
- 2. Rivers have been straightened**
- 3. Surface water extracted for irrigation and other use**
- 4. Waters have been eutrophied**
- 5. Lakes have been acidified**
- 6. Waters have been chemically polluted**
- 7. Species have been lost**
- 8. New species have been introduced**

Eutrophication – overusing fertilisers in agriculture and wastewater from cities

- **Too much nutrients to the environment leads to overgrowth called eutrophication**
- **New species take over. Ecosystems change.**
- **Most important are nitrogen (N) and phosphorus (P), which normally are limiting**

Chemical pollution – careless use of chemicals in industry and society

- **Persistent Organic Pollutants (POP) to the environment leads to poisoning of species and ecosystems**
- **Some species may be lost, especially top predators. Human is one of them. Ecosystems change.**
- **Most important are PCB (Polychlorinated Biphenyls) and other chlorinated organics and heavy metals, especially cadmium**

Coral reefs are ancient ecosystems

The most diverse marine ecosystems on Earth

Cover <1% of Earth's surface but harbour 1.5 - 2 million species

Includes quarter of all marine fish species

Coral reefs confer a net value of approximately \$29.8 billion per year

Tourism & recreation \$9.6 billion; coastal protection \$9 billion; fisheries \$5.7 billion; biodiversity \$5.5 billion

Feed about 1 billion people per year





Examples of reefs from the Great Barrier reef that are analagous to the state of coral reefs in the future under different climate scenarios CRS-A, CRS-B and CRS-C. CRS-A = conditions stabilised at todays CO₂ levels. IPCC scenario B1 is predicting 550ppm CO₂ by 2100 and A2 800ppm.

Critical concerns:

Overuse of surface and groundwater.
Irrigation.

Draining of rivers and wetlands.

Eutrophication of surface and coastal water.

Acidification of surface water and oceans.
Coral reefs.

Animals and Biodiversity crisis

- The story of biodiversity decrease accelerates through millenia, centuries and years.
- Extinction of the American megafauna; The European megafauna; May the African megafauna be saved?
- The story of fishing culminated in the 1990s with peak fish and the extinction of the Newfoundland cod population.

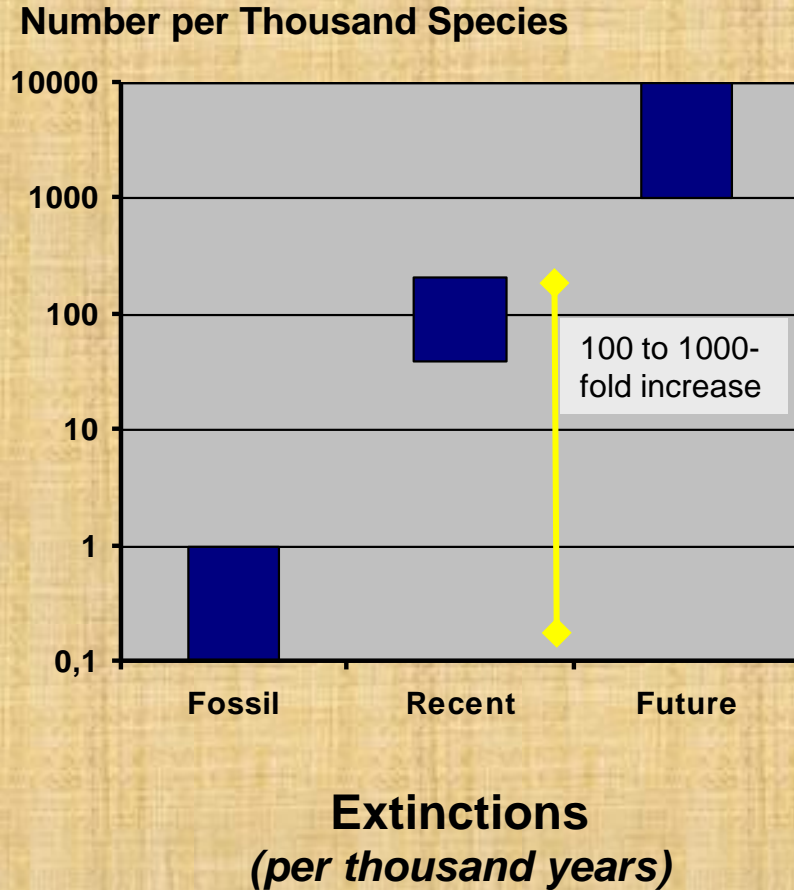
How much of Earth's biomass is affected by humans?

- We find out that humans and their livestock now comprise about 96% of all mammal biomass on Earth. All other mammals – whales, sea lions, bears, elephants, badgers, shrews, deer, bear, cougars, rats, wolves, and all the rest – are about 4.2%.
- Mammals, including humans and their livestock, represent only about 0.03% of Earth's biomass. All animals – the mammals plus fish, insects, worms, birds, and others – account for only 0.37% of biomass.
- The two primary producers of biomass from solar energy – plants and bacteria – still dominate terrestrial and marine life forms, accounting for over 95% of all living biomass.

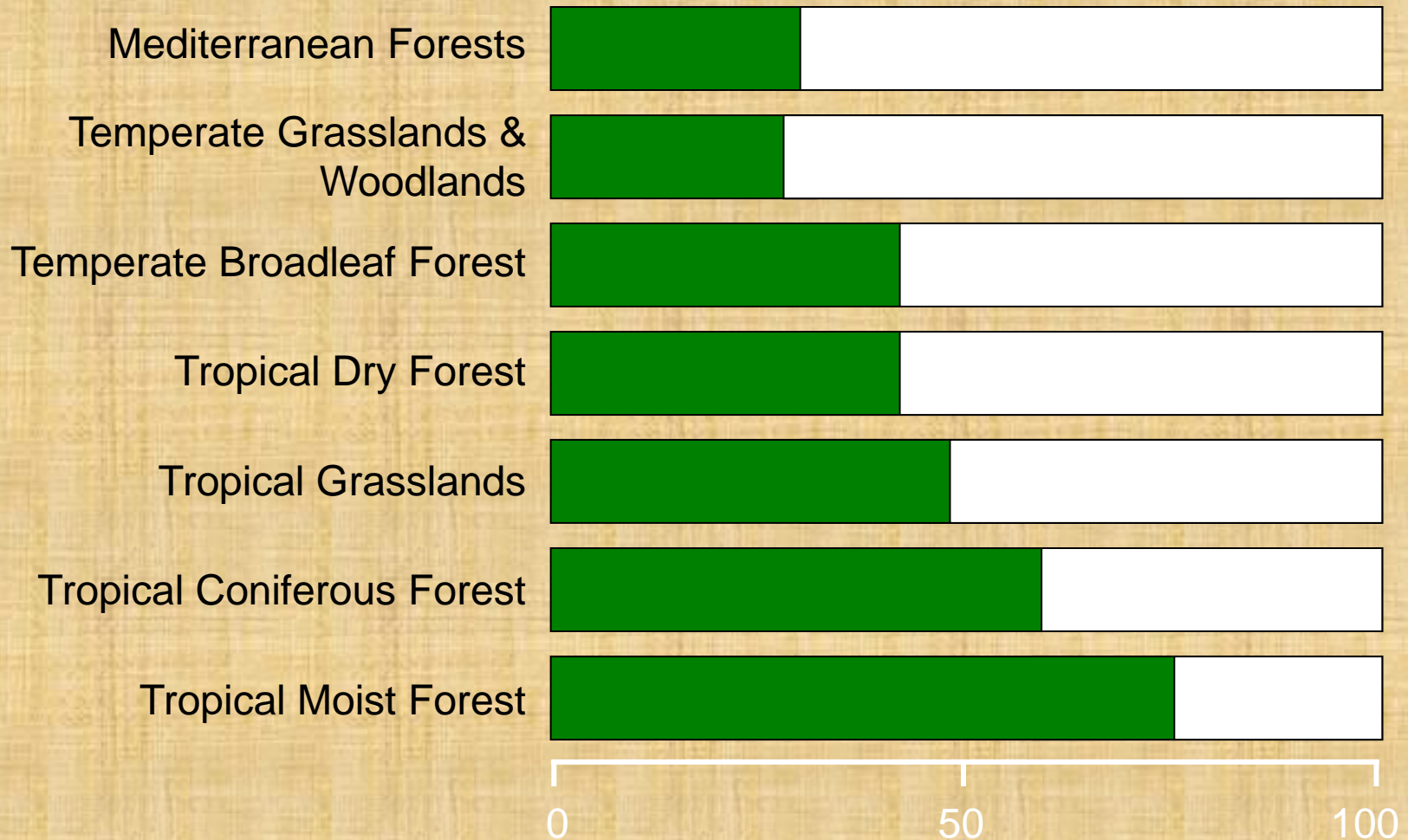
- <https://www.greenpeace.org/international/story/17788/how-much-of-earths-biomass-is-affected-by-humans/>

Change in Species Diversity

Rate of extinctions



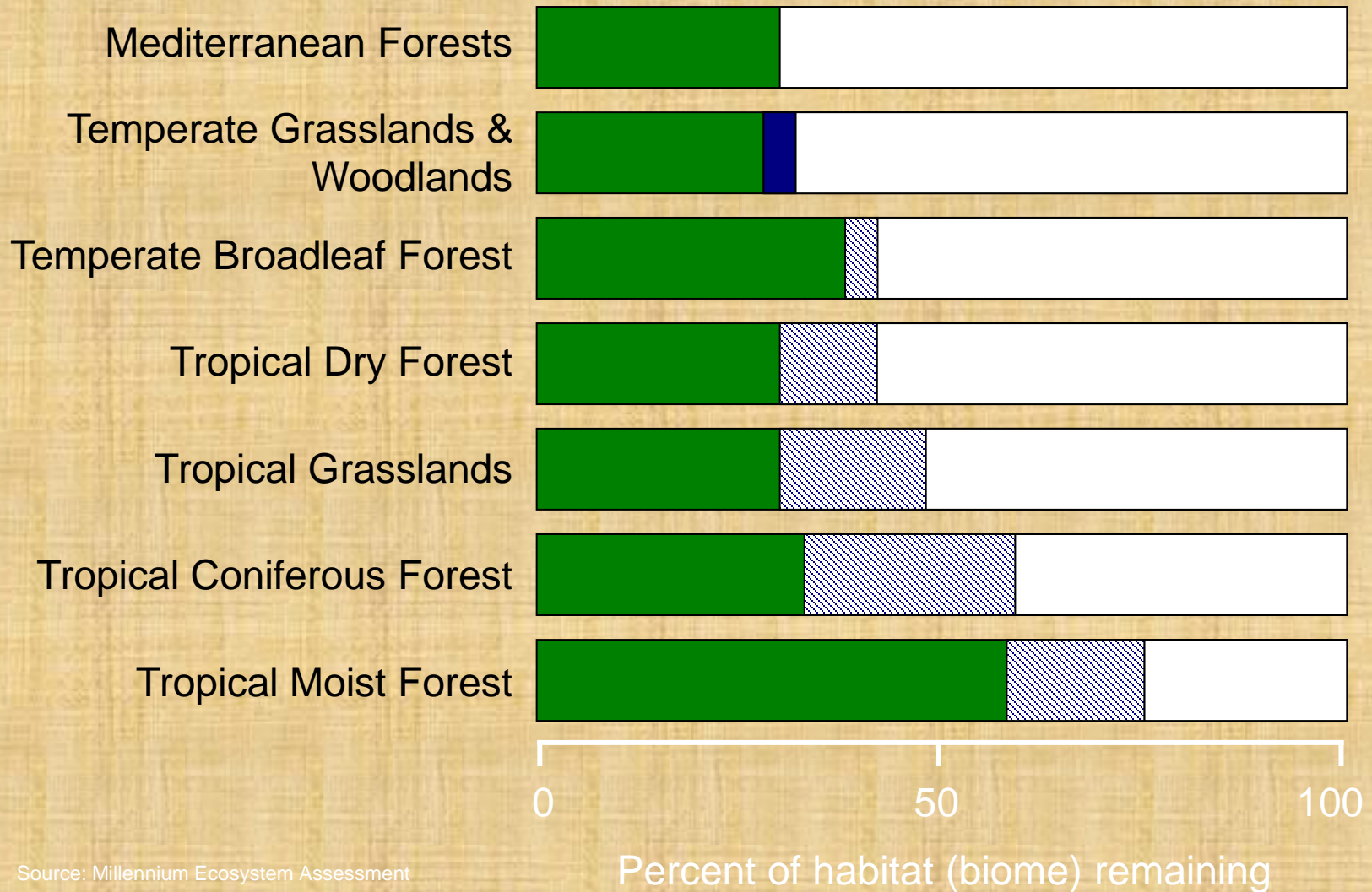
Habitat Loss to 1990



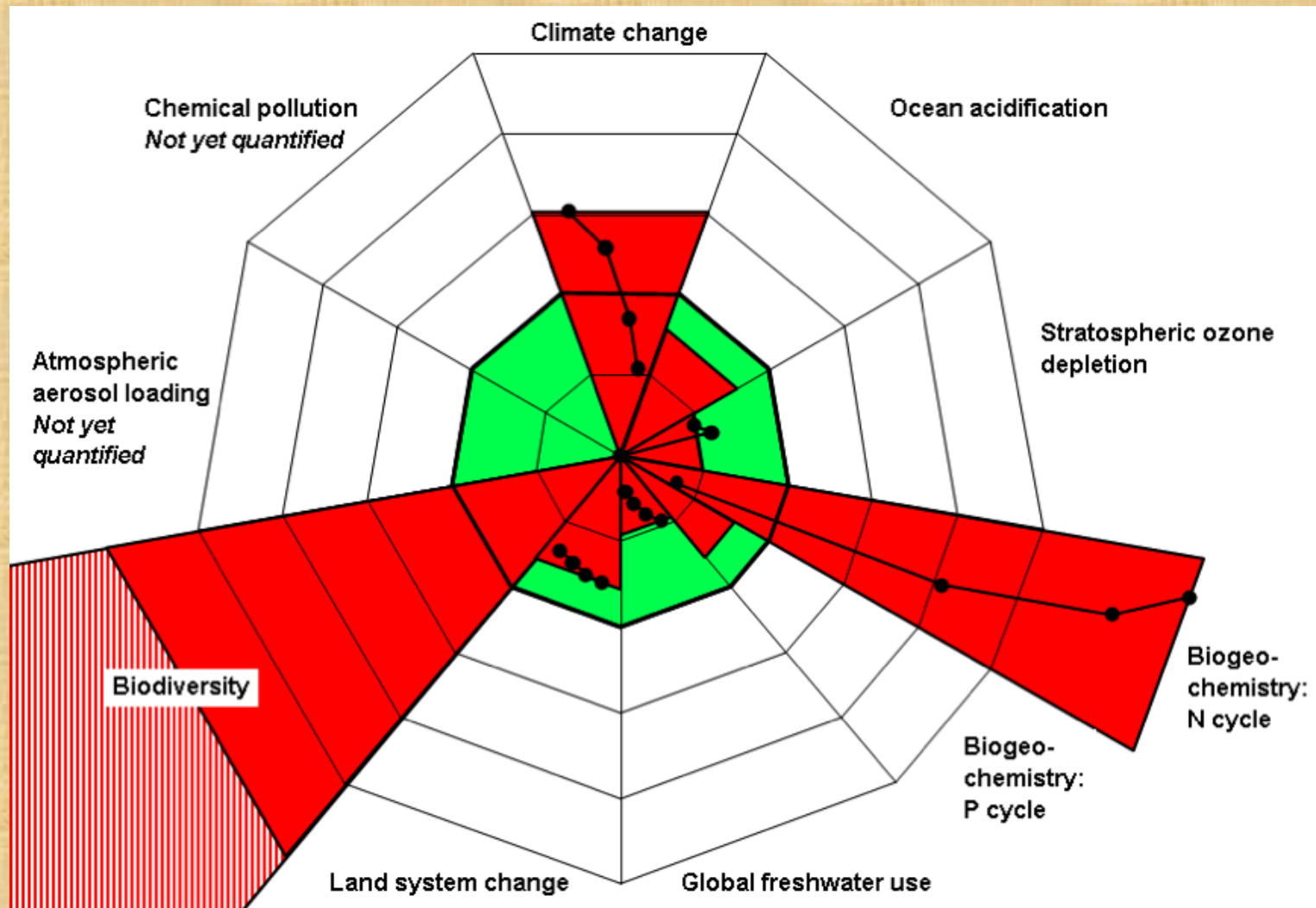
Source: Millennium Ecosystem Assessment

Percent of habitat (biome) remaining

Habitat Loss to 2050 under MA Scenarios



Planetary boundaries



Rockström, J. et al., 2009. Nature, September 24, 2009.

A sustainable society can not tolerate biodiversity loss on the present scale.

Intrusion on habitats is the largest environmental impact in our world.

Critical concerns:

1. Habitat loss
2. Invasive species
3. Overhunting/Overfishing
4. Pollution
5. Climate Change

Ecosystem services

Provisioning

- Crop production
- Food production



Regulating

- Beneficial from



Cultural

- Natural beauty



Provisioning Services

Goods produced or provided by ecosystems

- Food

- Crops
- Livestock
- Capture Fisheries
- Aquaculture
- Wild Foods

- Fiber

- Timber
- Cotton, hemp, silk
- Wood Fuel

- Genetic resources

- Biochemicals

- Freshwater



Regulating Services

Benefits obtained from regulation of ecosystem processes

- Air Quality Regulation
- Climate Regulation
 - Global (CO₂ sequestration)
 - Regional and local
- Erosion regulation
- Water purification
- Disease regulation
- Pest regulation
- Pollination
- Natural Hazard regulation



Cultural Services

Non-material benefits obtained from ecosystems

- Spiritual and Religious Values
- Knowledge Systems
- Educational values
- Inspiration
- Aesthetic Values
- Social Relations
- Sense of Place
- Recreation and Ecotourism



The UN Convention on Biological Diversity

- Signed by 150 government leaders at the 1992 Rio Earth Summit, the Convention on Biological Diversity is dedicated to promoting sustainable development. Now 196 parties.
- The convention has three main goals: the conservation of biological diversity ([biodiversity](#)); the sustainable use of its components; and the fair and equitable sharing of benefits arising from [genetic resources](#). Its objective is to develop national strategies for the conservation and sustainable use of [biological diversity](#); it is often seen as the key document regarding [sustainable development](#).



Convention on
Biological Diversity

COP 15 Cumming Montreal



global targets for 2030

- Protect 30% of Earth's lands, oceans, coastal areas, inland waters;
- Reduce by \$500 billion annual harmful government subsidies;
- Cut food waste in half;
- Financing restoration of ecosystems by at least \$200 billion per year

<https://www.cbd.int/article/cop15-cbd-press-release-final-19dec2022>

European Bison in Roumania



Rewilding Europe

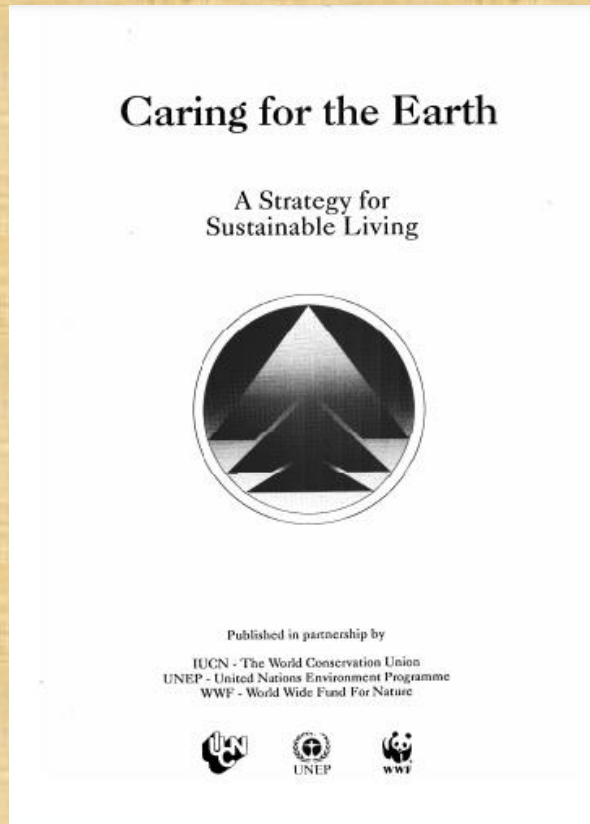


<https://rewildingeurope.com/news/something-old-something-new/>



International Conservation Union, IUCN

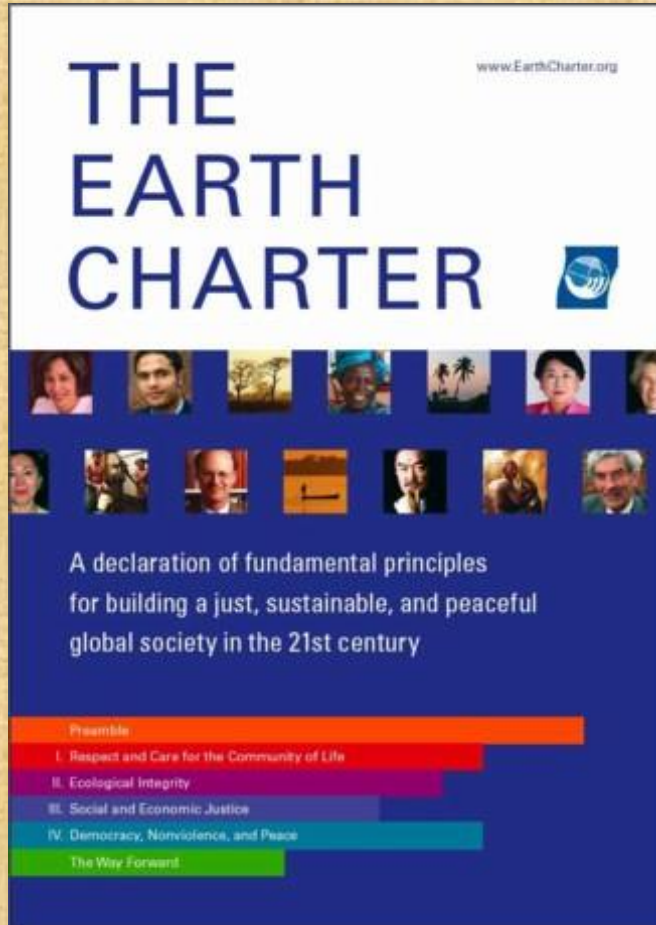
1. A strategy for sustainable living (an ethics of SD)
2. Red list of threatened species



- Established in 1964, the International Union for Conservation of Nature's **Red List of Threatened Species** has evolved to become the world's most comprehensive information source on the global extinction risk status of animal, fungus and plant species.

The Earth Charter

A Consensus Declaration of Shared Vision, Values and Ethical Principles
for Building a Just, Sustainable, and Peaceful World



The Earth Charter

Preamble

We stand at a critical moment in Earth's history, a time when humanity must choose its future. As the world becomes increasingly interdependent and fragile, the future at once holds great peril and great promise. To move forward we must recognize that in the midst of a magnificent diversity of cultures and life forms we are one human family and one Earth community with a common destiny. We must join together to bring forth a sustainable global society founded on respect for nature, universal human rights, economic justice, and a culture of peace. Towards this end, it is imperative that we, the peoples of Earth, declare our responsibility to one another, to the greater community of life, and to future generations.

Earth, Our Home

Humanity is part of a vast evolving universe. Earth, our home, is alive with a unique community of life. The forces of nature make existence a demanding and uncertain adventure, but Earth has provided the conditions essential to life's evolution. The resilience of the community of life and the well-being of humanity depend upon preserving a healthy biosphere with all its ecological systems, a rich variety of plants and animals, fertile soils, pure waters, and clean air. The global environment with its finite resources is a common concern of all peoples. The protection of Earth's vitality, diversity, and beauty is a sacred trust.

The Global Situation

The dominant patterns of production and consumption are causing environmental devastation, the depletion of resources, and a massive extinction of species. Communities are being undermined. The benefits of development are not shared equitably and the gap between rich and poor is widening. Injustice, poverty, ignorance, and violent conflict are widespread and the cause of great suffering. An unprecedented rise in human population has overburdened ecological and social systems. The foundations of global security are threatened. These trends are perilous—but not inevitable.

The Challenges Ahead

The choice is clear: form a global partnership to care for Earth and one another or risk the destruction of ourselves and the diversity of life. Fundamental changes are needed in our values, institutions, and ways of living. We must realize that when basic needs have been met, human development is primarily about being more, not having more. We have the knowledge and technology to provide for all and to reduce our impacts on the environment. The emergence of a global civil society is creating new opportunities to build a democratic and humane world. Our environmental, economic, political, social, and spiritual challenges are interconnected, and together we can forge inclusive solutions.

Universal Responsibility

To realize these aspirations, we must decide to live with a sense of universal responsibility, identifying ourselves with the whole Earth community as well as our local communities. We are at once citizens of different nations and of one world in which the local and global are linked. Everyone shares responsibility for the present and future well-being of the human family and the larger living world. The spirit of human solidarity and kinship with all life is strengthened when we live with reverence for the mystery of being, gratitude for the gift of life, and humility regarding the human place in nature.

We urgently need a shared vision of basic values to provide an ethical foundation for the emerging world community. Therefore, together in hope we affirm the following interdependent principles for a sustainable way of life as a common standard by which the conduct of all individuals, organizations, businesses, governments, and transnational institutions is to be guided and assessed.

I. Respect and Care for the Community of Life

PRINCIPLES

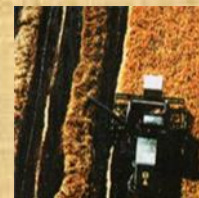
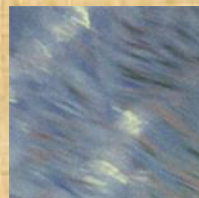
- 1. Respect Earth and life in all its diversity.**
 - a. Recognize that all beings are interdependent and every form of life has value regardless of its worth to human beings.
 - b. Affirm faith in the inherent dignity of all human beings and in the intellectual, artistic, ethical, and spiritual potential of humanity.
- 2. Care for the community of life with understanding, compassion, and love.**
 - a. Accept that with the right to own, manage, and use natural resources comes the duty to prevent environmental harm and to protect the rights of people.
 - b. Affirm that with increased freedom, knowledge, and power comes increased responsibility to promote the common good.
- 3. Build democratic societies that are just, participatory, sustainable, and peaceful.**
 - a. Ensure that communities at all levels guarantee human rights and fundamental freedoms and provide everyone an opportunity to realize his or her full potential.
 - b. Promote social and economic justice, enabling all to achieve a secure and meaningful livelihood that is ecologically responsible.
- 4. Secure Earth's bounty and beauty for present and future generations.**
 - a. Recognize that the freedom of action of each generation is qualified by the needs of future generations.
 - b. Transmit to future generations values, traditions, and institutions that support the long-term flourishing of Earth's human and ecological communities.

In order to fulfill these four broad commitments, it is necessary to

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The Millennium Ecosystem Assessment (MA)

- Largest assessment ever undertaken of the health of ecosystems
 - Prepared by 1360 experts from 95 countries;
 - Extensive peer review and consensus of the world's scientists
- Designed to meet needs of decision-makers among government, business, civil society
 - Information requested through 4 international conventions



The Balance Sheet of MA 2005

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 (15 out of 24) are Degraded

IPBES

- The **Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services** (IPBES) is the intergovernmental body which assesses the state of biodiversity and of the ecosystem services it provides to society, in response to requests from decision makers.
- It is meant to be a parallel to IPCC
- <https://www.ipbes.net/>



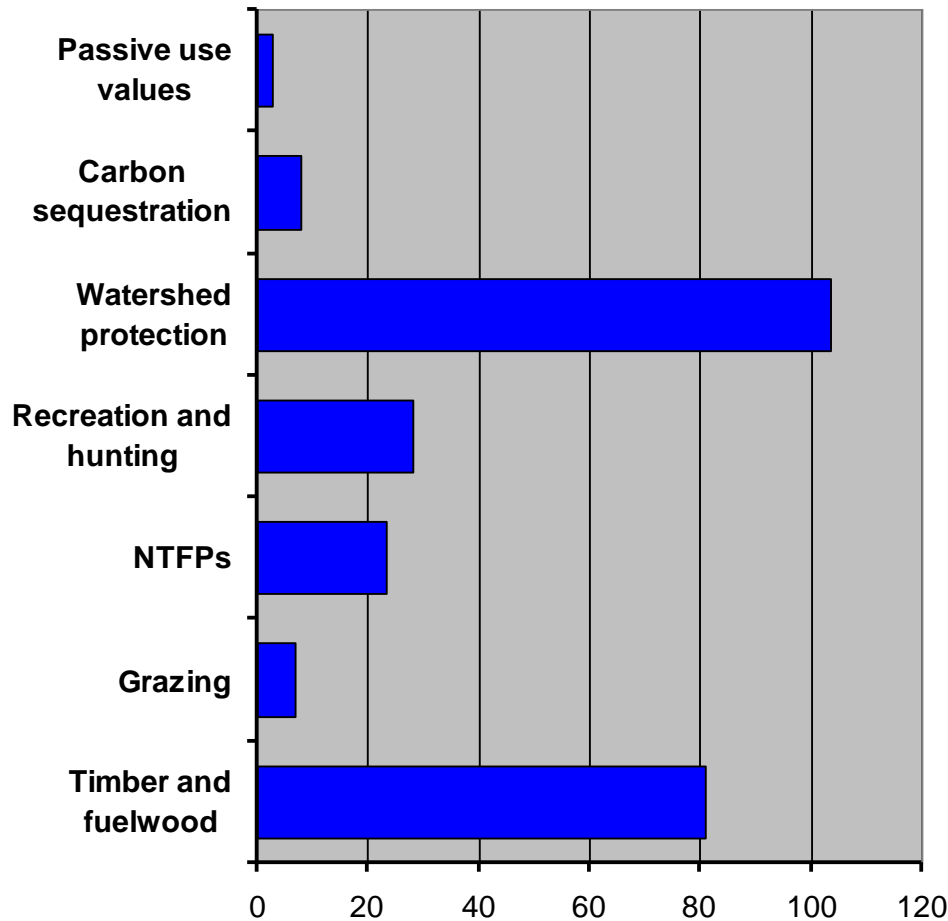
ipbes



The assessment report on
**POLLINATORS,
POLLINATION AND
FOOD PRODUCTION**

Economic value of non-marketed services can be high

Forests in Italy

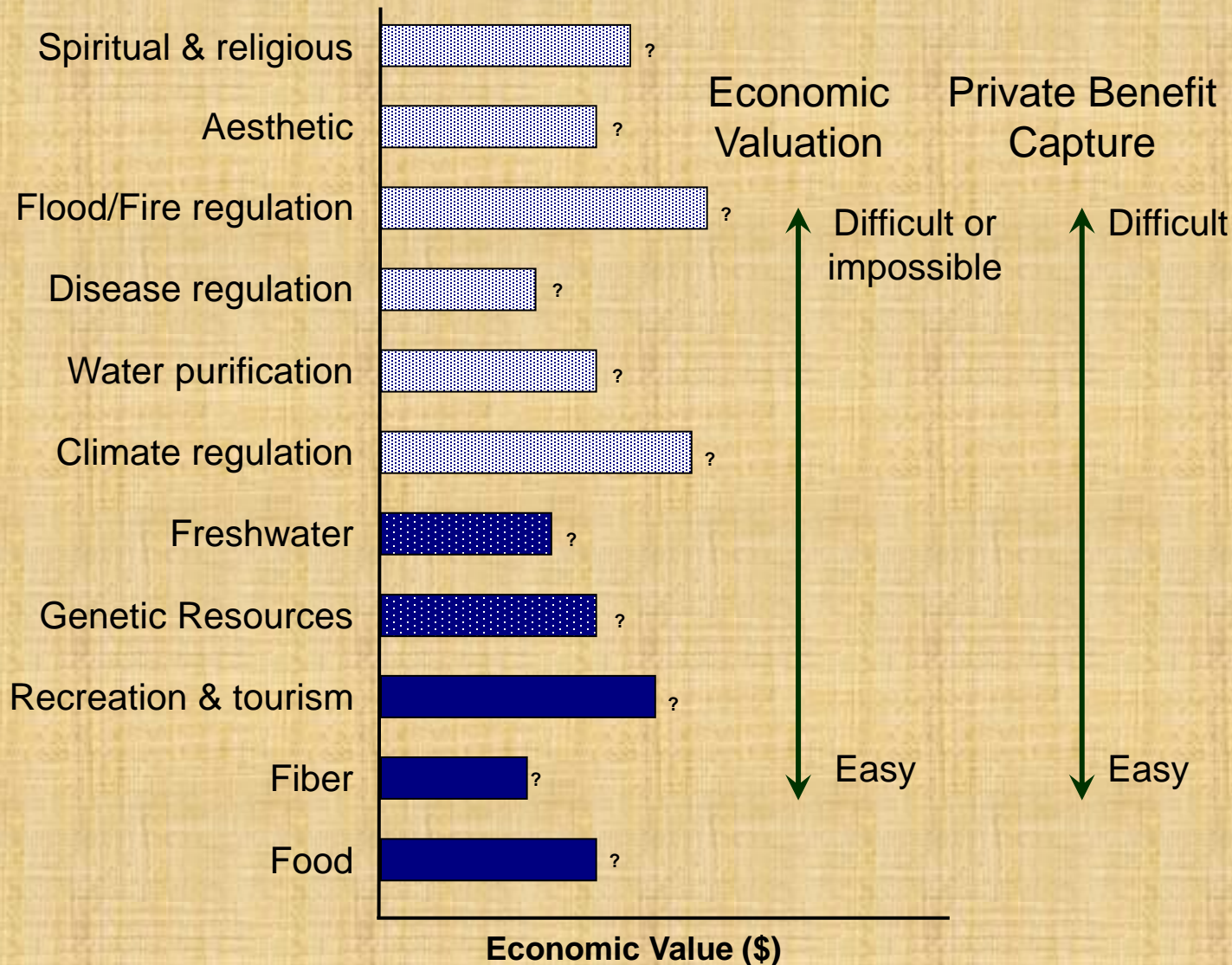


Forests in Croatia



Economic Value (\$ per hectare)

Many services are public goods



Human is always part of an
ecosystem!

Biological conditions for SD

1. For sustainability, ecosystems dispose of wastes and replenish nutrients by **recycling** all elements.
2. For sustainability, ecosystems use **sunlight** as their source of energy.
3. For sustainability, the **size of consumer populations** are maintained so that overgrazing or over-use does not occur.
4. For sustainability, **biodiversity** is maintained.

Large scale ecosystem restoration

- <http://www.youtube.com/watch?v=hZx2nsrJG3Y>
- <https://www.youtube.com/watch?v=IDgDWbQtIKI>

Lessons from the Chinese Experience: Loess Plateau Region

- Focus on agricultural production as well as on ecosystem functions
- Integrate agricultural economy in overall economic development process
- Sustainability requires decreasing pressure on the land
- It takes a long time



<http://www.youtube.com/watch?v=rQjKLYcu1PI>

Lessons from the Kenya Experience: Machakos District

- Secure Land Tenure encourages long term investment in farms
- Access to markets generates commercial production
- Integrated crop and livestock production facilitates better nutrient management
- Achievements can only be sustained if population pressure can be controlled over time



**An example of good forest
management and development**

Las Gaviotas, Colombia

http://www.youtube.com/watch?v=xogJew_nlko

https://www.youtube.com/watch?v=xogJew_nlko

To read

Lecture 5 Ecosystems

- *Sustainable Use and Management of Natural Resources*. Chapter 2 The planet and its natural resources. pp 26-45.
- Environmental Science. 2003. Chapter 7. *Society and landscape. Space intrusion and habitat destruction. The history of landscape change*. pp 187-195.
- Environmental Science. 2003. Chapter 8. *Changing the living world. Biodiversity*. pp 240-246.
- Intergovernmental Science-Policy Platform for Biodiversity and Ecosystem Services, IPBES *The global assessment report on biodiversity and ecosystem services. Summary for policymakers. Key messages*. pp 10-19.

BREAK

- **Describe some examples of losses of ecosystems in your area.**
- **Describe some examples of losses of ecosystem services in your area.**