SVENSKA ARALSJÖSÄLLSKAPET

Swedish Aral Sea Society

5. Ecosystems

Lars Rydén
Professor Emeritus
Uppsala University
Uppsala, Sweden

Farhod Ahrorov
Professor
Tashkent State Univ.
of Economics
Samarkand Branch

Björn Frostell
Professor Emeritus
Royal Institute of Technology
Stockholm, Sweden

For Uzbekistan by Karakalpak State University and SASS
Master Course on Sustainable Development and Sustainability Science
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Ecosystems are built of resources

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

Supporting ecosystem services

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

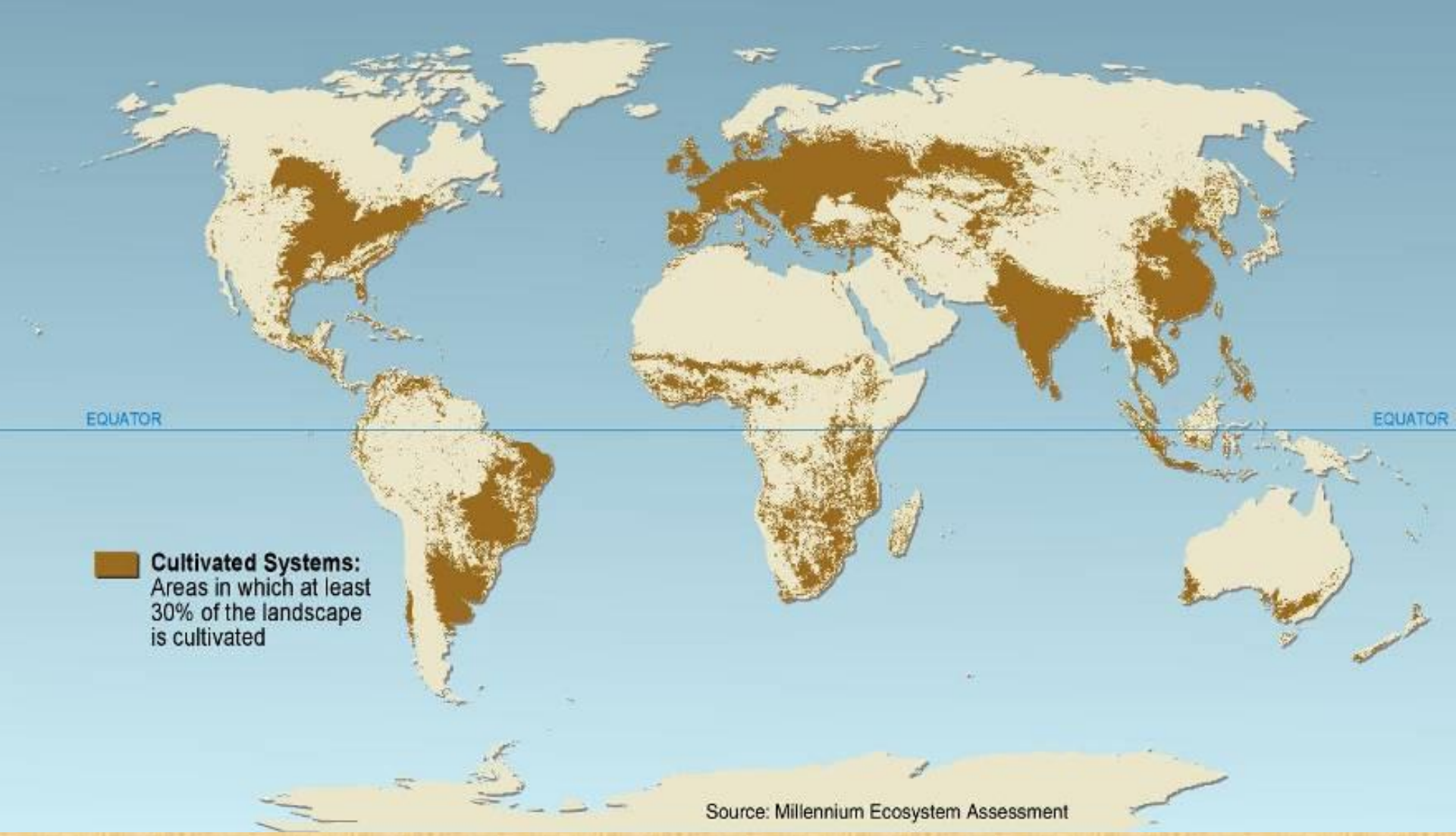
Land Area

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

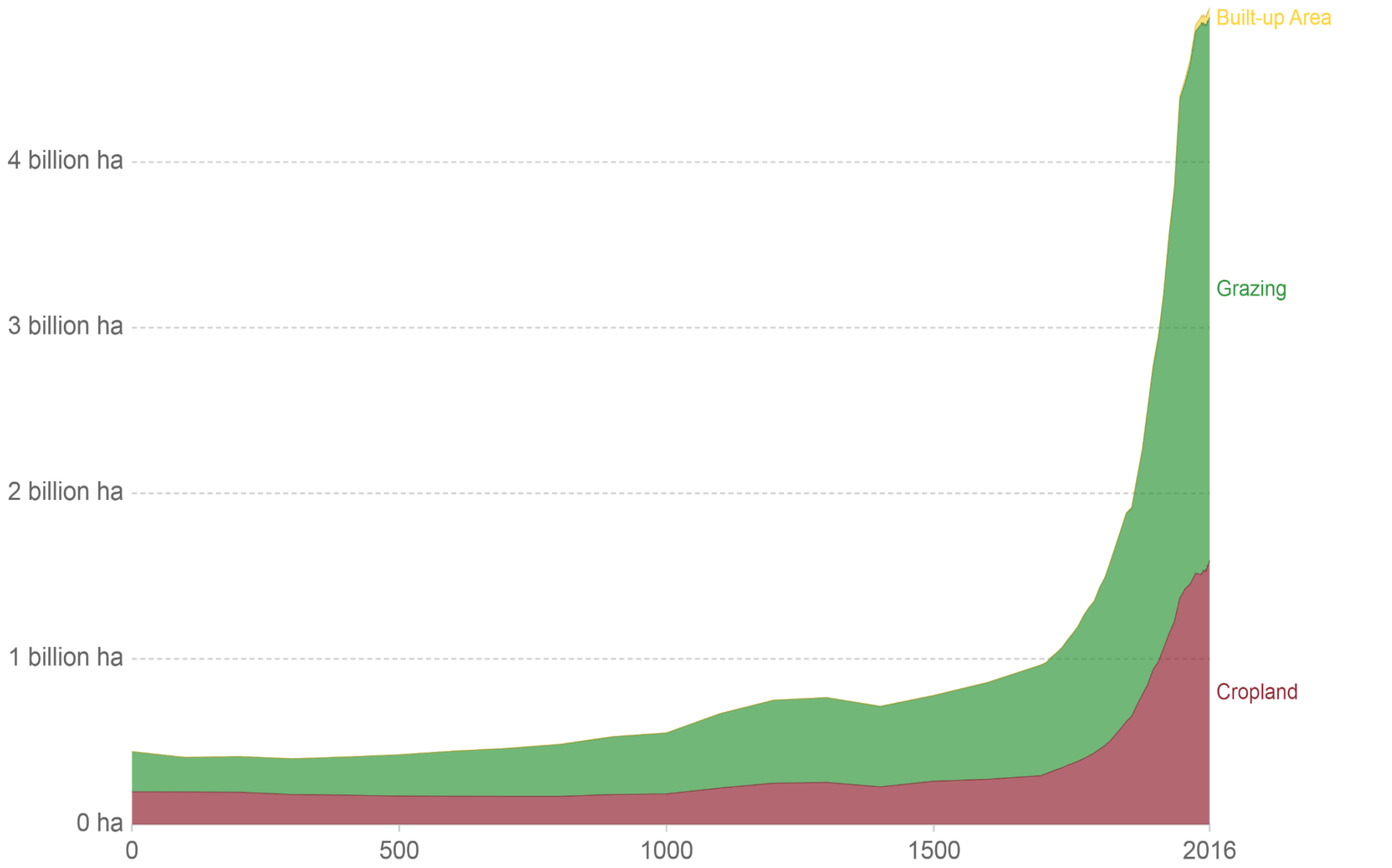
Land Use - Our World in Data 2019

https://ourworldindata.org › land-use


EQUATOR
EQUATOR
Cultivated Systems:
Areas in which at least
30% of the landscape
is cultivated
Source: Millennium Ecosystem Assessment

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

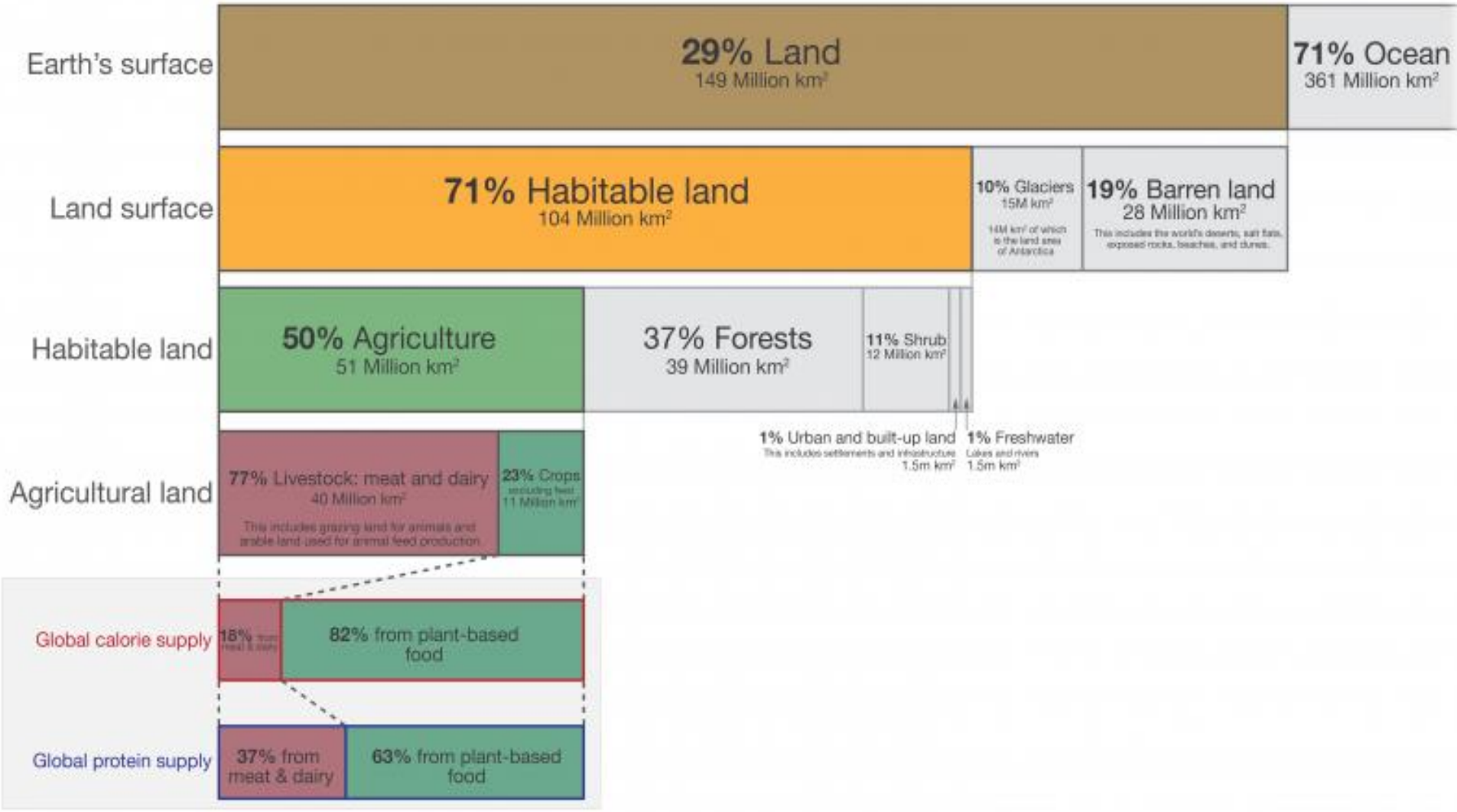
Total land area used for cropland, grazing land and built-up areas (villages, cities, towns and human infrastructure).



Source: History Database of the Global Environment (HYDE)

Global land use for food production

Our World in Data



Data source: UN Food and Agriculture Organization (FAO)

OurWorldinData.org – Research and data to make progress against the world's largest problems.

The soil

Ancient civilizations indirecty mined soil to fuel the growth as agricultural practice accelarated 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 Amazone basin today. The worlds 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

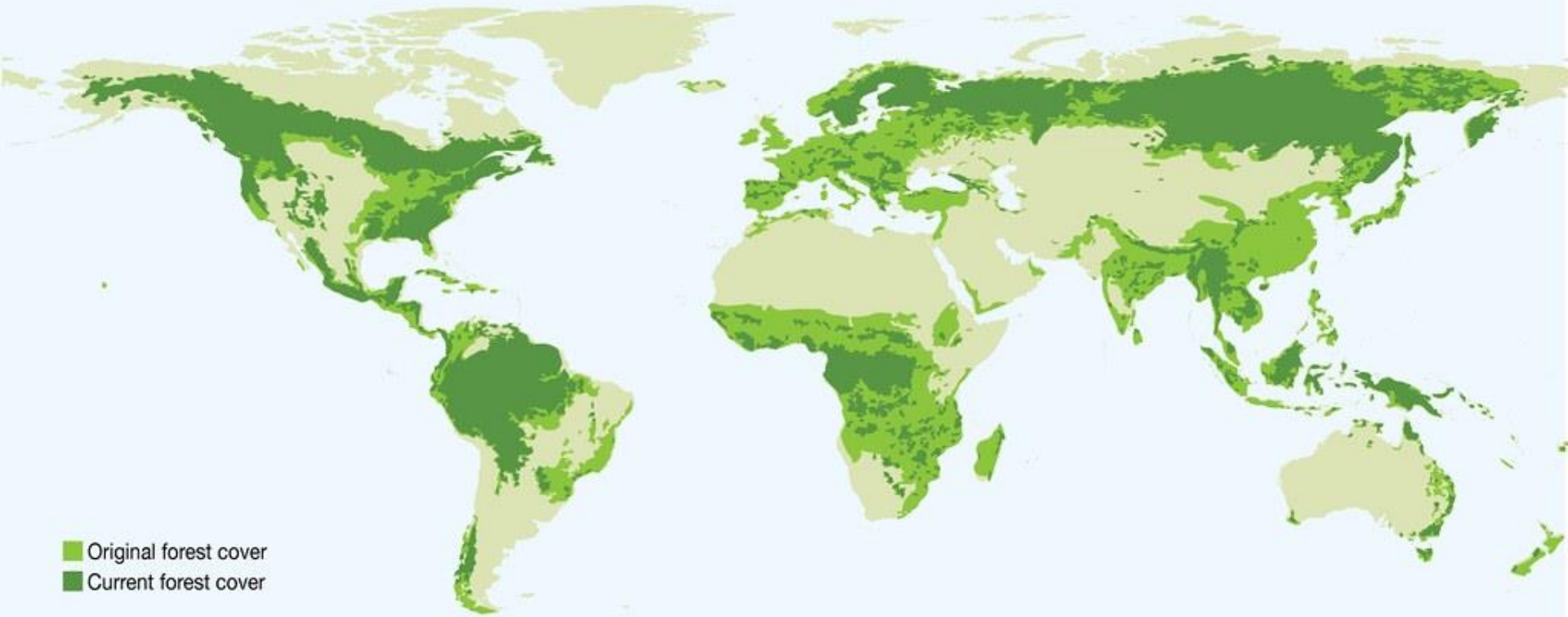
- Include soil in carbon funding

Legally

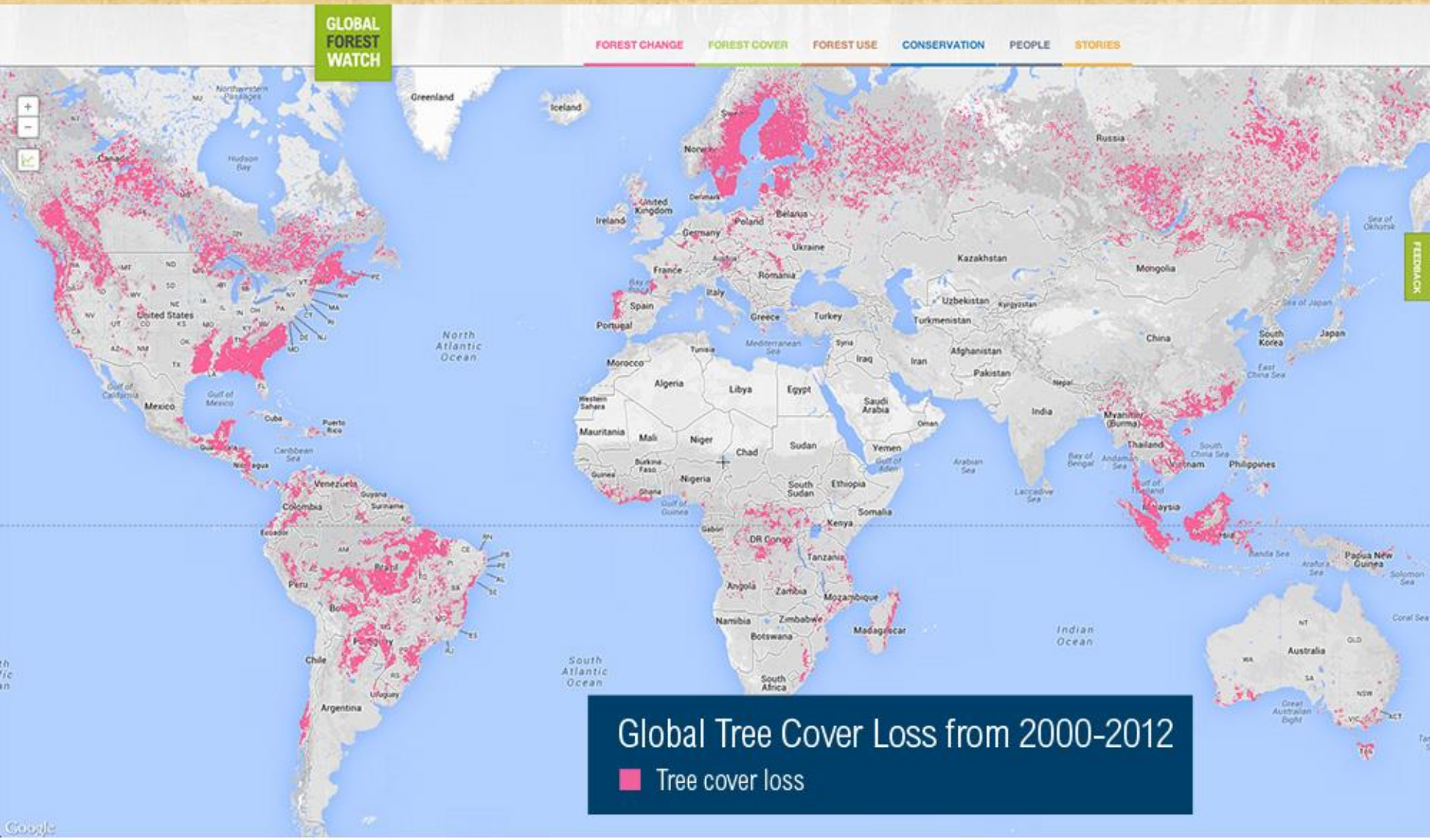
- Protect soil


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



www.globalforestwatch.org

WORLD RESOURCES INSTITUTE

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 CO_2 levels. IPCC scenario B1 is predicting 550ppm CO_2 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?

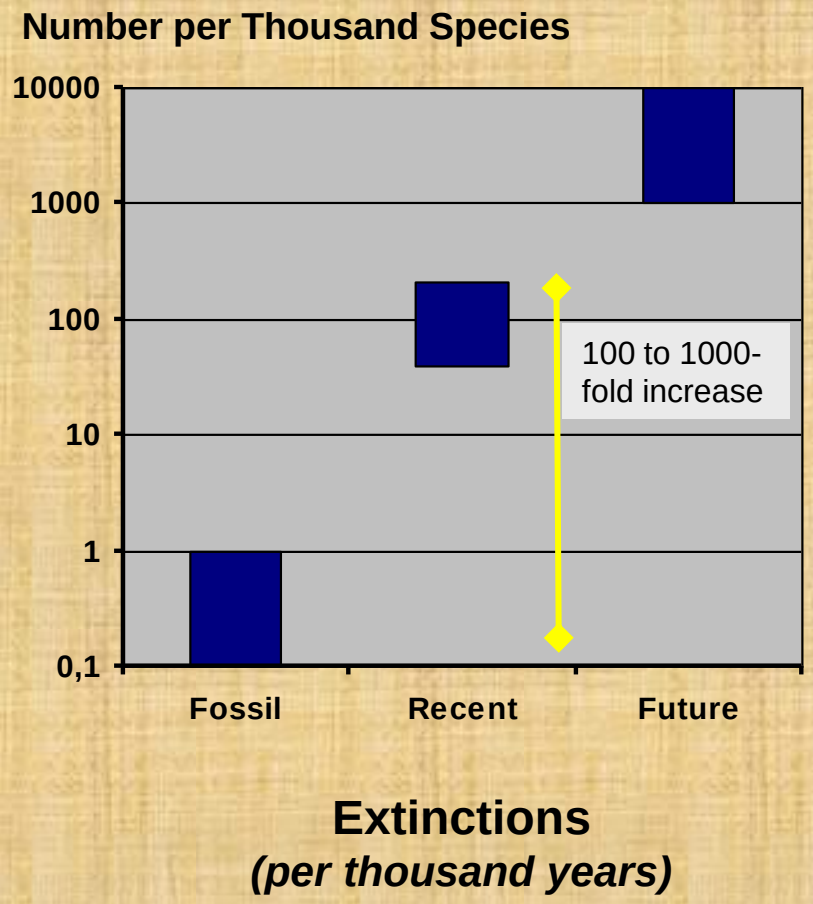
- **We find out that humans and their livestock now comprise about 96% of all mammal biomass on Earth. All other mammals – whales, sea lions, bears, elephants, badgers, shrews, deer, bear, cougars, rats, wolves, and all the rest – are about 4.2%.**

- **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.**

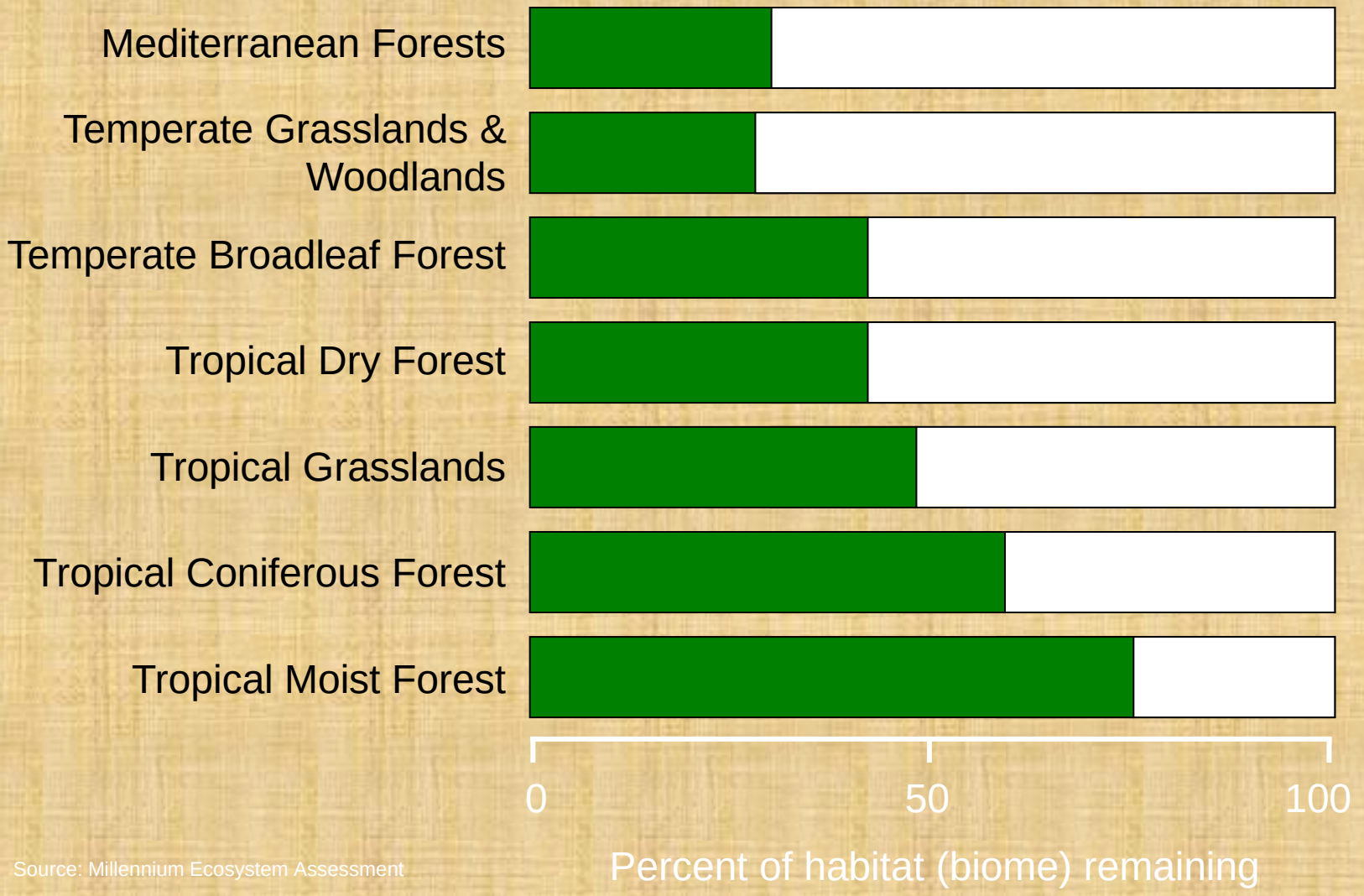
- https://www.greenpeace.org/international/story/17788/how-much-of-earths-biomass-is-affected-by-humans/

Change in Species Diversity
Rate of extinctions



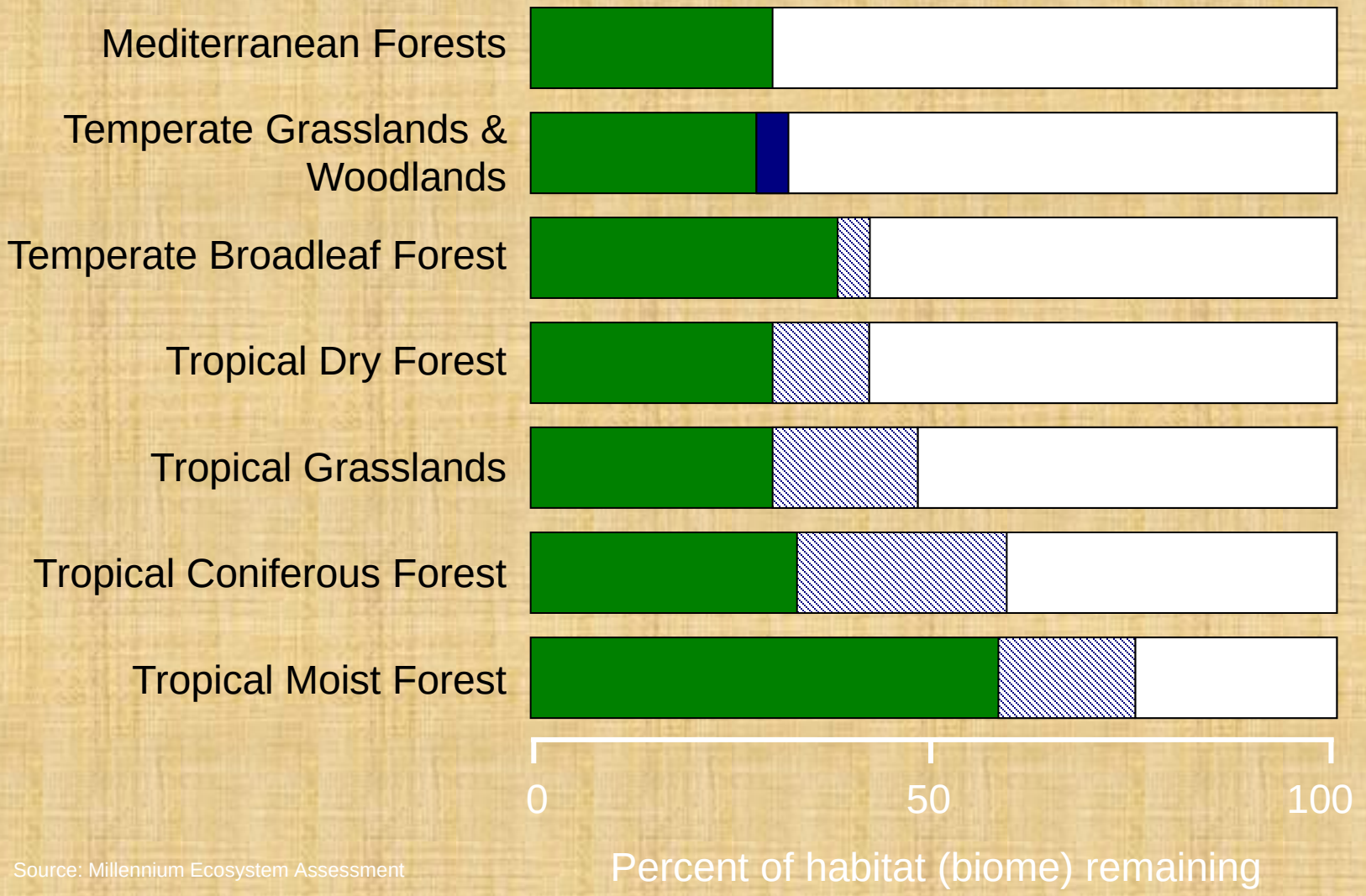
Source: Millennium Ecosystem Assessment

Habitat Loss to 1990



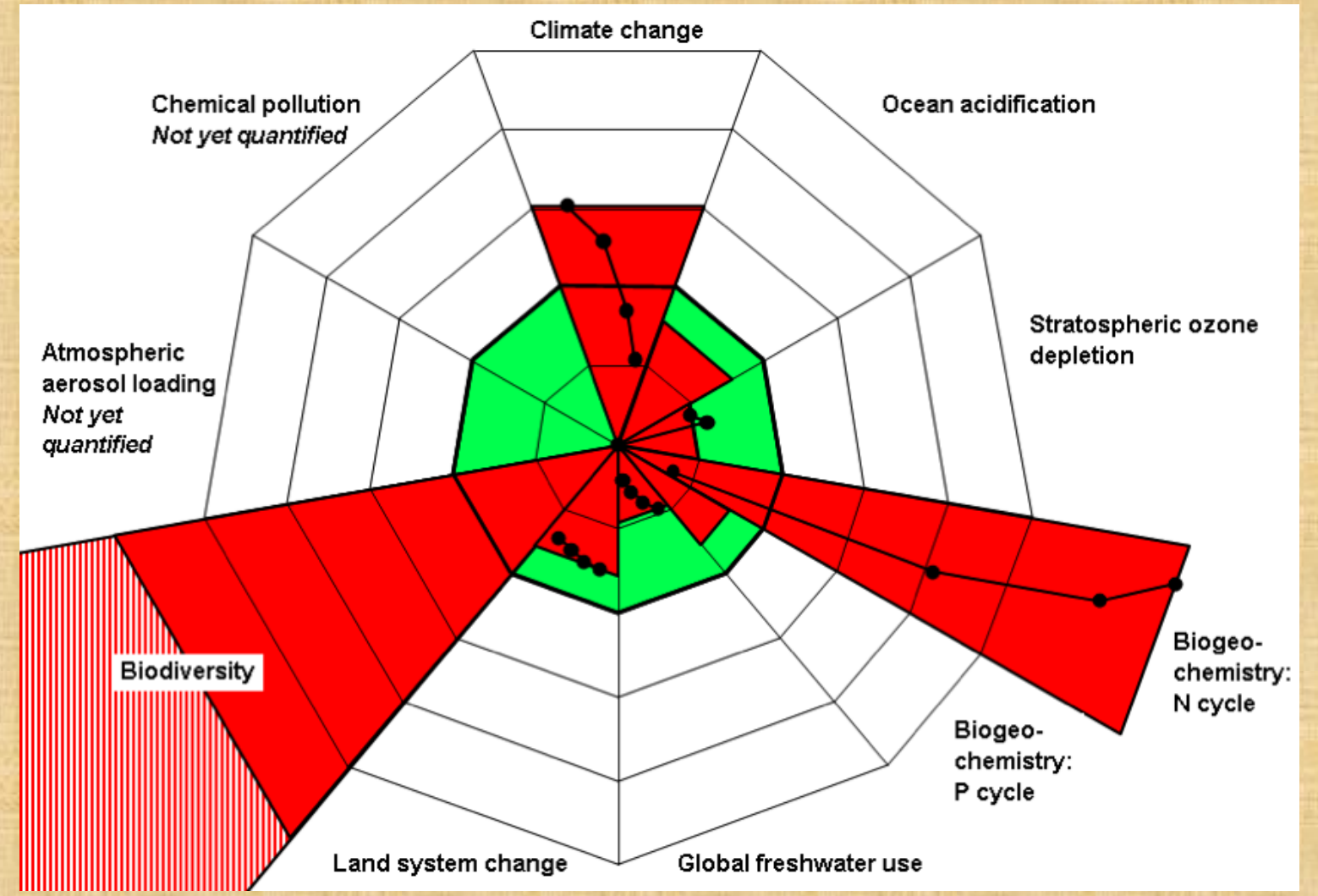
Source: Millennium Ecosystem Assessment

Habitat Loss to 2050 under MA Scenarios



Source: Millennium Ecosystem Assessment

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

Ecosystem services

Provisioning

Regulating

Cultural

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

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

Photo credit (top): Tran Thi Hoa (World Bank),

Regulating Services

Benefits obtained from regulation of ecosystem processes

- Air Quality Regulation
- Climate Regulation
  - Global (CO_2 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

Photo credits (top to bottom): W. Reid, Mary Frost, Staffan Widstrand, unknown.

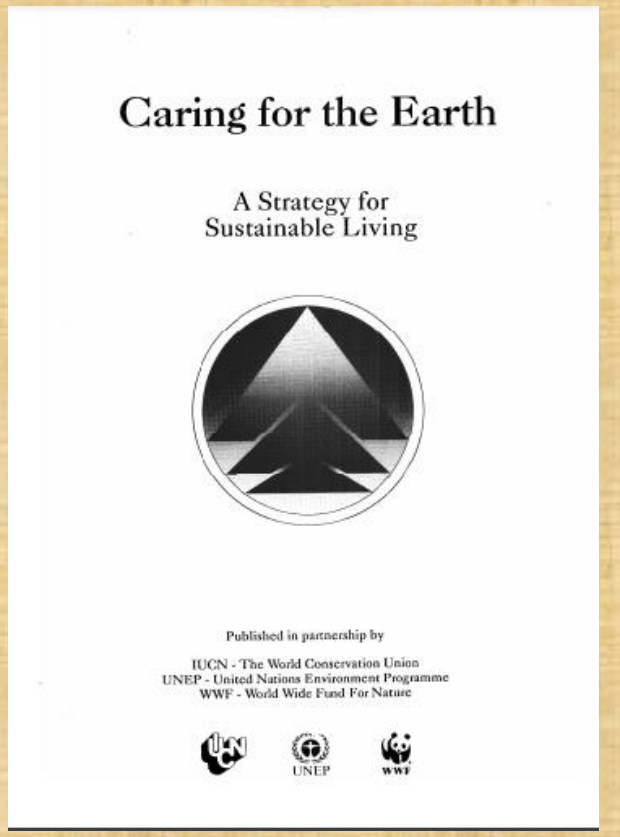
The UN Convention on Biological Diversity

- 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.

International Conservation Union, IUCN

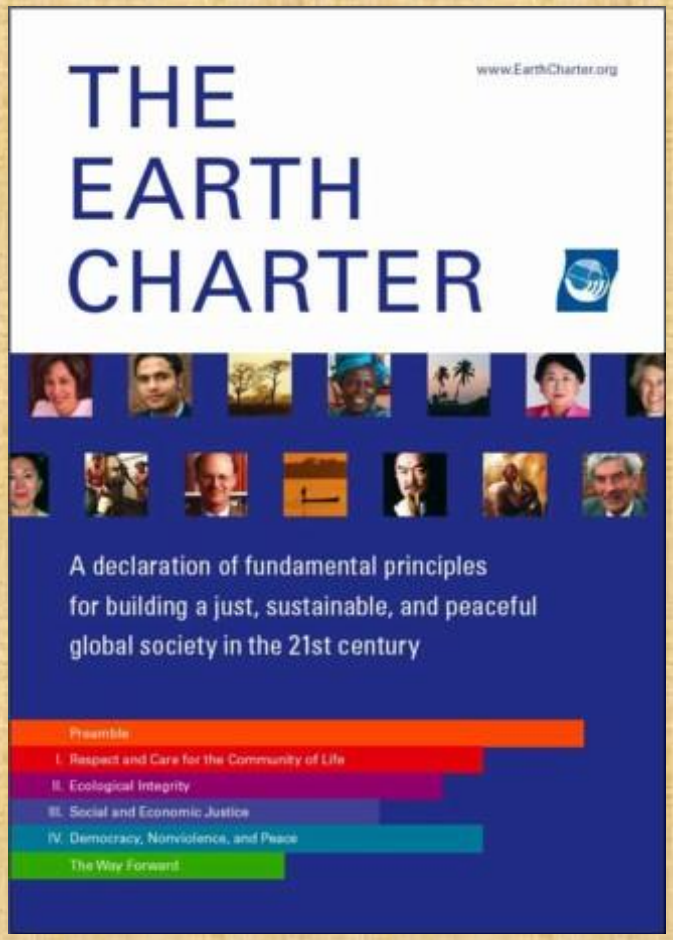
1. **A strategy for sustainable living (an ethics of SD)**
2. **Red list of threatened species**

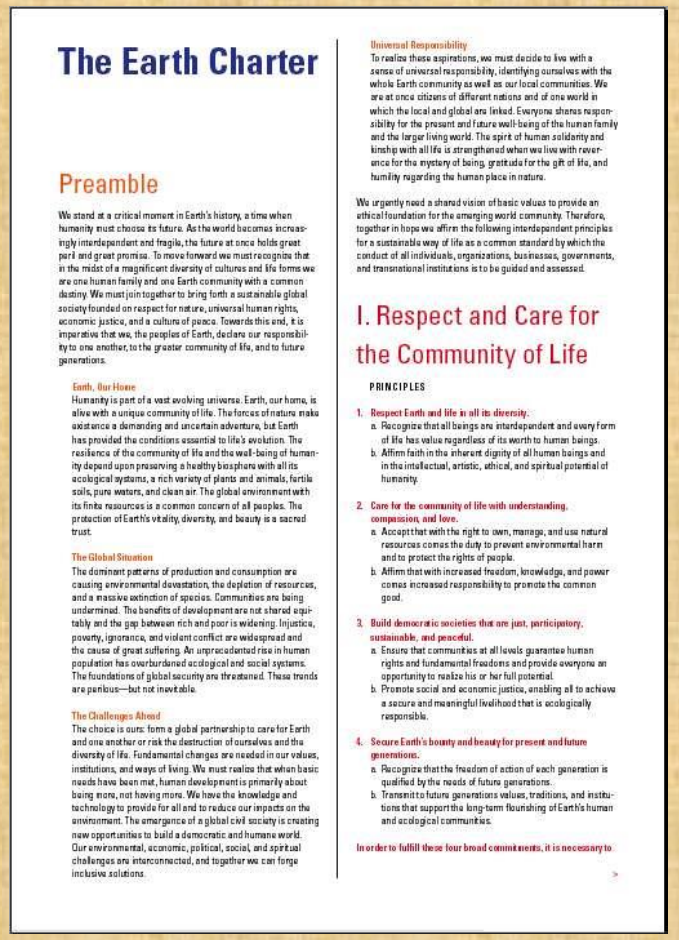


- **Established in 1964, the International Union for Conservation of Nature's Red List of Threatened Species has evolved to become the world's most comprehensive information source on the global extinction risk status of animal, fungus and plant species.**

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 ours: 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

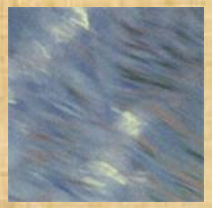
1. **Respect Earth and life in all its diversity.**
   a. Recognize that all beings are interdependent and every form of life has value regardless of its worth to human beings.
   b. Affirm faith in the inherent dignity of all human beings and in the intellectual, artistic, ethical, and spiritual potential 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

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.

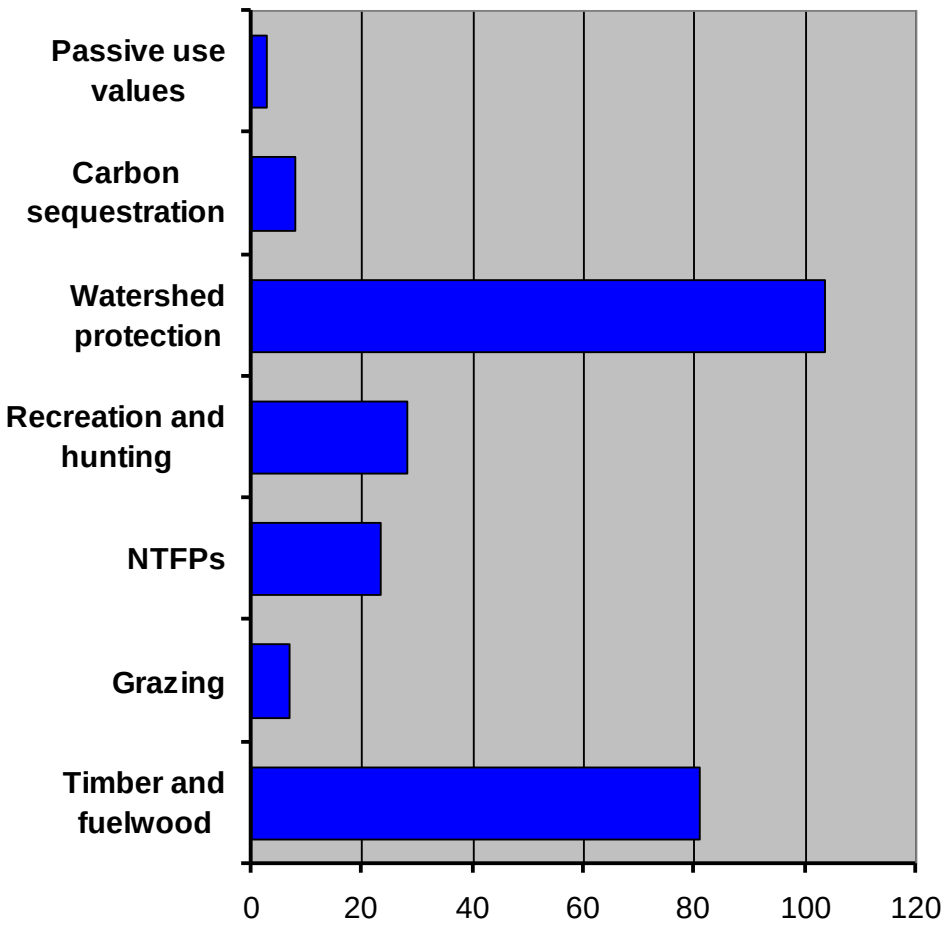
- It is meant to be a parallel to IPCC

- https://www.ipbes.net/

The assessment report on

POLLINATORS, POLLINATION AND FOOD PRODUCTION

Economic value of non-marketed services can be high

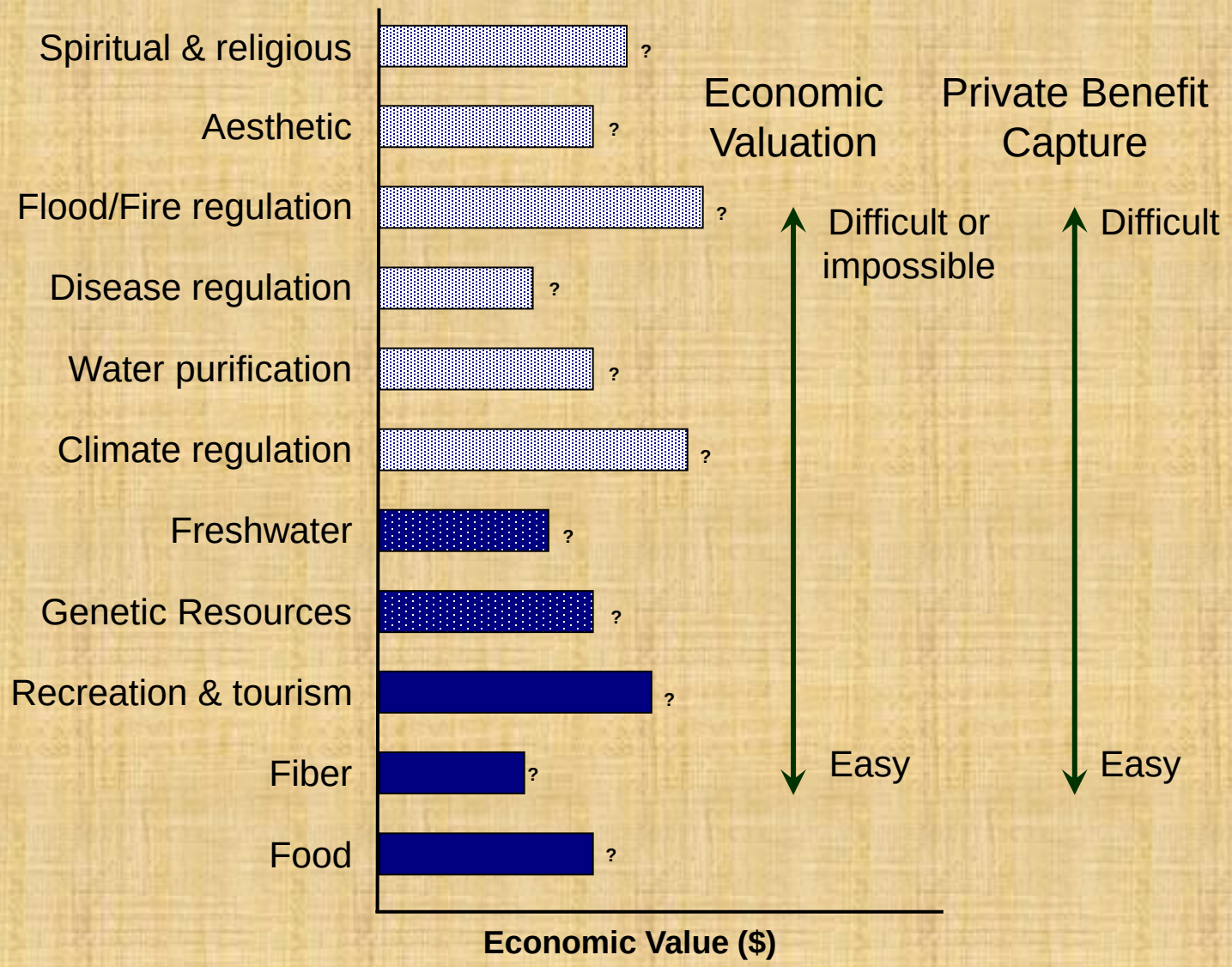


Economic Value ($ per hectare)

Source: Millennium Ecosystem Assessment

Photo: W. Reid

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=IDgDWbQtlKI

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 managment and development

Las Gaviotas, Columbia

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

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

BREAK

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

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

Ecosystems, land use, agriculture, forestry, water, salinization and biodiversity. Case of Uzbekistan

Farhod Ahrorov.

Samarkand branch of TSUE, Uzbekistan

Uzbekistan: General Info

- Area: 447,400 km^2
- Population: 35,271 mln. (01.01.2021)
- Population density: 78,83 inhabitants / km2
- Capital: Tashkent (3.0 million inhabitants)
- Currency: Sum (about 12500 UZS = 1 €)
- Official language Uzbek (since 1989)

Major industries

- Agriculture (cotton, cereals, fruits, vegetables, livestock)
- Food processing
- Textile industry
- Chemical industry
- Oil and gas processing
- Mining (gold, uranium, copper)
- Machinery and equipment
- Automotive
- Aircraft
- Construction

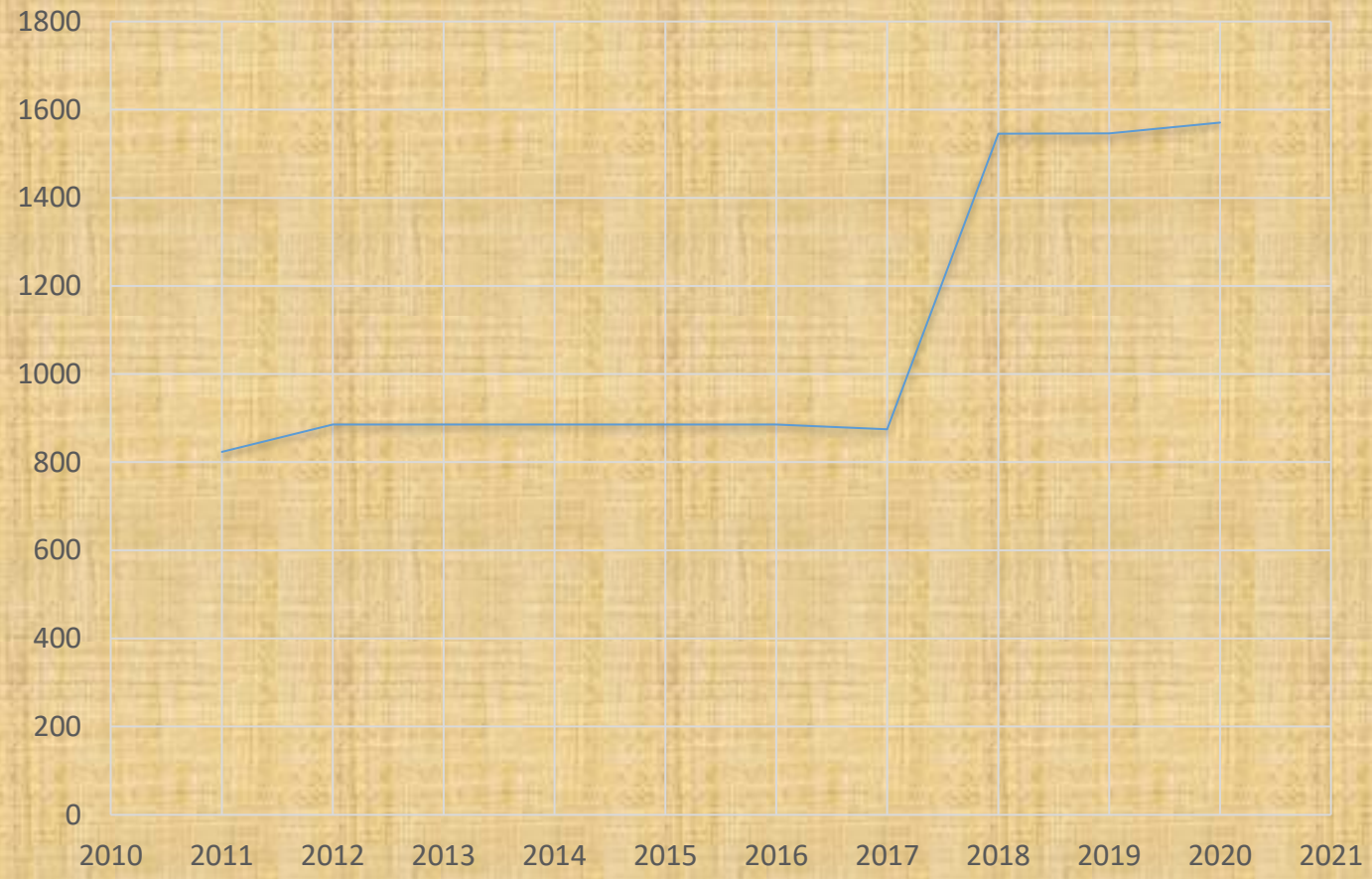
Agriculture in Uzbekistan

- agr. used area 24,057 million hectares = 65.95% of TA
- 13.9% of arable land, 71.17% pasture, 10.68% forests
- Share of GDP: 2020-43,8%
- about 48% of the population lives in rural areas

Source: Ministry of Agriculture 2021

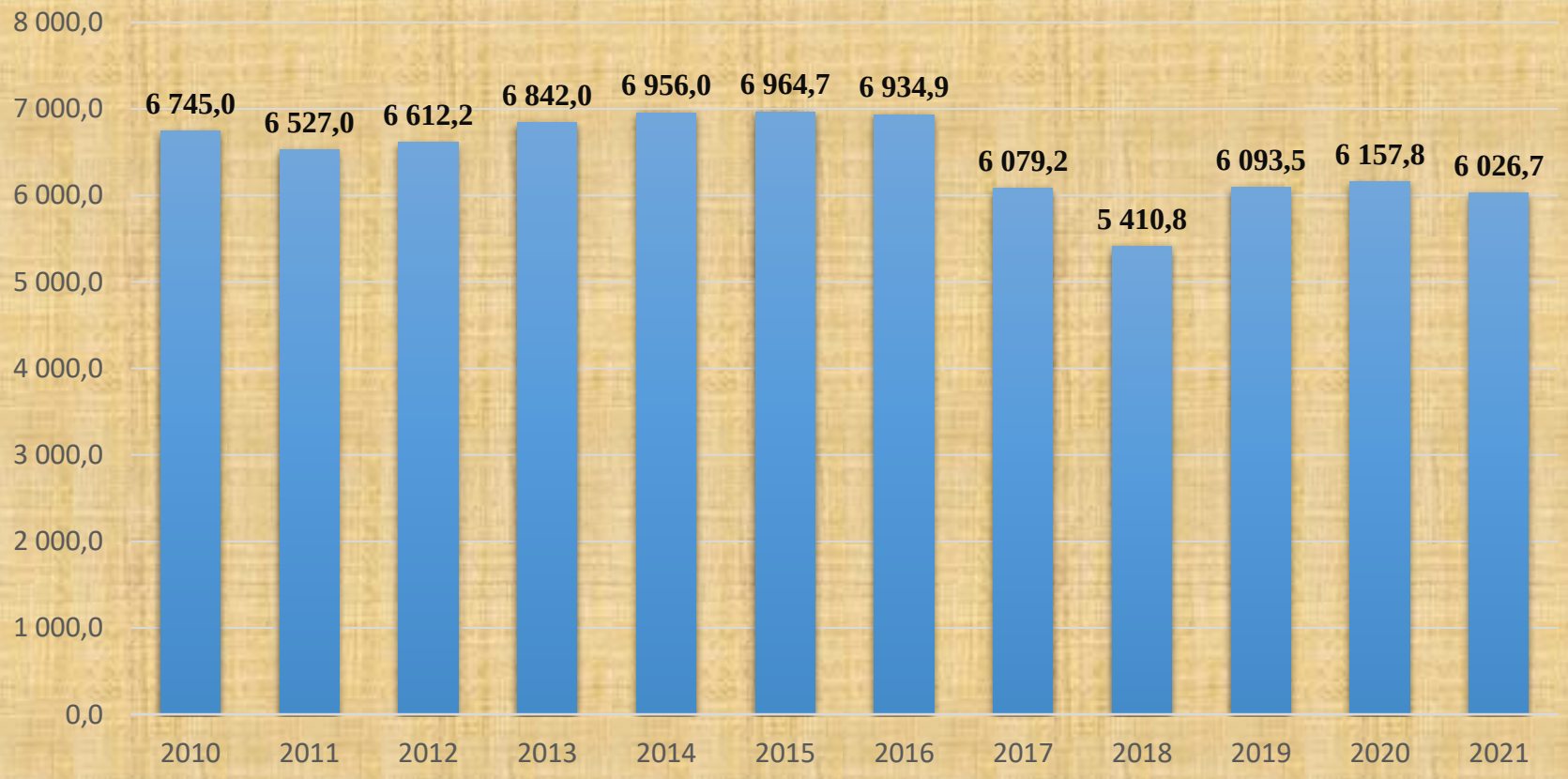
Protected natural areas

(thousand hectares)



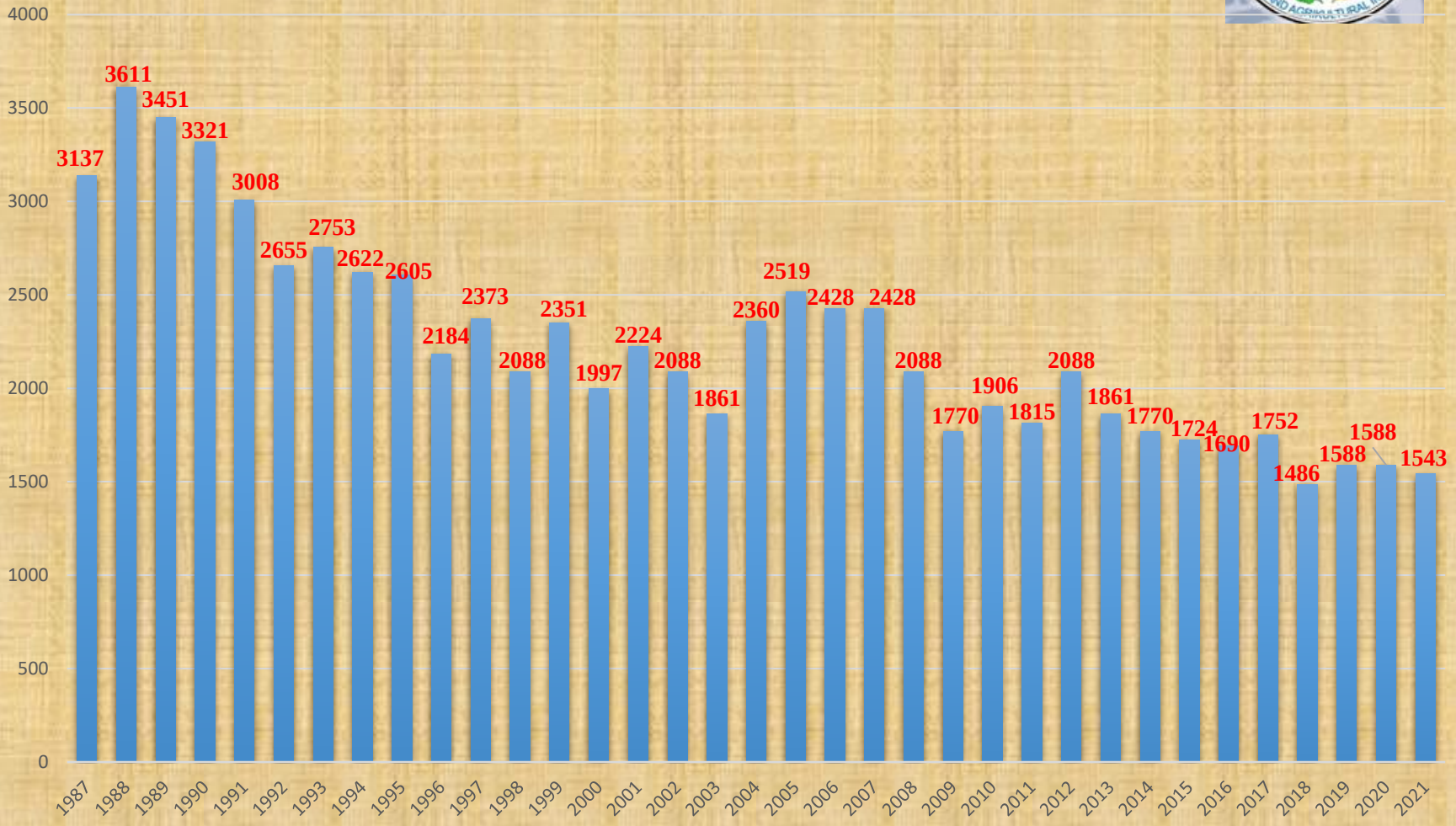
Sourse: stat.uz

Employed in agriculture, in thousands



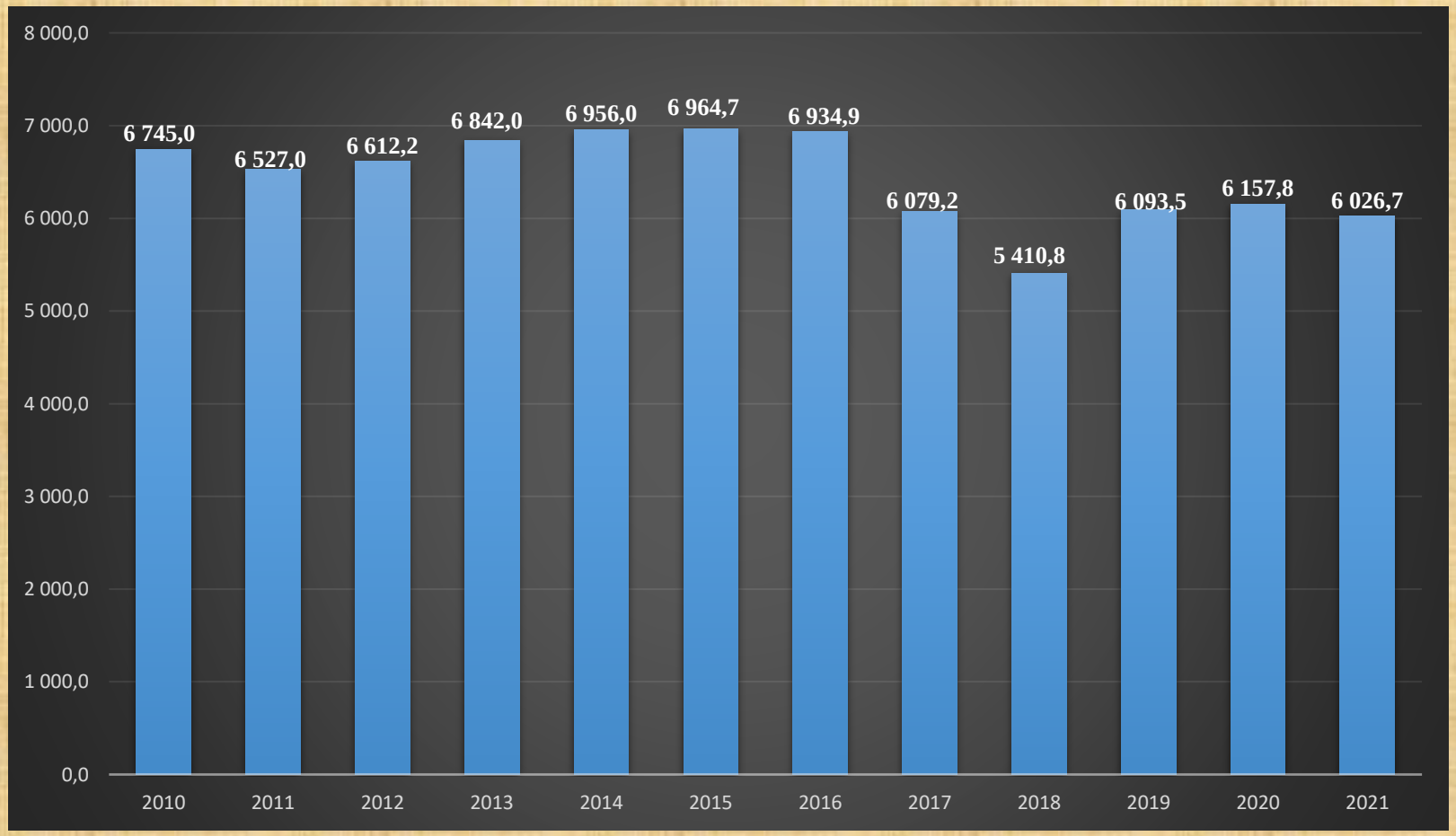
Source: stat.uz 2021

Cotton production in Uzbekistan, th.ton



Source: https://www.indexmundi.com/agriculture/?country=uz

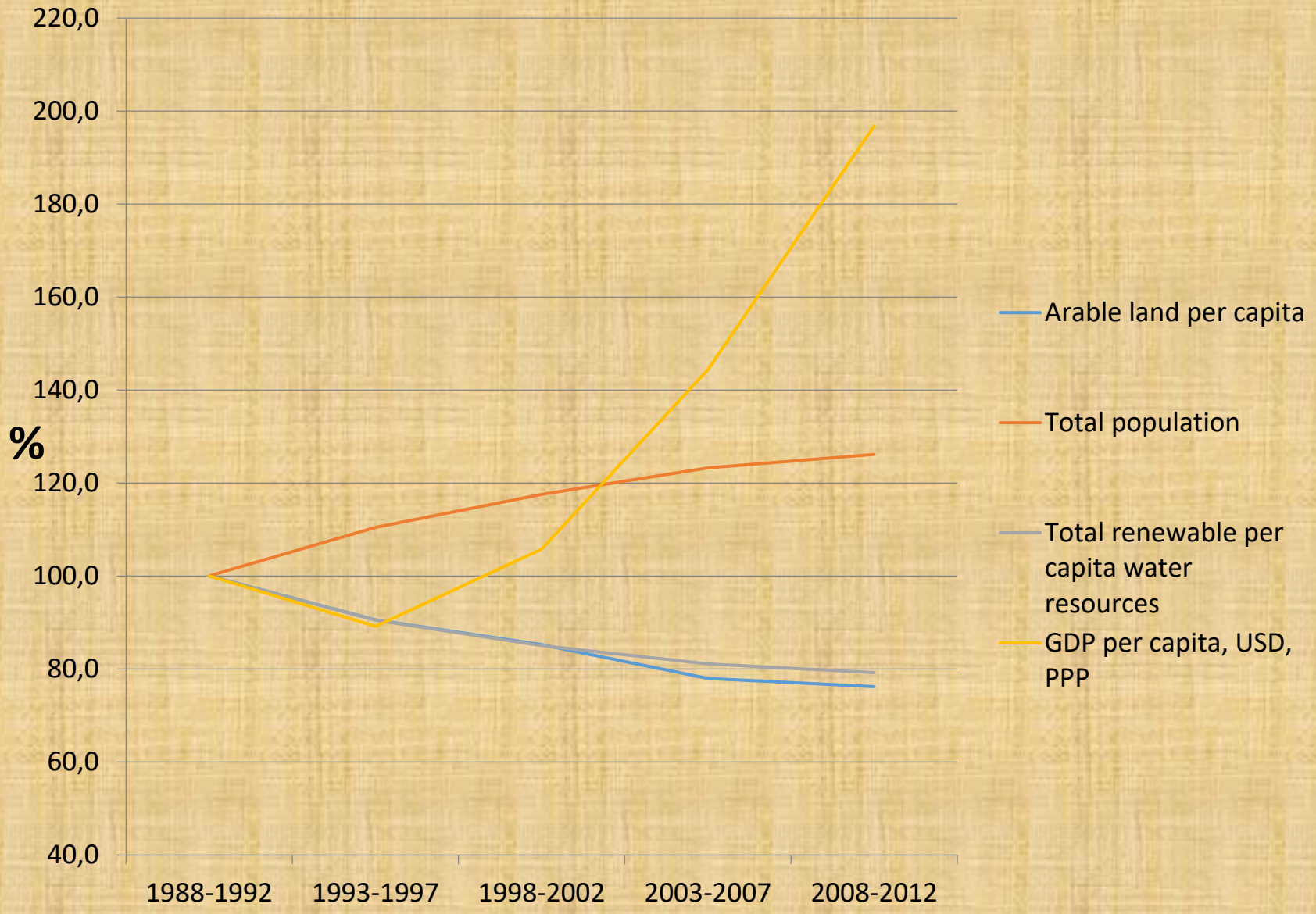
Wheat production in Uzbekistan, th.tonnes



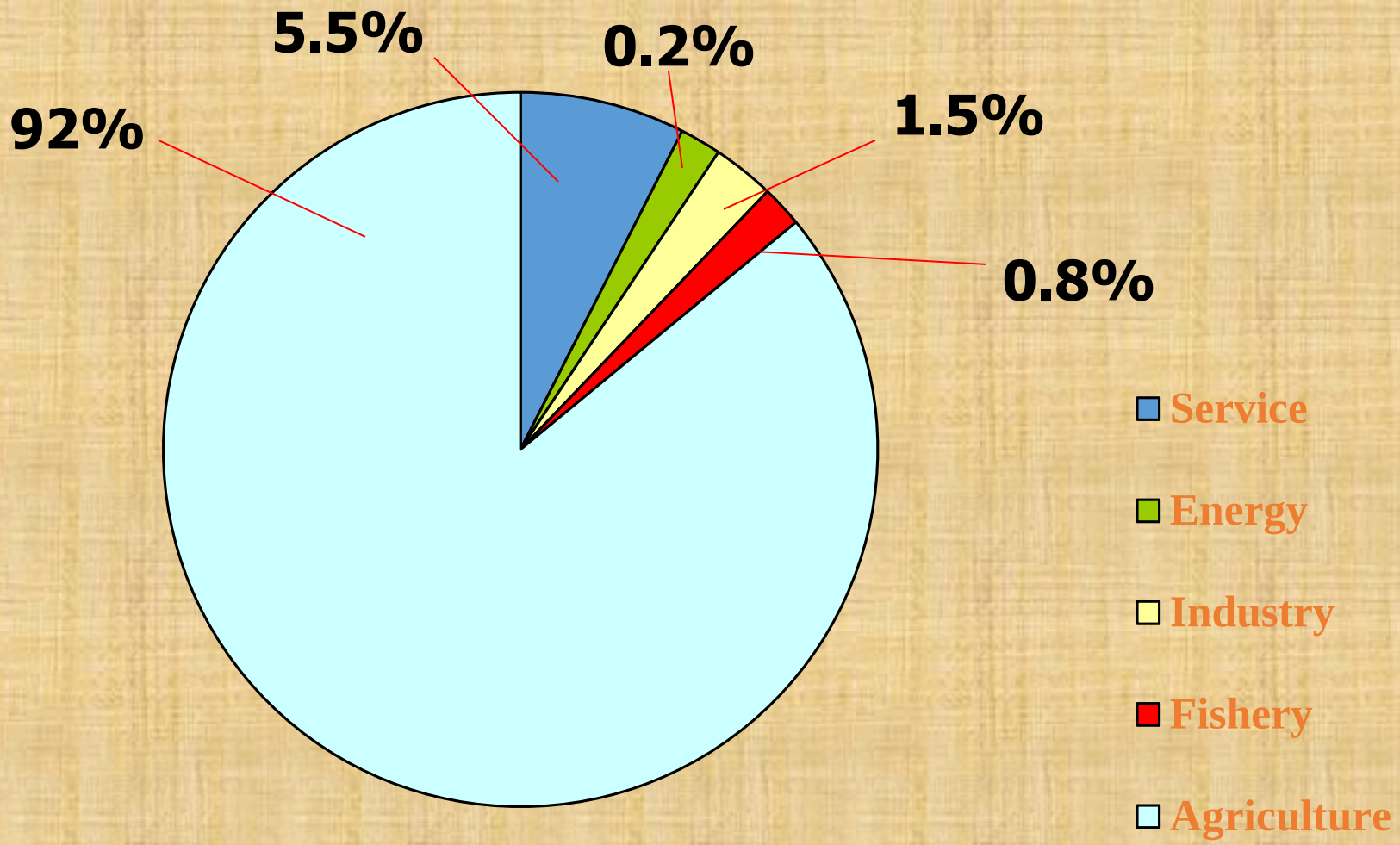
Source: stat.uz

Problems of agriculture of Uzbekistan

Pressure to natural resource in agriculture of Uzbekistan



Water use by branches of economy



Land degradation in the Uzbek agriculture

- Irrigation erosion - 722 thousand ha
- Wind erosion - 1,812 thousand ha
- Due to the erosion yield losses in cotton 450-500 thousand tons per year

Source: Soil and cadastre committee Uzbekistan, 2012

Possible recommendations for a Sustainable use of resources (I)

- Charges on irrigation water would undoubtedly contribute to improved water management;
- Therefore is a prerequisite for the introduction of water pricing and land pricing, the liberalization of markets;
- Reallocation of taxes from land tax to water tax(payment).
- As consequence, investments on newer methods and technologies such as drip or sprinkler irrigation will be profitable.

Possible recommendations for a Sustainable use of resources (II)

- No monoculture, crop rotation of cultures
- Modification of the design of the leasehold right to be given;
- Protection against erosion;
- Liberalization of prices and markets;
- Measures to improve the environment (market access, pricing system, etc.);

Thank you!

The Fräkentorp centre for climate transformation in agriculture and forestry

Björn Frostell
Former Professor Industrial Ecology KTH
Senior Consultant Ecoloop AB
Vice President, Swedish Aral Sea Society

Short presentation in the course Sustainable Development and Sustainability Science
2022-03-30

ECOnomy - The Fräkentorp Centre for Climate Transformation in Agriculture and Forestry

The Vision

The ECOnomy Agriculture and Forestry Centre gathers people committed to develop and spread ecologically sustainable culture systems and techno logical solutions for production of food, forest raw materials and ecosystem services. Here are also included a strive to maintain and develop socially sustainable work conditions and a high level of animal and ecosystem ethic

Expected outcomes

- A development journey towards a more sustainable farming and forestry for small and middle-sized farming and forestry activities
- Farming and forestry activities much more self supported with renewable energy leading to a lower climate impact and higher farming resilience
- A more climate friendly supply of protein (meat, pork, poultry fish and vegetable protein), milk and milk products as well as grains
- Forestry activities with an increased continuous forestry leading to a hig wood stock in the forest (carbon sequestration) improved water cycle functioning, higher plant diversity and in the end increased biodiversity,

ECOnomy - The Fräkentorp Centre for Climate Transformation in Agriculture and Forestry

Existing ecologically oriented activities at the Fräkentorp

- Ecologic milk production based on 60 cows
- Ecologic meat production based on bullocks
- Ecologic feed production on grasslands
- Production of forest raw materials on 300 ha forest land (spruce, pine and birc
- Photovoltaic energy production with an installed capacity of 160 kW
- Production of heat in wood pellet furnaces (capacity 80 + 80 kW) fuelled with wood residues from own forestry
- Production of biocarbon in one of the two wood residue fed furnaces
- Production (in demonstration scale) of fish fry and full size fish of Tilapia in an aquaponic system
- Provision of ecosystem services in a newly constructed wetland with the main to capture phosphorus from upstream farmlands

ECOnomy - The Fräkentorp Centre for Climate Transformation in Agriculture and Forestry

Ecologically oriented activities under discussion

- Start up of a purchased 300 m^3 biogas plant for treatment of manure and other organic wastes
- Establishment of a local/regional network of farmers for mutual learning and exchange of knowledge
- Construction of a wetland for improved pike reproduction (a so called pike facto
- Financing activities aimed at evaluating the overarching achievements
- Start-up of organized visit and education programs

Pastures – several hundred years old - at Fräkentorp farm

The Bjursätter barn at Fräkentorp with

Spruce production forest at Björn Frostell's farm in northern Sweden

ECOnomy - The Fräkentorp Centre for Climate Transformation in Agriculture and Forestry

Main outbuildings with 125 kW photovoltaic system on roof structure and 300 m^3 biogas plant main tank at Fräkentorp farm

Aquaponic pilot plant in Bjursätter barn at Fräkentorp farm

Tilapia fry in the Bjursätter barn at Fräkentorp farm

Fräkentorp 300 m^3 steel tank biogas digester under installation spring 2022

Barn roof at Fräkentorp farm covered with photovoltaic cells with a max generation capacity of 125 kW

Phosphorus removal pond at a small creek mouth into lake Björken at Fräkentorp farm, Malmköping , Sweden; 2022-03-29 time 07.15

To read

The Fräkentorp centre for climate transformation in agriculture and forestry, short Booklet in English dated 2022-03-30

Thank you!

Contact: bjornfrostell@gmail.com

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.