Biodiversity and the future of food security

José Sarukhán
CONABIO

3rd. International conference: Biodiversity and Food Security - From Trade-offs to Synergies

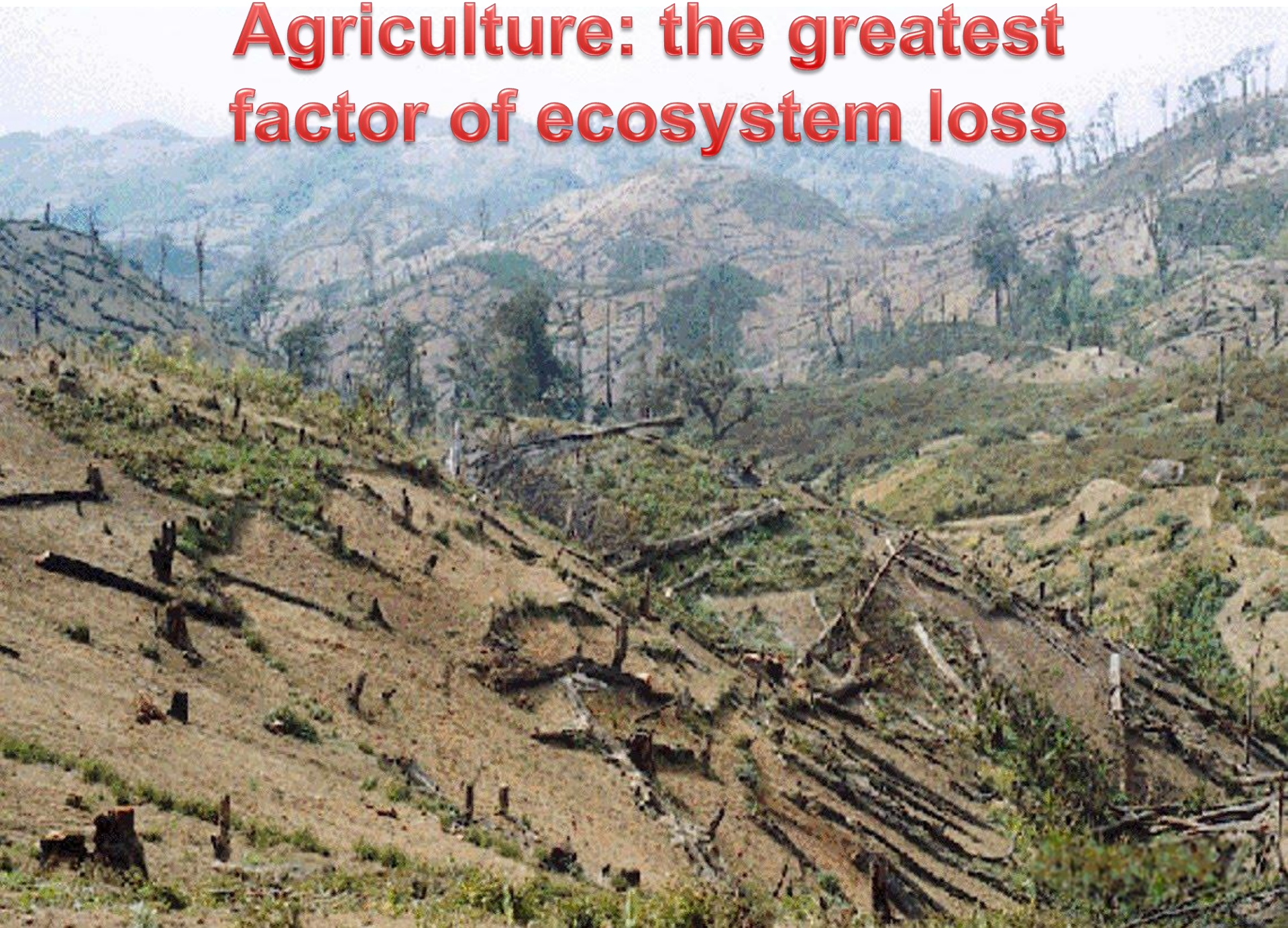
Aix-en-Provence 28-31 October 2014

Food security and food sovereignty

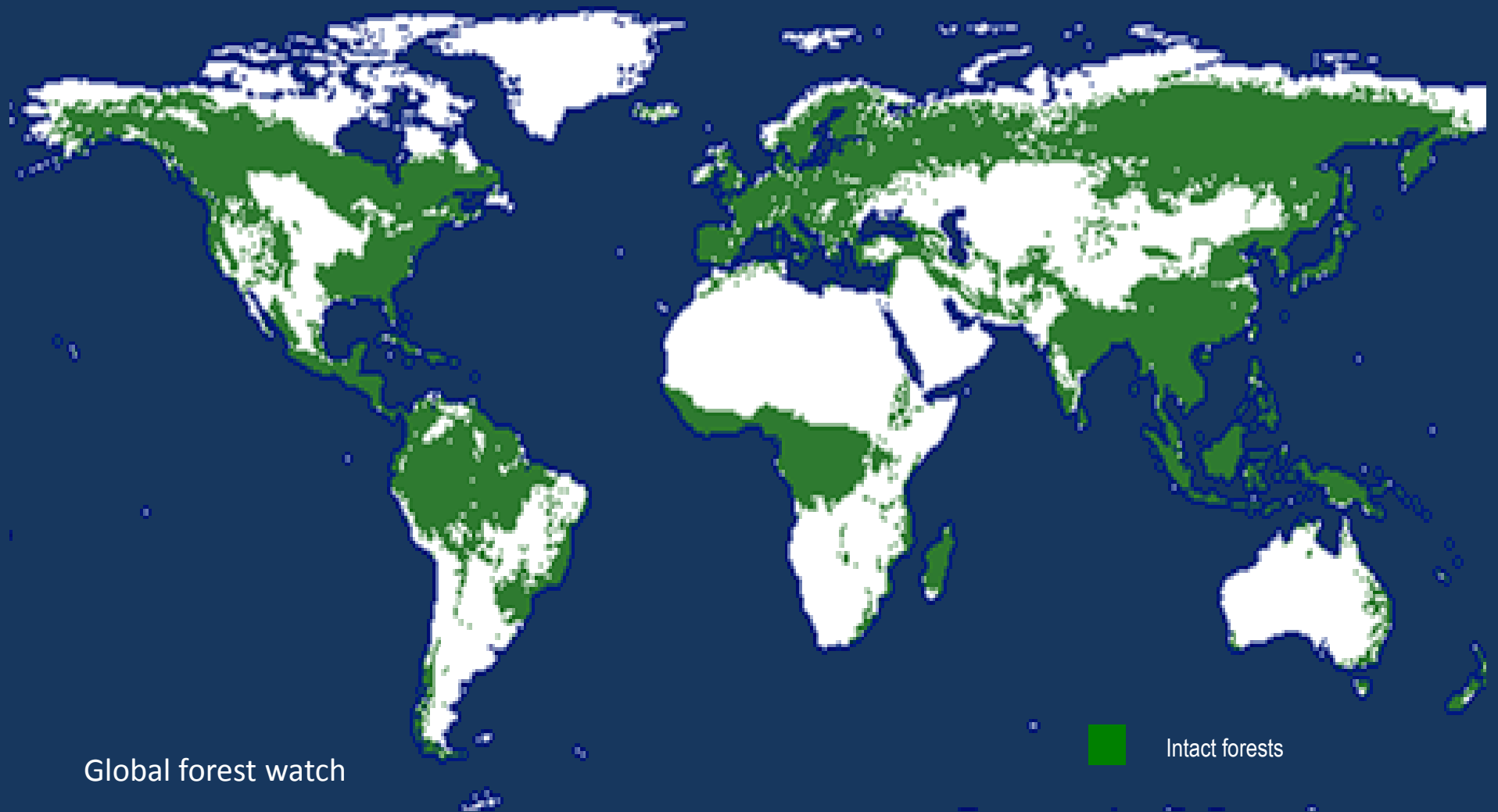
- **Security**: When all people, all the time have physical, social and economical access to sufficient, safe and nutritious food to satisfy its dietary requirements and food preferences for an active, healthy life (FAO)
- **Sovereignty**: The right of people to healthy and culturally appropriate sustenance, produced with ecologically sustainable methods and the right to choose its own agricultural and alimentary systems (*La via campesina*, 2007)

1. How the population of mid-21st century will be fed, will define the degree of conservation of the remaining natural ecosystems in the Planet

Agriculture: the greatest factor of ecosystem loss

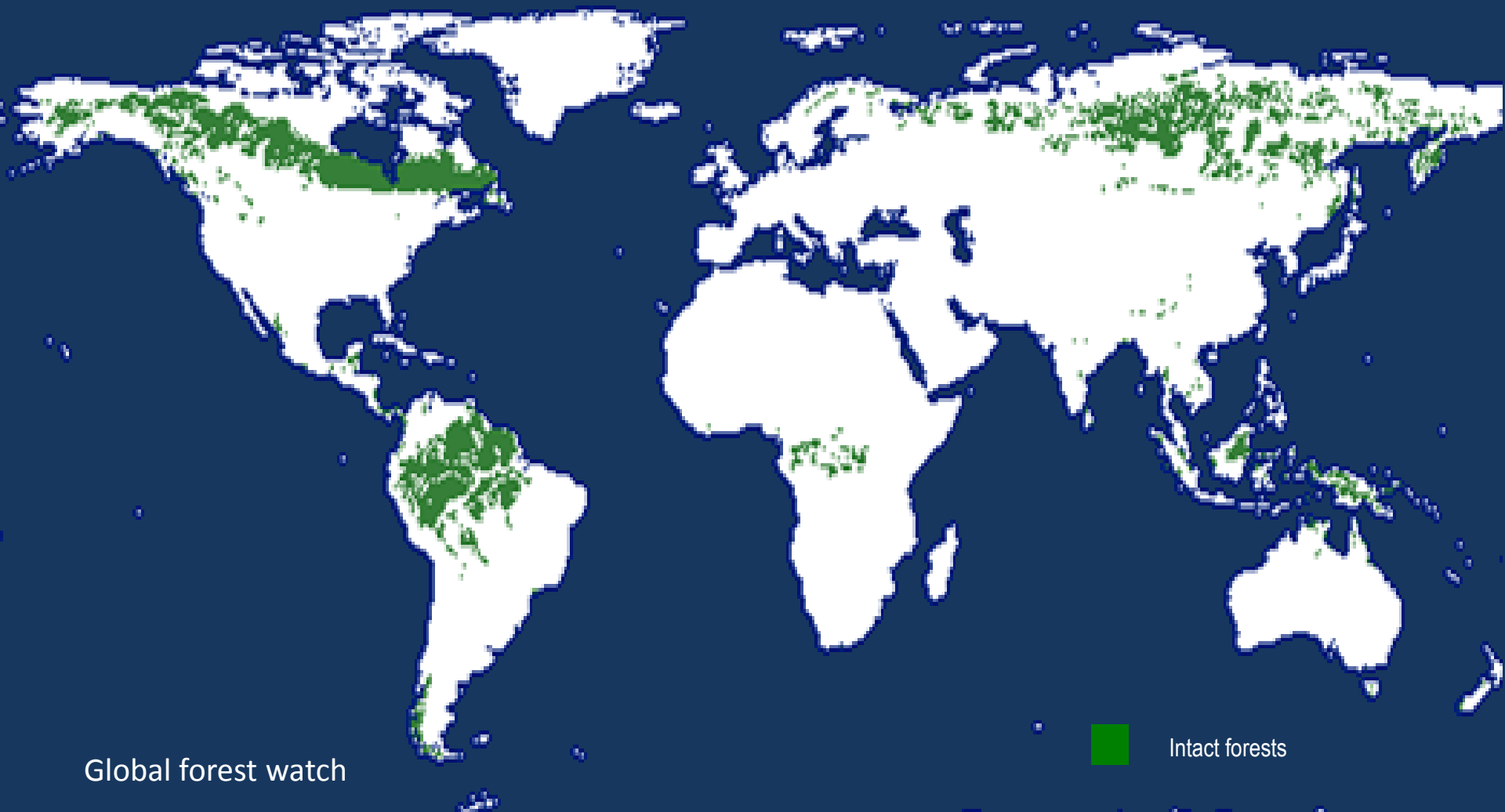


Intact forests 8,000 years ago



Global forest watch

Intact forests today

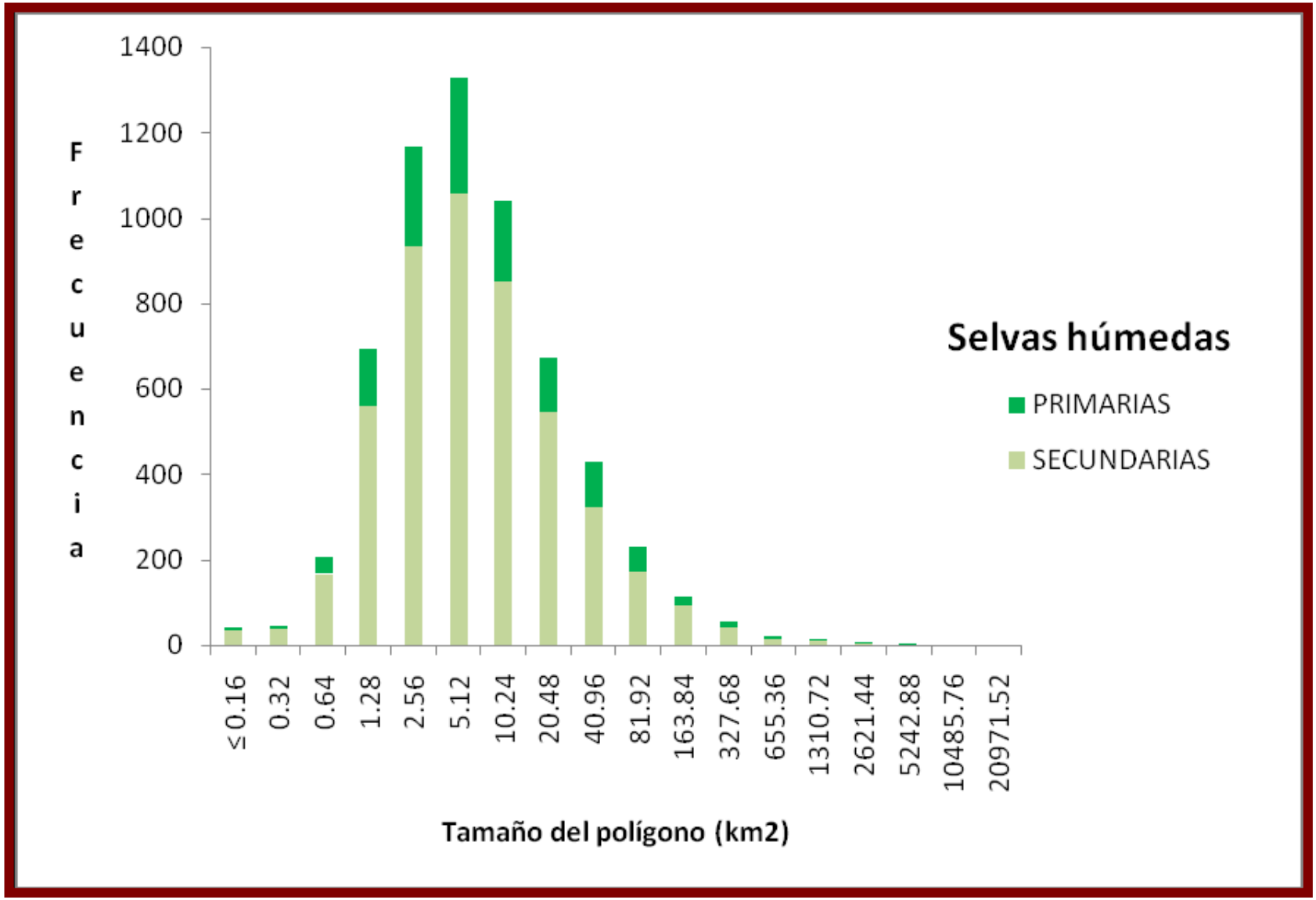


Global forest watch

Tropical forests loss in Mexico

CONABIO 2011

Fragmentation of tropical rain forests in Mexico



Sólo 15% de los polígonos tienen > 20 km^2 . La mayoría de áreas remanentes tienen vegetación secundaria

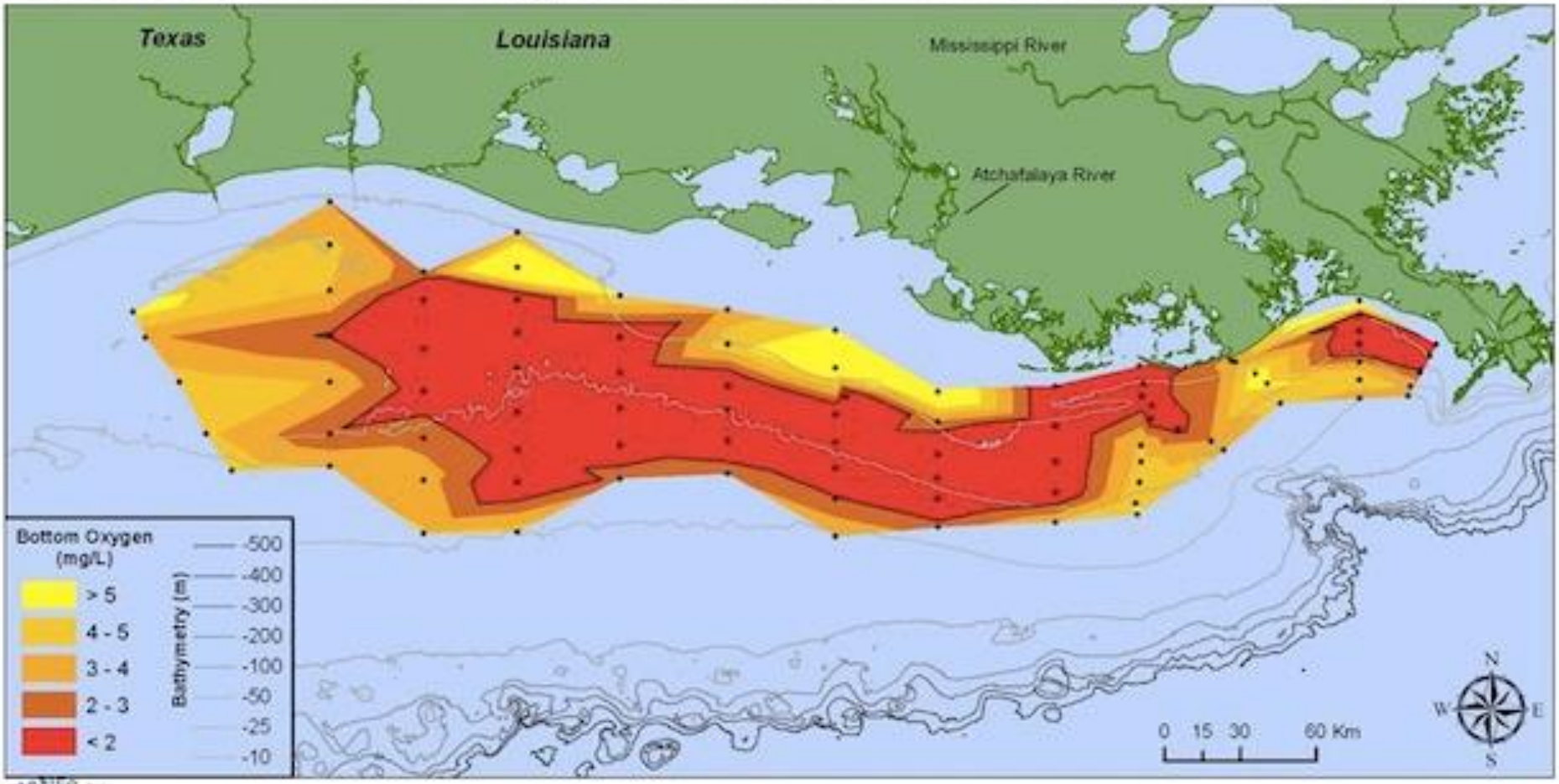
CONABIO 2011


Motozintla, Chis. 2005

2. High-tech agriculture, as it is applied today, is ecologically and economically unsustainable. Its social, economical and environmental externalities are unacceptable

Marine dead zone in the Gulf of Mexico (15,000 km^2)

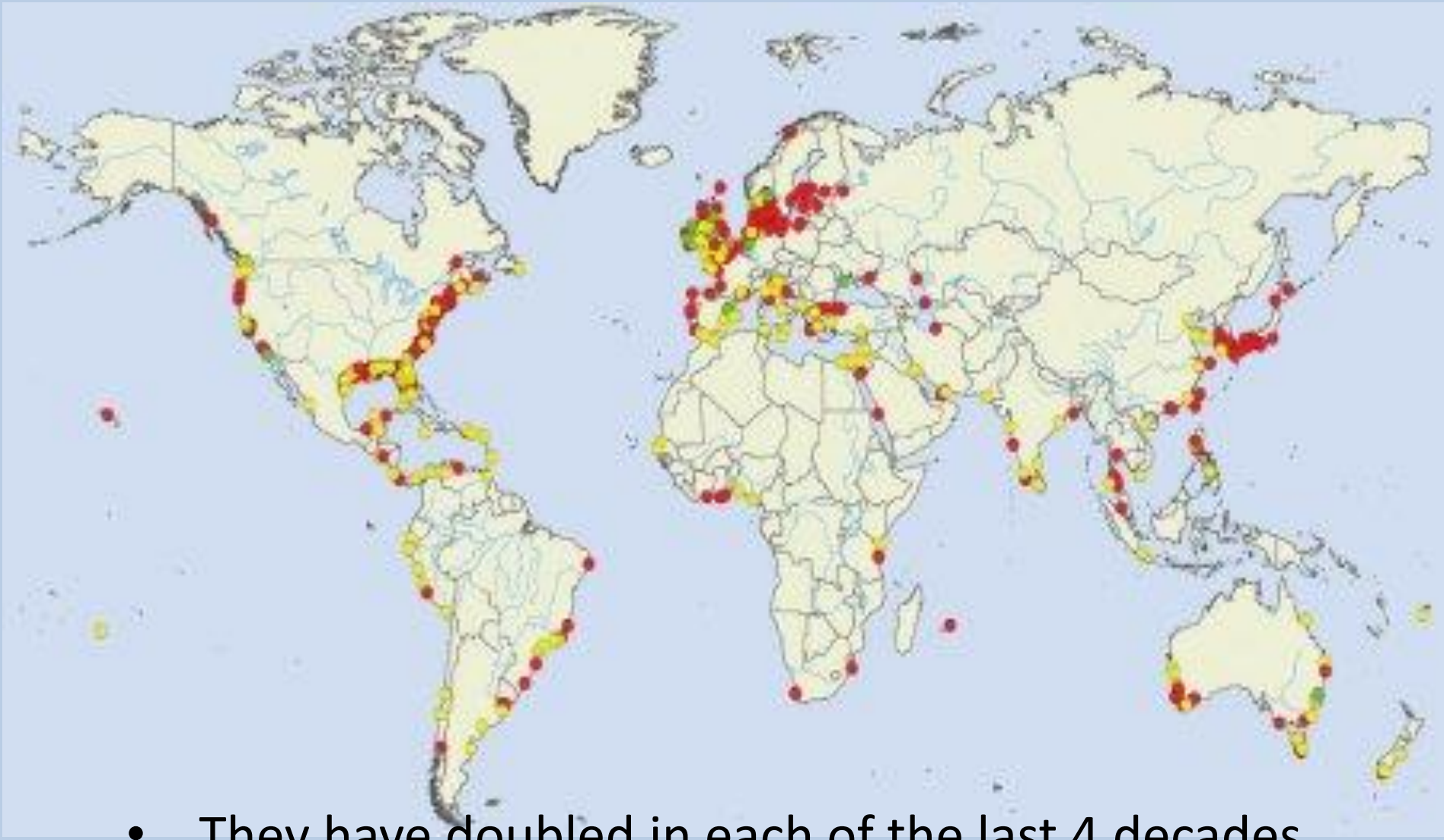
Bottom-water dissolved oxygen across the Louisiana shelf from July 22-28, 2013



Data source: N.N. Rabalais, Louisiana Universities Marine Consortium, R.E. Turner, Louisiana State University

Funded by: NOAA, Center for Sponsored Coastal Ocean Research

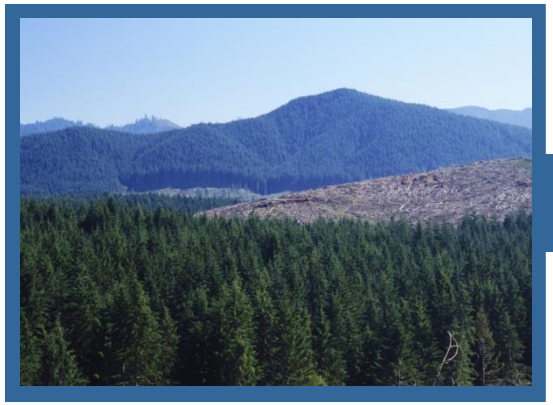
Marine dead zones



- They have doubled in each of the last 4 decades
- A 16-fold increment!

Environmental trade-offs

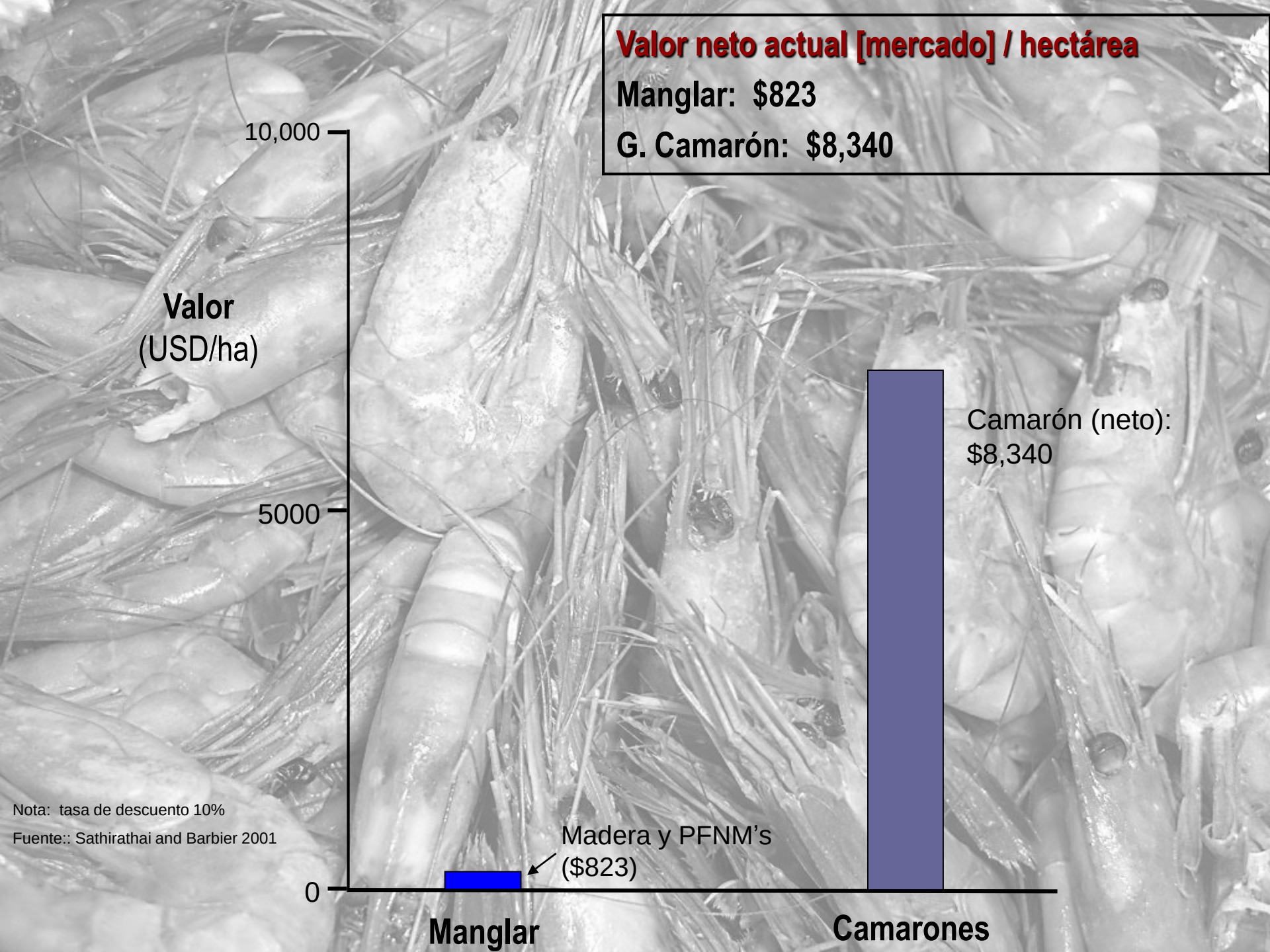
Transforming an ecosystem for a good that increases human well-being means gaining a benefit, but also the loss of an ecosystem service



Valor neto actual [mercado] / hectárea

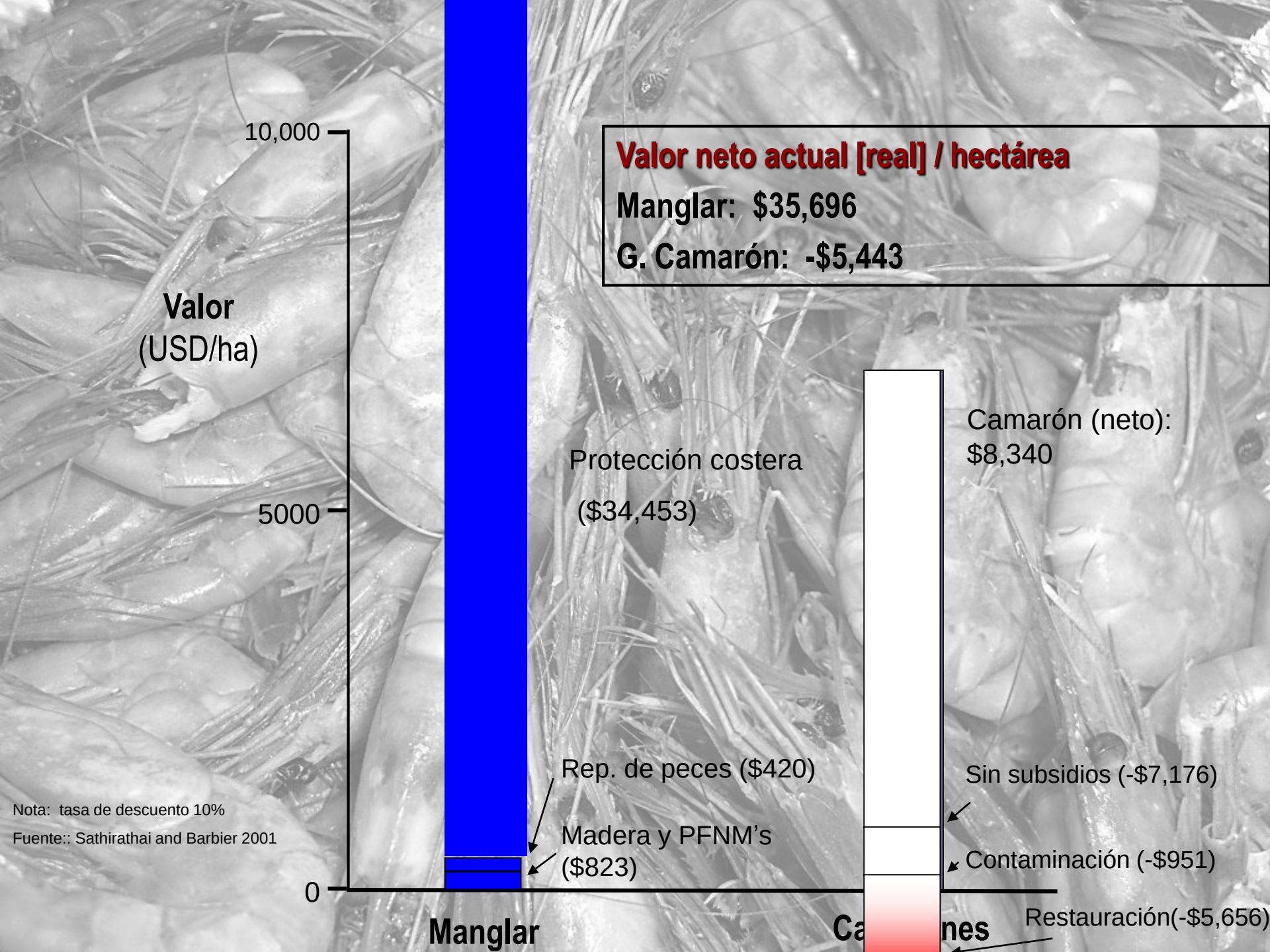
Manglar: $823

G. Camarón: $8,340



Nota: tasa de descuento 10%

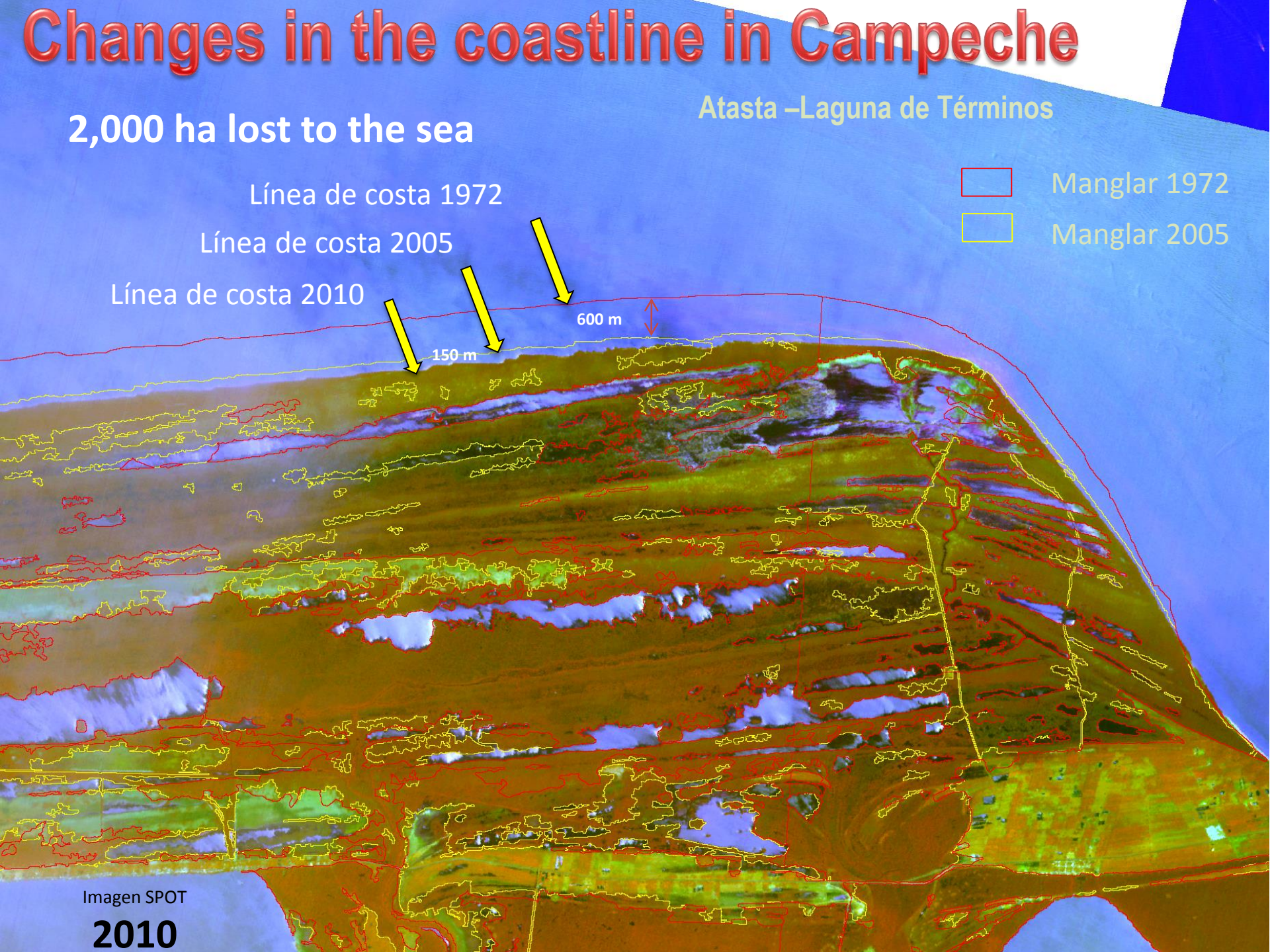
Fuente:: Sathirathai and Barbier 2001


Valor neto actual [real] / hectárea
Manglar: $35,696
G. Camarón: -$5,443
10,000
5000
0
Valor
(USD/ha)
Protección costera
($34,453)
Rep. de peces ($420)
Madera y PFNM's
($823)
Camarón (neto):
$8,340
Sin subsidios (-$7,176)
Contaminación (-$951)
Restauración(-$5,656)
Manglar
Nota: tasa de descuento 10%
Fuente:: Sathirathai and Barbier 2001

Changes in the coastline in Campeche

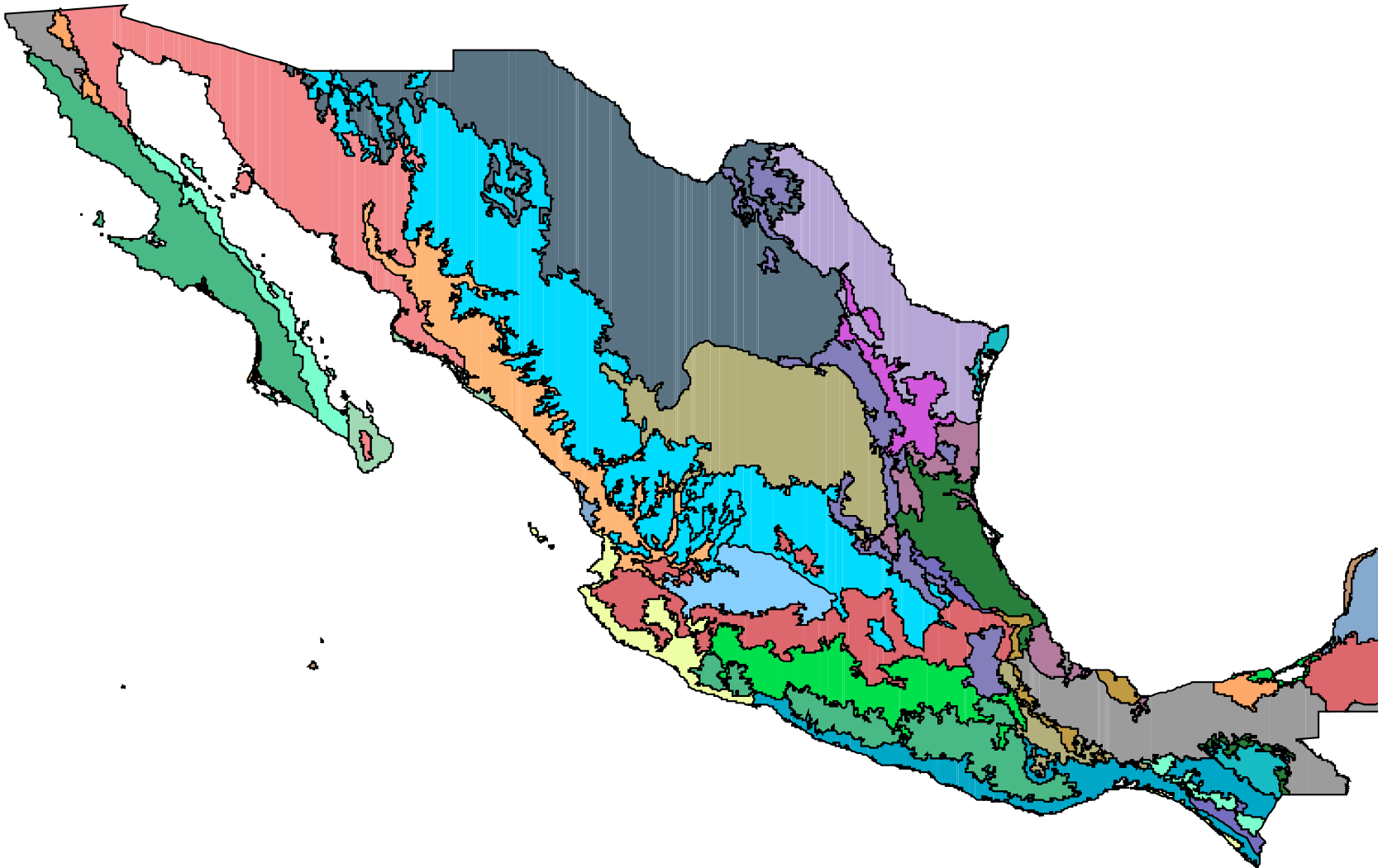
2,000 ha lost to the sea

Atasta –Laguna de Términos



3. Given the ecological diversity of megadiverse countries (often with a large ethnic/cultural diversity) no single agricultural system may solve the problems of food security

Mexico is a megadiverse country, with over 30 different ecosystems, and is one of the 4 Vavilov centers of plant domestication in the World



Present day indigenous people's territories

Linguistic diversity

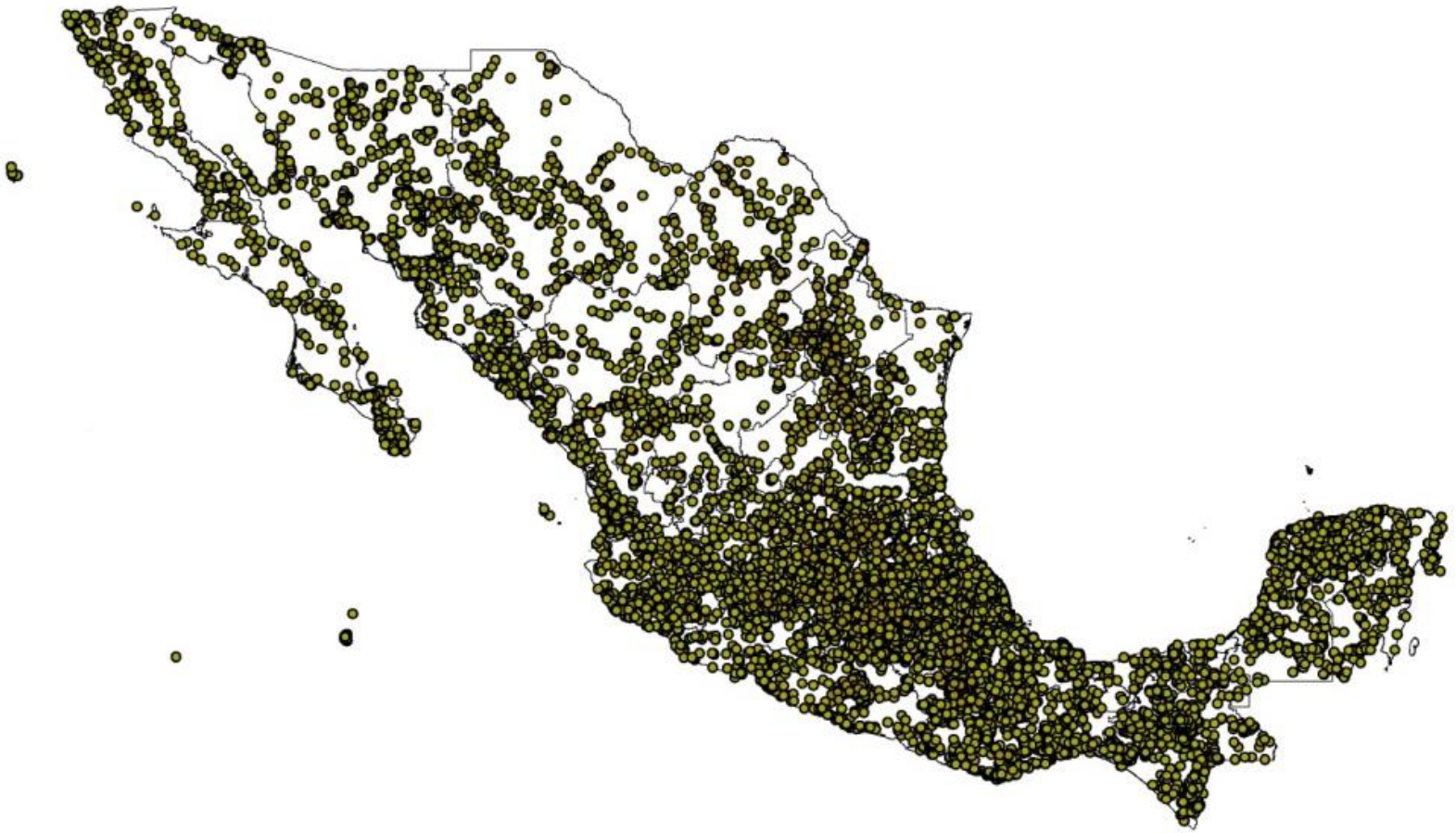
Entity	Families	Languages
MEXICO	**11(12)**	**291**
Veracruz	6	23
Puebla	4	29
Guerrero	3	16
Oaxaca	6	158
Chiapas	4	25
GUATEMALA	3	54
HONDURAS	7	10
NICARAGUA	4	7
COSTA RICA	2	9

Fuente: Gordon 2005, Inali 2005, *Encyclopedia Britannica* 2006 en Capital Natural de México 2008

Mexico is center of origin and genetic diversity of many crops

Maize, bean, cotton, tomato, squashes/pumpkin, chilis, vainilla, cacao, *nopales*, *chayote*, green tomato, agave, avocado, …

All-Crop Wild Relatives in Mexico in SNIB



Parientes silvestres

0 175 350 700 1,050 1,400

Kilómetros

Squashes, Pumpkins, *Calabaza* (*Cucurbita* sp.)

Cultivated species :

**Cucurbita argyrosperma*
subsp. *argyrosperma* (calabaza pipiana)
Cucurbita ficifolia (chilacayote)
Cucurbita maxima (zapallo)
**Cucurbita moschata* (calabaza de castilla)
**Cucurbita pepo* subsp. *pepo* (calabacita)
*Domesticated in México and having wild relatives in the country

Wild species in Mexico:

Cucurbita argyrosperma subsp. *sororia, C.cordata, C. digitata, C. foetidissima, C. lundelliana, C.okeechobeensis* subsp. *martinezi, C. palmata, C. pedatifolia, C. pepo* subsp. *fraterna, C. radicans, Cucurbita x scabridifolia*

Bean, *Frijol* (*Phaseolus* sp.)

Cultivated and domesticated species having wild relatives in Mexico:

Phaseolus acutifolius (teparí, escumite)
Phaseolus coccineus (ayocote)
Phaseolus dumosus (acalete, gordo)
Phaseolus lunatus (ib, patashete)
Phaseolus vulgaris (común)

Plus aproximately 40 wild species inside the *Phaseolus* genera

Projects on crops and wild relatives supported by CONABIO

2002 - 2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016

cotton

cotton, brassicas, pumpkins and pines

maize landraces and its wild relatives

cotton, amaranth, cempasuchil, pumpkins, chayotes , chilis, green tomato, vanilla, xoconostles.

avocados and green tomatoes

genetic diversity of maize landraces

cotton

Cotton conservation program

beans

genetic diversity of pumpkins

diversity and uses maize landraces

teosintles

cocoa, sunflower, tomato,, potato, papaya, etc.

maize risk map

Estimated cost of projects $36,720,000.00 Mexican pesos
2,127,000.00 EUROS

Finalized or ongoing projects

Projects in preparation

Integrated National Project on crops and their wild relatives

- Will comprise a broad range of:
  - **disciplines**: from molecular biology to ethnobotany, from agro-economy to agro-sociology.
  - **actors**: farmers (campesinos), scientists, extentionists, gvmt. decision makers, industry, etc.
  - **funding**: federal and state resources, international programmes.
- **Must have a long term vision**

4. A broad range of technologies suited to the environmental characteristics of each region are needed.

It is necessary to know, understand and help improve, when necessary, the traditional technologies with full participation of the farmers.

Food and Agriculture Organization of the United Nations

2014

The State of Food and Agriculture

Innovation in family farming

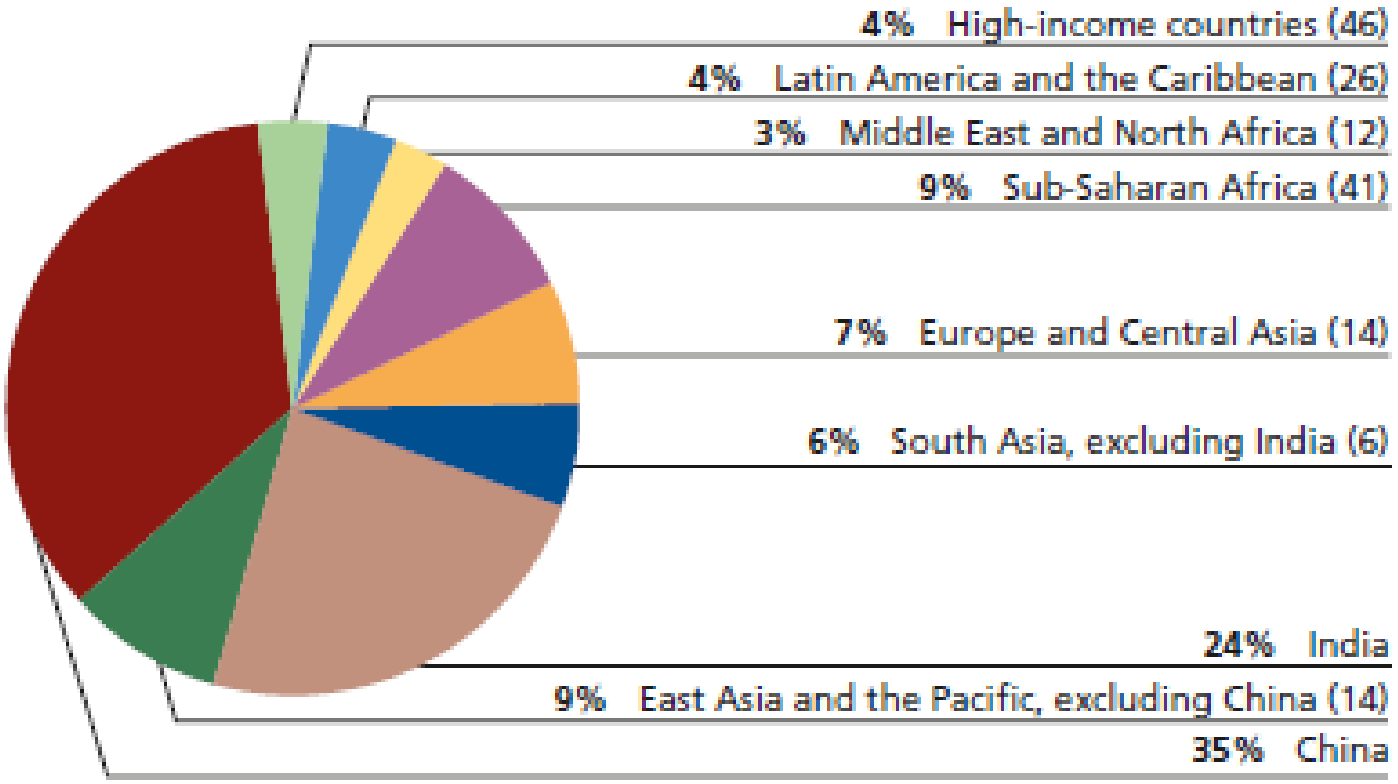
http://www.fao.org/3/a-i4040e.pdf

Family units of food production

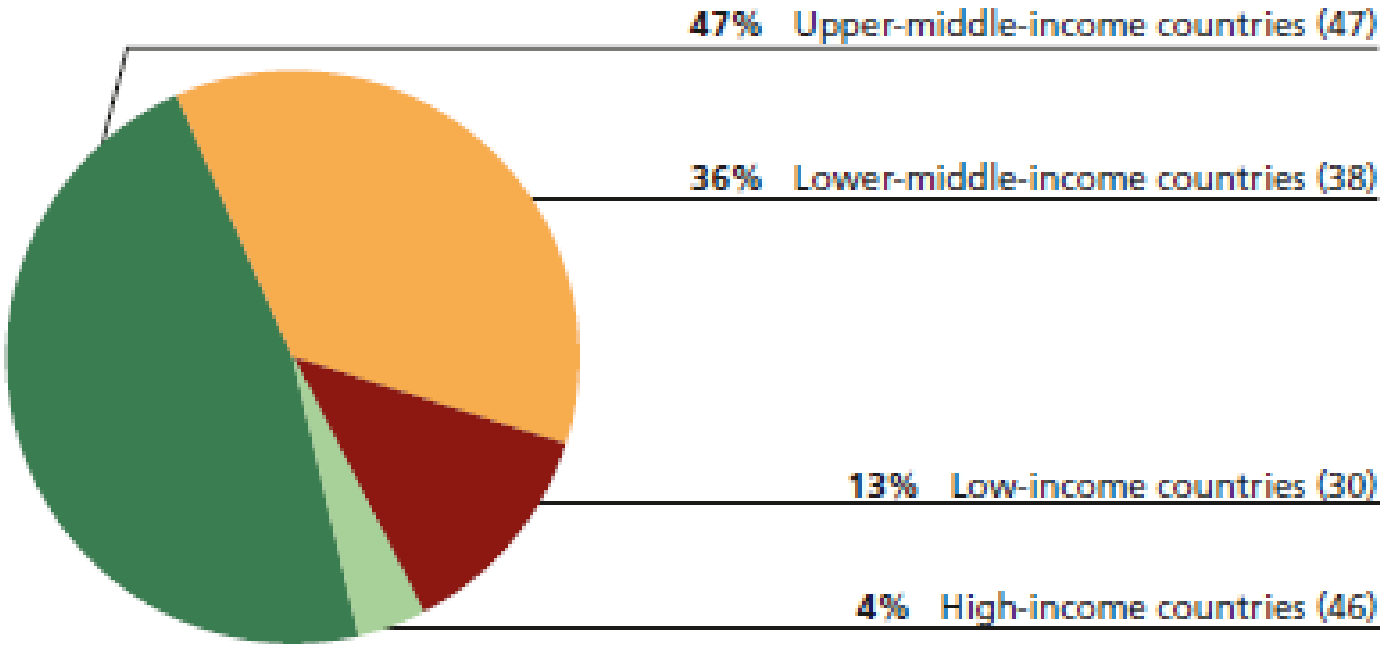
FAO in its last Report (2014) mentions:

- About 570 million family food producing units produce the largest proportion of food in the world
- They are by far the dominant form of agriculture in the world
- They occupy 70 to 80% of agricultural land and produce more than 80% of the value of food stuffs

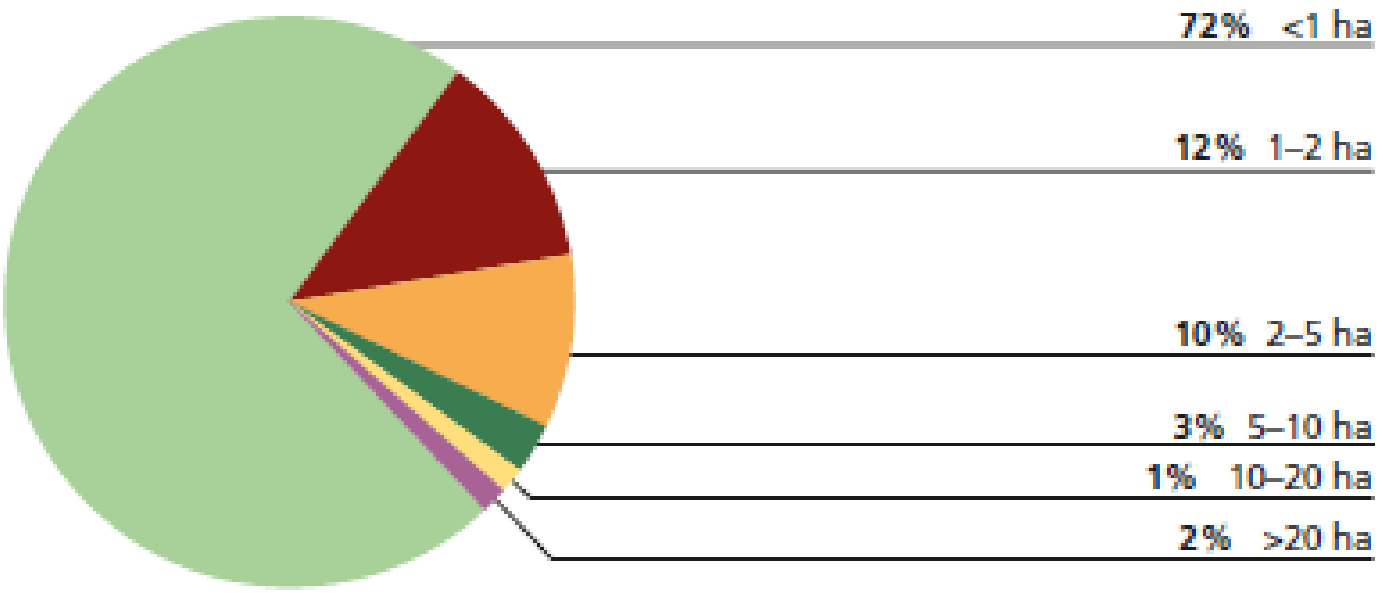
Share of farms by region, country or group



Share of farms, by income group



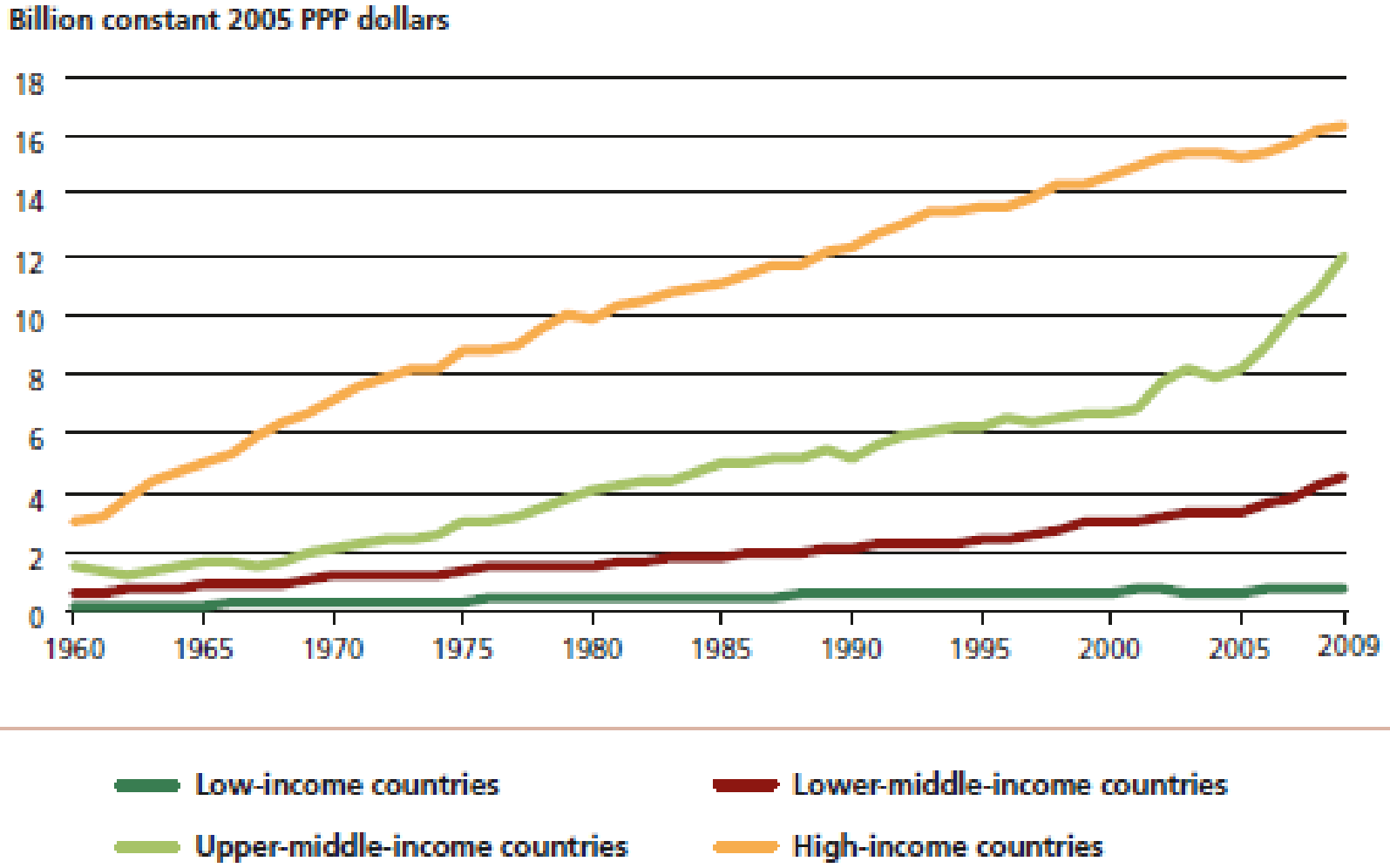
Share of farms, by land size class



More public-funded research in agriculture is needed

- Public funded agricultural research has fallen sharply since the last 3-4 decades as well as extension services
- Research should focus also on sustainable intensification and the maintenance and use of agricultural biodiversity

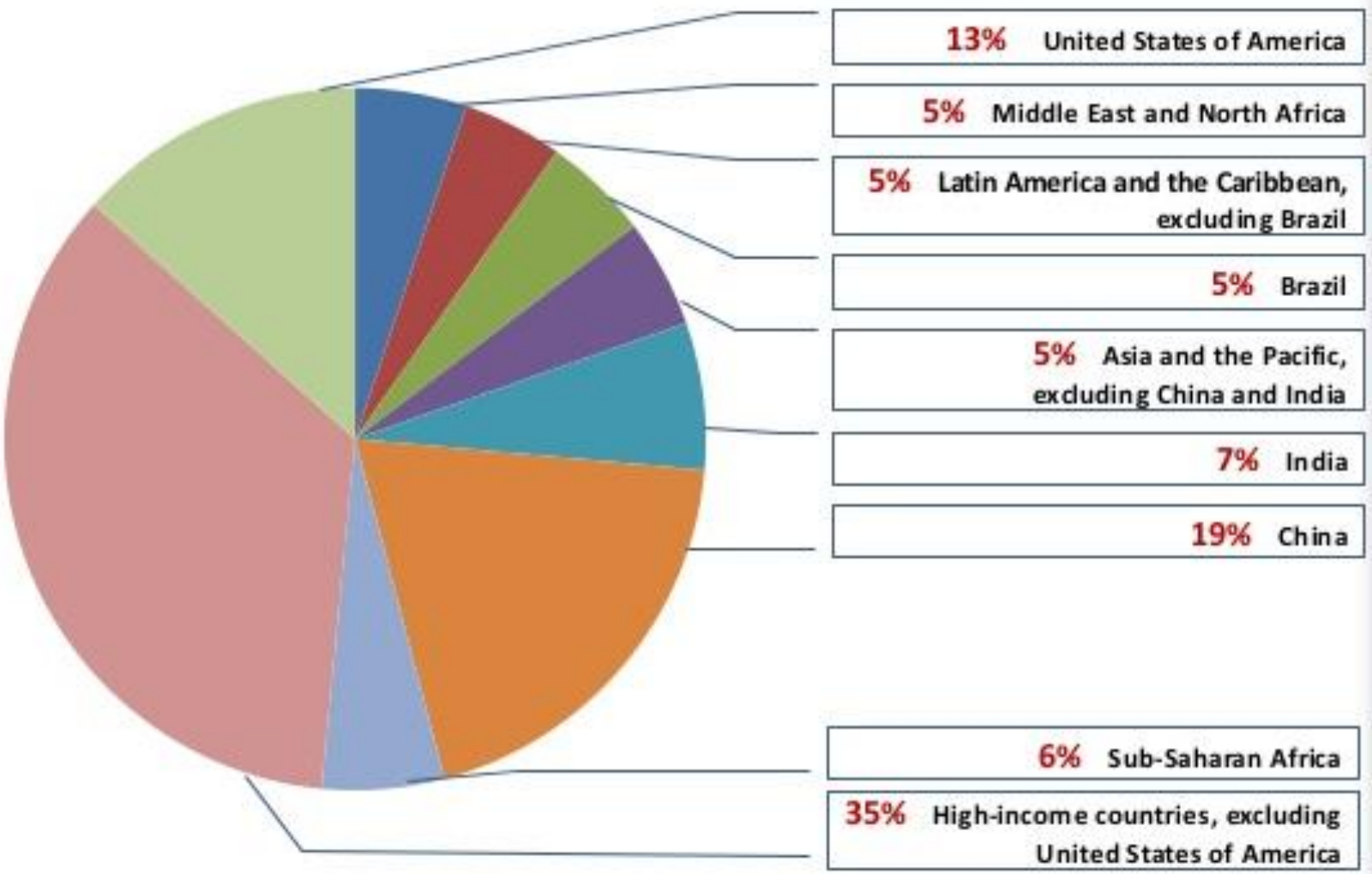
Public expenditures on agricultural R&D, by income group



Note: Data exclude countries in Eastern Europe and the former Soviet Union.
Source: FAO.

Agricultural R&D is crucial but most takes place in only a few countries

Geographic distribution of public expenditure on agricultural R&D, 2009



#sofa2014

5. The genetic diversity of the native cultivars results from thousands of years of selection under domestication.
The diversity of their wild relatives represents millions of years of natural selection:
they both are the most valuable and irreplaceable source of responses for food production under climatic changes

Essential building blocks for innovation:
(according to the FAO)

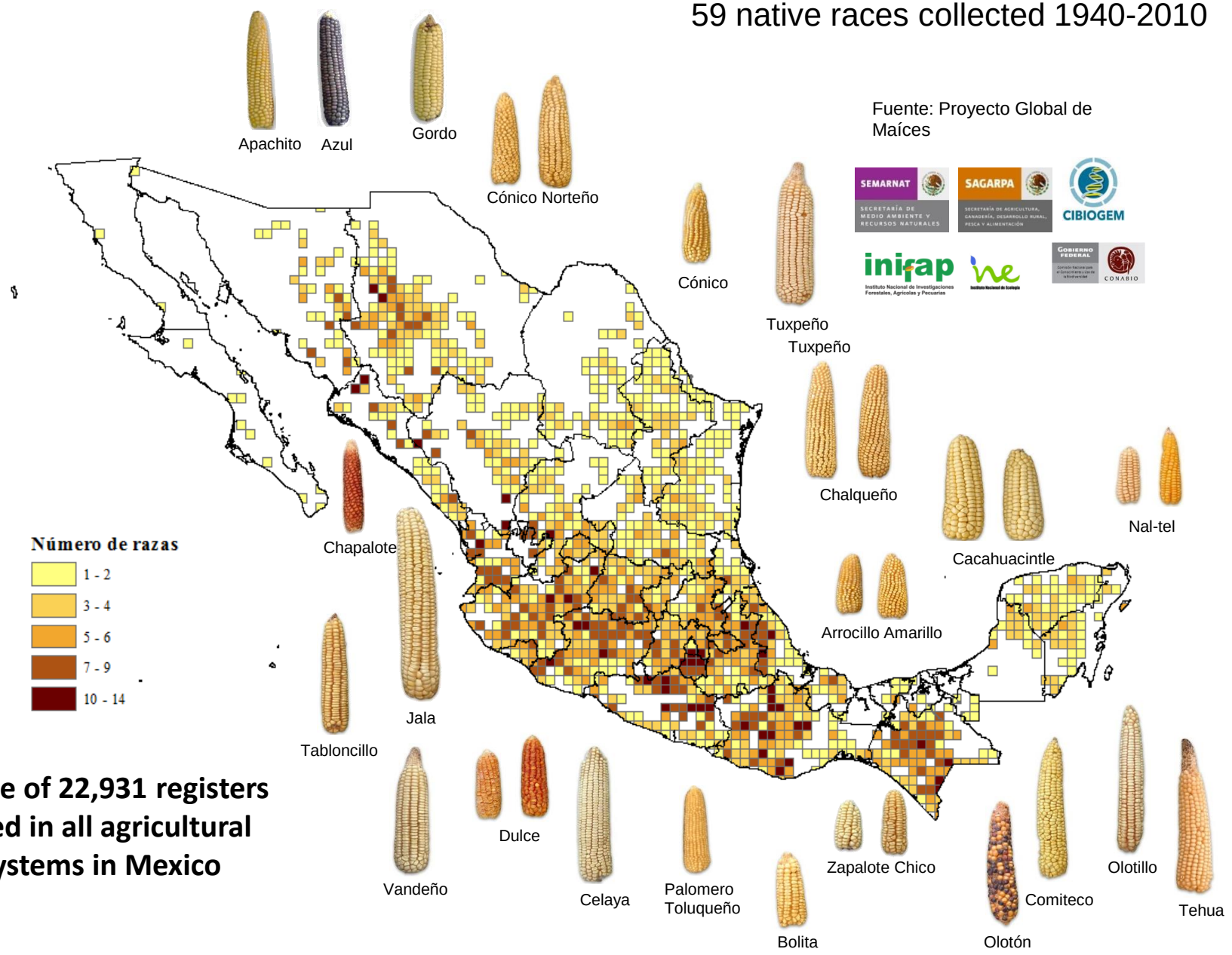
- well-run local government institutions,
- efficient agricultural advisory services,
- productive research and development centres,
- efficient producers' organizations,
- cooperatives and other community-based organizations,
- and –at the most basic level – an education system that fosters students' capacity to create and innovate

---

BUT NOTHING IS SAID ABOUT THE GENETIC ADAPTABILITY OF CROPS…

Mexico is a center of origin and diversity of maize.

59 native races collected 1940-2010



Fuente: Proyecto Global de Maíces

Data base of 22,931 registers collected in all agricultural ecosystems in Mexico

From teocinte to all native races, across a wide range of environments: from sea level to 3,000 m, from hot dry tropics to wet cold mountains

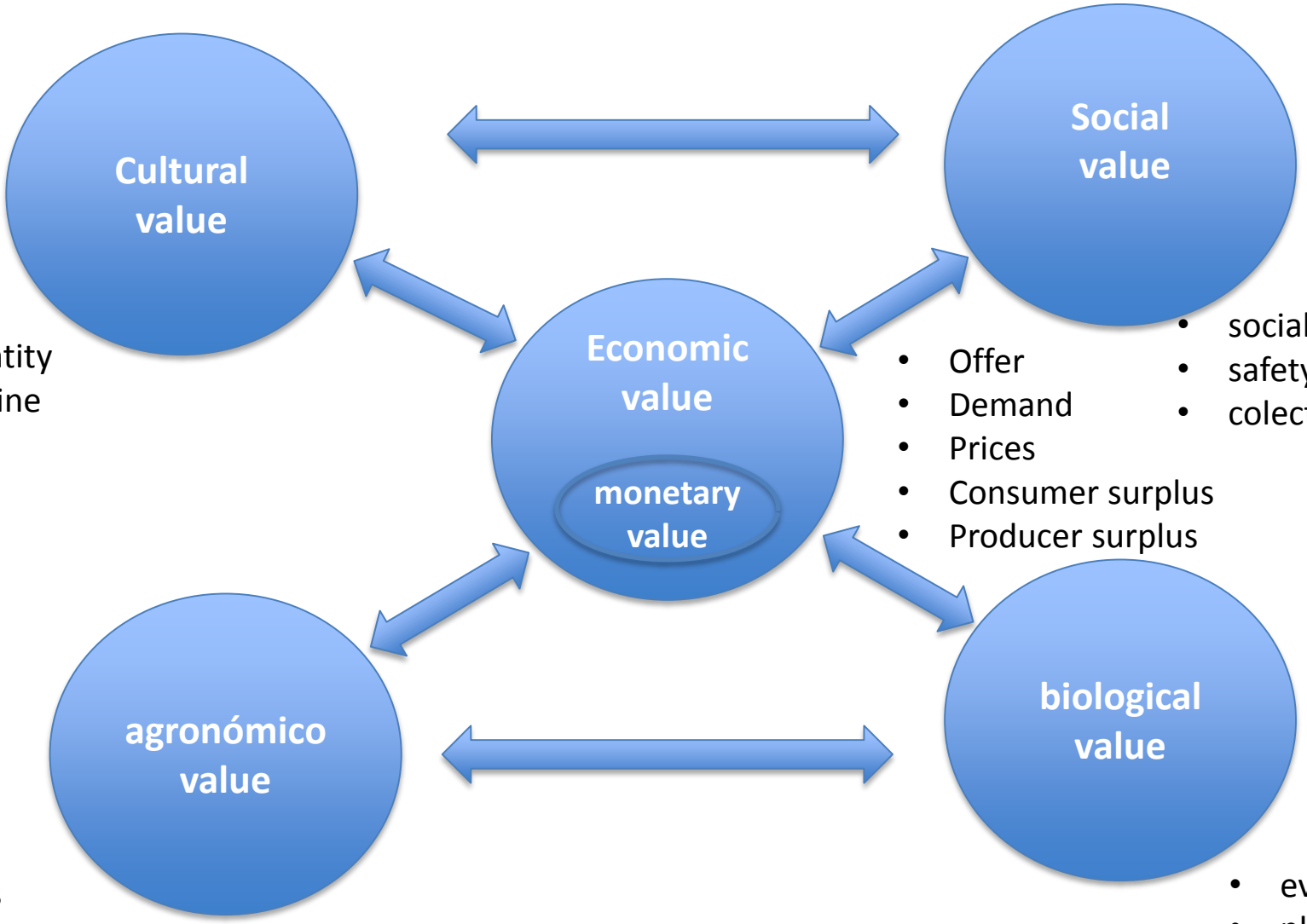
There is no technology capable of repeating, substituting or improvising such reservoirs of genetic variability

6. The world's gene-banks can only preserve "a few frames of the film" of the millennial process of genetic diversification under domestication. It is imperative to maintain *in situ,* and carefully study, these processes where they still exist, e.g. the milpa in Mexico

Valuation of the process of evolution under domestication

- Neither the process of domestication, nor the genetic variability of crops and relatives, seems to represent a value in today's national economies
- Yet there are many examples of such value (e.g. potato blight in the XIX century)
- The process of domestication of crops and their wild relatives, represent an evolutionary service essential to confront climate change

A very simple model



- identity
- cuisine

- Offer
- Demand
- Prices
- Consumer surplus
- Producer surplus

- social cohesion
- safety
- colective action

- yields
- adaptation

- evolution
- plasticity


An ecosystem
built by humans

A few of the edible plants of importance which originated as “weeds” of the milpa

- *Ustilago maydis (huitlacoche)*
- *Amaranthus spp. (alegría, huautle, quintonil)*
- *Phaseolus vulgaris, lunatus, coccineus, acutifolius (varios frijoles)*
- *Physalis coscomatl (tomatillo)*
- *Sechium edule* (chayote)
- *Salvia spp. (chia)*
- *Capsicum spp. (chiles)*
- *Chenopodium ambrosoides (epazote)*
- *Cucurbita pepo, moschata, maxima, argyrosperma (calabazas)*
- *Lycopersicum esculentum (jitomate)*
- *Portulaca oleracea (verdolaga)*

Thank you