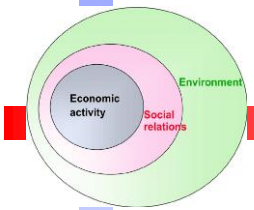
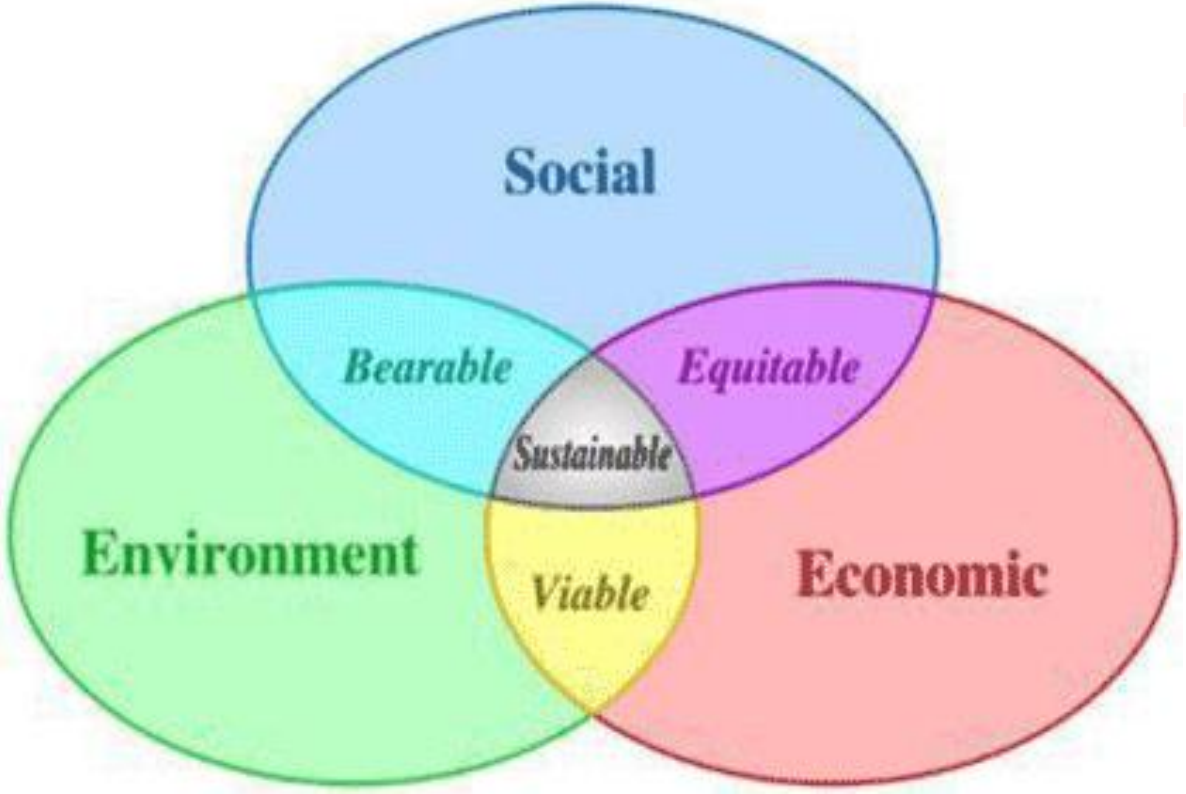
Leadership for Sustainable Development

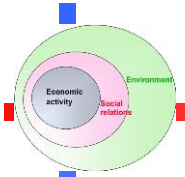
Tecnológico de Monterrey
Graduate programs

Spring, 2019





https://ops.fhwa.dot.gov/publications/fhwahop12006/sec_3.htm



Your professors:

Diego Fabián Lozano García (Dr. Fabián)
Biology, UNAM (Remote Sensing of the Environmet)
M. Sc. Remote Sensing. Purdue University, USA. West Lafayette, IN. USA.
Ph. D. Remote Sensing. Purdue University, West Lafayette, IN. USA.

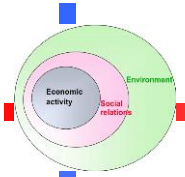
Previous Work Experience:
Researcher at Instituto Nacional de Investigaciones sobre Recursos Bióticos, Xalalpa, Ver.,
Research Asistant at Laboratory for Applications of Remote Sensing (LARS) at Purdue Univ.
Remote Sensing Applications Manager at LARS, Purdue University

Member of Sistema Nacional de Investigadores (SNI) CONACyT

Scientific publications: More tan 50 research papers, several book chapters.

Teaching experience: Graduate level: Leadership for Sustainable Development, Geographic Information Systems, Remote Sensing of the Environment, Environmental Science.
Undergraduate: Geomatics, Ecology and Biodiversity, Geographic Information Systems

At ITESM: Full Professor at Centro de Calidad Ambiental,
Director of Geographic Information Systems Laboratory (LabSIG),



Your professors:

Rosamaría López-Franco (Dra. Roma)

Biology, UNAM (Plant Ecology)

M. Sc. Microbiology. Purdue University, West Lafayette, IN. USA

Ph. D. Biología Celular. Purdue University, West Lafayette, IN. USA

Previous Work Experience: Dirección de Ecología del Gobierno del Edo. Veracruz
Secretaría Forestal y de la Fauna, assigned to Veracruz State

Have been Professor/Researcher at:
UNAM, (UA-Mor, UA-Ver)
Purdue University, ITESM, UDEM

Have been member of Sistema Nacional de Investigadores (SIN) CONACyT

Publications: A book on Mayan Ethnobotany and more than 30 research papers.
Teaching Experience at the Graduate level: Ecology, Sustainable Development, Molecular Biology.
Teaching Experience at the Undergraduate level: Molecular Biology, Biochemistry, Molecular genetics, Microbiology, etc.

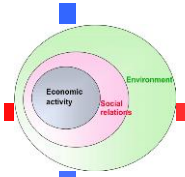
At ITESM: Full Professor at the Biotechinology Center, Director of Biotechnology Master Program, Director of Microbiology Laboratory, Responsible of the Master Research Program in Medicine. Director of Biotechnology Center, Professor at the School of Medicine.

Who are you?

Please give us the following information and upload it in BB: HOMEWORKS Discussion Board: "The students"

1. Full name (as you are registered):
2. Place of birth:
3. Where do you live:
4. Undergraduate degree (University, School):
5. Graduate program at ITESM:
6. Thesis topic (if you have it already):
7. Where do you work? (if it applies)

Please answer in the indicated order



Where and when to find us:

- Anytime by email PLEASE indicate in the SUBJECT: Your name Course Title and Campus:
  - Ej. SUSTAINABLE DEVELOPMENT Juan Pérez. Campus CDMX
    - Email: rmlopez@tec.mx
    - Email: dflozano@tec.mx
- By phone:
  - 81 8358 1400 ext. 5275 or 5288
- At LabSIG: mondays 4 – 6 pm
- LabSIG is located at: CEDES SS1-1013

Objetive

The student will be able to identify and critically appreciate the concept of sustainable development, within a framework of professional responsibility, proposing alternatives committed to this development scheme: a) that raise the quality of human life and b) with full awareness of their rights and responsibilities.

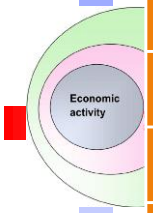
https://www.slideshare.net/mes0/sustainable-development-goals-sdgs-70859274

Learning methodology

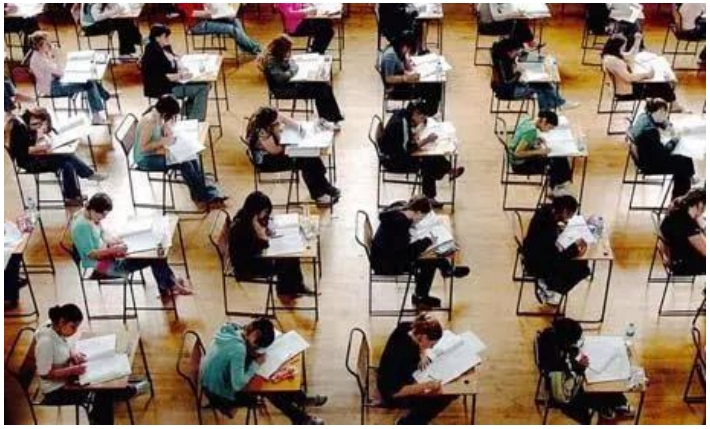
The course will include:

- Teacher presentations
- Presentations by students (teams).
- Development and discussion of cases.
- Participation of students.
- Preparation and presentation of a project (by team) that discusses and proposes an alternative that manages the concept of sustainable development.

Wk.	Topics
1	Course presentation
2	Why sustainability
3	Non sustainable systems. Student Projects Presentations
4	Day off
5	Why societies collapse
6	Climate change
7	Social dimension: population
8	Economic dimensión: ecosystems services
9	Mid term exam. Project reports by students
10	Day off
11	Technology: guilt or solution
12	Design for sustainability: Life cycle analysis
13	Measuring sustainability. Green energy
14	Sustainable consumption
15	Our impact on the planet: ecological and water footprint
16	Student final Project presentations



Pop quizzes



Because we want to help you to be up-to-date with your Reading material, we will have pop-quizzes during the semester.

The quizzes will include the reading material for the week and perhaps previous weeks.

Please download the Socrative (student) program in your computers/tablets.

The quizzes will take place at the begining of the class and will last 8-10 min.

There will be a quick feedback.

https://blog.peerinstruction.net/2016/01/25/how-to-flip-your-class-with-quizzes-in-5-steps/

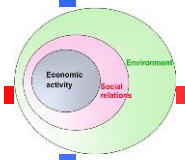
Weekly news

The last 15 min of the class will be devoted to discuss, analyze some current news that each team will upload in the discussion board of the week.

During the week, each team must discuss any topic related to Sustainable Development and write a small summary (half-page) that will be presented during the last 15 min of the class.

The professors will select the team and it should be uploaded the previous friday to the class.

https://stories.flipkart.com/flipkart-news-mar-31/weekly-news-update-2/



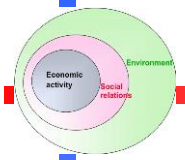
Organization for final project

The students will be organize by teams* of 3 (minimum) to 4 (maximum) people. The work team will develop the following activities:

1. Discussion and report of assigned activities.
2. Research and preparation of final project.

- The work teams will develop a final project that addresses the problem of sustainable development and its relationship with its current environment (academic activities, work in the industry, social and economical alternatives, etc.).
- Proposals: students team's will submit a presentation of their proposals and present it to the class on feb-28th. 10 min per team.
- Preliminary presentation of the project report on mar 11th. 10 min per team.
- Final project presentation on may 6th. 15 min per team.

* Teams MUST be approved by teachers to ensure professional diversity



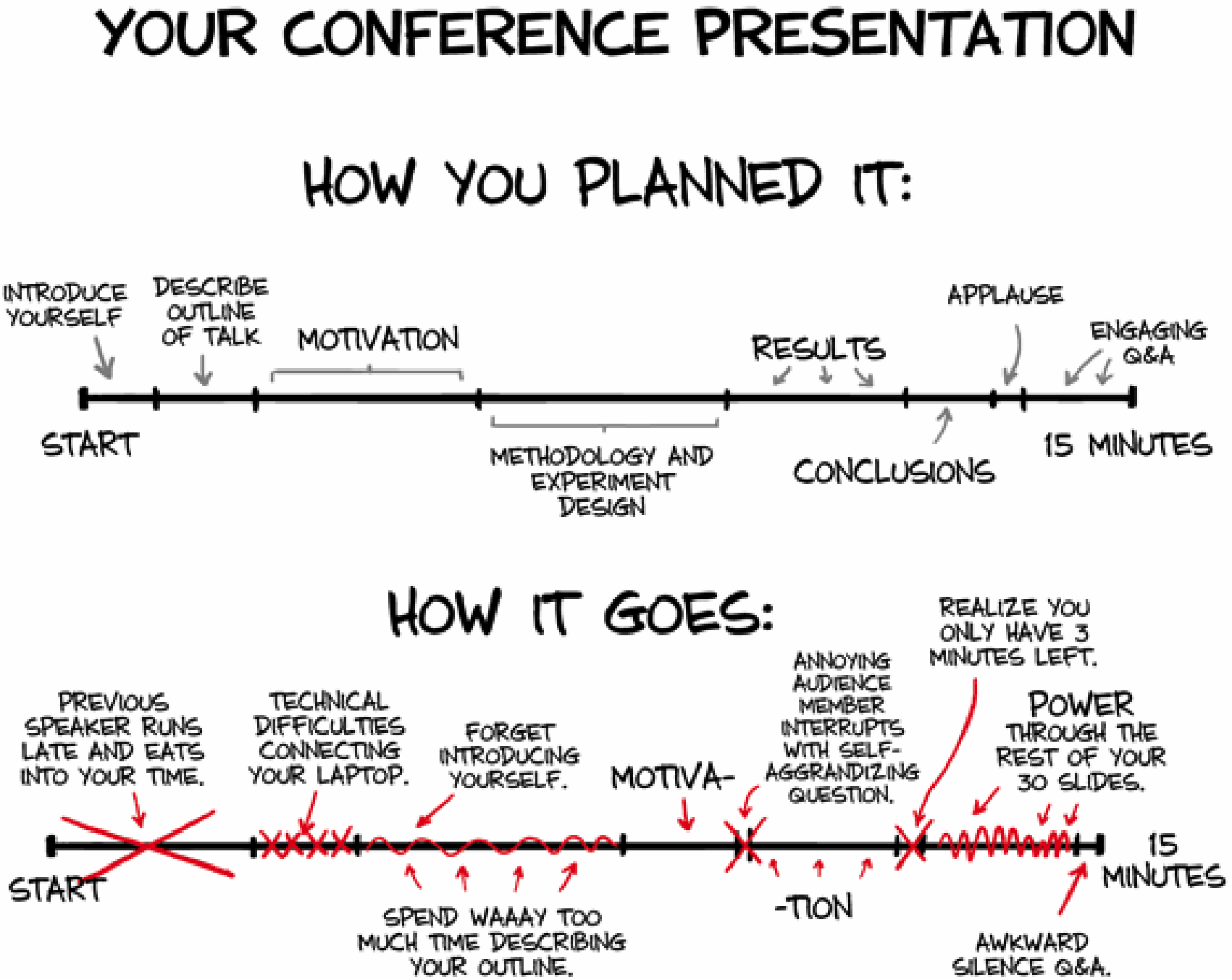
Project proposal

Must include the following items:

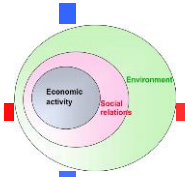
1. Title and team members
2. Problem background
3. Objective(s)
4. Expected results

https://conbizresources.com/project-proposal-structure-leads-to-project-success/

Avoid this in your presentations



https://www.slideshare.net/MUHAMMADHUZAIFACHAUD/paper-to-talk-original



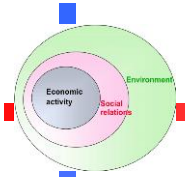
Evaluation

Midterm exam*	30%
Final project	40%
Homework's, Quizzes, etc.	20%
Participation	10%
TOTAL	100%

Students must obtain at least 70% of the total credits to pass this course.

Sorry a 69.9999 will not be rounded up to 70.

* Lectures, Reading material and Activities



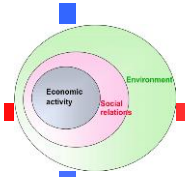
Code of ethics…

I declare that I will maintain the highest standards in academic integrity, therefore,the answers in my exams, quizes and my homework will be my soley responsability and the product of my own effort and knowledge. I will not carry any act that attempts to the academic integrity of mine or my classmates as the use of unauthorized materials in any assigment, quiz or exams.

I know the consecuences of breaking the academic integrity as they are documented in the Reglamento General de Alumnos.

I accepts the terms written above.

http://www2.ccm.itesm.mx/reglamentos/archivos/reglamentoprofesionalago07.pdf



Consecuences of breaking the C of E

- They accumulate in the cardex.
- Loos the right to get Honors.
- Will prevent an academic Exchange through ITESM.
- Will prevent public appointments at the University or Government levels.
- Three notes in your cardex, will be cause of expulsion from the Sistema Tec.

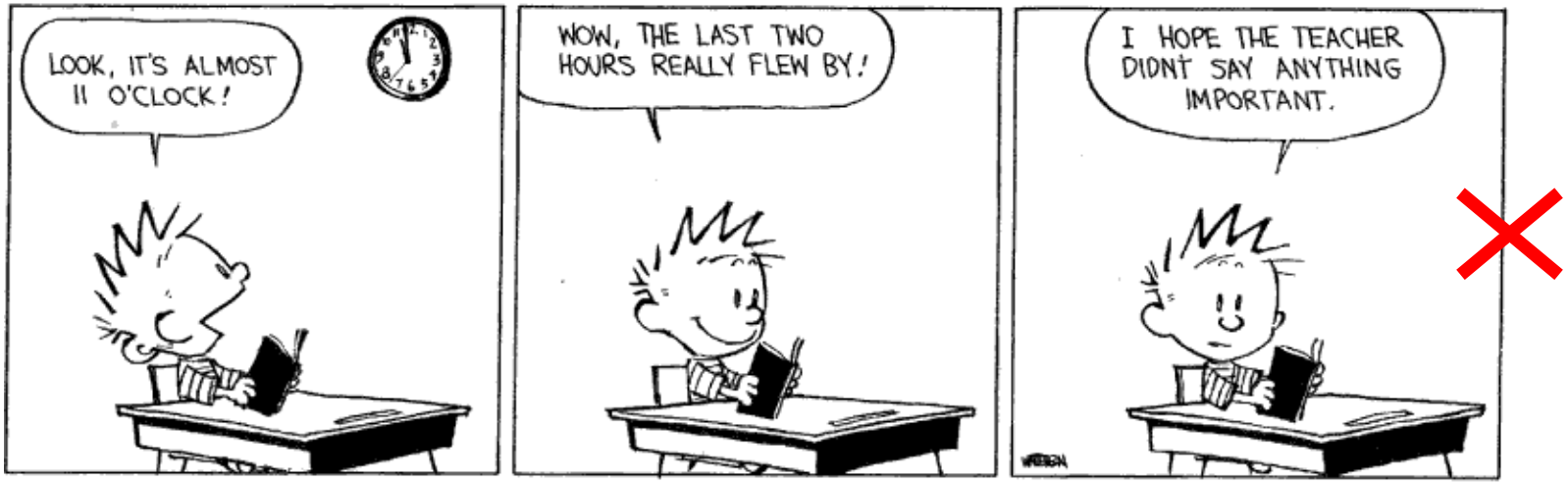
Important notes

Each student must bring to class a personal computer or tablet in order to participate and solve quizzes.

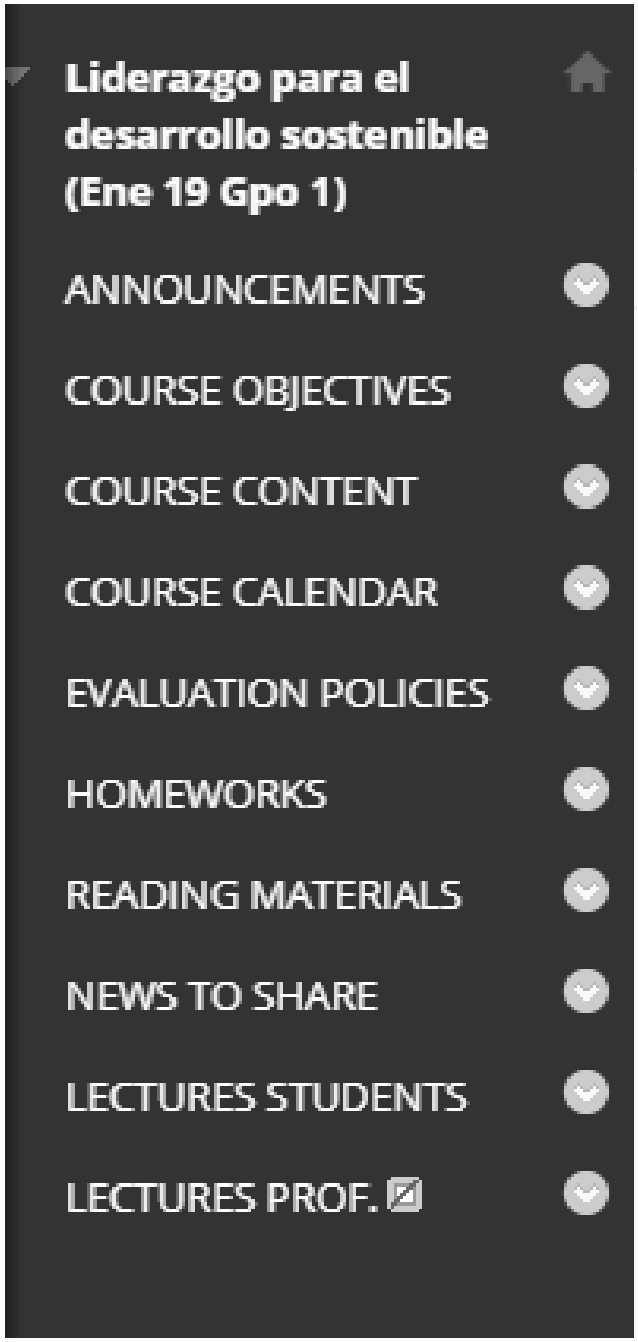
Please download the program *Socrative.com* (for students).

Important notes

- Discipline is your own responsability.
- You must pay attention to lectures and classmates participation and discussions within an environment of respect and tolerance.



Course in BB


Liderazgo para el desarrollo sostenible (Ene 19 Gpo 1)
ANNOUNCEMENTS
COURSE OBJECTIVES
COURSE CONTENT
COURSE CALENDAR
EVALUATION POLICIES
HOMEWORKS
READING MATERIALS
NEWS TO SHARE
LECTURES STUDENTS
LECTURES PROF.

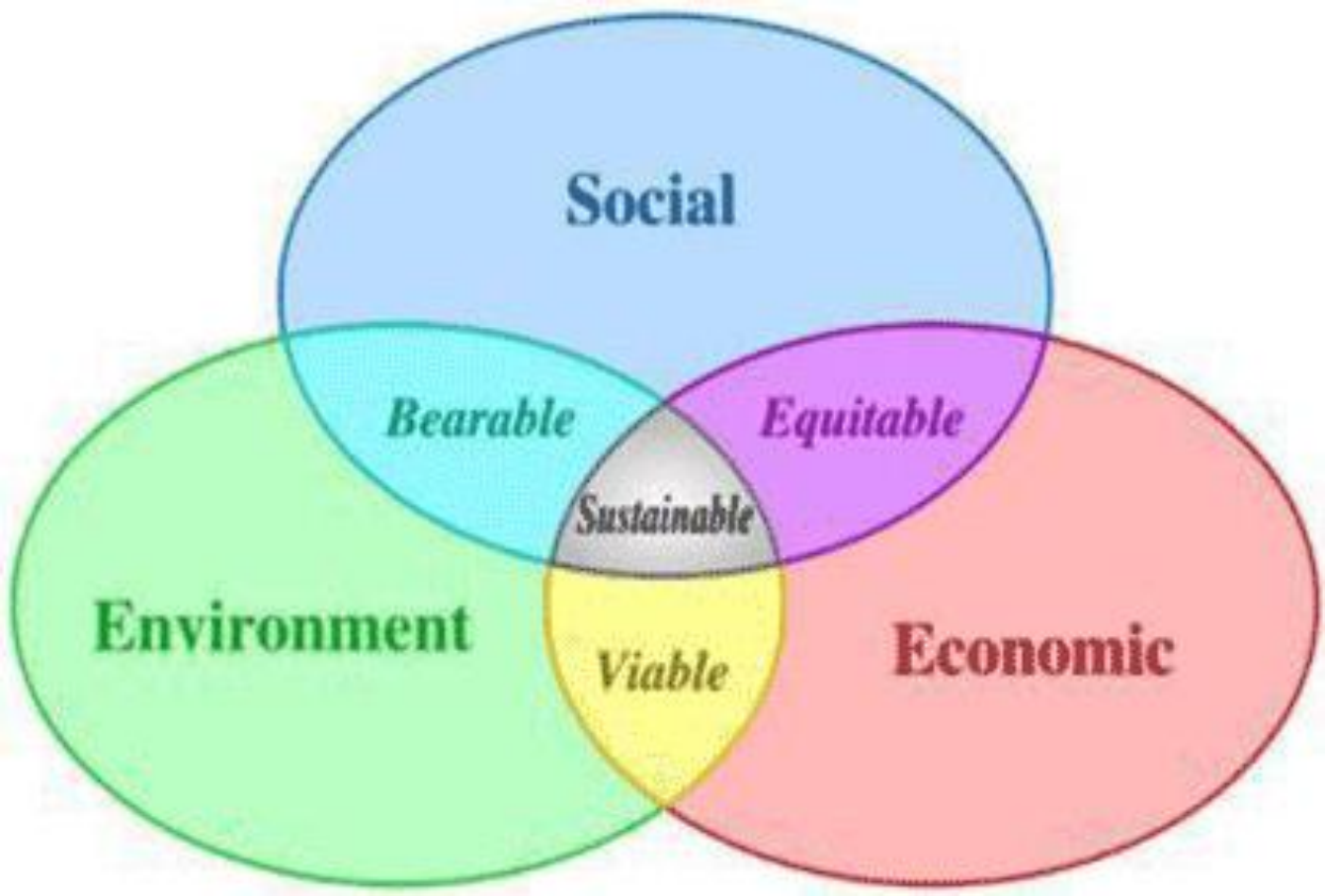
Calendar, Activities, Reading material

SUSTAINABLE DEVELOPMENT - CALENDAR SPRING 2019

JANUARY

Wk.	MONDAY	Activities	Reading material
1	**14** **Presentation of teachers/students** **Course objectives, policies and calendar**	Quliz: State of the world in numbers (in class)	
2	**21** **Why sustainability**	VIDEO: TED-conference, Ray Anderson: The business logic of sustainability https://www.ted.com/talks/ray_anderson_on_the_business_logic_of_sustainability Watch video and write an essay. Upload it in: BB HOMEWORK: Ray Anderson, Essay	1. Sustainability a view from IEEE president. Gordon Ray. 2. Sustainable Development. Strange and Bayley. CHAPTER 2 ONLY.
3	**28** **Non-sustainable systems** **Presentation of Project proposals. (10 min/team)**	Read the document of Planetary boundaries, discuss it with your team and write an essay of one page max. Upload in the secction BB: HOMEWORK: Planetary boundaries.	1.Planetary boundaries: Exploring the Salfe Operating Space for Humanity

Do we need sustainable development?



https://ops.fhwa.dot.gov/publications/fhwahop12006/sec_3.htm

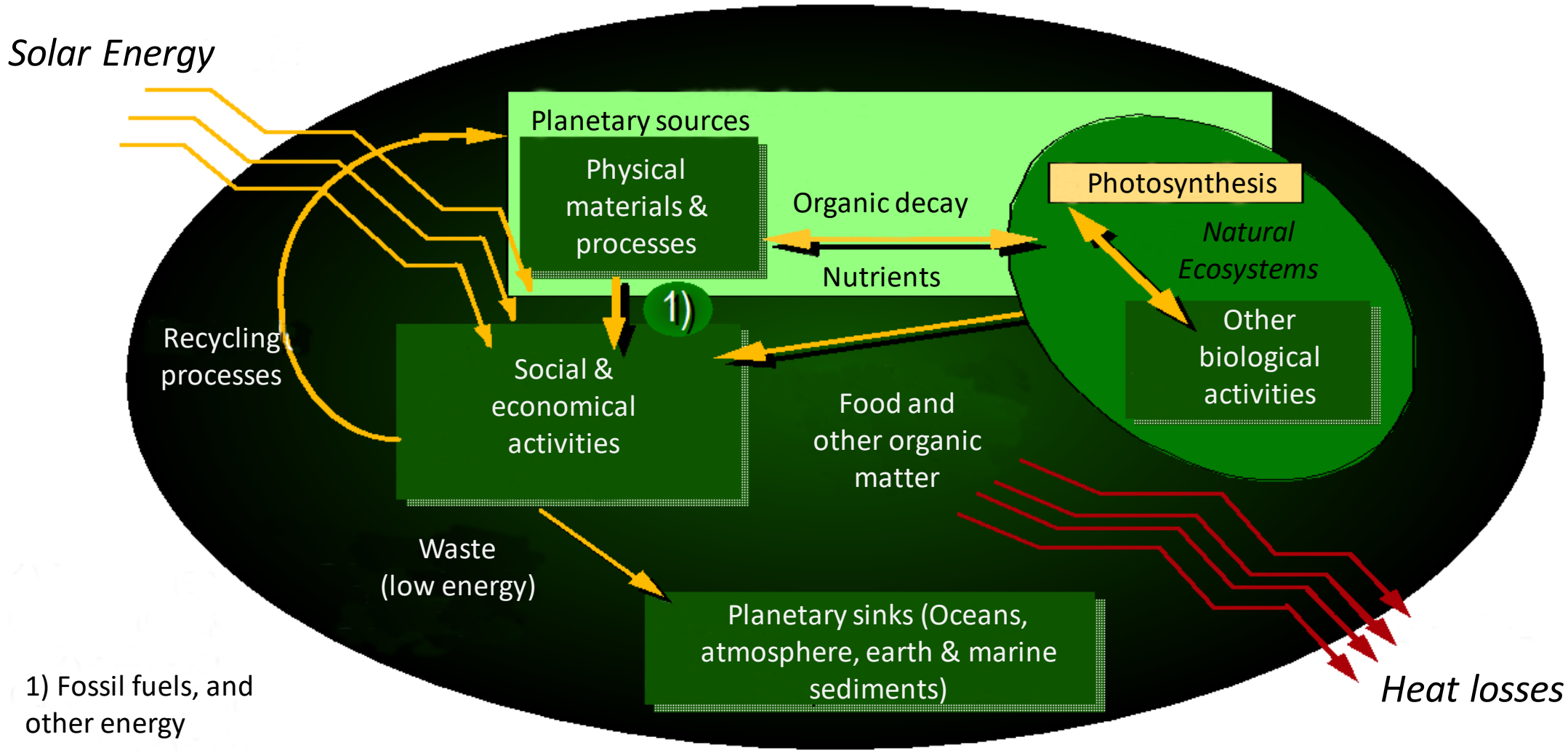
Presentation

In 2007, the Secretary General of the United Nations declared: "The future is in our hands, together, we must ensure that our grandchildren will not have to ask us why we failed to do the right thing by letting them suffer the consequences."

Sustainable development seeks to find answers to this statement.

This course presents to students the concept of SD in its three main bases, the individual and social responsibility that we all have to achieve this goal; as well as the role that technology plays in the search for sustainability within a holistic approach of peace and cooperation.

Biosphere, an almost closed system



1) Fossil fuels, and other energy sources

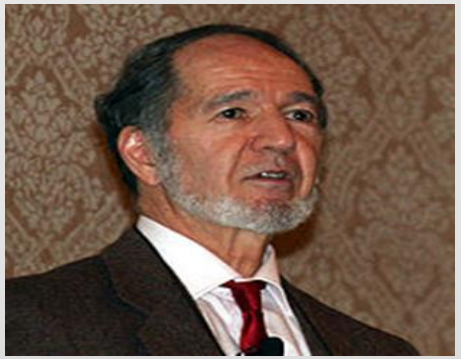
The environmental crisis of current development policies

- Global
- Unequal
- Transgenerational
- Uncertainty
- Complex
- Exponential
- Mutually reinforced
- Systemic
- Serious consequences
- Urgent

- (in scale)
- (in distribution)
- (in its effects)
- (in prediction)
- (dynamic systems)
- (growth rates)
- (in its structure)
- (in its causes)
- (survival of the human specie)
- (urgent to correct)

What we have learn…

- Jared Diamond (1937-) work points out that:
- Our history is full of examples of over-exploitation and destruction of unrestored habitats that have resulted in the collapse of societies, societies that have not operated sustainably.



- 1st approximation to the problem:

- Biological resources
- Social behavior towards development (archaeology & history)
- Analysis of the collapse of ancient civilizations to understand our current situation
- Looks to the future with an analysis of the implications that past lessons have left us

Framework

- Main causes of societal collapse:

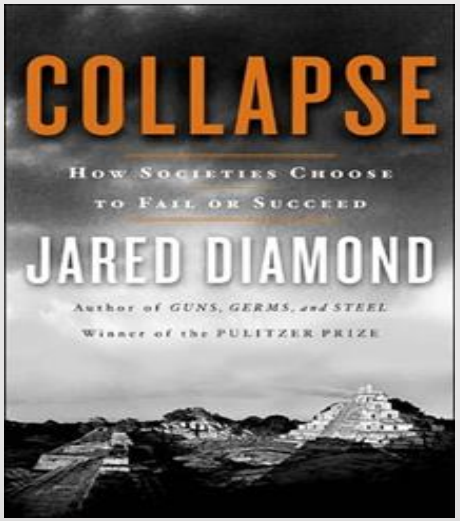
- Environmental degradation

- Climate change

- Unfriendly neighbors

- Commercial exchange and

- The response of society to environmental, social and economic problems



Eastern Island: deforestation

- Isolation
- Geographic position (latitude)
- Low rainfall

- Video de David Attengorough (7’13’’) The Lost Gods of Easter Island
- http://www.youtube.com/watch?v=-hO-vCPuuQQ

http://www.pbs.org/wgbh/nova/easter/

Anasazi, Mesa Verde, Colorado, EUA.

- Deforestation
- Desvío del arroyo
- Abatimiento de mantos freáticos
- Cambio climático
- Comercio interno

http://www.selectstone.com/historic-masonry/anasazi-ruins/

Montana: Bitterroot, Montana

- Mining
- Deforestation
- Erosion and soil degradation
- Reduction of water sources and water quality degradation

http://www.chasinglewisandclark.com/photos/montana/bitterrootvalley.htm

Diamond's: 11 environmental problems

1) Natural habitats destruction (mainly thru deforestation)
2) Lost of natural & native food sources (fishes, plant diversity)
3) Lost of biodiversity
4) Soil erosion
5) Natural resources depletion
6) Water contamination
7) Appropriation of natural photosynthesis
8) Introduction of toxic substances –new molecules-
9) Exotic species
10) Global climate change, induced by human activities
11) Overpopulation and its impact

Why societies make wrong decisions?

- Fail to anticipate problems
- We fail to perceive that the problem has arisen - we do not recognize it
- Misbehavior - conflicts of interest between the elites and the masses
- Disastrous social values: Religion
- Irrational failures
- Non-practical solutions
- Leadership almost null or null

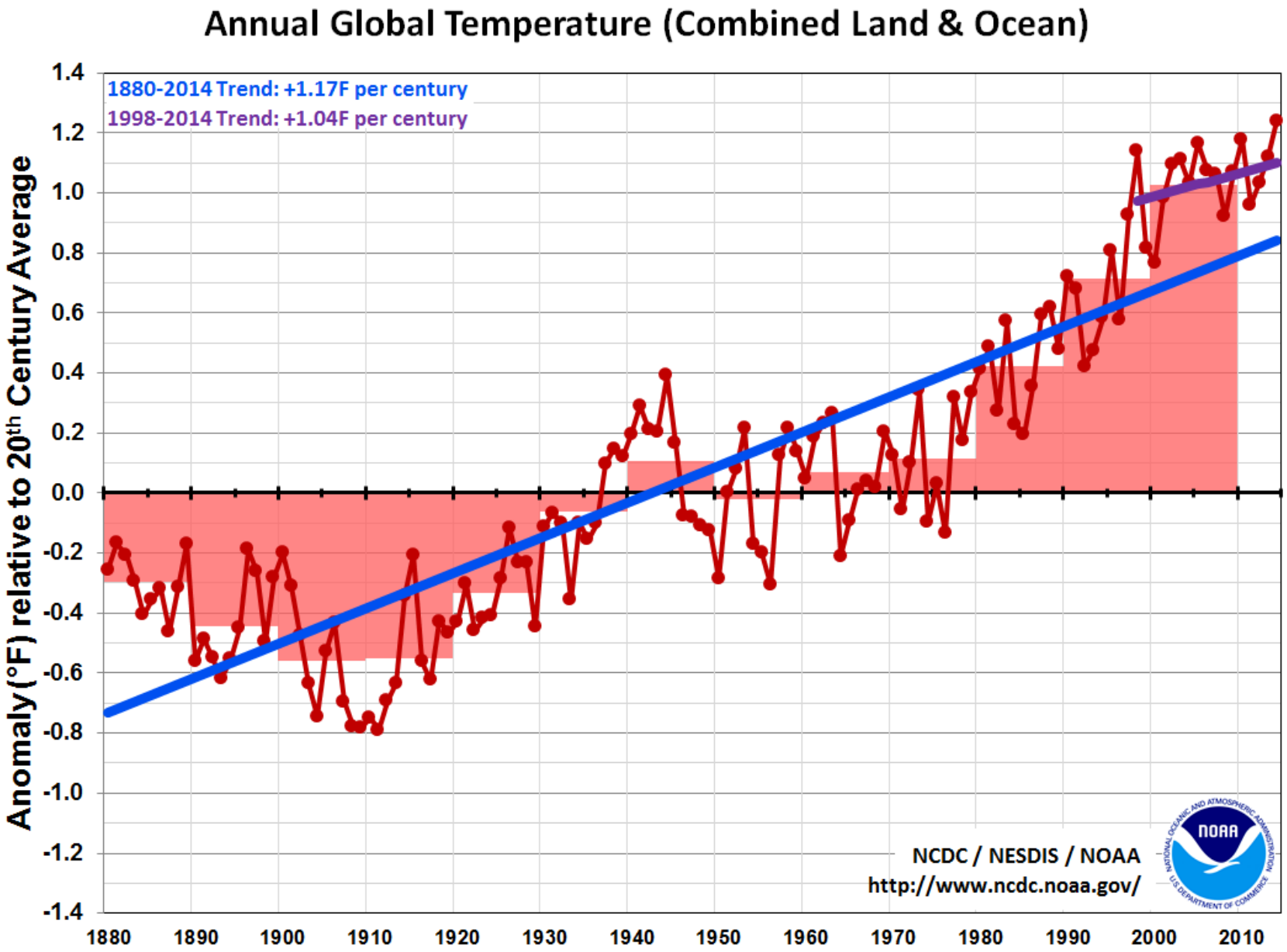
One example

Many scientist, policy makers and citizens argue that the climate of the planet will change due to human activities that alter the chemical composition of the atmosphere.

"Greenhouse gases have increased, altering the chemical composition of the atmosphere (mainly carbon dioxide, methane and nitrate oxides).

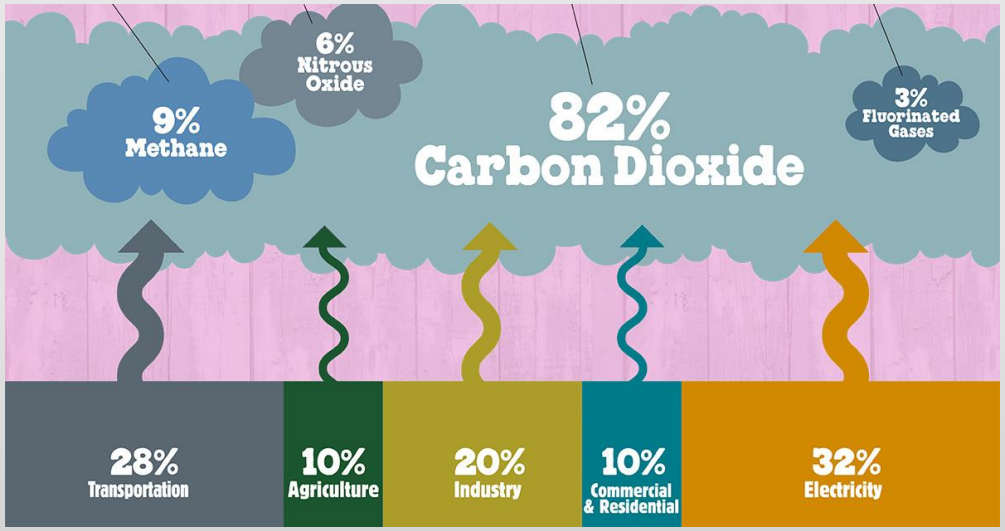
These gases have the ability to trap heat. It is not known exactly how this phenomenon will be reflected in the global climate.

The temperature of the planet has increased.


Annual Global Temperature (Combined Land & Ocean)
1880-2014 Trend: +1.17F per century
1998-2014 Trend: +1.04F per century
Anomaly (°F) relative to 20th Century Average
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0.0
-0.2
-0.4
-0.6
-0.8
-1.0
-1.2
-1.4
1880
1890
1900
1910
1920
1930
1940
1950
1960
1970
1980
1990
2000
2010
NCDC / NESDIS / NOAA
http://www.ncdc.noaa.gov/
NOAA

Other Greenhouse Gasses

• Besides CO_2, there are other gasses that have an important impact on the ability of earths atmosphere to trap heat.



Each gas has different heat absorption capacities, HFC and PFC are those that absorb less heat, while methane traps 21 times more heat than CO_2 and nitrous oxides absorb 270 times more heat than CO_2.

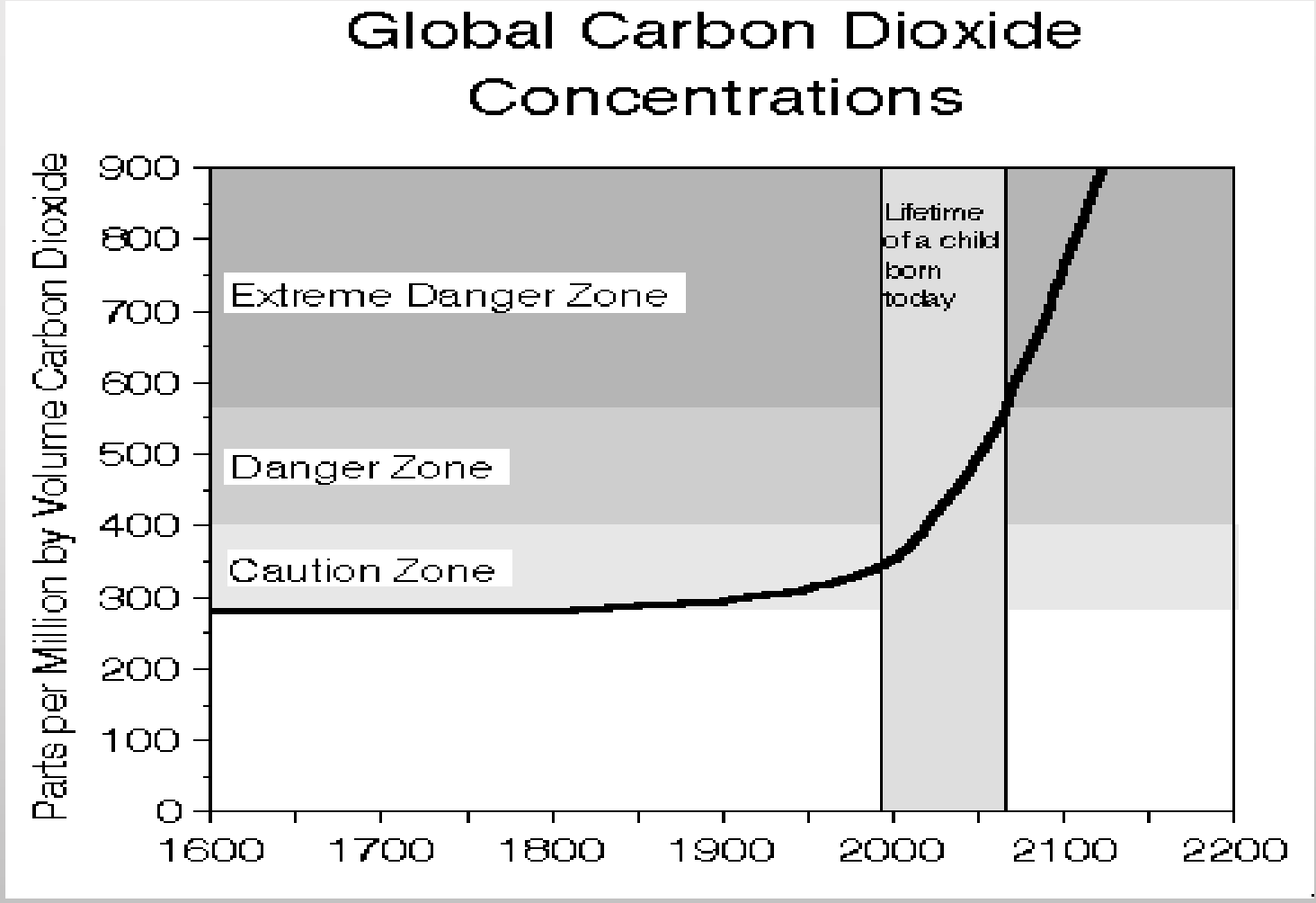
Since the beginning of the industrial revolution the concentration of GHG has increased:

CO2 has increased by 30% approx.
Methane has doubled
Nitrous oxides have increased 15%

Increasing the capacity of the atmosphere to trap heat !!!

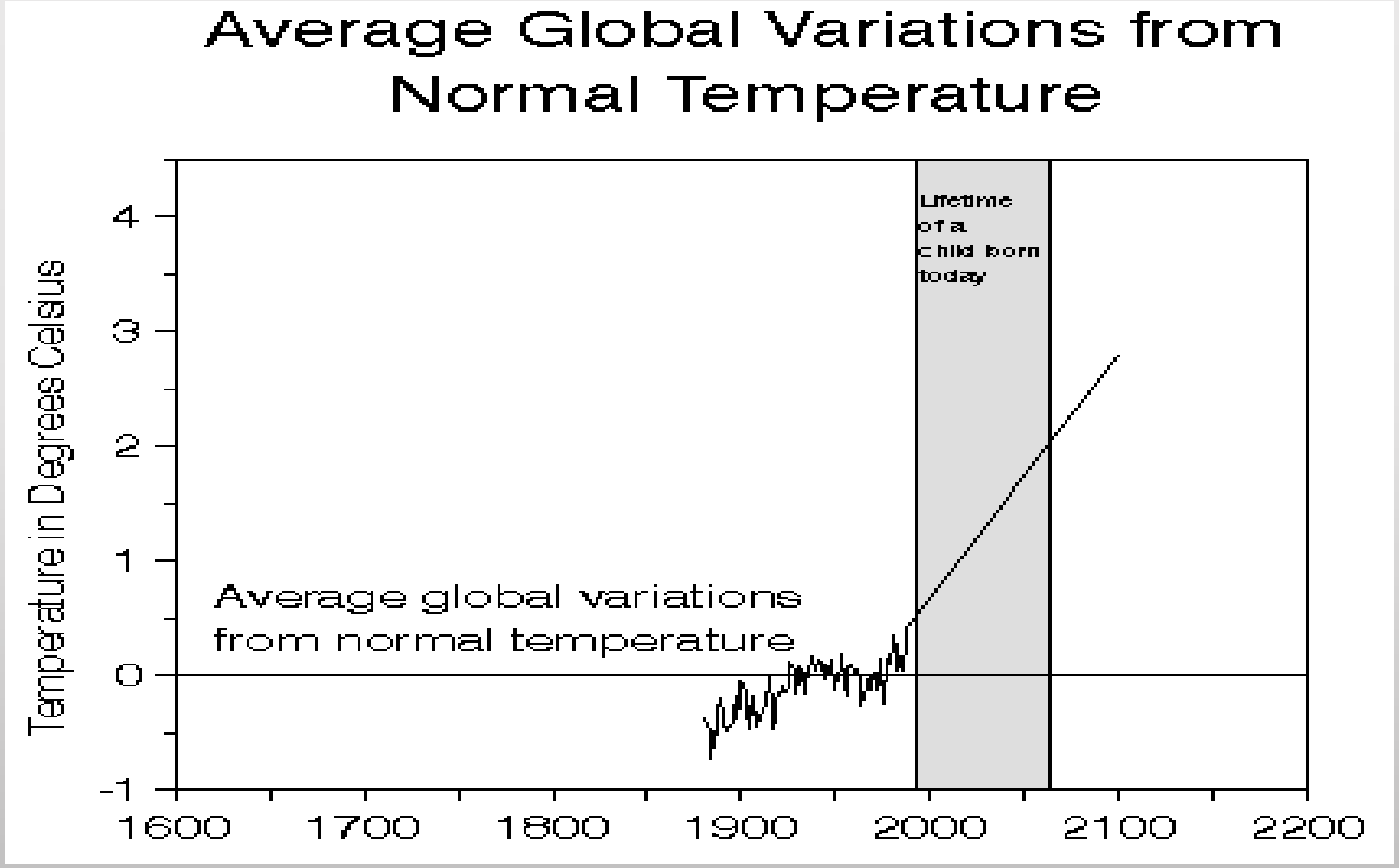
Sulfate aereoles are a pollutant that cools the atmosphere (they reflect light), but they are short-lived.

Indicators



IPCC Working Group I. June 1990. Policymakers Summary of the Scientific Assessment on Climate Change. "Business-as-usual" scenario. Nairobi: U.N. Environment Programme. pp. 7-9.

Indicators



Projections are from Scenario IS92a as presented in Intergovernmental Panel on Climate Change. 1992. 1992 IPCC Supplement. Nairobi: U.N. Environment Programme. p. 25. The historical data are from Hanson, J. E. 1988. As reported in Shabecoff, P. "Global Warming Has Begun, Expert Tells Senate. " The New York Times. 24 June 1988. p. A1.

Divergent points of view

Sustainable Development

Definition

Gro Harlem Burndtland

Norwegian PM and chair the World Commission on Environment and Development (WCED), widely referred to as the Brundtland Commission defines

SUSTAINABLE DEVELOPMENT as

" Development that meets the needs of the present without compromising the ability of future generations to meet their own "

Key concepts on Sustainable Development

Basic needs of the population must be covered with:

- Dignity
- Security

There are no absolute limits; the potential for development is a function of the current state of technology and its impact on the environment.

Sustainable Development

In 1990, the European Economic Comission indicated that:

- To achieve sustainable development, the political line should be based on the precautionary principle.

Principle of Caution

The precautionary principle indicates that environmental measures must:

- Anticipate, avoid and attack the causes of environmental deterioration.

Where there are threats or serious irreversible damage:

- The lack of scientific certainty should not be used as a pretext to postpone measures aimed at preventing the deterioration of the environment.

- As stated by Robert Constanza " is better to be approximately right, than precisely wrong".

Sustainability

«Human health and environment health are inseparable»

Rachel Carson

http://trevorloudon.com/2011/07/%E2%80%98sustainable-development%E2%80%99-explained/

The role of technology

In the 70´s, Paul Ehrlich proposed the following equation to estimate the human impact on the planet (I).

I = P*A*T

where

I = Human impact on the environment

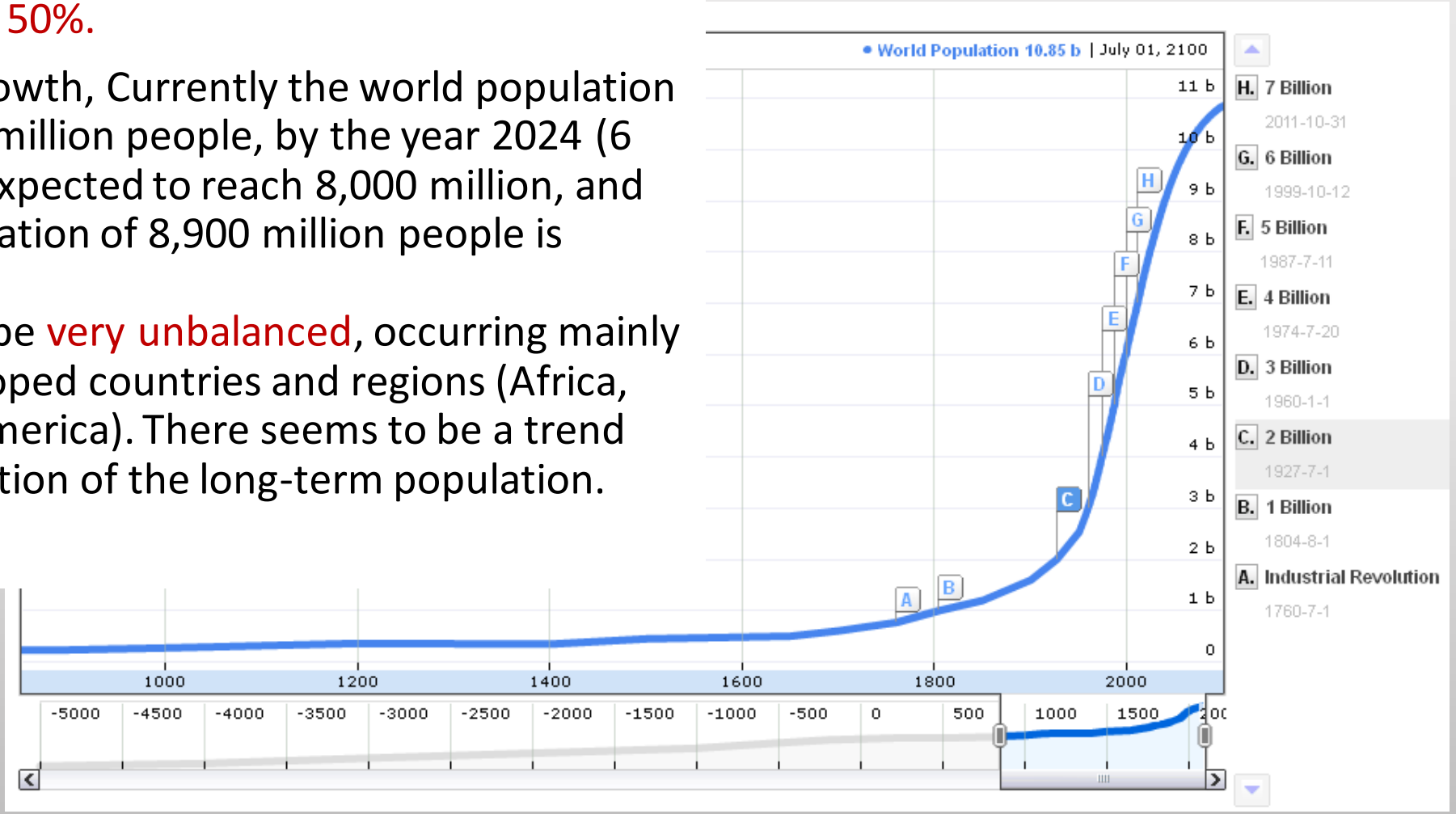
P = Population. Number of humans.

A = Affluence. average consumption of each person in the population, number of products and services consumed per capita (ie PIB).

T = Technology. Represents how resource intensive the production of affluence is.

Implications of the IPAT equation

- I: Environmental Impact, is not sustainable, it should be cut to around 50%.
- P: Population Growth, Currently the world population is approx. 7,140 million people, by the year 2024 (6 years ahead) is expected to reach 8,000 million, and by 2050, a population of 8,900 million people is expected.
  This growth will be very unbalanced, occurring mainly in the less developed countries and regions (Africa, Asia and Latin America). There seems to be a trend towards stabilization of the long-term population.



Implications of the IPAT equation

- A: Affluence, Standard of living -> The richest 20% consume 80% of the products and services, is this sustainable?
- On average, the rich countries (societies) consume 16 times more than the poor, with an average growth of the economies of the rich countries of 2%, by the year 2050 it will imply a growth factor of 2.7. If the poor countries want to reach the level of the the rich countries (societies), they will need a growth factor of 43.2 (16 * 2.7), which represents an annual growth of 7.8%.

Seen from the point of view of consumption, if global consumption is 100, rich countries consume 80 and if growth factor is 2.7, by 2050 consumption will be 216; and they leave the remaining 20 to the poor (currently), with a growth of 43.2, their consumption in 50 years will be 864, resulting in a global consumption of 1,080, ten times more than the initial one !!!!

Where to start????

- With the IPAT equation in mind, the first answer is on the population side; but in democratic societies, can we (in the short term) reduce the "P" factor ???
- What about the “A” factor? again in a democratic society, can we reduce the consumption rate and maintain the economic indicators at a sustainable level???
- How can we use the “T” factor???

The famuos Earth-rise photographs, take by Appolo VIII astronauts on December 24, 1968

Image of planet earth taken by the spacecraft Voyager 1 at a distance of 3.7 billion miles on February 1990, while the spacecraft was leaving the orbit of Neptune

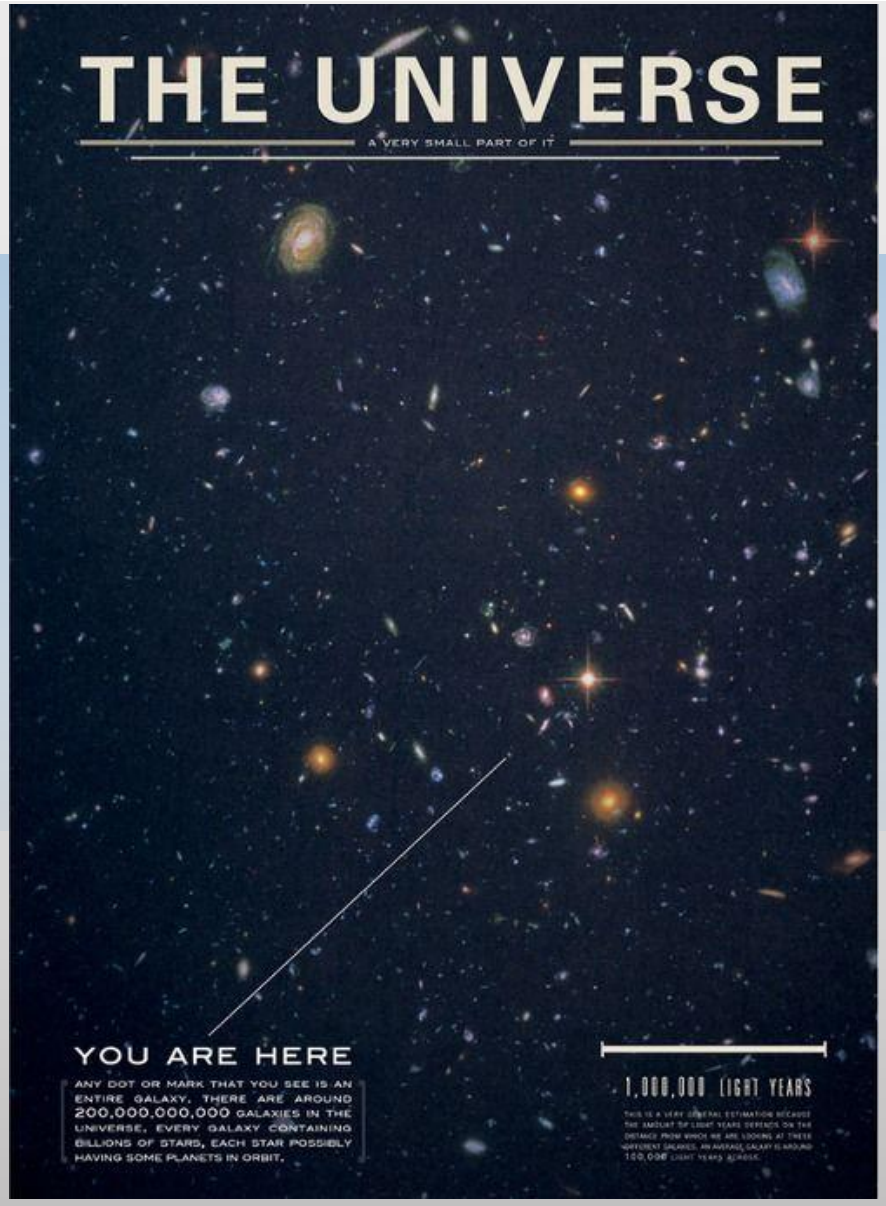
On spaceship Earth, there are no passenger, everybody is part of the crew.

Marshall McLuhan

Video

Steve Howard. 15 min.

- Selling sustainability

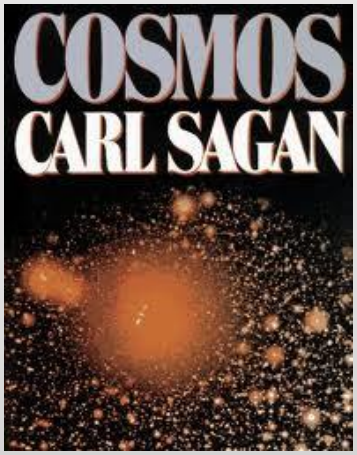


Our place in the Cosmos

https://www.pinterest.com.mx/pin/118641771403211011/?lp=true

Cosmic Year

More than a CD from progressive rock band from the US



([From The Dragons of Eden - Carl Sagan and the PBS Video Cosmos and its new adaptation with Neal deGrasse Tyson])

Cosmos: A Spacetime odyssey-Cosmic calendar:

https://www.dailymotion.com/video/x3sjrbk

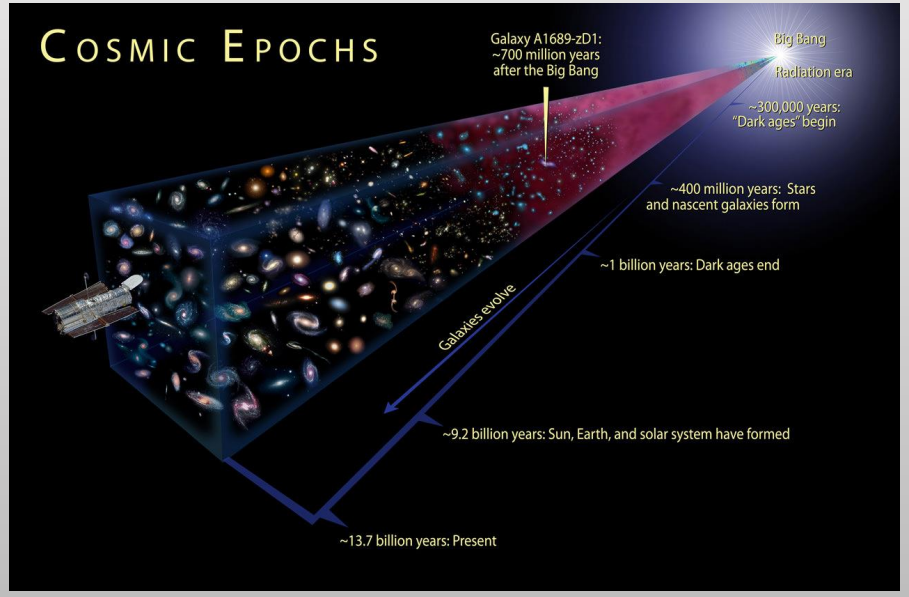
12'36"

The puzzle

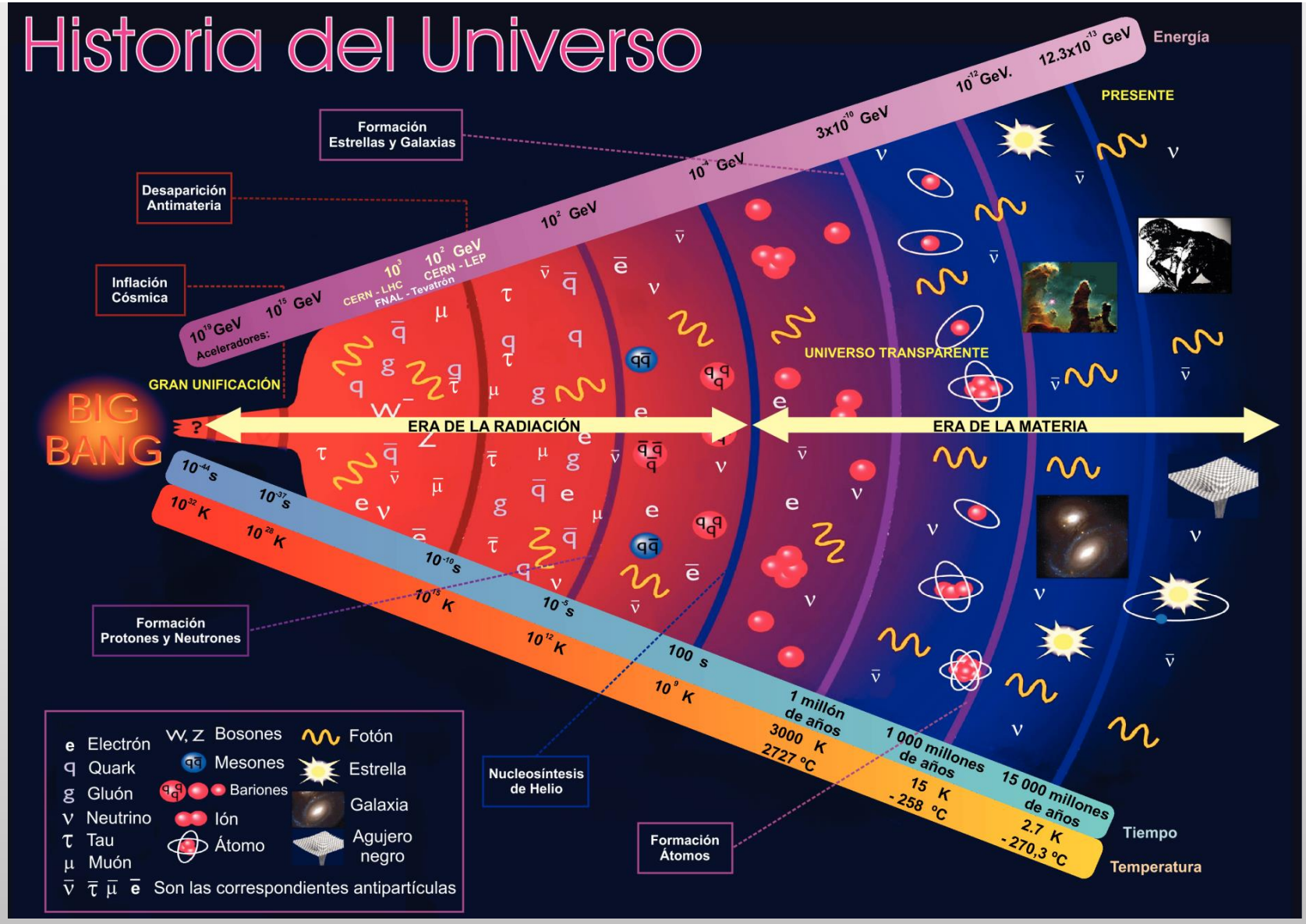
In order to be able to build the puzzle…

"You have to know the past to understand the present."

Carl Sagan

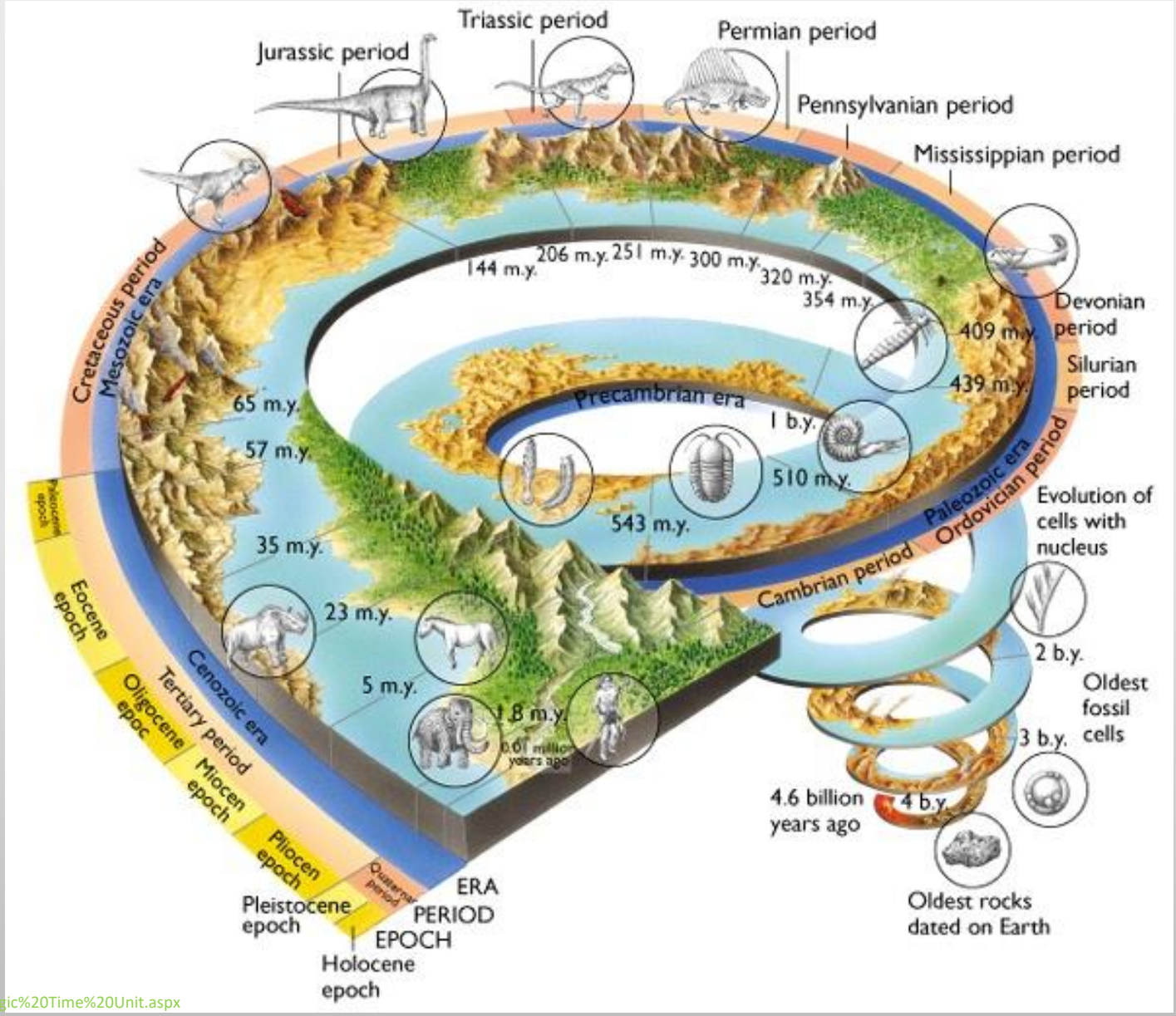


https://www.universetoday.com/137048/universe-filled-light/



https://sites.google.com/site/eluniversoejaljd/

Our distant past



http://teachers.greenville.k12.sc.us/sites/mmills/Pages/Geologic%20Time%20Unit.aspx

Pre-December dates

Big Bang	January 1
Origin of Milky Way Galaxy	May 1
Origin of the solar system	September 9
Formation of the Earth	September 14
Origin of life on Earth	~ September 25
Formation oldest rocks known on Earth	October 2
Date of oldest fossils (bacteria and blue-green algae)	October 9
Invention of sex (by microorganisms)	~ November 1
Oldest fossil photosynthetic plants	November 12
Eukaryotes (first cells w/nuclei) flourish	November 15

https://science.howstuffworks.com/what-did-big-bang-sound-like.htm

December 1-21st.

1 Significant oxygen atmosphere begins to develop on Earth.

5 Extensive vulcanism and channel formation on Mars

16 First Worms.

17 Precambrian ends. Paleozoic Era and Cambrian Period begin. Invertebrates flourish.

18 First oceanic plankton. Trilobites flourish.

19 Ordovician Period. First fish, first vertebrates

20 Silurian Period. First vascular plants. Plants begin colonization of land.

21 Devonian Period begins. First insects. Animals begin colonization of land.

https://phys.org/news/2017-05-continental-crust-illuminates-billion-years.html

December 22-31st.

22 First amphibians. First winged insects

23 Carboniferous Period. First trees. First reptiles

24 Permian Period begins. First dinosaurs

25 Paleozoic Era ends. Mesozoic Era Begins

26 Triassic Period. First mammals.

27 Jurassic Period. First birds.

28 Cretaceous Period. First flowers. Dinosaurs become extinct.

29 Mesozoic Era ends. Cenozoic Era and Tertiary Period begin. First cetaceans. First primates

30 First evolution of frontal lobes in the brains of primates. First hominids. Giant mammals flourish.

31 End of Pliocene Period. Quaternary (Pleistocene and Holocene) Period. First humans.

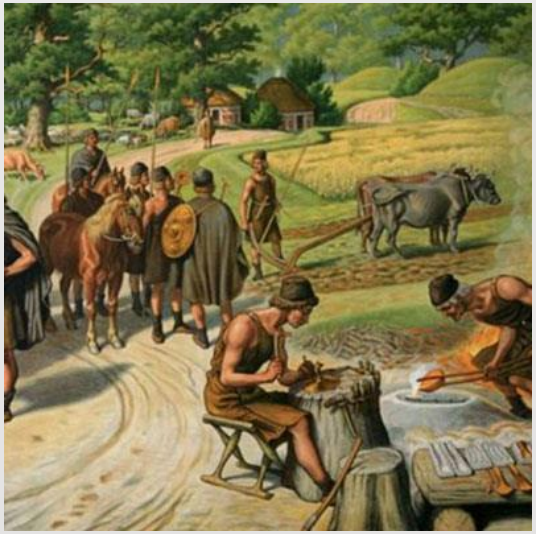
https://www.pinterest.com.mx/pin/366199013434221087/?lp=true

December 31

Origin of *Proconsul* and *Ramapithecus*, probable ancestors of apes and men	~ 1:30 p.m.
First humans	~ 10:30 p.m.
Widespread use of stone tools	11:00 p.m.
Domestication of fire by Peking man	11:46 p.m.
Beginning of most recent glacial period	11:56 p.m.
Extensive cave painting in Europe	11:59 p.m.
Invention of agriculture	11:59:20 p.m.
Neolithic civilization; first cities	11:59:35 p.m.
First dynasties in Sumer, Ebla and Egypt; development of astronomy	11:59:50 p.m. (10s)

https://www.independent.co.uk/topic/human-evolution
https://www.intrepidtravel.com/adventures/guide-to-local-etiquette-in-egypt/

Invention of the alphabet; Akkadian Empire	11:59:51 p.m. (9s ago)
Hammurabic legal codes in Babylon;	
Middle Kingdom in Egypt	11:59:52 p.m. (8s ago)
Bronze metallurgy; Mycenaean culture; Trojan War;	
Olmec culture; invention of the compass	11:59:53 p.m. (7s ago)
Iron metallurgy; First Assyrian Empire;	
Kingdom of Israel; founding of Carthage by Phoenicia	11:59:54 p.m. (6s ago)
Asokan India; Ch'in Dynasty China;	
Periclean Athens; birth of Buddha	11:59:55 p.m. (5s ago)
Euclidean geometry; Archimedean physics;	
Ptolemaic astronomy; Roman Empire; birth of Christ	11:59:56 p.m. (4s ago)
Zero and decimals invented in Indian arithmetic;	
Rome falls; Moslem conquests	11:59:57 p.m. (3s ago)
Mayan civilization; Sung Dynasty China;	
Byzantine empire; Mongol invasion; Crusades	11:59:58 p.m. (2s ago)



https://www.flagfen.com/5-greatest-civilizations
https://www.britannica.com/place/Bonampak

December 31st. cont...

Renaissance in Europe; voyages of discovery from Europe and from Ming Dynasty China; emergence of the experimental method in science.

11:59:59 p.m. (2s ago)

Widespread development of science and technology;
emergence of global culture;
acquisition of the means of self-destruction of the human species;
first steps in spacecraft planetary exploration and the search of extraterrestrial intelligence

Now: The first second of New Year's Day

https://en.wikipedia.org/wiki/Renaissance
https://www.smithsonianmag.com/smart-news/nasa-scientists-are-trying-make-medicine-onboard-iss-180958612/

How many humans have walked on earth?

So, the history of all humans, according to the Population Reference Bureau, the 108 billion (107'602'707,791 by mid 2011) humans that have lived on the earth since the origin of Homo sapiens; can be compressed into those final seconds of the final day, of the last month on the cosmic calendar."

Today estimated population (at 8:11 am): 7'262'405,500
-> Open link: www.census.gov/popclock/

-> Open link:
http://www.worldometers.info/world-population/

http://www.prb.org/Publications/Articles/2002/HowManyPeopleHaveEverLivedonEarth.aspx
https://writescience.wordpress.com/2014/11/13/the-audacity-of-exploration/

Evolution

"We are the product of 4.5 billion years of fortuitous, slow biological evolution.

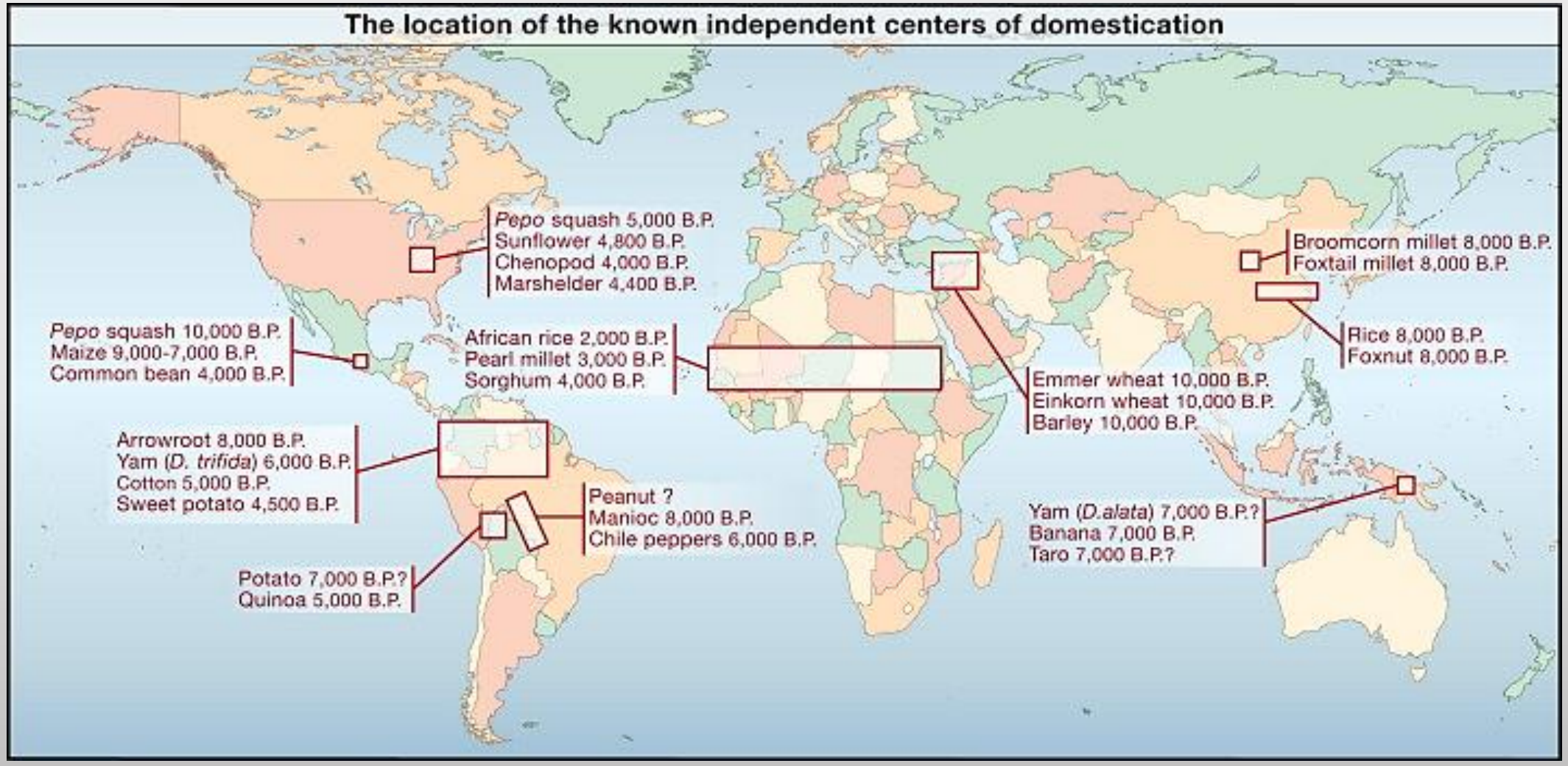
There is no reason to think that the evolutionary process has stopped.

Humans are a transitional animal. We are not the climax of creation."

Carl Sagan

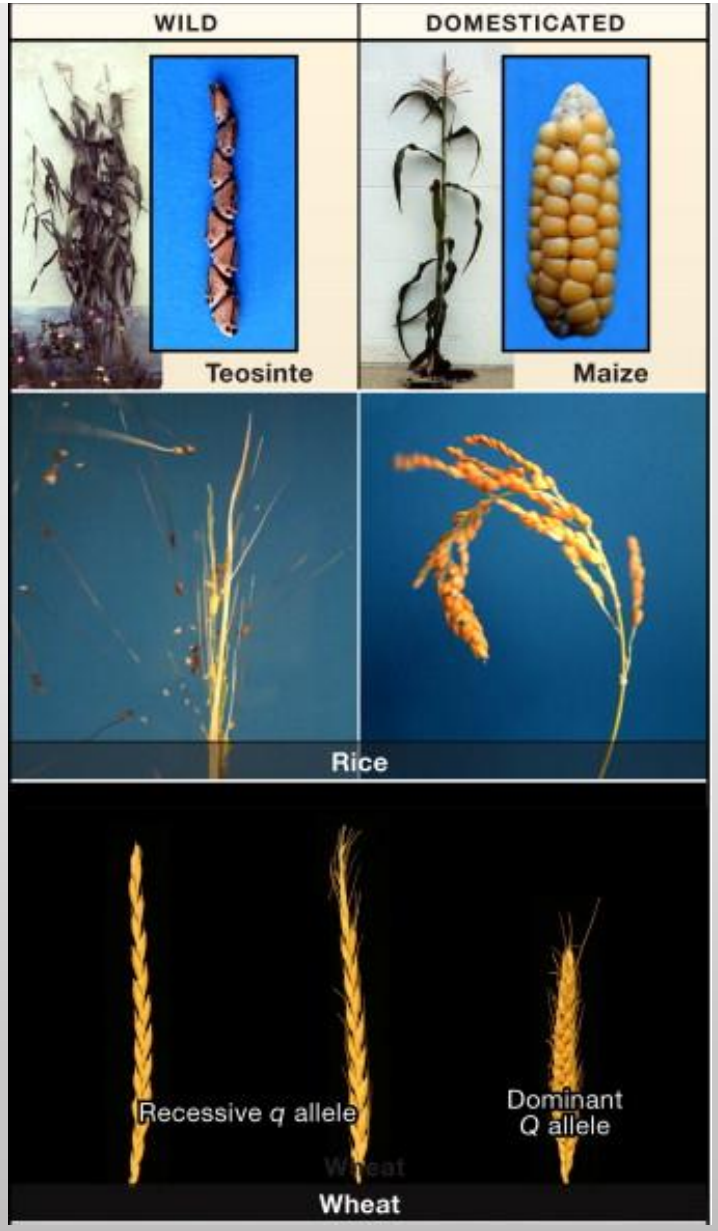
VIDEO: http://www.openculture.com/2014/03/carl-sagan-explains-evolution-in-an-eight-minute-animation.html 7'55"

Plant domestication

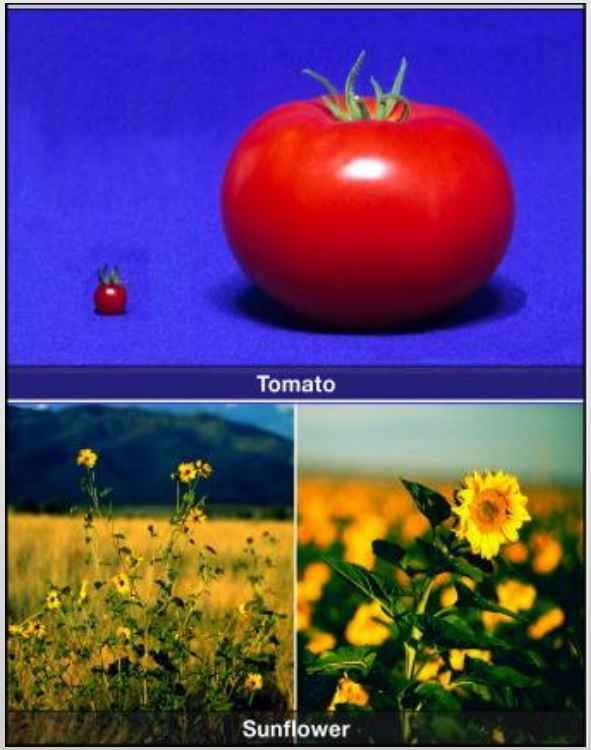


https://www.sciencedirect.com/science/article/pii/S0092867406015923

http://www.sciencedirect.com/science/article/pii/S0092867406015923



http://www.sciencedirect.com/science/article/pii/S0092867406015923



https://www.sciencedirect.com/science/article/pii/S0092867406015923

How many humans and agrigultural systems

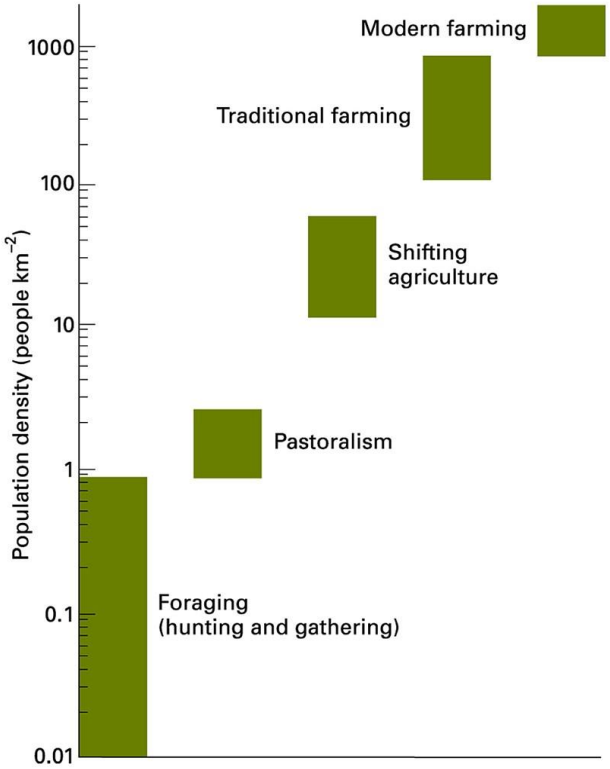


Figure 1.6 Comparison of carrying capacities of foraging, pastoralist and agricultural societies.

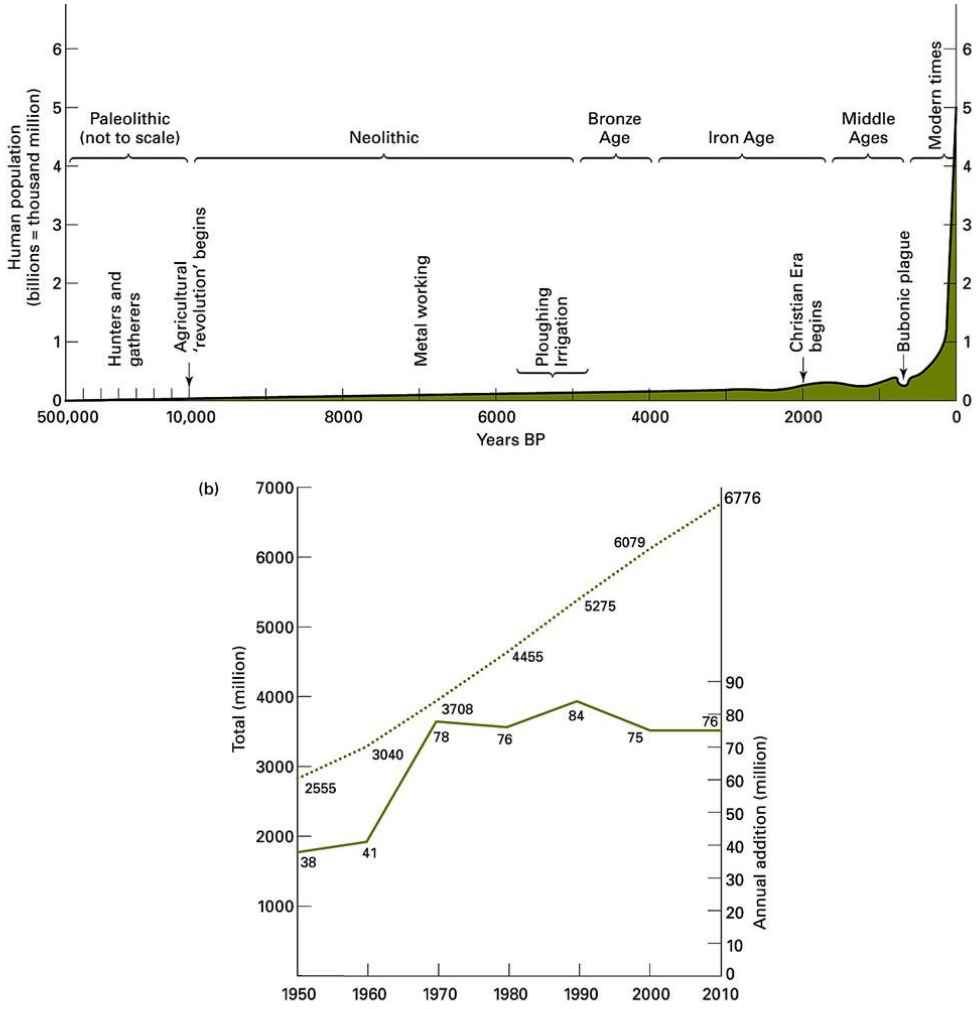


Figure 1.2 (a) The growth of human numbers for the past half million years (modified from Ehrlich et al., 1977, figure 5.2). (b) Annual growth of population since 1950.

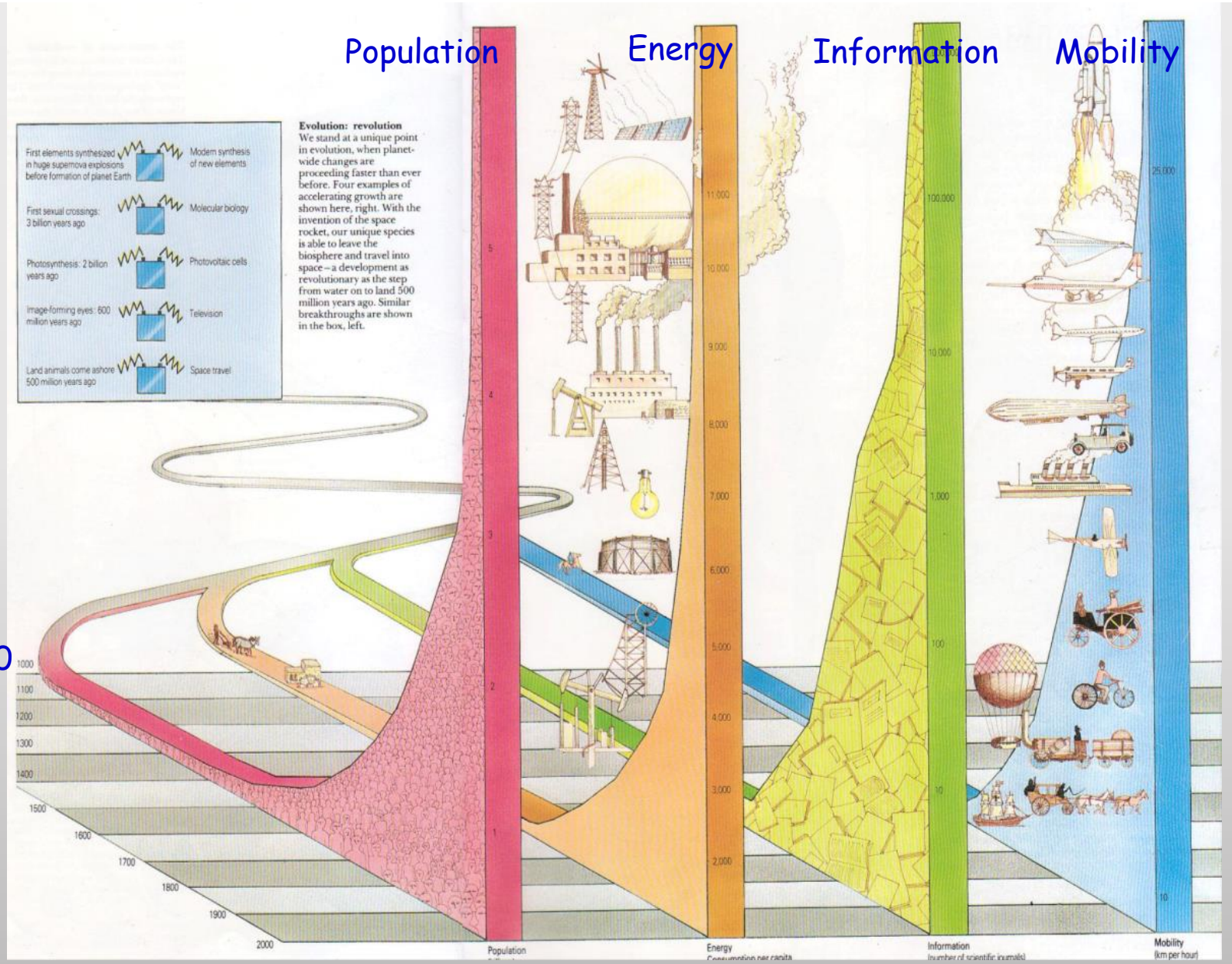
Population

Energy

Information

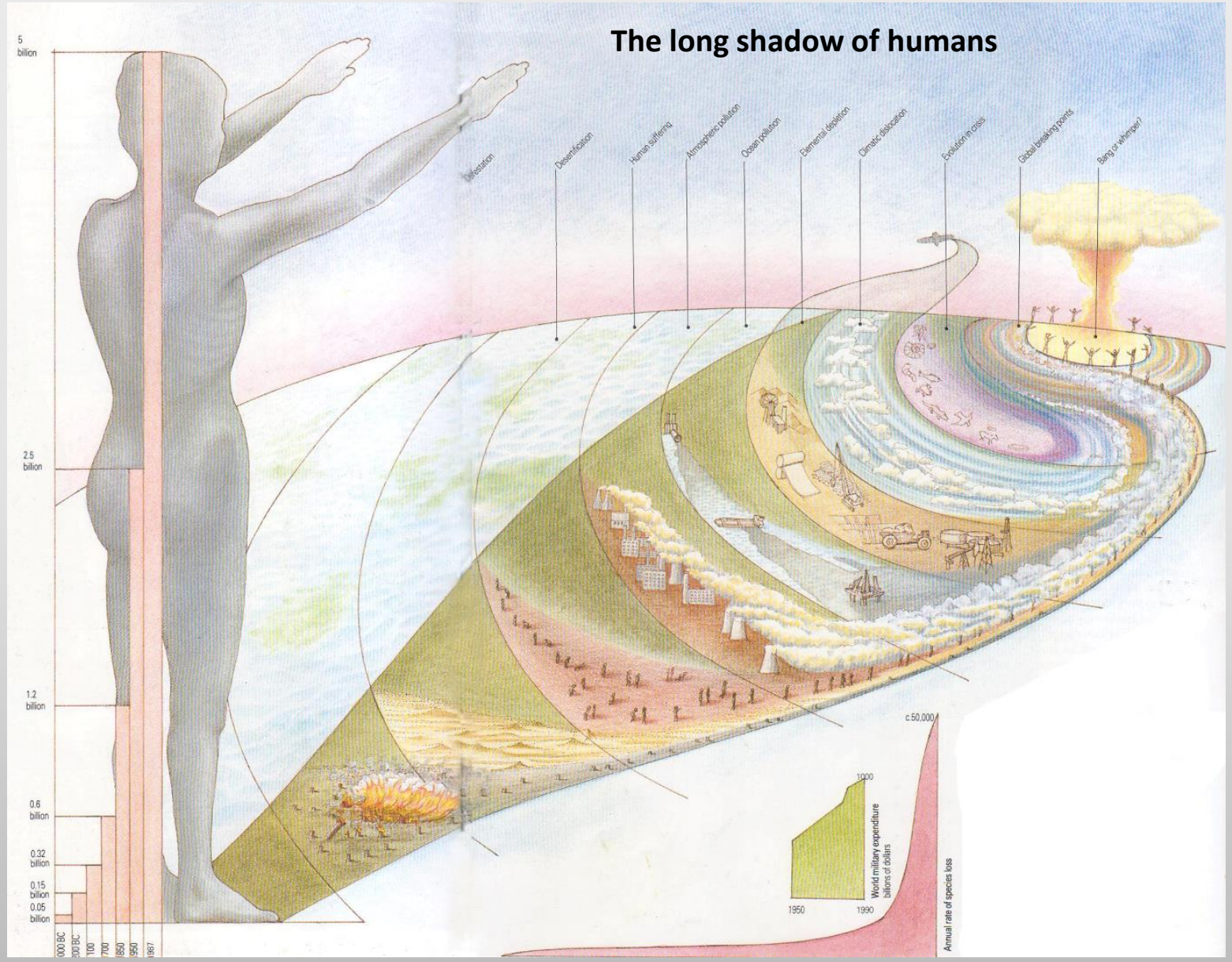
Mobility

Aparición del ser humano

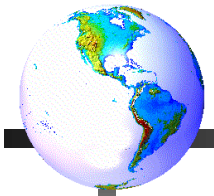


1,000

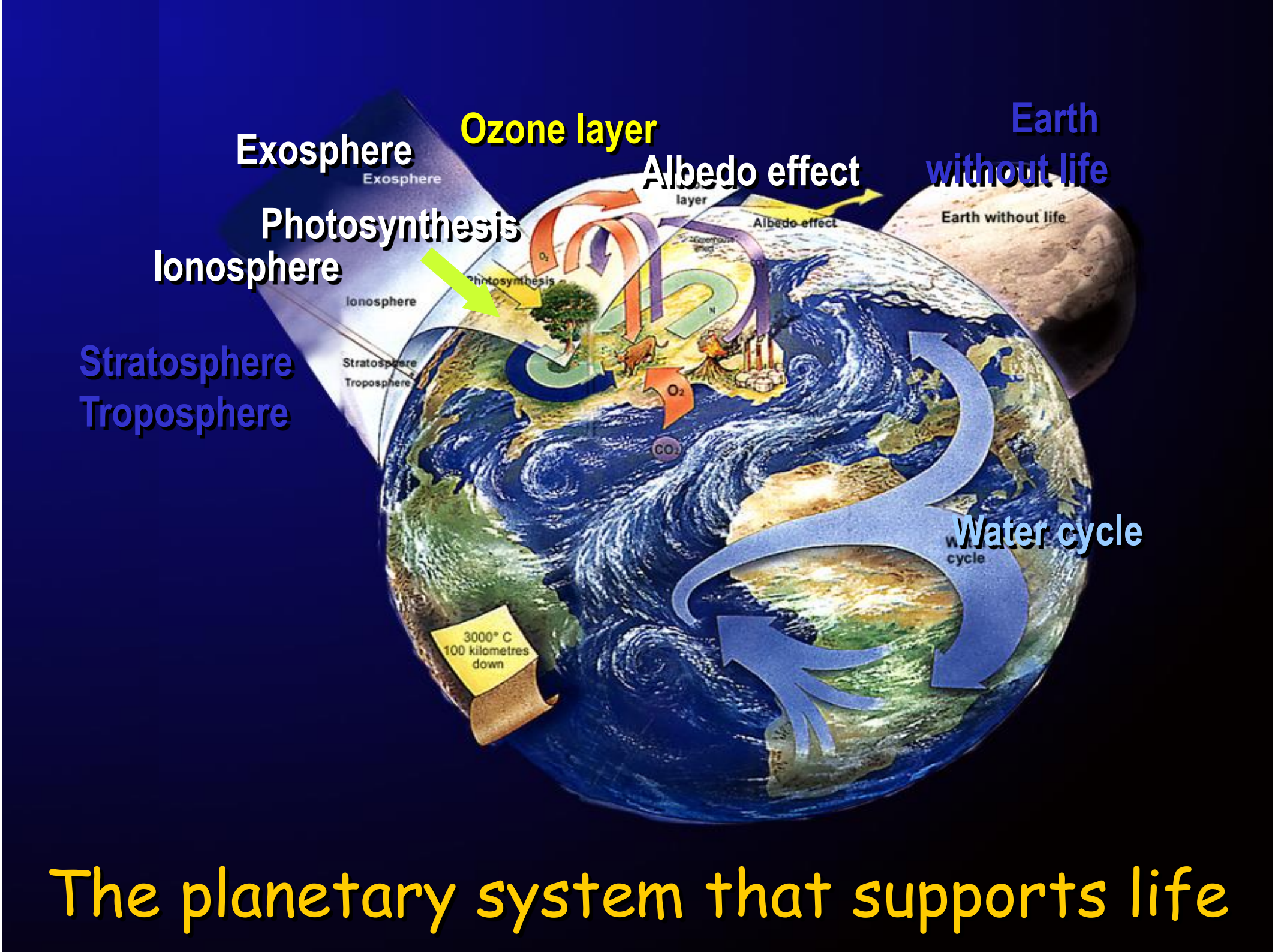
Gaia Book


The long shadow of humans
5 billion
2.5 billion
1.2 billion
0.6 billion
0.32 billion
0.15 billion
0.05 billion
Deforestation
Desertification
Human suffering
Atmospheric pollution
Ocean pollution
Elemental depletion
Climatic dislocation
Evolution in crisis
Global breaking points
Bang or whimper?
c.50,000
1000
World military expenditure billions of dollars
1950
1990
Annual rate of species loss

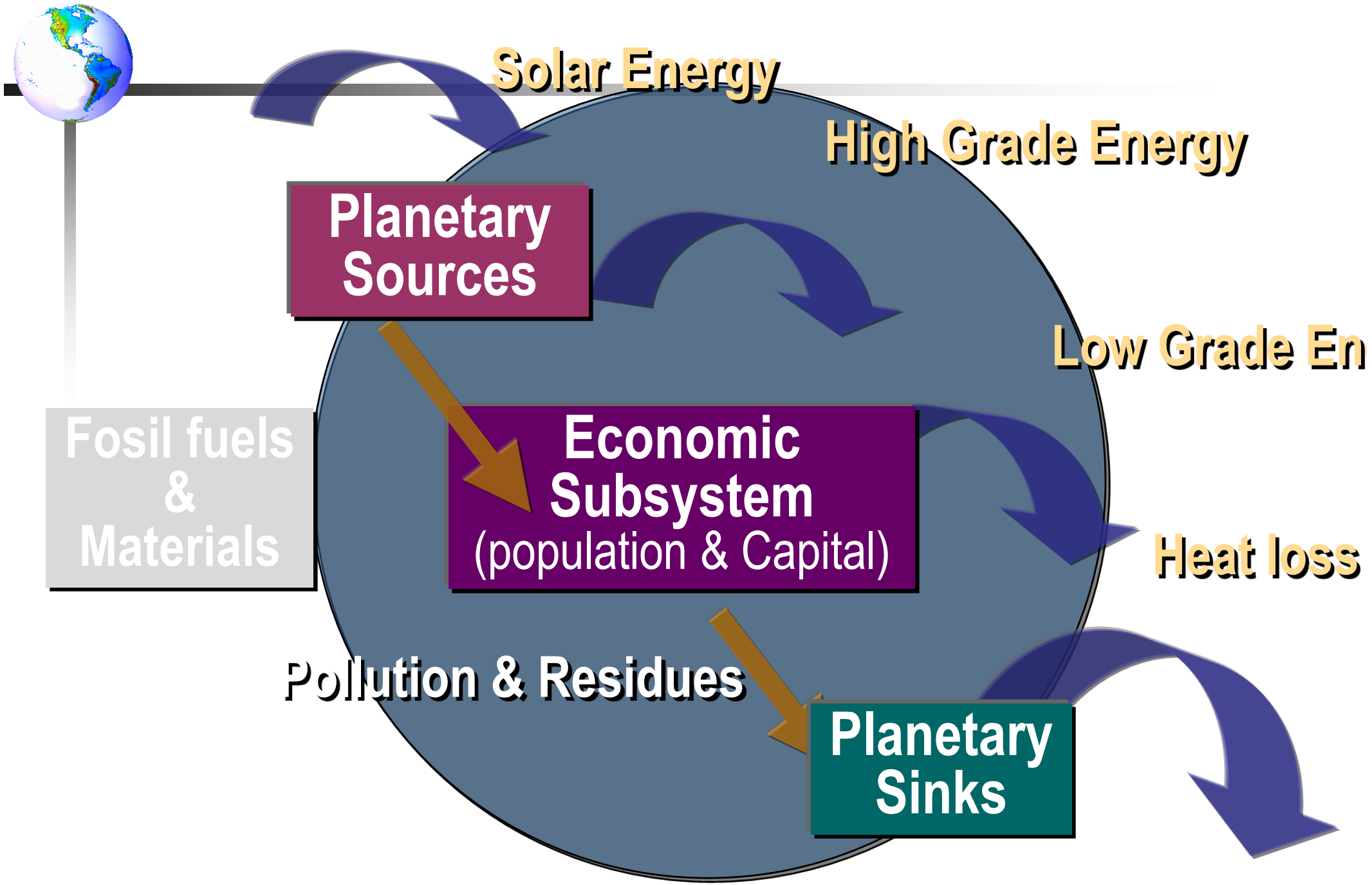
Gaia Book



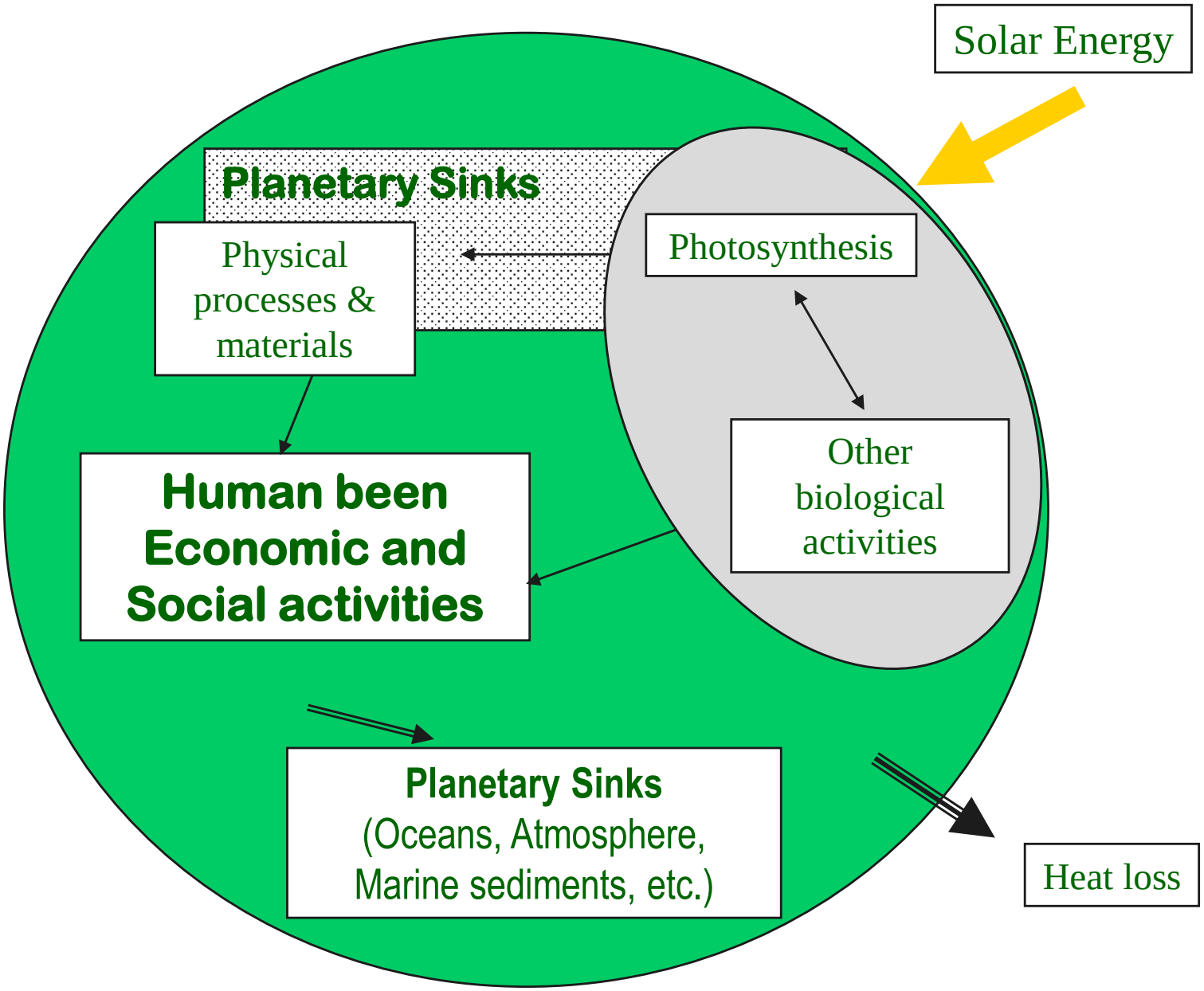
Planetary System



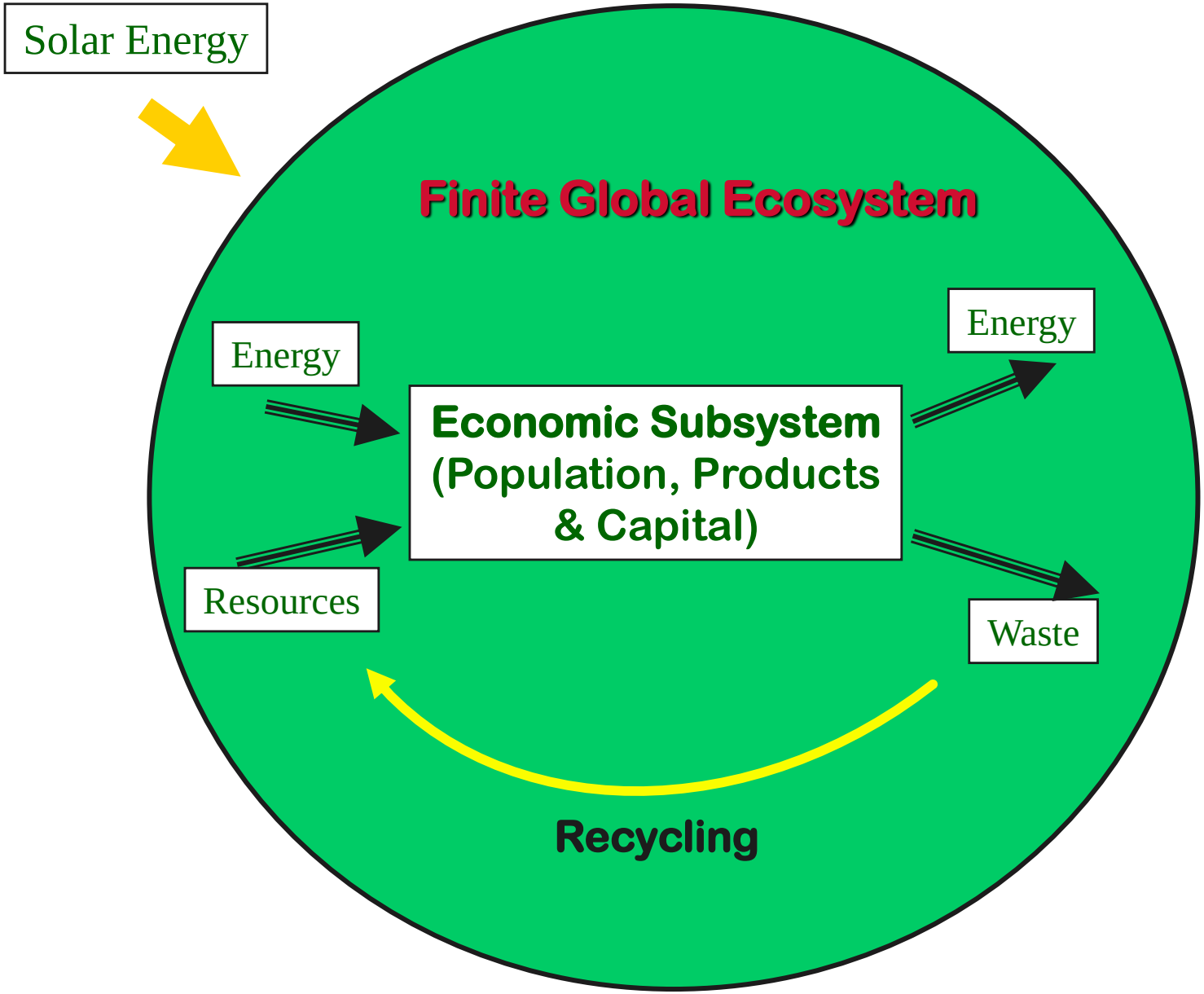
The planetary system that supports life


Solar Energy
High Grade Energy
Planetary Sources
Low Grade En
Fosil fuels & Materials
Economic Subsystem
(population & Capital)
Heat loss
Pollution & Residues
Planetary Sinks

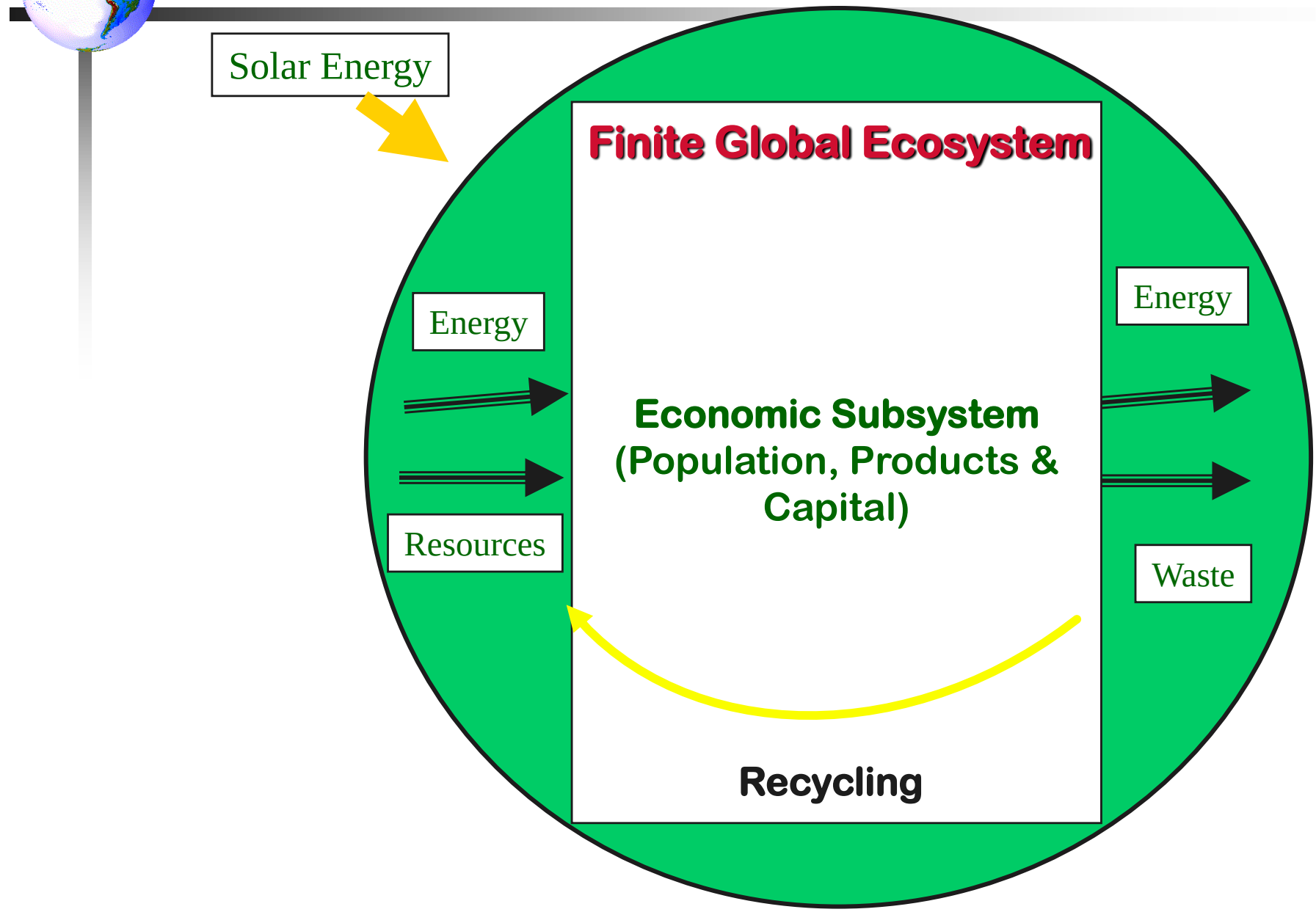
Interactions: Planetary sinks



Earth: finite system

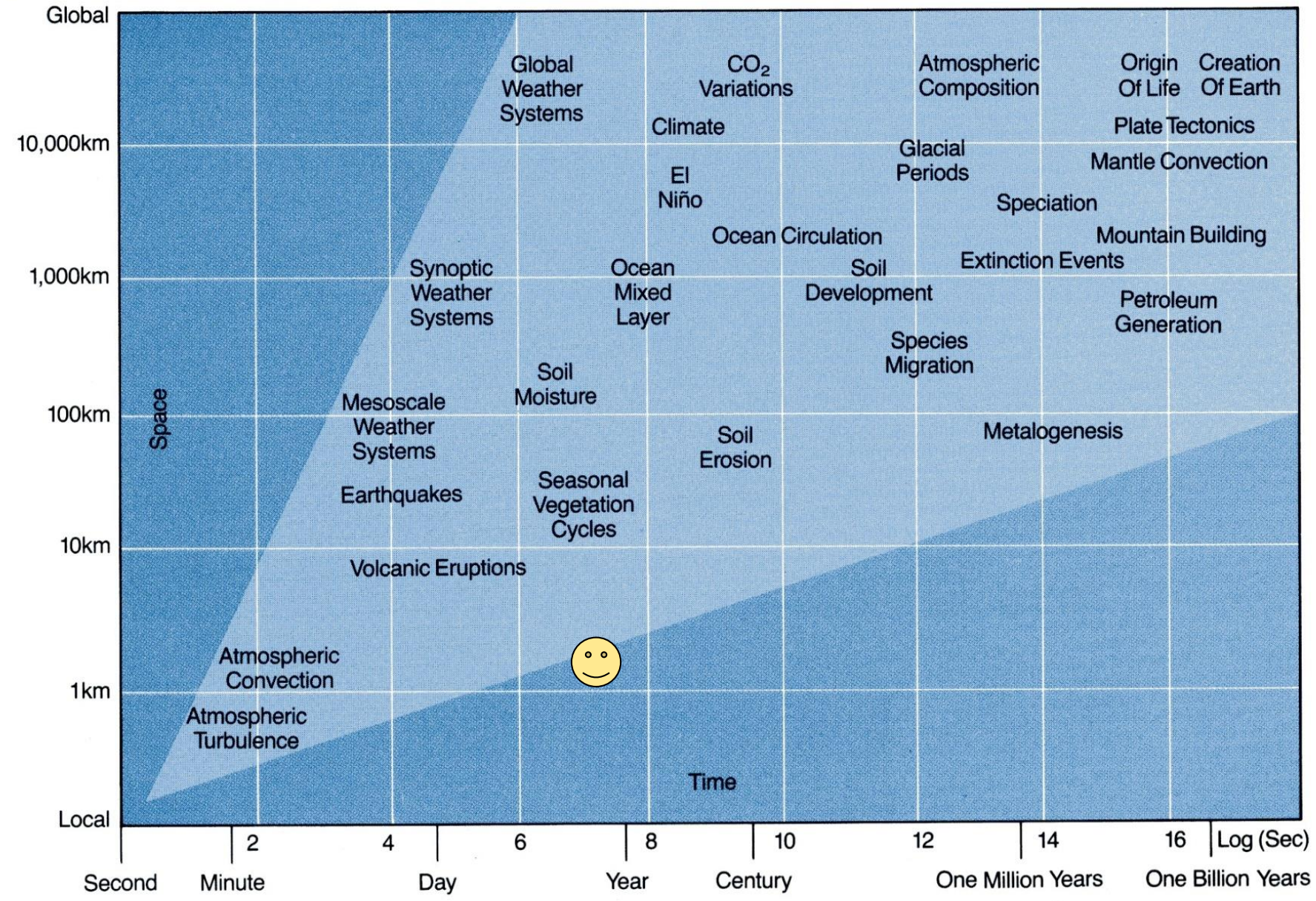


Earth: finite system

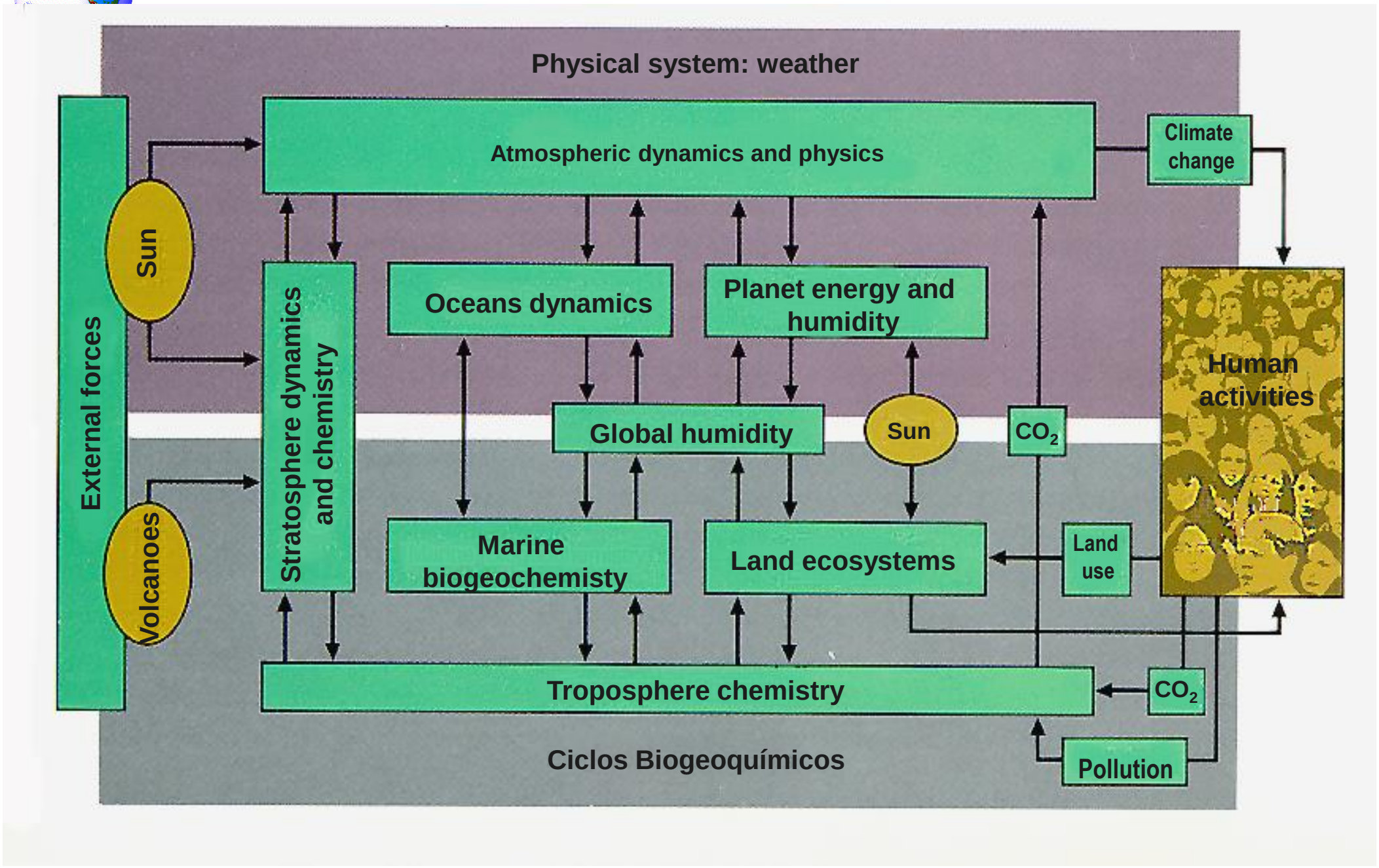


Planetary Processes

Figure 1. EARTH SYSTEM PROCESSES:
CHARACTERISTIC SPACE AND TIME SCALES



Planetary Interactions



Planetary Interactions

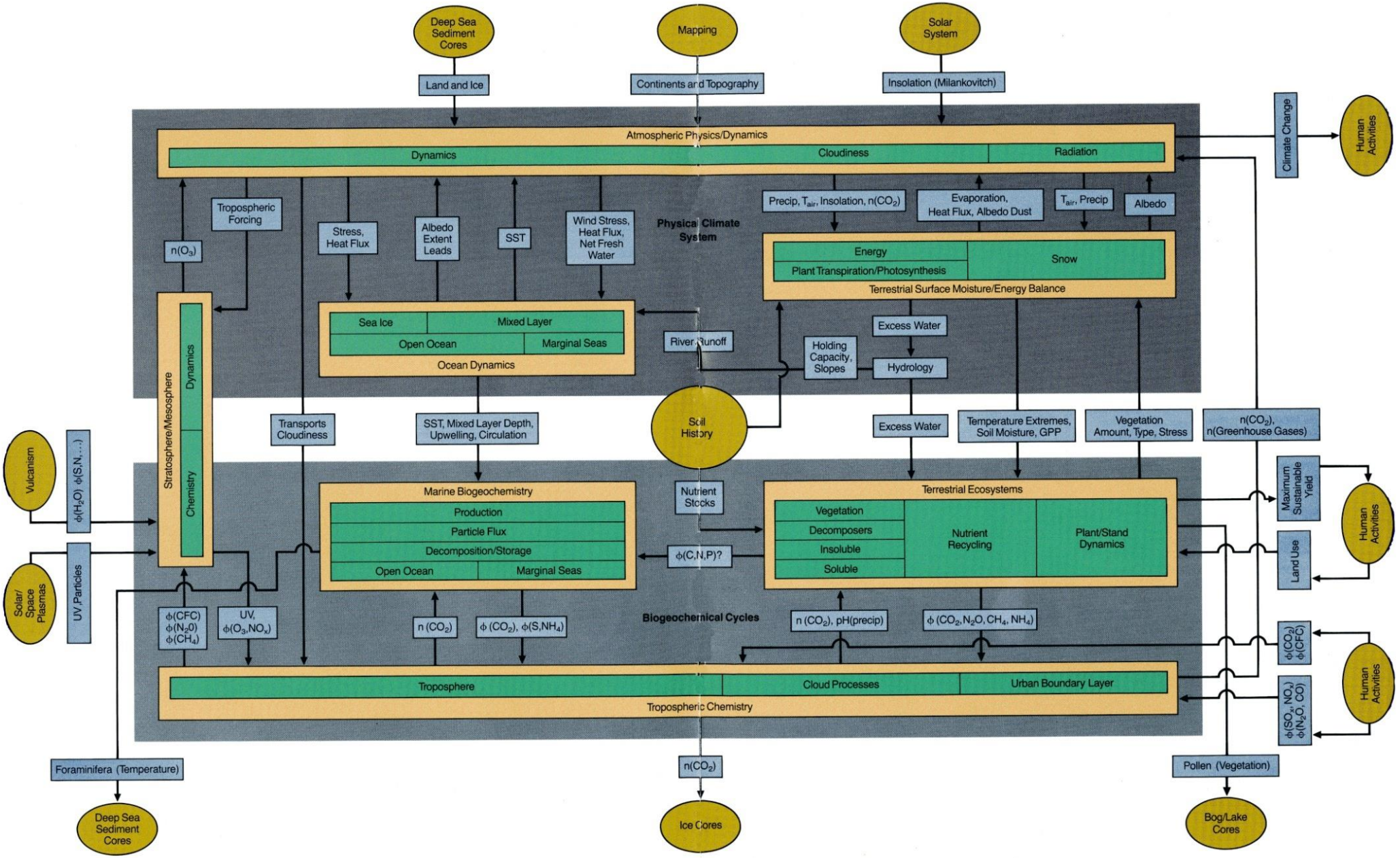


Figure 3. FLUID AND BIOLOGICAL EARTH PROCESSES: DETAILED INFORMATION FLOW
[$\phi(\ldots)$ = flux, $n(\ldots)$ = concentration]

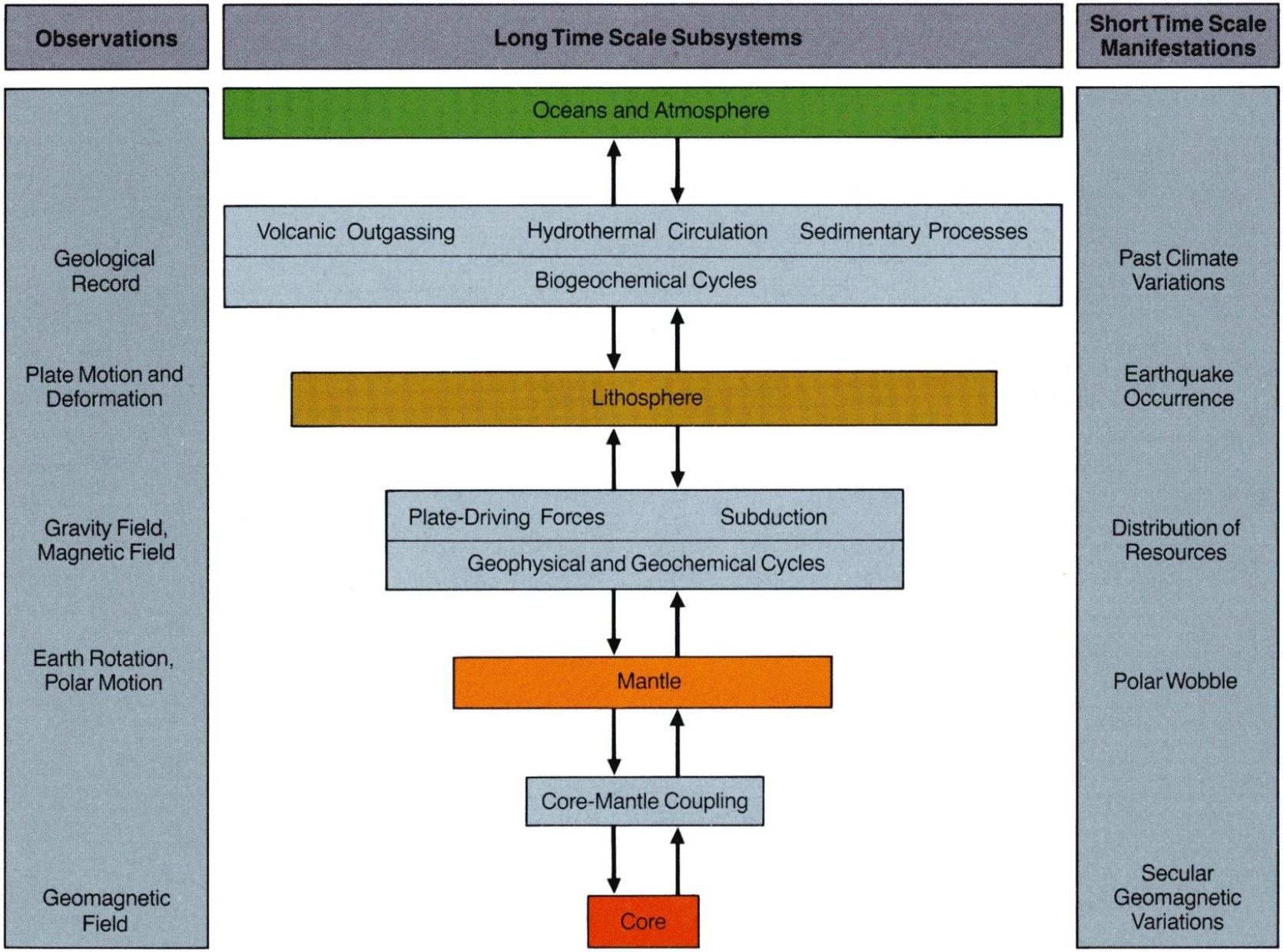
Visualizing Earth Systems

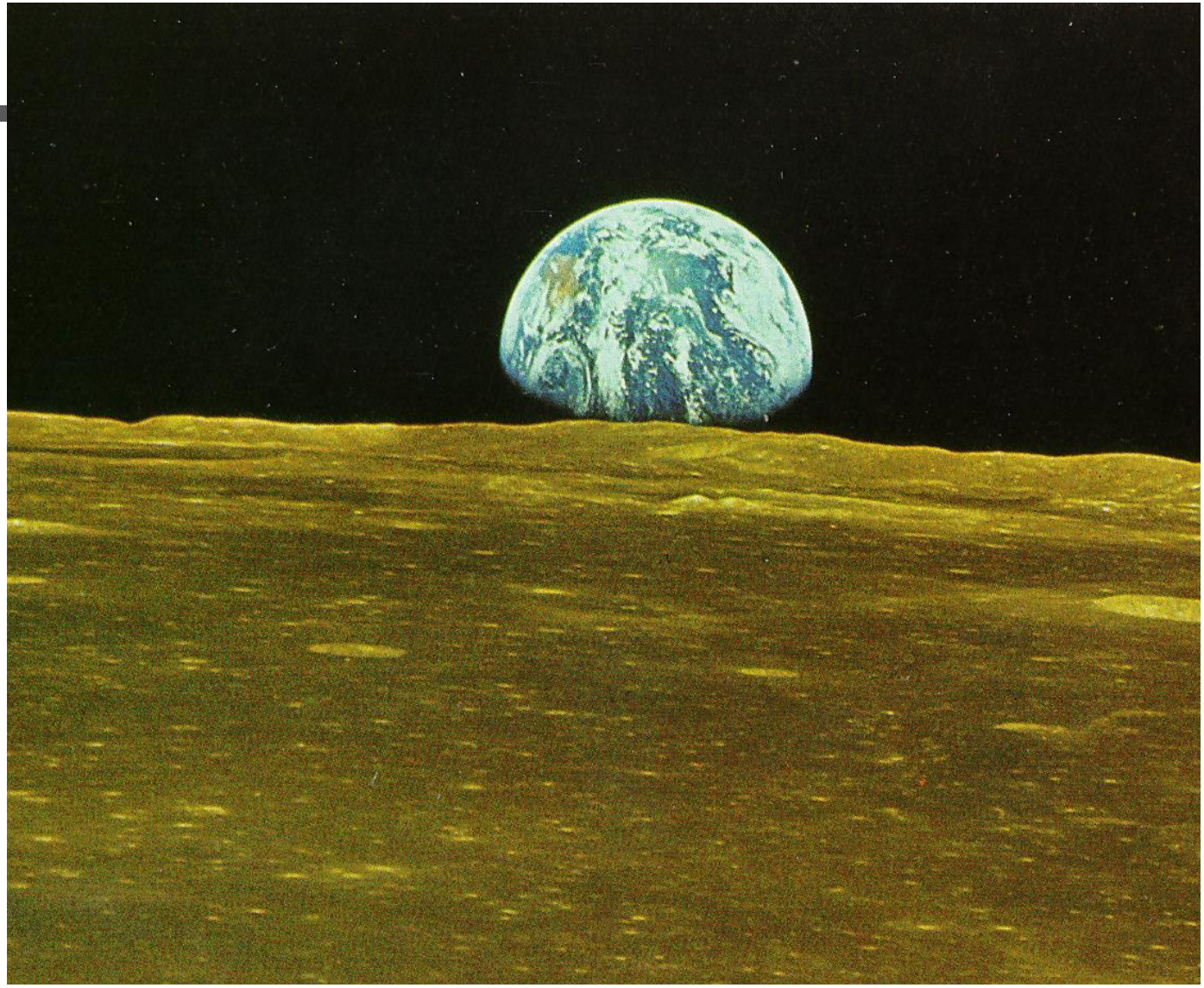
Ocean dynamic, the green planet and Planet on Fire

https://www.csun.edu/science/books/sourcebook/chapters/8-organizing/files/earth-systems-interactions.html

Planetary Processes

Figure 2a: SOLID EARTH PROCESSES

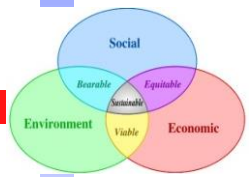




"We are the first generation to see and study planet earth as system".

Robert A. Frosch

Population Clock



http://www.worldometers.info/world-population/

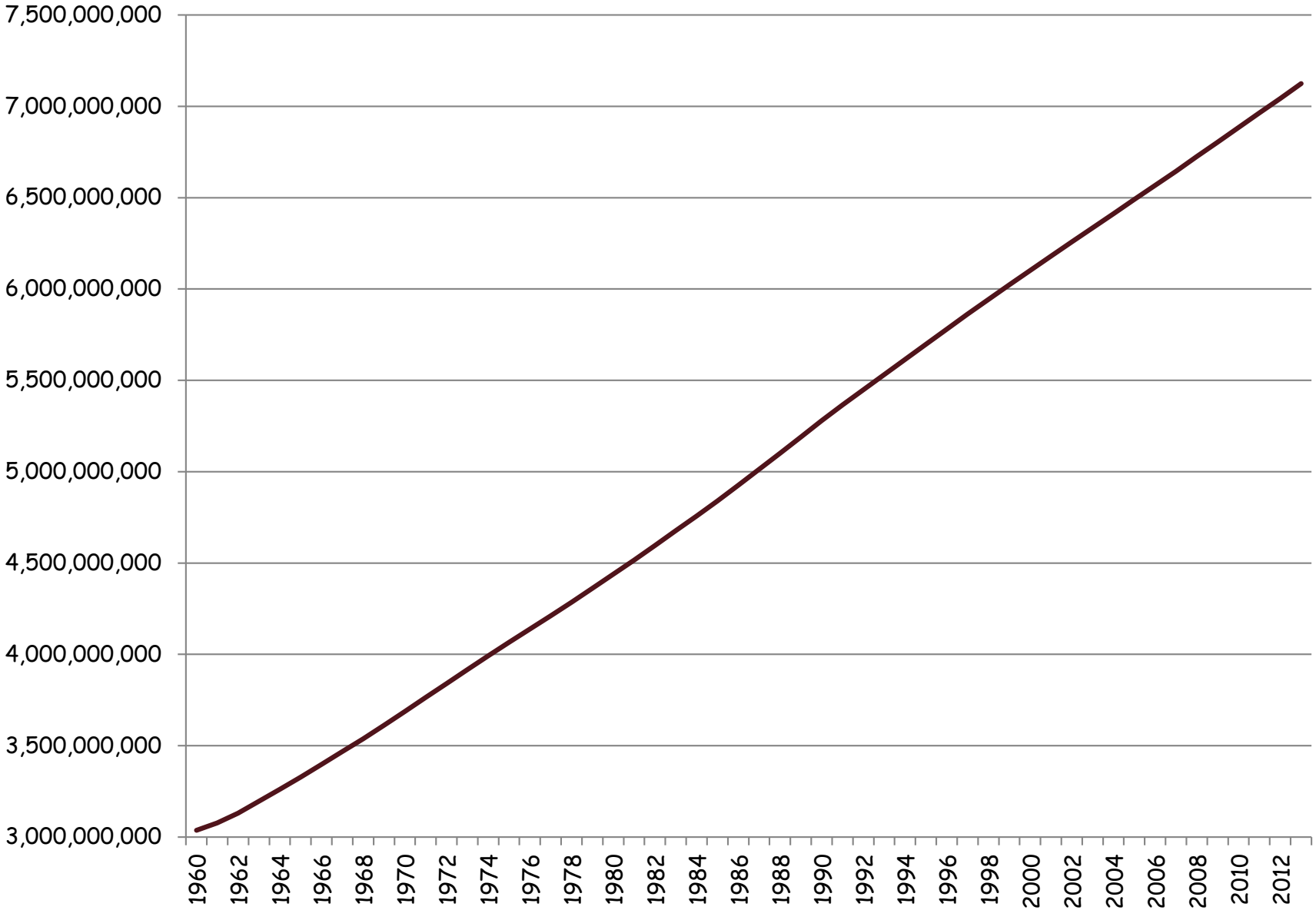
State of the World Indicators

World Population:	5,841,952,540 [RED]	7,324,782,000
Years Until Insufficient Land - Northern Diet:	8 [RED]	
Years Until Insufficient Land - Southern Diet:	39 [RED]	
Species Extinctions Per Day:	104 [RED]	
Years Until 1/3 Of Species Are Lost:	9 [RED]	
Years Until Half of Crude Oil Is Gone:	3 [YELLOW]	
Years Until 80% of Crude Oil Is Gone:	23 [RED]	
Percent Antarctic Ozone Depletion:	70+ [YELLOW]	
Carbon Dioxide, Years Until Doubling:	60 [RED]	
Water Availability (000 cubic meters/person/year):	10 (estimate) [YELLOW]	

The above set of indicators were chosen to give you a quick overview of the state of the world in a number of key areas.
[GREEN] indicates values are at safe (sustainable) levels;
[YELLOW] indicates values are approaching dangerous levels;
[RED] indicates values are dangerously high or low; and
[BLACK] is used for indicators where we don't yet have an idea of what value is safe or sustainable.

http://www.igc.apc.org/millennium/inds
21 May, 1997 y 28 Jan, 2015

World population



Datos: Banco Mundial: http://data.worldbank.org/indicator/SP.POP.TOTL/countries/all?display=default

Country variations
Visiting the worldmeters site

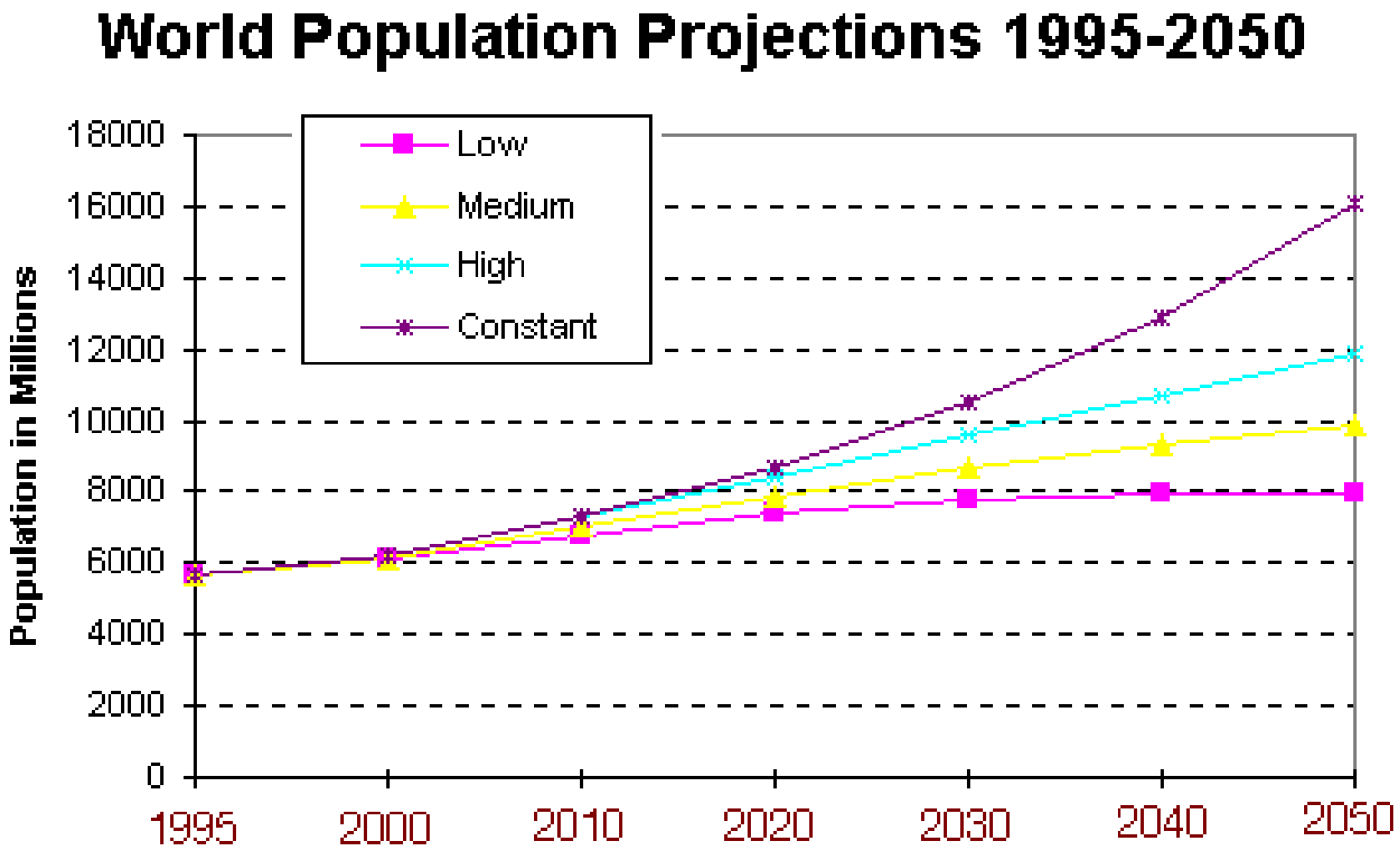
http://www.worldometers.info/world-population/population-by-country/

and

The worldpopdata site to see geographic variations

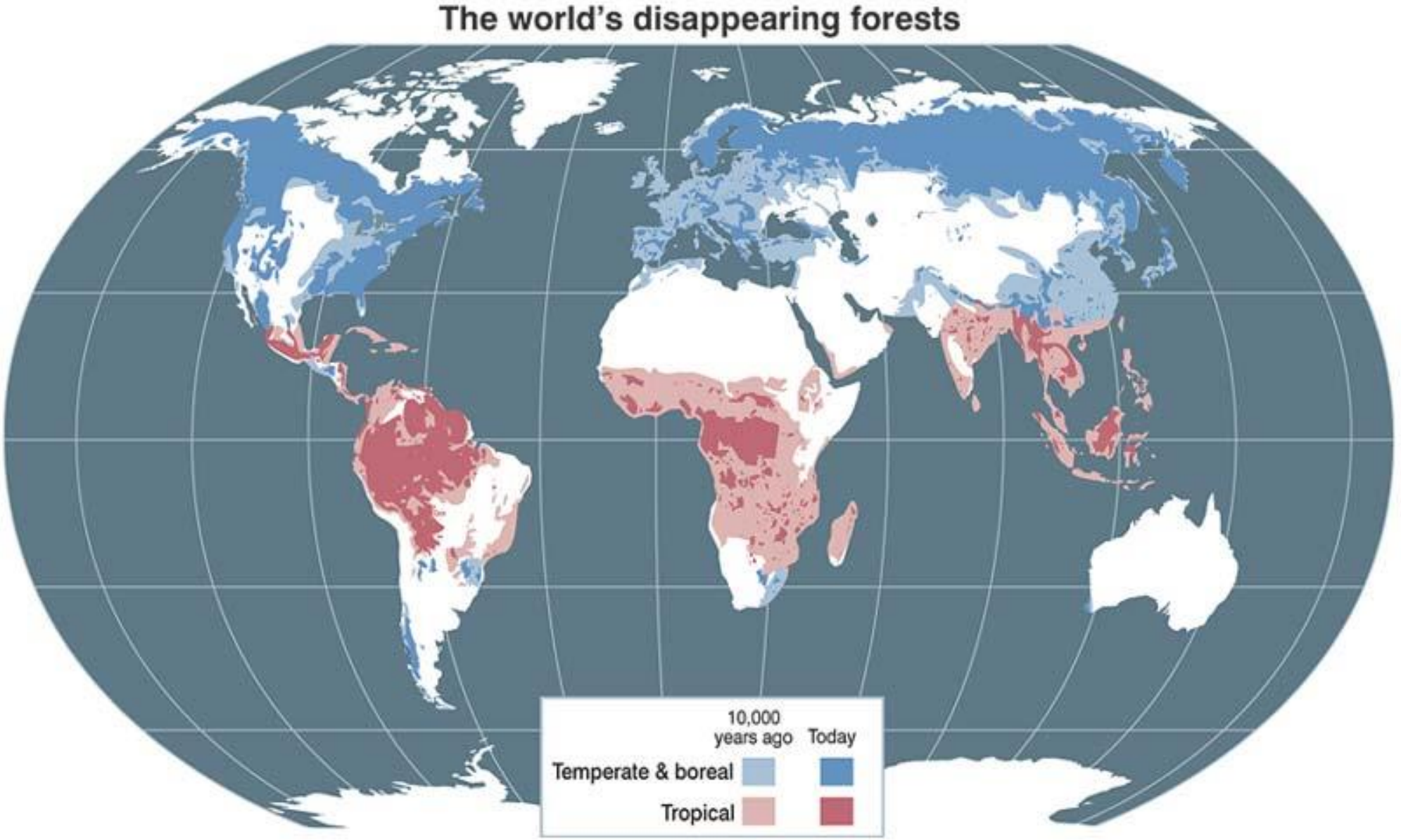
http://www.worldpopdata.org/map

Indicators: Population



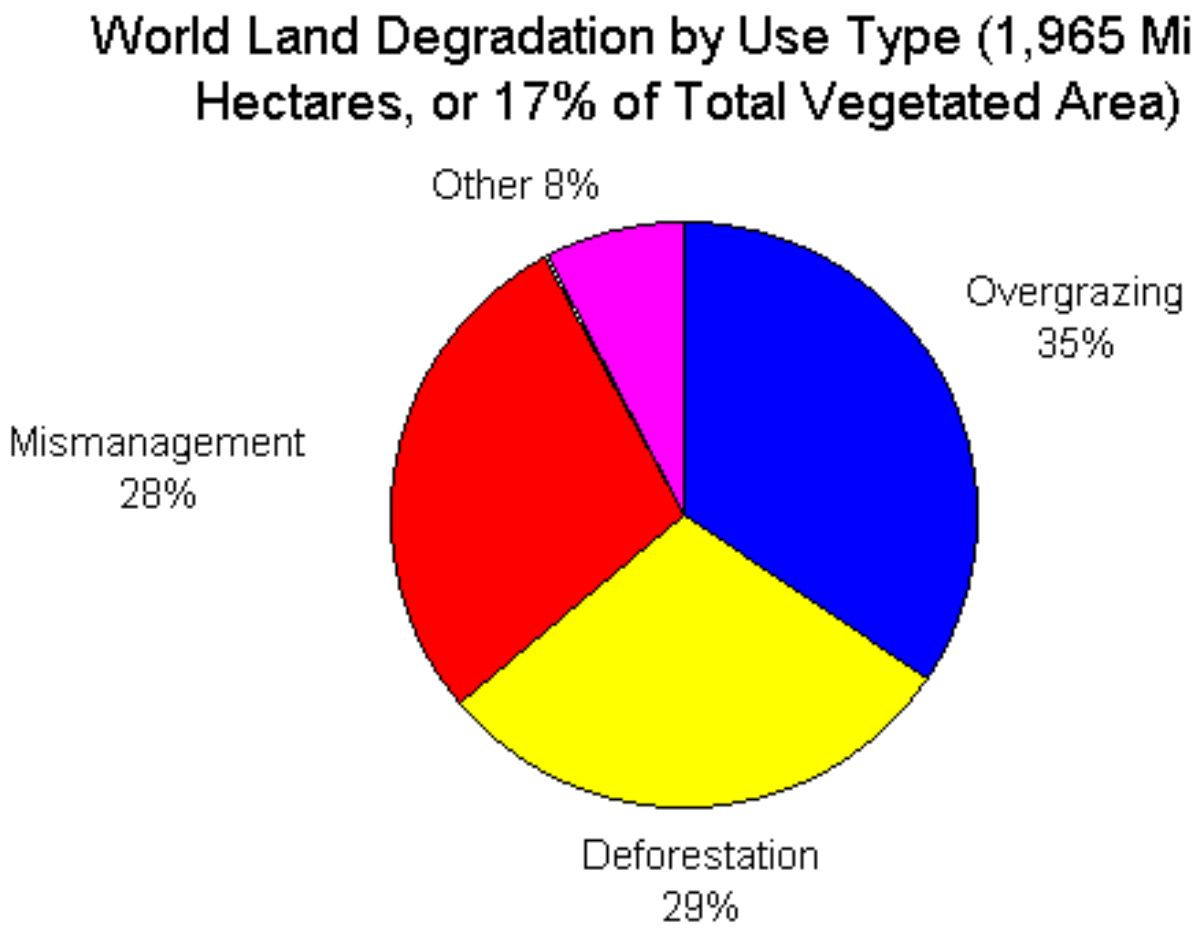
Data from the United Nations

Indicators: Forests



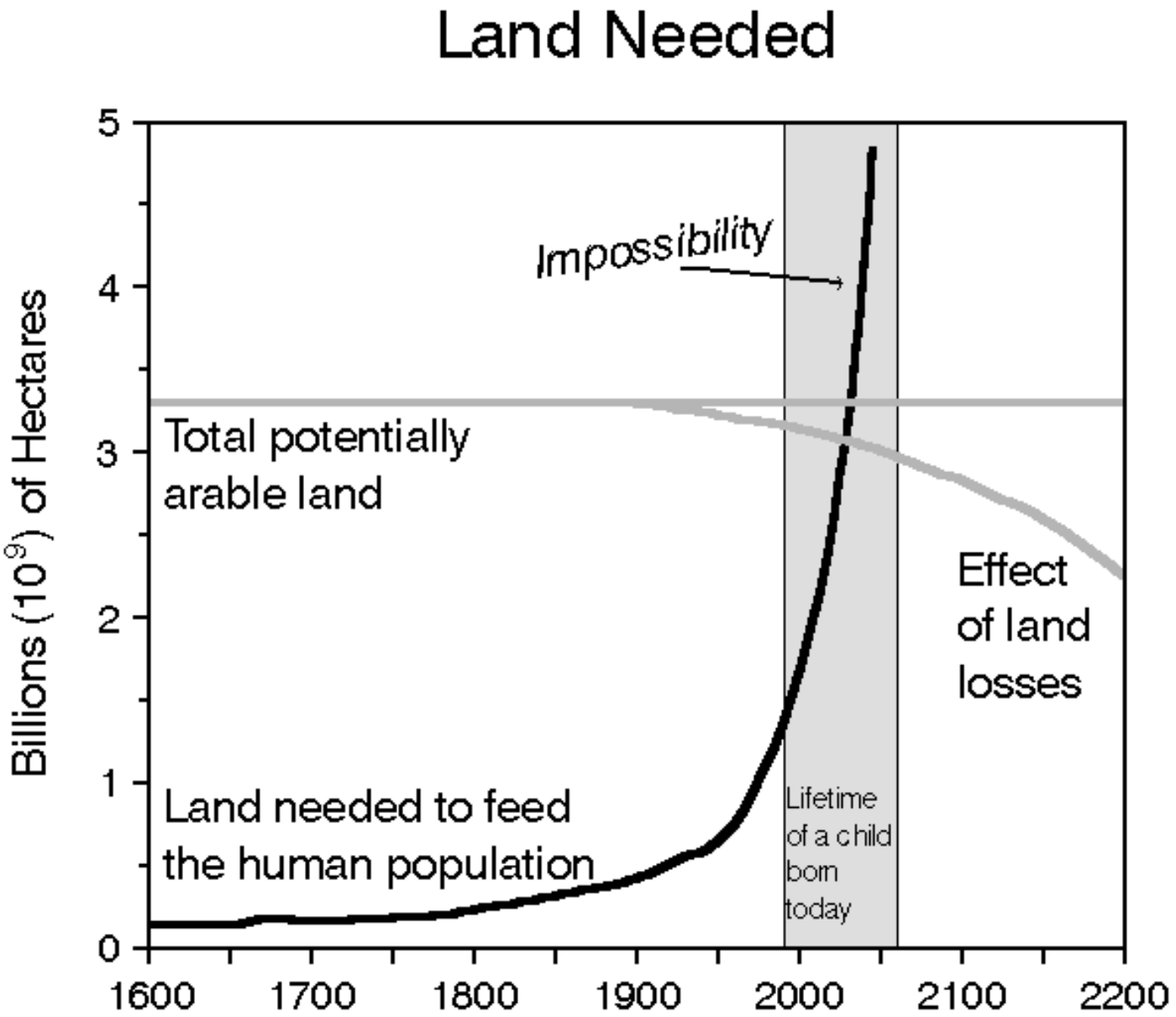
http://www.newscientist.com/hottopics/climate/img/spread-2-4.jpg

Indicators: Land degradation



Compiled by Worldwatch Institute, based on "The Extent of Human-Induced Soil Degradation," Annex 5 in L. R. Oldeman et al., World Map of the Status of Human-Induced Soil Degradation (Wageningen, Netherlands: United Nations Environment Program and International Soil Reference and Information Center 1991."

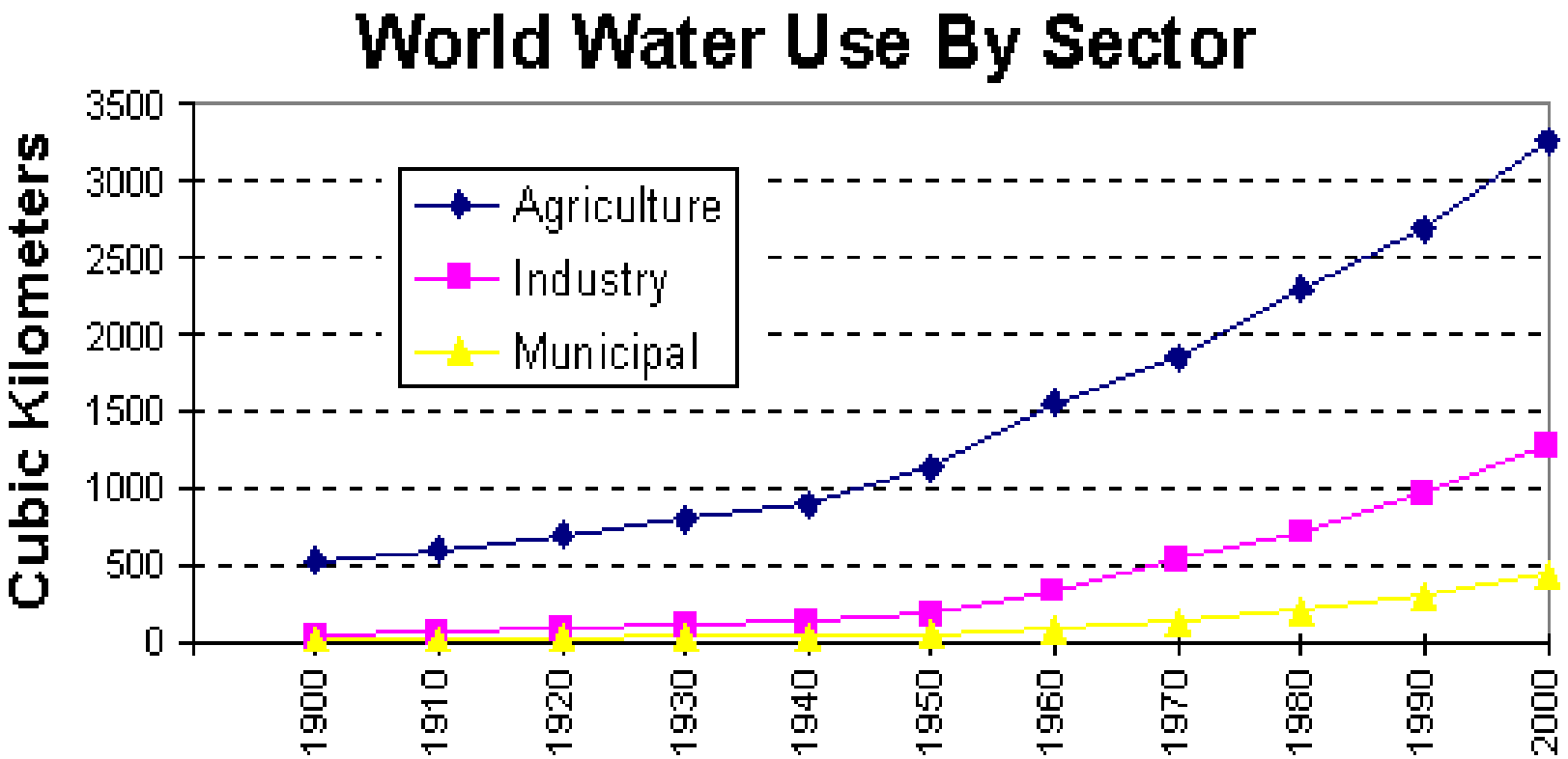
Indicators: land needed…



Barney, Jane Blewett, and Kristen Barney. 1996 Global 2000 Revisited: What Shall We Do? the Millennium Institute.

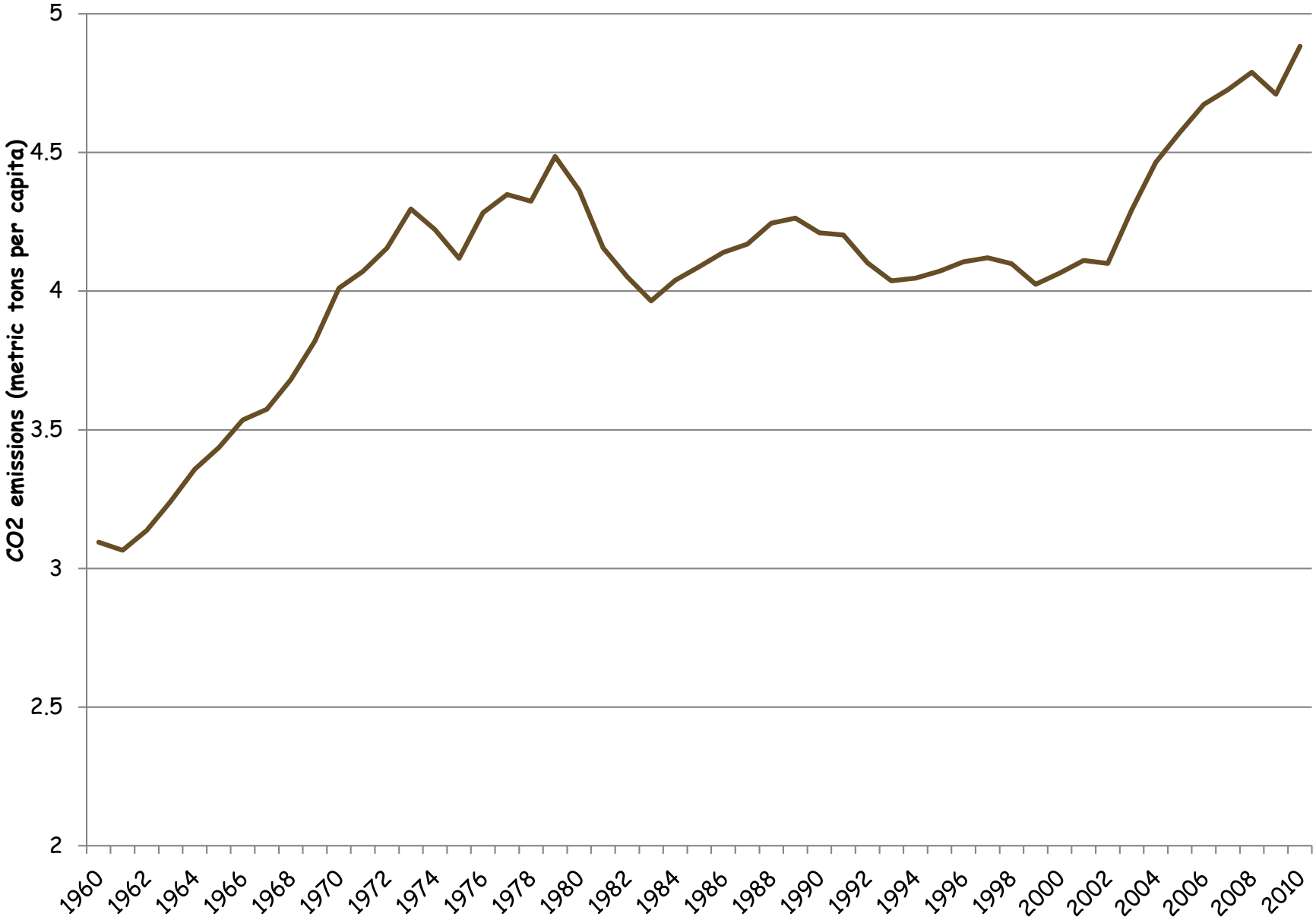
http://www.igc.apc.org/millennium/world.html

Indicators: water by sector

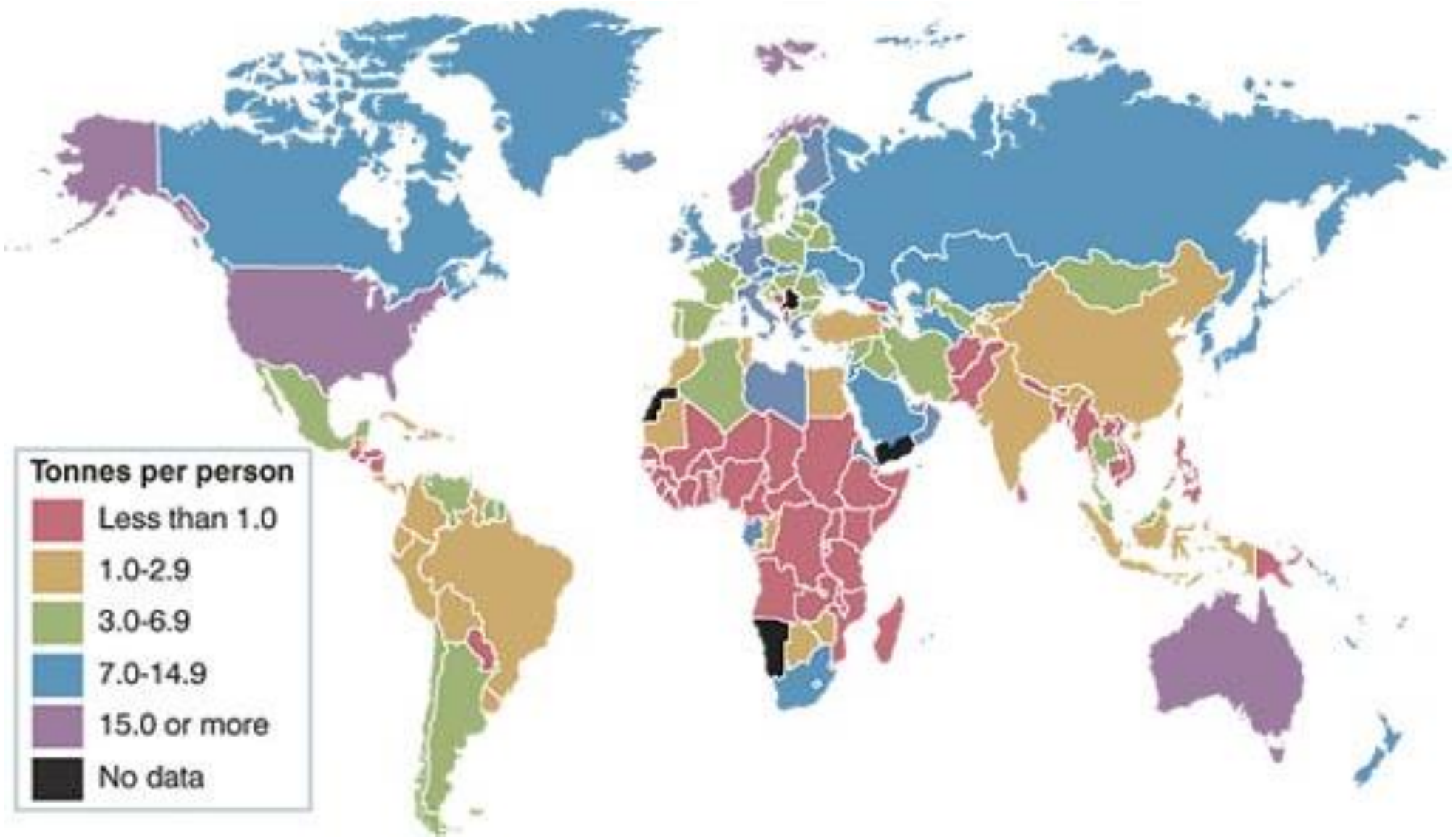


Compiled by Worldwatch Institute from Igor A. Shiklomanov, "World Fresh Water Resources," in P.H. Gleick, ed. "Water in Crisis" (New York, Oxford University Press, 1993.

Indicators: CO_2 emissions/capita

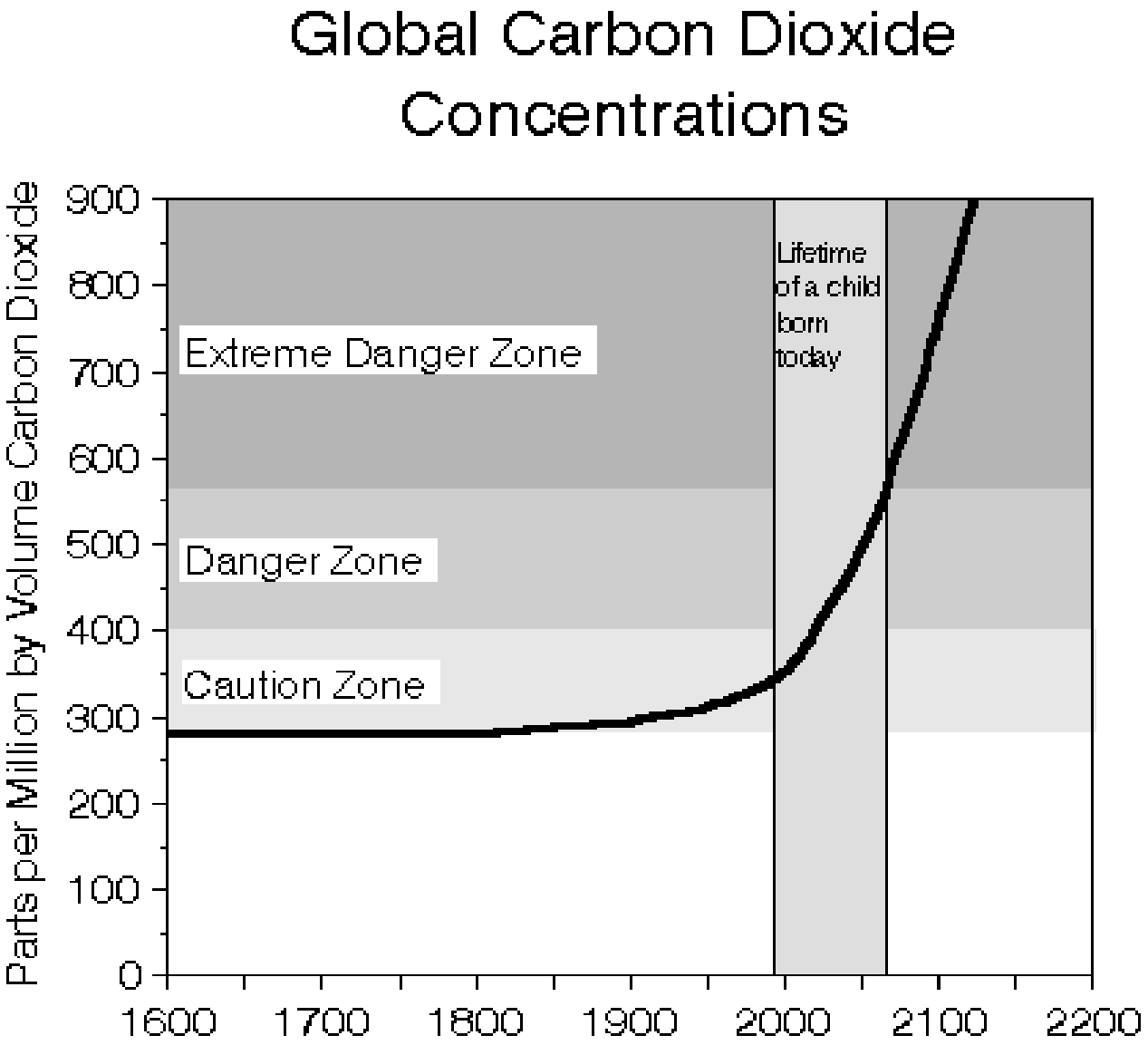


Indicators: who pumps out the most CO_2?



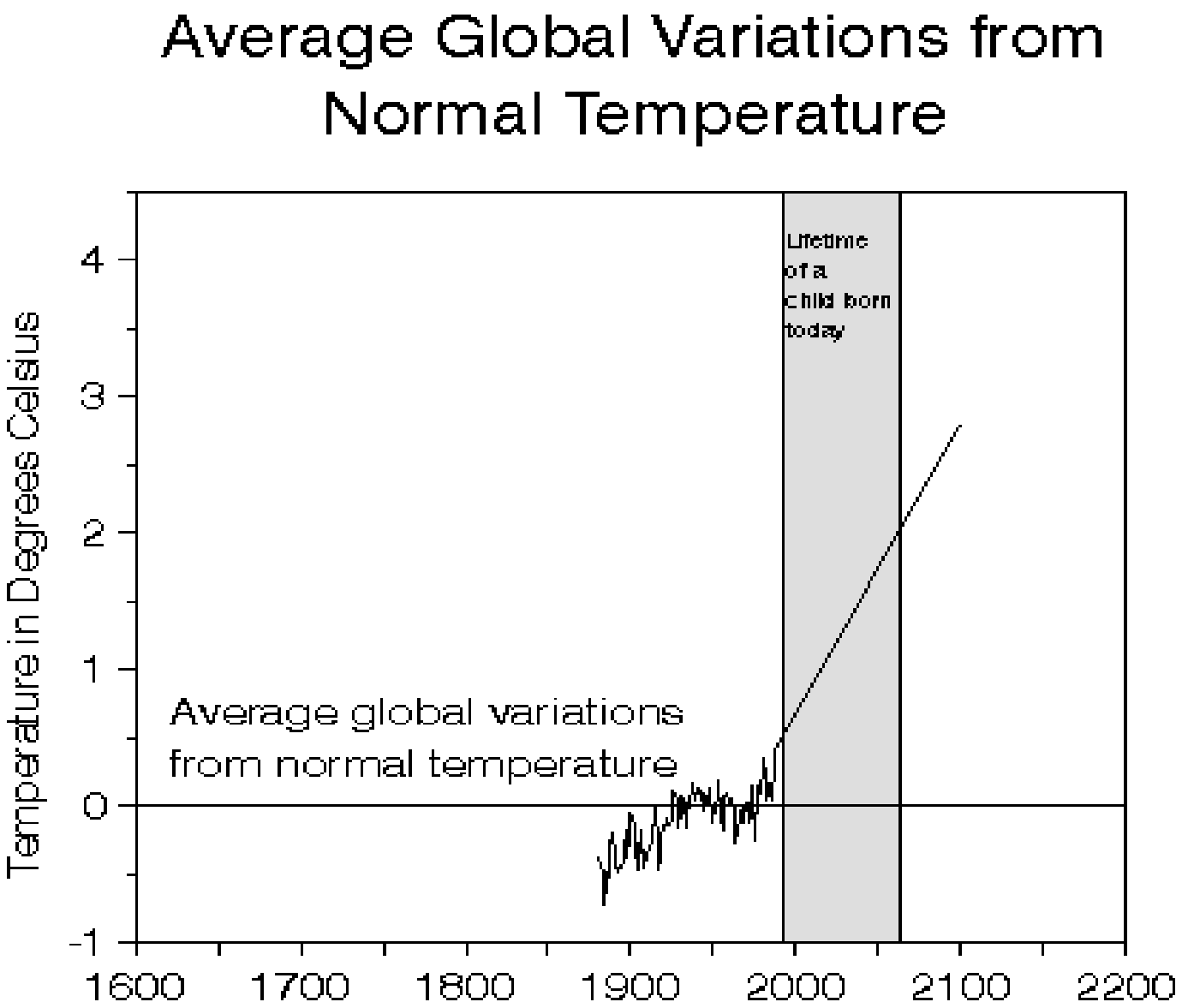
http://www.newscientist.com/hottopics/climate/img/spread-2-7.jpg

Indicators: Global [CO_2]



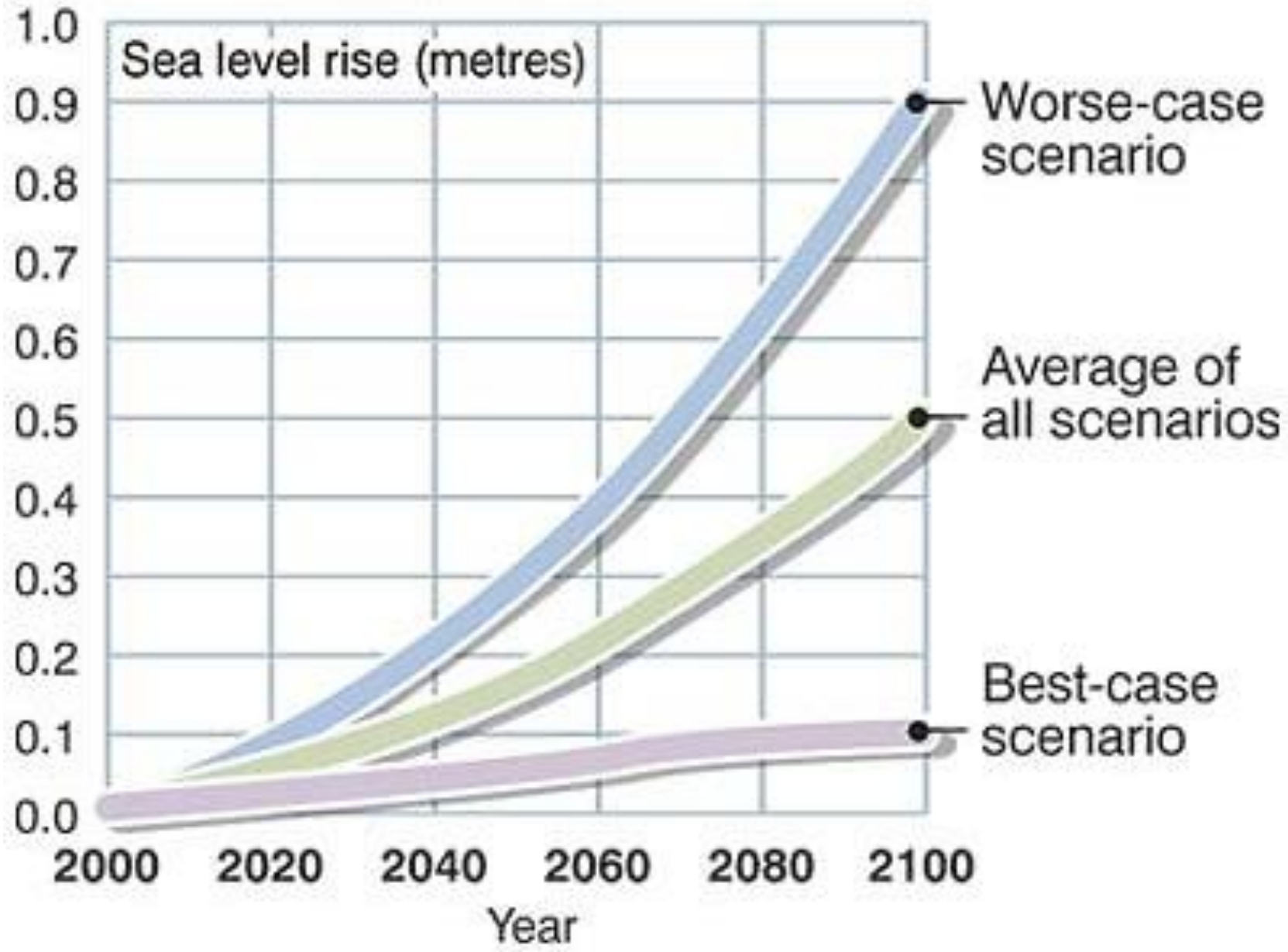
IPCC Working Group I.
June 1990.
Policymakers Summary of the Scientific Assessment on Climate Change. "Business-as-usual" scenario. Nairobi: U.N. Environment Programme. pp. 7-9.

Indicators: temperature variations



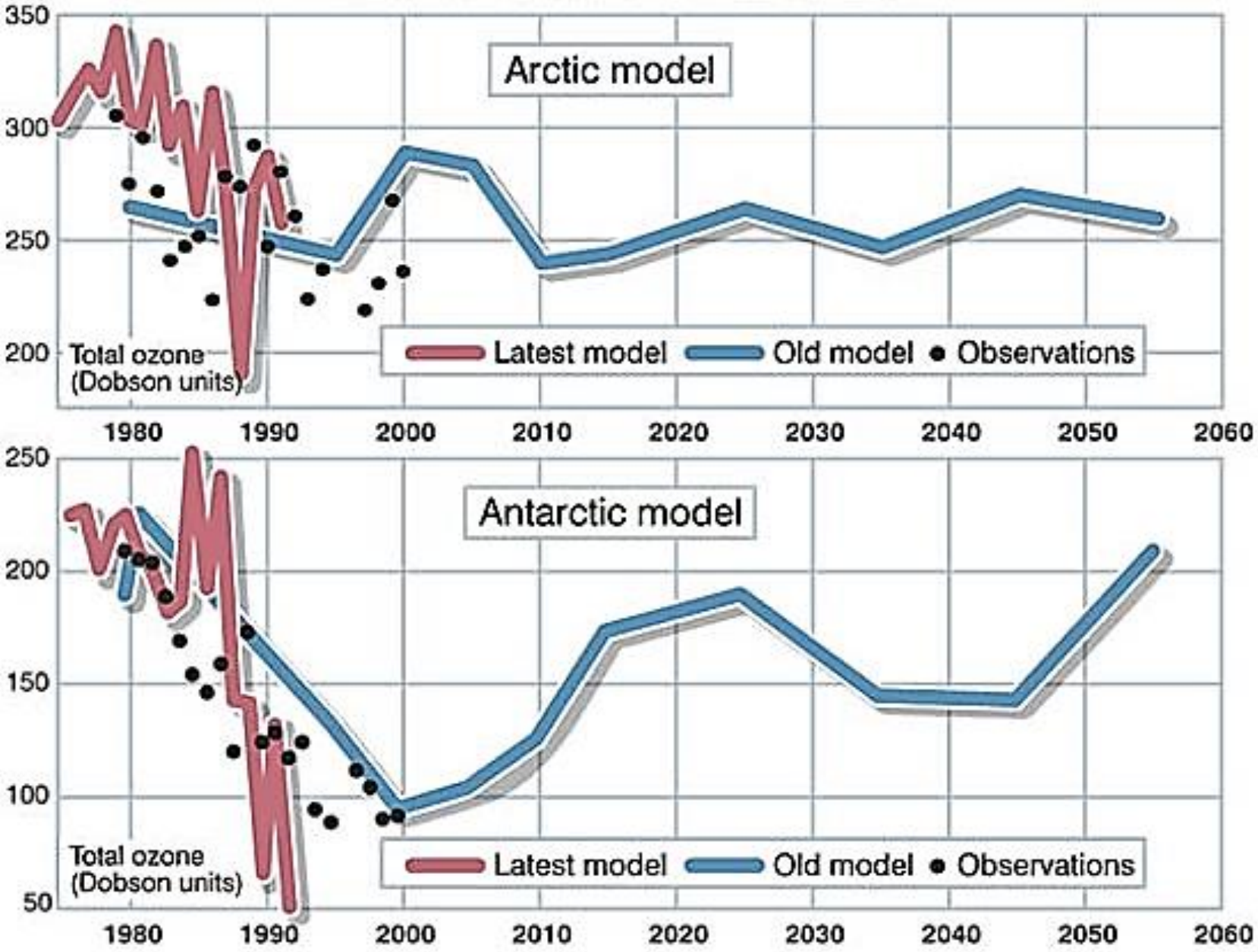
Projections are from Scenario IS92a as presented in Intergovernmental Panel on Climate Change. 1992. 1992 IPCC Supplement. Nairobi: U.N. Environment Programme. p. 25. The historical data are from Hanson, J. E. 1988. As reported in Shabecoff, P. "Global Warming Has Begun, Expert Tells Senate. " The New York Times. 24 June 1988. p. A1.

Indicators: oceans rise



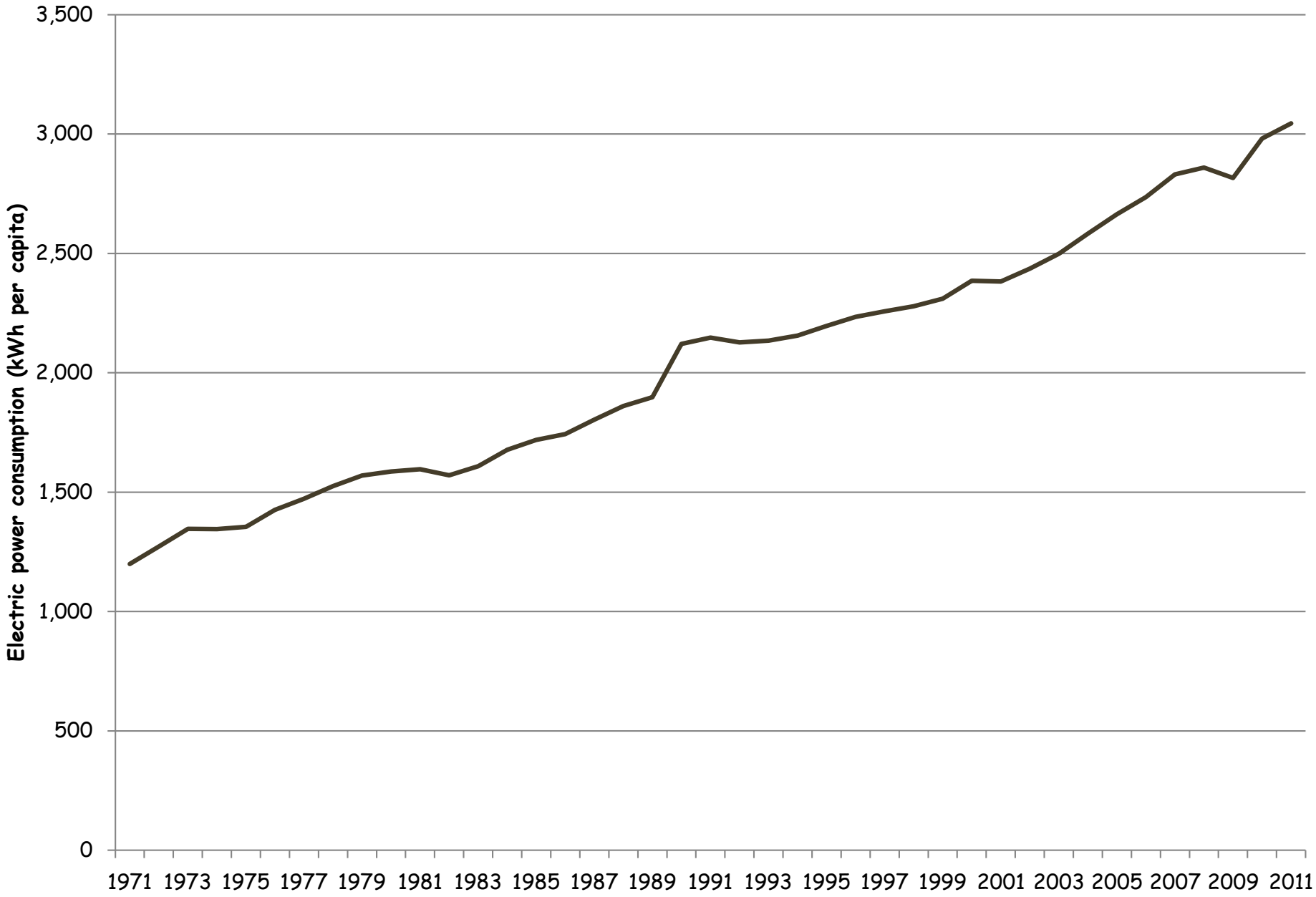
http://www.newscientist.com/hottopics/climate/img/spread-2-1.jpg

Indicators: lowest anual ozone levels

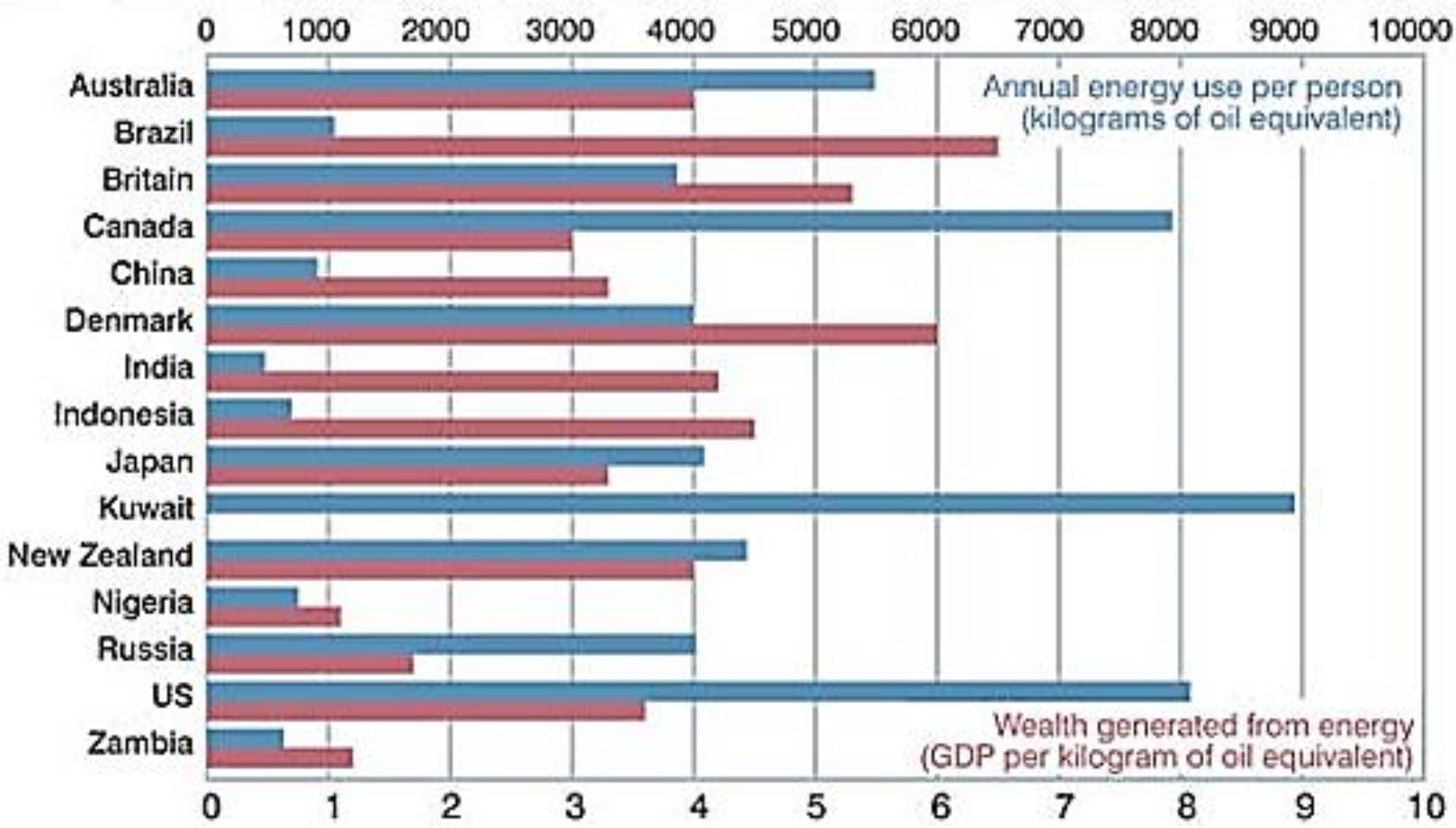


http://www.newscientist.com/hottopics/climate/img/spread-2-6.jpg

Indicators: electric energy

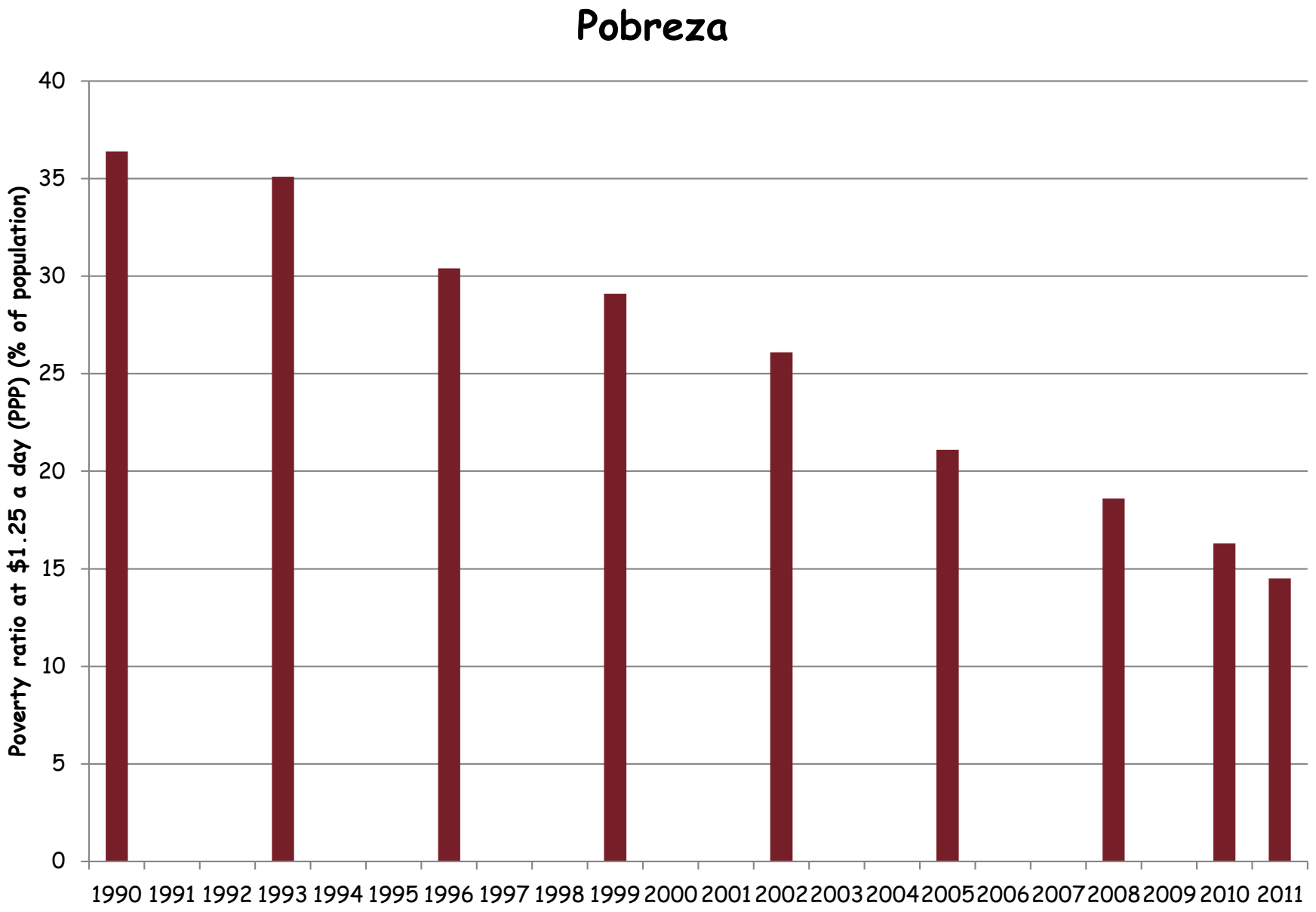


Who uses most energy? Who gest most value for money?

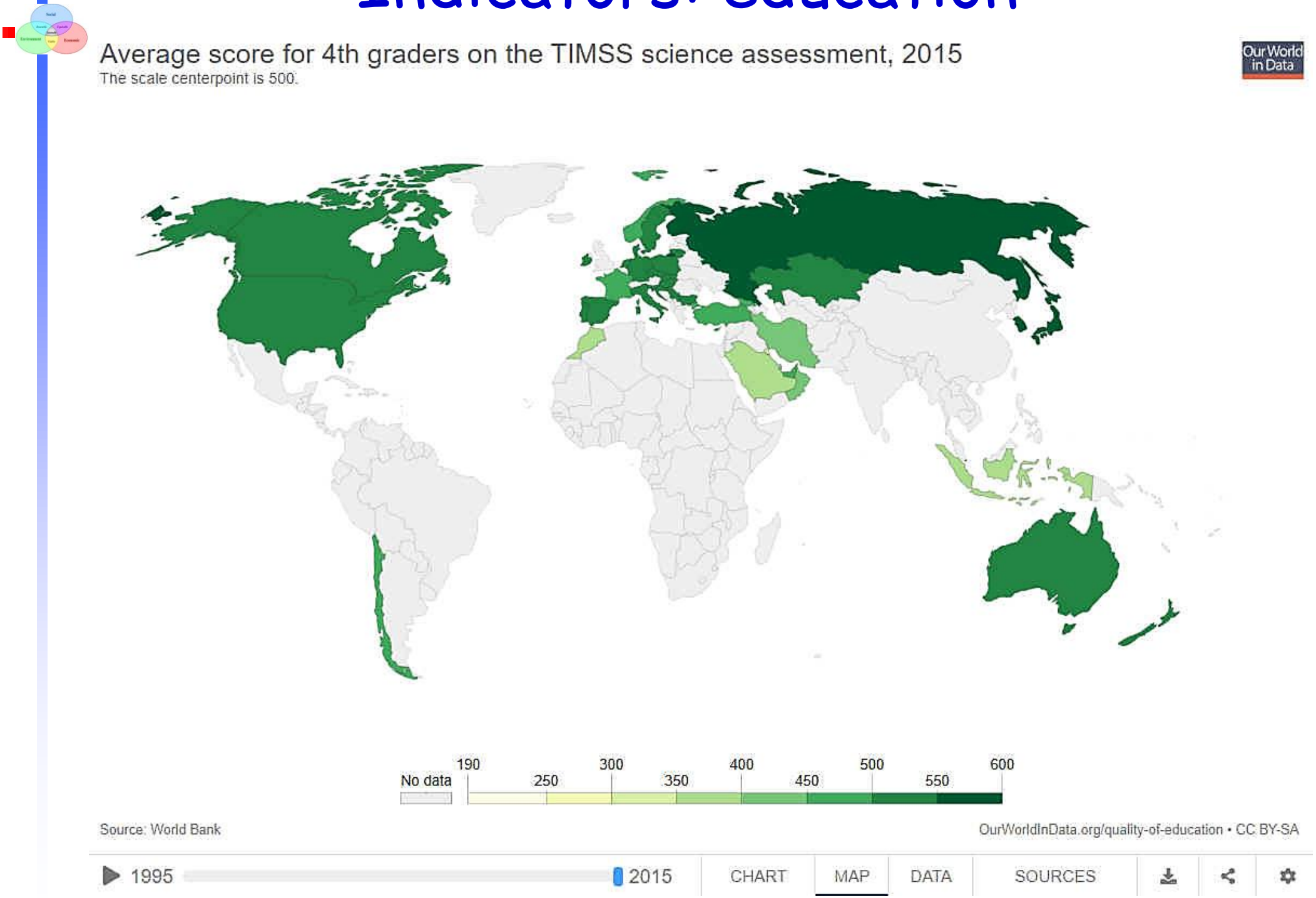


http://www.newscientist.com/hottopics/climate/img/spread-2-5.jpg

Indicators: poverty

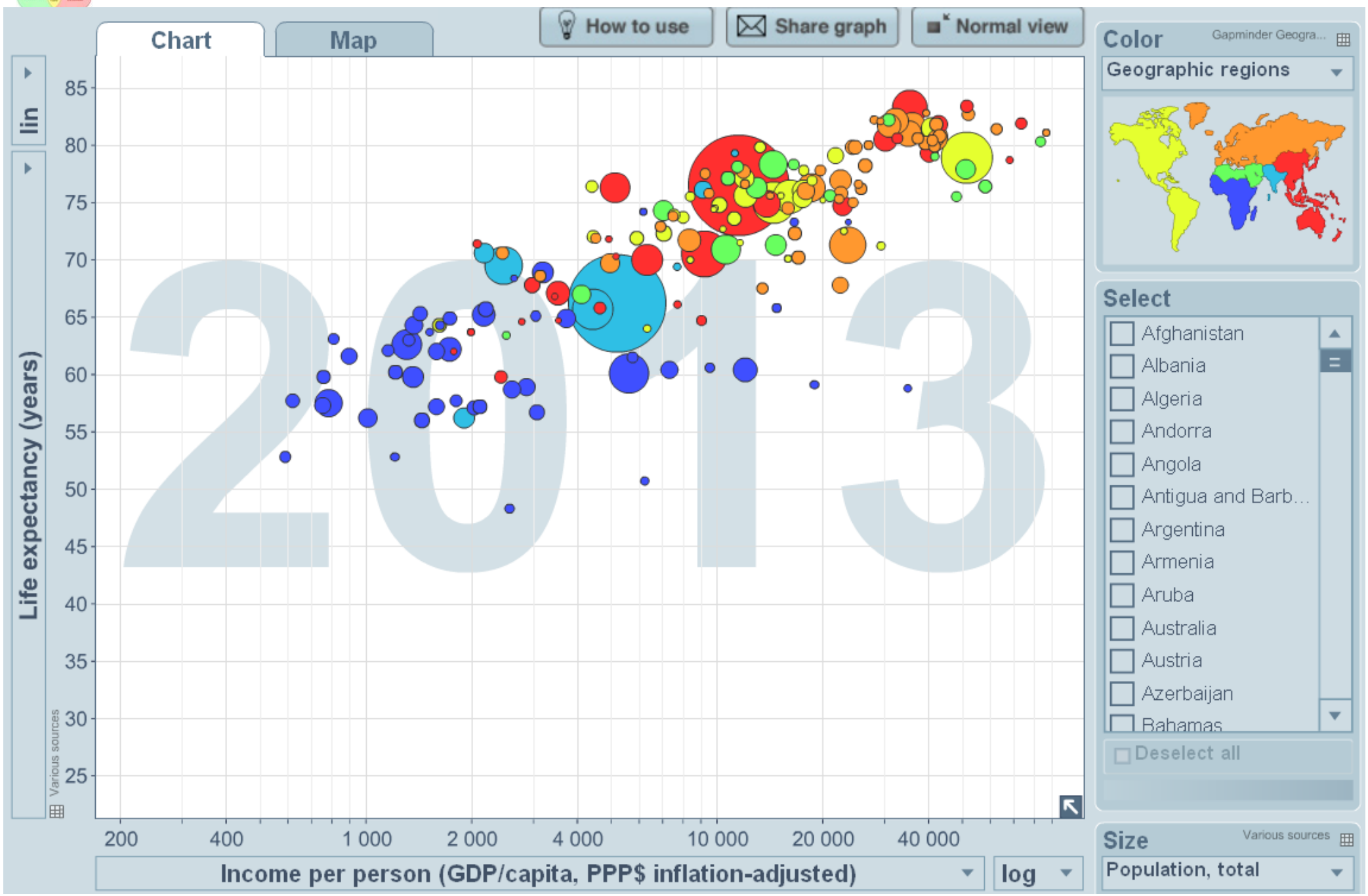


Indicators: education



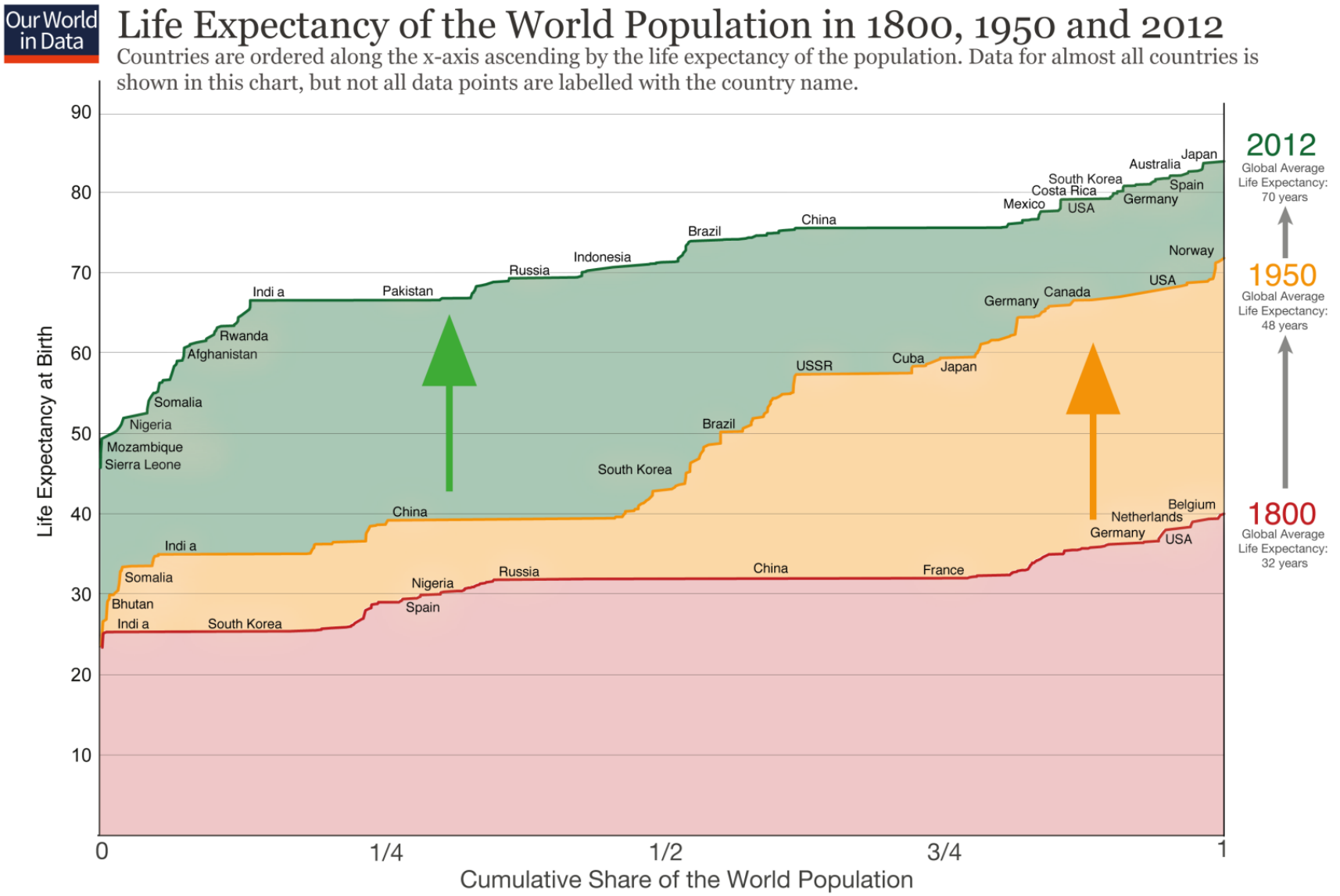
https://ourworldindata.org/quality-of-education

Indicators (play the link)



Indicators

GapMinder: Life expectancy and population, changes over time



Data source: The data on life expectancy by country and population by country are taken from Gapminder.org.
The interactive data visualisation is available at OurWorldinData.org. There you find the raw data and more visualisations on this topic.

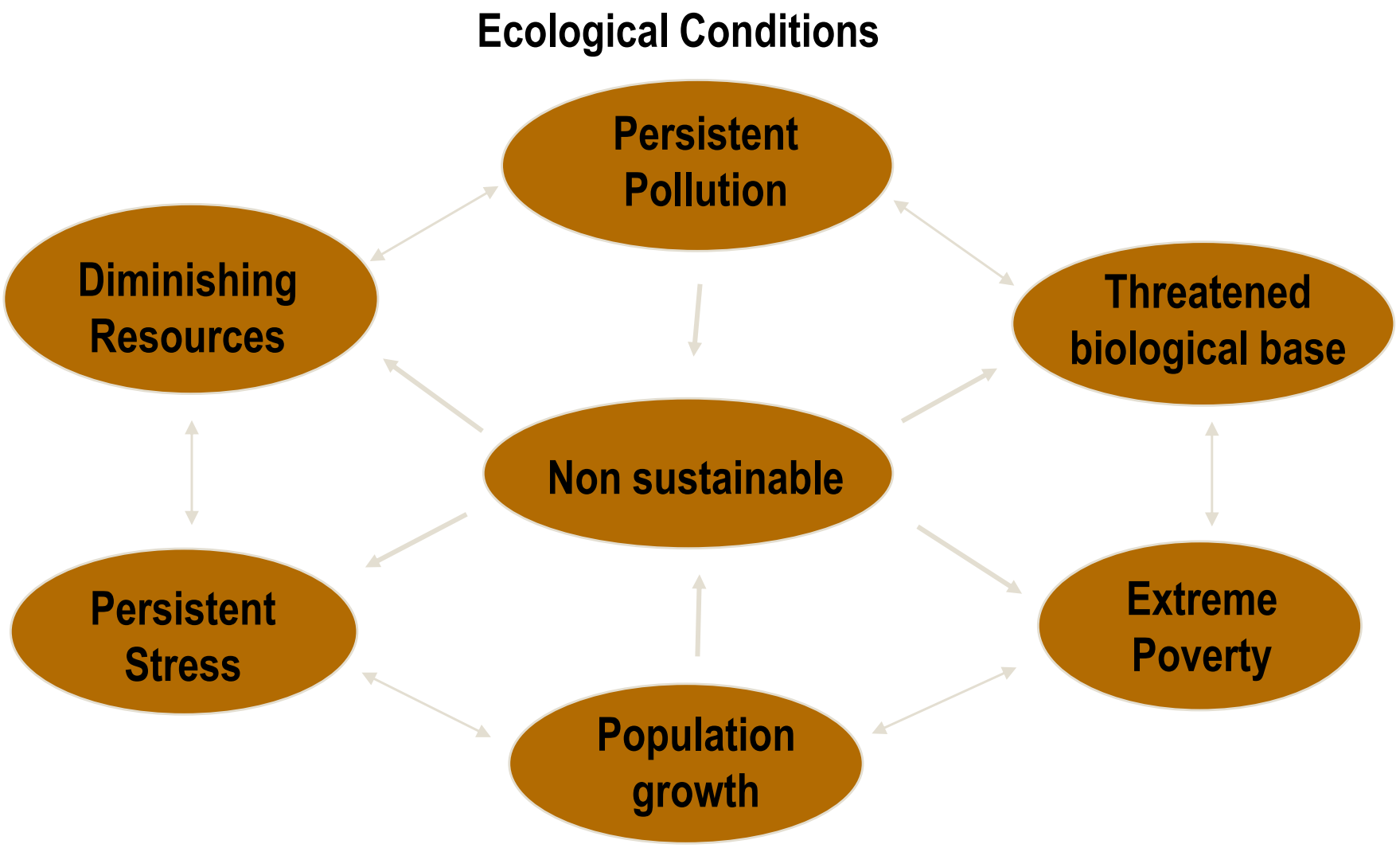
https://ourworldindata.org/health-meta

The environmental crisis

- Global
- Unequal
- Transgenerational
- Uncertainty
- Complex
- Exponential
- Mutually reinforced
- Systemic
- Serious consequences
- Urgent

- (in scale)
- (in distribution)
- (in its effects)
- (in prediction)
- (dynamic systems)
- (growth rates)
- (in its structure)
- (in its causes)
- (survival of the human specie)
- (urgent to correct)

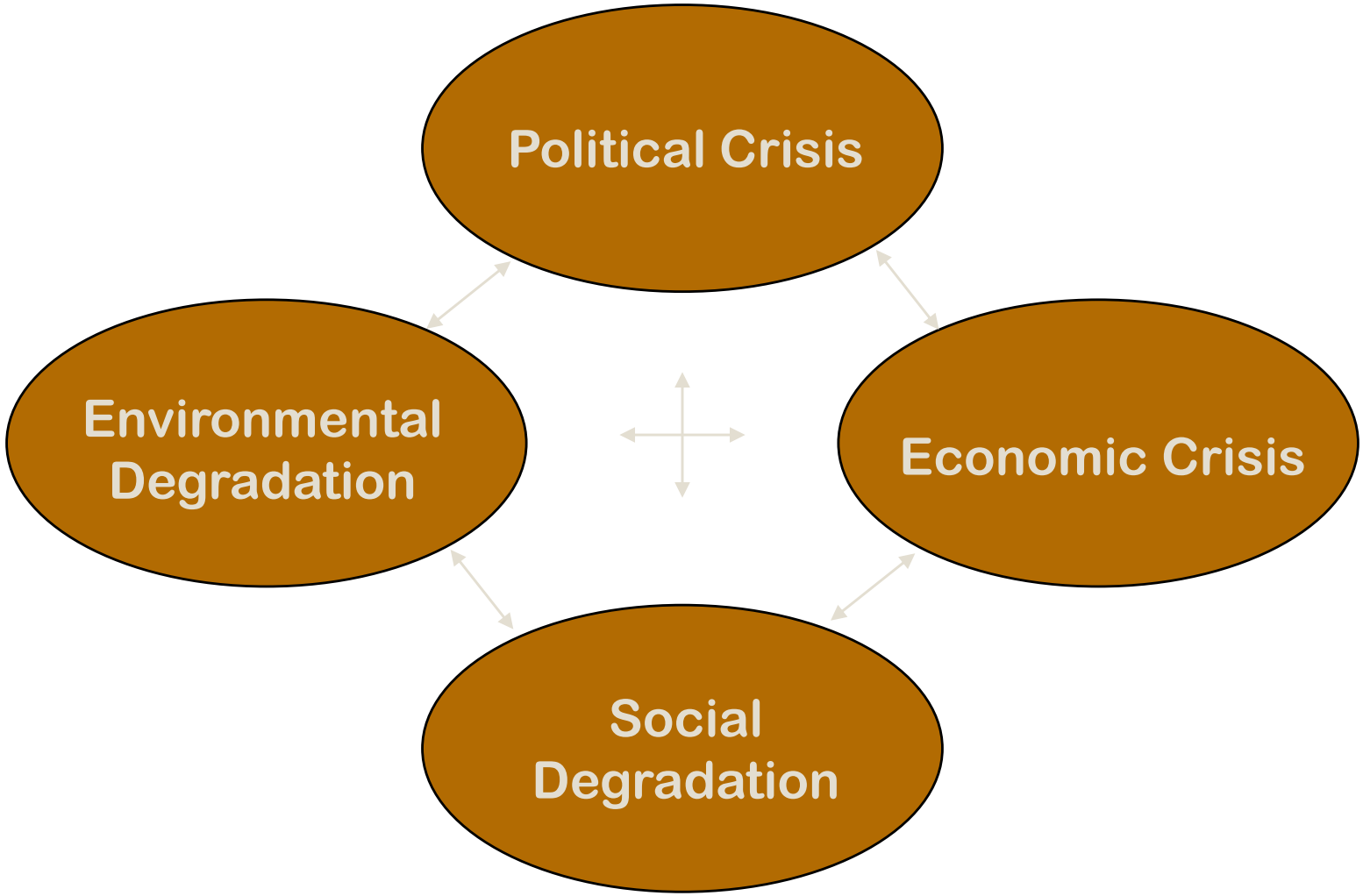
Signals


Ecological Conditions
Persistent Pollution
Diminishing Resources
Threatened biological base
Non sustainable
Persistent Stress
Extreme Poverty
Population growth
Socio-economic Conditions

Origen

The environmental problems are increasingly complex, global and diffuse, they do not originate in the environment, but in society.

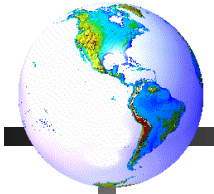
Consequences



Planetary Boundaries

https://chrisriedy.me/planetary-boundaries-for-a-sustainable-future-2145584c998f

Planetary Boundaries



Non-linear transitions in the functioning of coupled human-environmental systems (Schellnhuber 2002, Lenton)

Thresholds are intrinsic features of those systems and are often defined by a position along one or more control variables.

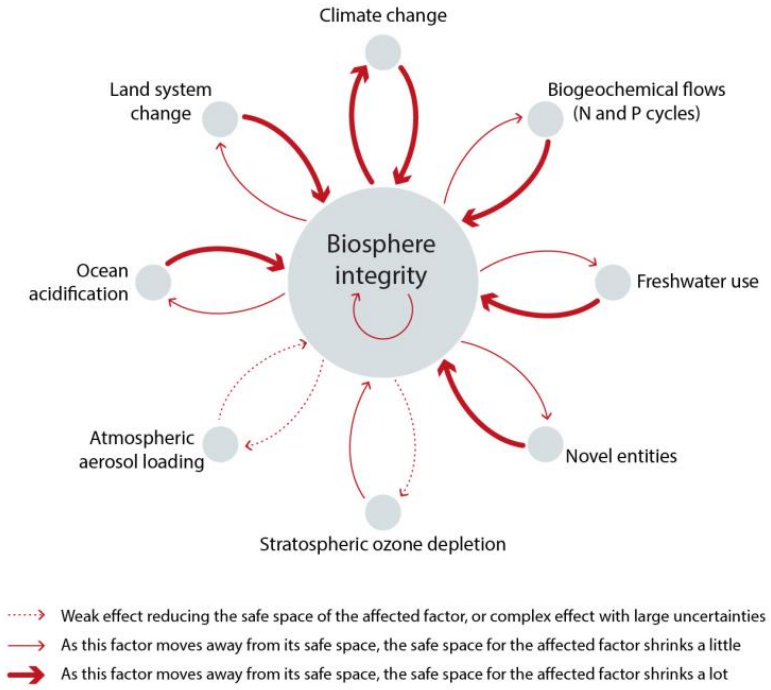
The choice of control variable for each planetary boundary (PB) was based on our assessment of the variable that on balance may provide the most comprehensive, aggregated, and measurable parameter for individual boundaries

Boundaries, on the other hand, are human determined values of the control variable set at a "safe" distance from a dangerous level.

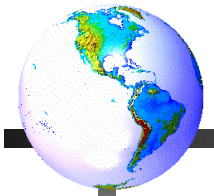
Planetary Boundaries

Much of the uncertainty in quantifying planetary boundaries is due to:

- Our lack of scientific knowledge about the nature of the biophysical thresholds themselves,
- The intrinsic uncertainty of how complex systems behave,
- The ways in which other biophysical processes such as feedback mechanisms interact with the primary control variable,
- And uncertainty regarding the allowed time of overshoot of a critical control variable in the Earth System before a threshold is crossed.



http://www.futureearth.org/blog/2015-feb-6/planetary-boundary-biodiversity



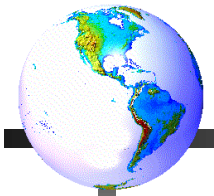
Planetary Boundaries

The PB approach rests on three branches of scientific inquiry.

1. The scale of human action in relation to the capacity of the Earth to sustain it.

2. The work on understanding essential Earth System processes.

3. The framework of resilience and its links to complex dynamics

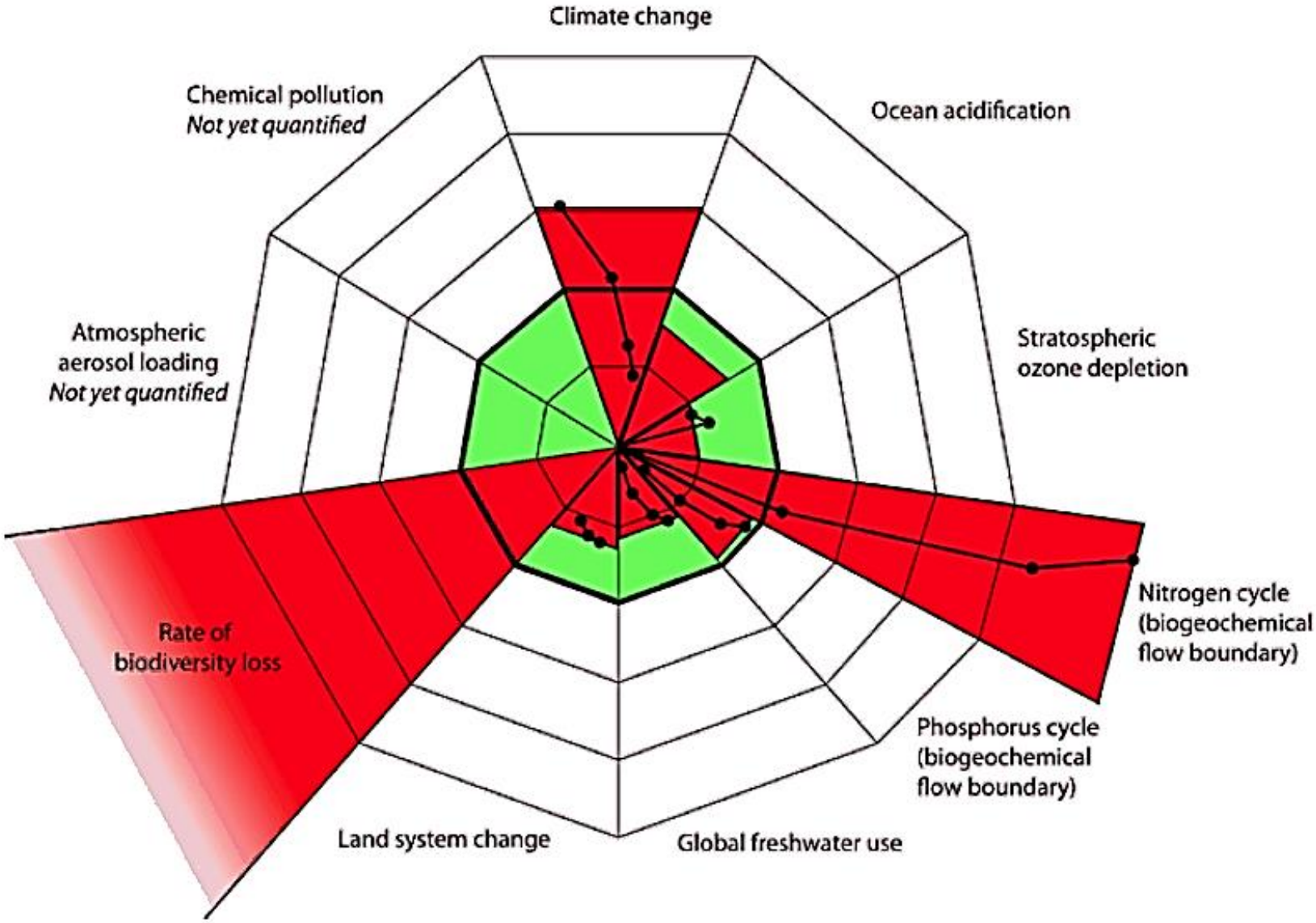


Planetary Boundaries

Normative judgment influence the definition and position of PB.

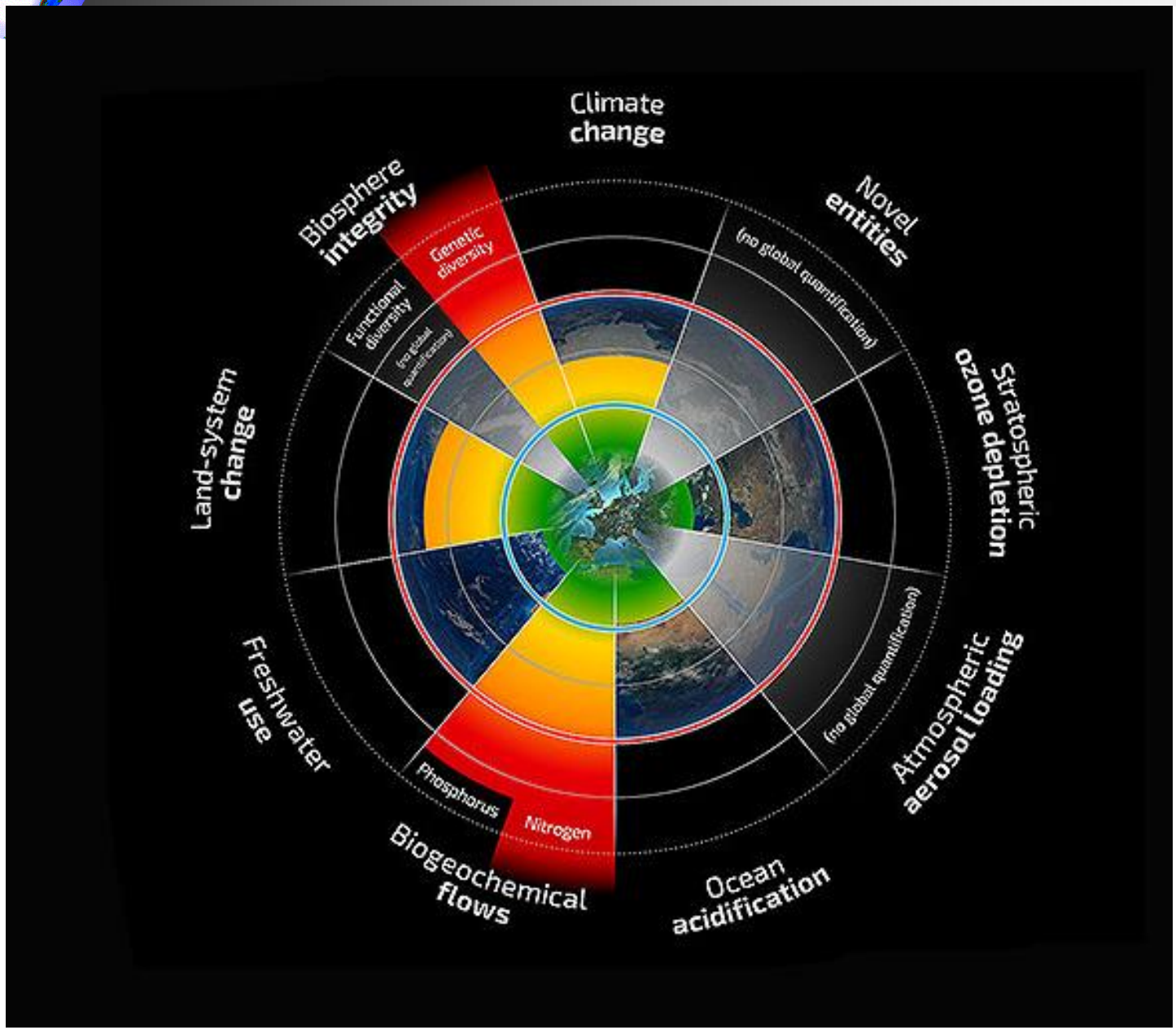
- Selection ➡ What constitutes unacceptable human-induced global environmental change.
- Position ➡ Function of the degree of risk the global community is willing to take.
- Position ➡ Is furthermore a function of the social and ecological resilience of the impacted societies.
- Identified ➡ For processes where the time needed to trigger an abrupt or irreversible change is within an "ethical time horizon".

Boundaries we must NOT CROSS



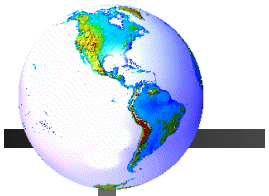
http://energyskeptic.com/2011/9-planetary-boundaries/

Boundaries we must NOT CROSS, update

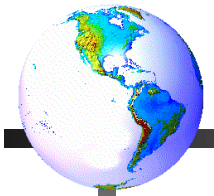


- Climate change
- Loss of biodiversity
- Biogeochemical cycles of N & P

https://www.stockholmresilience.org/research/research-news/2015-01-15-planetary-boundaries---an-update.html

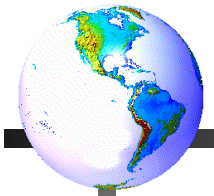


Boundary character Scale of process	Processes with global scale thresholds	Slow processes without known global scale thresholds
Systemic processes at planetary scale	Climate Change Ocean Acidification Stratospheric Ozone	
Aggregated processes from local/regional scale	Global P and N Cycles Atmospheric Aerosol Loading Freshwater Use Land Use Change	Biodiversity Loss Chemical Pollution



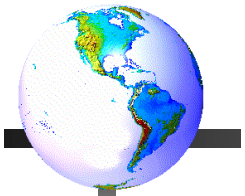
Planetary Boundaries

Earth System process	Control variable	Threshold avoided or influenced by slow variable	Planetary Boundary (zone of uncertainty)	State of knowledge*
Climate change	Atmospheric CO_2 concentration, ppm; Energy imbalance at Earth's surface, W m^{-2}	Loss of polar ice sheets. Regional climate disruptions. Loss of glacial freshwater supplies. Weakening of carbon sinks.	Atmospheric CO_2 concentration: 350 ppm (350–550 ppm) Energy imbalance:+1 W m^{-2} (+1.0–+1.5 W m^{-2})	1. Ample scientific evidence. 2. Multiple sub-system thresholds. 3. Debate on position of boundary.
Ocean acidification	Carbonate ion concentration, average global surface ocean saturation state with respect to aragonite (Ω_{arag})	Conversion of coral reefs to algal-dominated systems. Regional elimination of some aragonite- and high-magnesium calcite-forming marine biota Slow variable affecting marine carbon sink.	Sustain ≥80% of the pre-industrial aragonite saturation state of mean surface ocean, including natural diel and seasonal variability (≥80%–≥70%)	1. Geophysical processes well known. 2. Threshold likely. 3. Boundary position uncertain due to unclear ecosystem response.
Stratospheric ozone depletion	Stratospheric O_3 concentration, DU	Severe and irreversible UV-B radiation effects on human health and ecosystems.	<5% reduction from pre-industrial level of 290 DU (5%–10%)	1. Ample scientific evidence. 2. Threshold well established. 3. Boundary position implicitly agreed and respected.
Atmospheric aerosol loading	Overall particulate concentration in the atmosphere, on a regional basis	Disruption of monsoon systems. Human-health effects. Interacts with climate change and freshwater boundaries.	To be determined	1. Ample scientific evidence. 2. Global threshold behavior unknown. 3. Unable to suggest boundary yet.



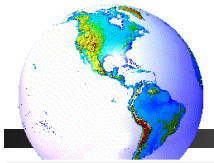
Planetary Boundaries

Earth System process	Control variable	Threshold avoided or influenced by slow variable	Planetary Boundary (zone of uncertainty)	State of knowledge*
Biogeo-chemical flows: interference with P and N cycles	P: inflow of phosphorus to ocean, increase compared with natural background weathering N: amount of N_2 removed from atmosphere for human use, Mt N yr^{-1}	P: avoid a major oceanic anoxic event (including regional), with impacts on marine ecosystems. N: slow variable affecting overall resilience of ecosystems via acidification of terrestrial ecosystems and eutrophication of coastal and freshwater systems.	P: < 10× (10× - 100×) N: Limit industrial and agricultural fixation of N_2 to 35 Mt N yr^{-1}, which is ~ 25% of the total amount of N_2 fixed per annum naturally by terrestrial ecosystems (25%–35%)	P: (1) Limited knowledge on ecosystem responses; (2) High probability of threshold but timing is very uncertain; (3) Boundary position highly uncertain. N: (1) Some ecosystem responses known; (2) Acts as a slow variable, existence of global thresholds unknown; (3) Boundary position highly uncertain.
Global freshwater use	Consumptive blue water use, km^3 yr^{-1}	Could affect regional climate patterns (e.g., monsoon behavior). Primarily slow variable affecting moisture feedback, biomass production, carbon uptake by terrestrial systems and reducing biodiversity	<4000 km^3 yr^{-1} (4000–6000 km^3 yr^{-1})	1. Scientific evidence of ecosystem response but incomplete and fragmented. 2. Slow variable, regional or subsystem thresholds exist. 3. Proposed boundary value is a global aggregate, spatial distribution determines regional thresholds



Planetary Boundaries

Earth System process	Control variable	Threshold avoided or influenced by slow variable	Planetary Boundary (zone of uncertainty)	State of knowledge*
Land-system change	Percentage of global land cover converted to cropland	Trigger of irreversible and widespread conversion of biomes to undesired states. Primarily acts as a slow variable affecting carbon storage and resilience via changes in biodiversity and landscape heterogeneity	≤15% of global ice-free land surface converted to cropland (15%–20%)	1. Ample scientific evidence of impacts of land-cover change on ecosystems, largely local and regional. 2. Slow variable, global threshold unlikely but regional thresholds likely. 3. Boundary is a global aggregate with high uncertainty, regional distribution of land-system change is critical.
Rate of biodiversity loss	Extinction rate, extinctions per million species per year (E/MSY)	Slow variable affecting ecosystem functioning at continental and ocean basin scales. Impact on many other boundaries—C storage, freshwater, N and P cycles, land systems. Massive loss of biodiversity unacceptable for ethical reasons.	<10 E/MSY (10–100 E/MSY)	1. Incomplete knowledge on the role of biodiversity for ecosystem functioning across scales. 2. Thresholds likely at local and regional scales. 3. Boundary position highly uncertain.
Chemical pollution	For example, emissions, concentrations, or effects on ecosystem and Earth System functioning of persistent organic pollutants (POPs), plastics, endocrine disruptors, heavy metals, and nuclear wastes.	Thresholds leading to unacceptable impacts on human health and ecosystem functioning possible but largely unknown. May act as a slow variable undermining resilience and increase risk of crossing other thresholds.	To be determined	1. Ample scientific evidence on individual chemicals but lacks an aggregate, global-level analysis. 2. Slow variable, large-scale thresholds unknown. 3. Unable to suggest boundary yet.

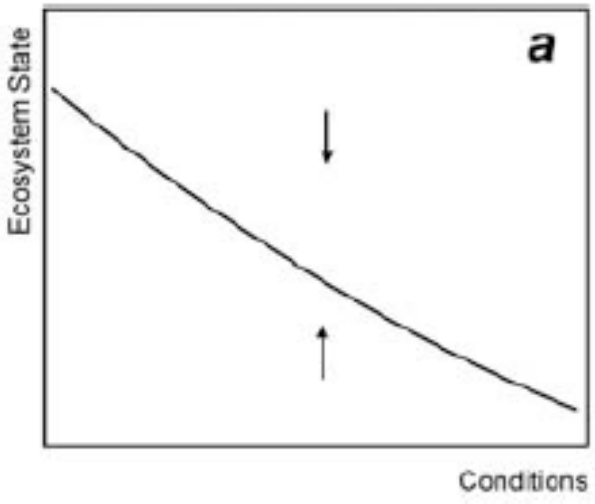


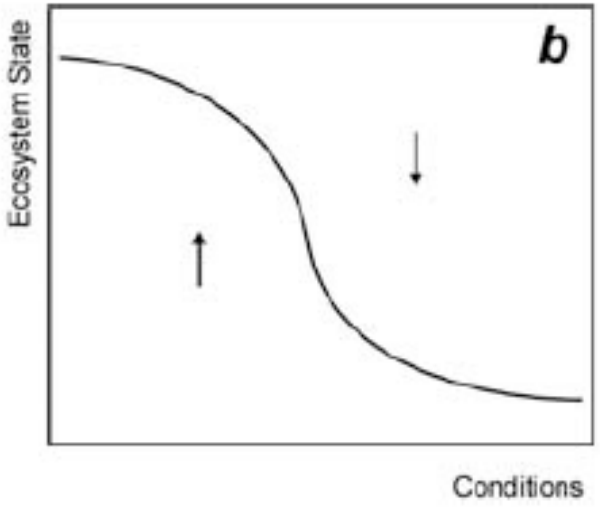
PB, A comparison of what we know

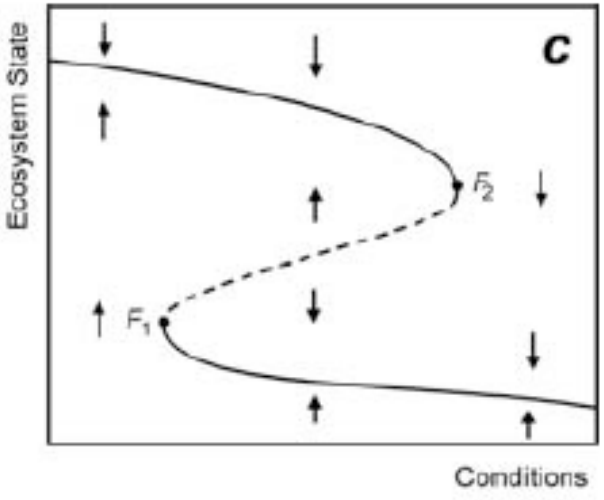
Earth System process	Control variable	Boundary	Pre-industrial	1950	1970	1990	Latest data
Climate change	Atmos-pheric CO2 (ppm)	350	280	311	326	354	387
Ocean acidification	Global aragonite saturation ratio	2.75	3.44	n.a.	n.a.	n.a.	2.90
Stratospheric Ozone	O3 concentration (DU)	276	290	n.a.	292	282	283
Nitrogen cycle	Amount of N2 re-moved (Mt/yr)	35	0	4	39	98	121
Phosphorus cycle	Quantity of P flowing (Mt/yr)	11	1.1	3.4	6.0	8.5	10.3
Freshawater	Consumptive use (km3/yr)	4,000	415	887	1,536	2,192	2,600
Land system change	% of natural cover to cropland (Mha)	15	5	n.a.	10.71	11.45	11.68
Biodiversity	Extintion rate (# of species per million per year	10	1	n.a.	n.a.	n.a.	>100

PB, Dynamics of system change

Ecosystems have different responses.



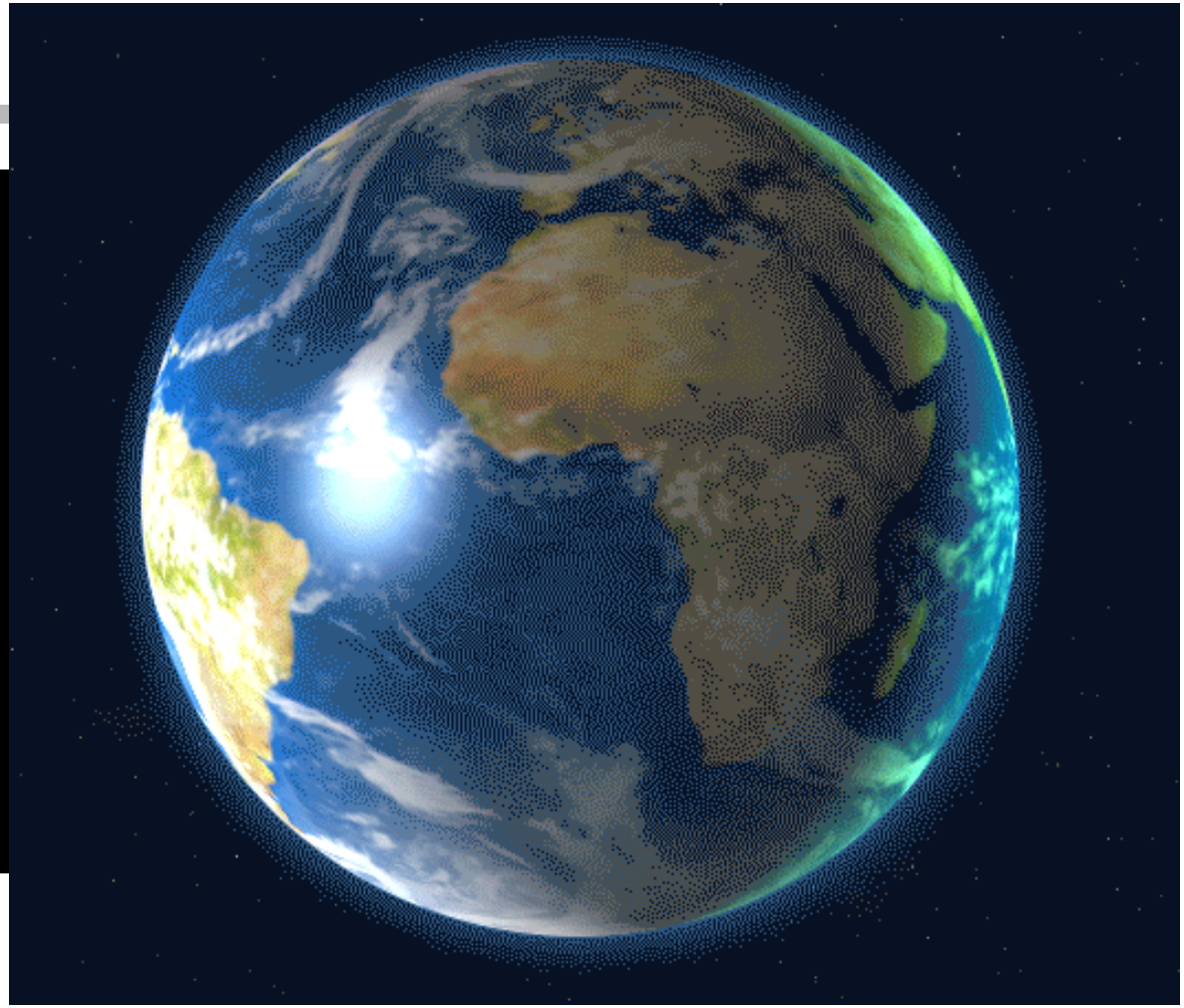




Beyond the Anthropocene, Johan Rockström

https://www.fotomuseum.ch/en/explore/still-searching/articles/27011_welcome_to_the_anthropocene

https://www.youtube.com/watch?v=V9ETiSaxyfk 21'14''



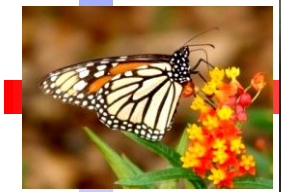
We have our foot on the accelerator driving towards the Abyss…"

Ban Ki-moon Secretary General of the UN Sept 2009

Biodiversity

"Scientists know we must protect species because they are working parts of our life-support system."

Paul Ehrlich



"Our health relies entirely on the vitality of our fellow species on Earth."

Harrison Ford

http://biodiversity.eionet.europa.eu/announcements/ann1270635623
http://www.unmultimedia.org/radio/english/detail/102144.html

Biological Diversity

It refers to a great variety of life forms, from the molecular level, to the level of ecosystems.

It is reflected in the number of species, ecological systems and genetic variability that make them unique in every corner of the planet.

It represents the variety of life and its forms: genetic, species and ecosystems

Estimated number of species by major groups (thousands)

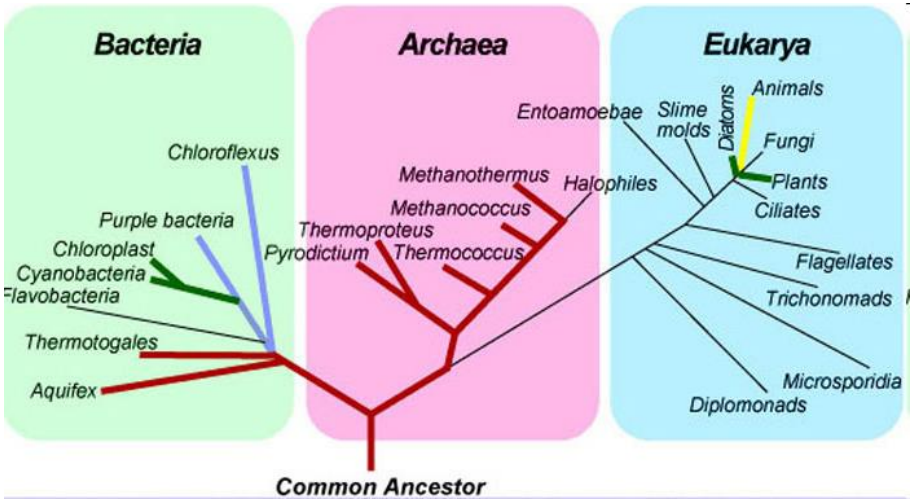
Group	# described	Estimation HIGH	Estimation LOW	Aprox.	Certainty
Virus	4	1,000	50	400	Very low
Bacteria	4	3,000	50	1,000	Very low
Fungi	72	2,700	200	1,500	Moderate
Protozoa	40	200	60	200	Very low
Algae	40	1,000	150	400	Very low
Plants	270	500	300	320	Good
Nematods	25	1,000	100	400	Low
Crustaceans	40	200	85	150	Moderate
Spiders	75	1,000	300	750	Moderate
Insects	950	100,000	2,000	8,000	Moderate
Molluscs	70	200	100	200	Moderate
Cordata	45	55	50	50	Good
Others	115	800	200	25	Moderate
TOTALS	1,750	111,655	3,635	13,620	Very low

http://www.sustainablescale.org/AreasofConcern/Biodiversity/BiodiversityandScale/QuickFacts.aspx

Biodiversity

Biodiversity is an expression of how living systems use the elements that translate into a wide range of complexities, from genes to biomes.

It is a unique example of nature and its ability to solve survival challenges in a wide range of conditions. This translates into the great diversity of life forms.



http://www.sustainablescale.org/AreasofConcern/Biodiversity/BiodiversityandScale/QuickFacts.aspx

Megadiversity: Mammals % endemisms

Brasil	524	26
Indonesia	515	39
China	449	15
Colombia	456	6
México	450	31
USA	428	24
Congo	359	7
India	350	13
Perú	344	13
Uganda	315	?

From a total of 5,487 species

In Memoriam: Lobo mexicano, hunted to extinction in the 1950's (some individuals survive in zoos)

≈25% of marine mammals are classified as threatened

http://www.press.uchicago.edu/Misc/Chicago/468283.html

http://www.vivanatura.org/Biodiversity_causes.html
http://www.ciceana.org.mx/contenido.php?cont=220

Megadiversity: Birds % endemism

Colombia	1,815	8
Peru	1,703	6
Brasil	1,622	12
Ecuador	1,559	2
Indonesia	1,531	26
Venezuela	1,360	3
India	1,258	4
Bolivia	1,257	1
China	1,244	8
Congo	1,094	2

http://www.press.uchicago.edu/Misc/Chicago/468283.html

Hawaii is the locality with the highest extinction rate of birds, followed by Indonesia y Brazil

http://www.camacdonald.com/birding/actionalerts.html

IN MEMORIAM

The last Po'o-uli (one of the Hawaiian Honeycrepers) died in in captivity at the San Diego Zoo in November, 2004.

Passenger Pigeon "Martha" the last individual, died on 1 Sep 1914 at Cincinnati OH, Zoo.

Megadiversity: Anphibians % endemisms

Colombia	583	63
Brasil	517	57
Ecuador	402	34
México	284	60
China	274	64
Indonesia	270	37
Perú	241	27
India	206	53
Venezuela	204	37
Paupa N.G.	200	67

http://www.press.uchicago.edu/Misc/Chicago/468283.html

http://www.claudeschneiderphotography.com/photoblog/category/animals/
http://www.treehugger.com/files/2008/11/ubercool_mexica.php

Megadiversity: Reptiles % endemism

Australia	755	82
México	717	51
Colombia	520	19
Indonesia	511	29
Brasil	468	37
India	408	46
China	387	34
Ecuador	374	30
Paupa N.G.	315	30
Madagascar	300	91

Lonesome George, the last male of its species, hunted to extinction in the Galapagos Islands

http://www.press.uchicago.edu/Misc/Chicago/468283.html

http://blocs.xtec.cat/whitefields/2009/02/13/darwin-turtles-and-ants/

http://www.reptile-treasures.com/4newsletters/2005%20July/00-Front_Page.htm

Megadiversity: Butterflies % endemisms

Perú	3,550	10
Brasil	3,150	6
Colombia	3,100	10
Bolivia	3,000	7
Venezuela	2,300	5
México	2,250	9
Ecuador	2,200	9
Indonesia	1,900	37
RD Congo	1,650	?
Camerún	1,500	?

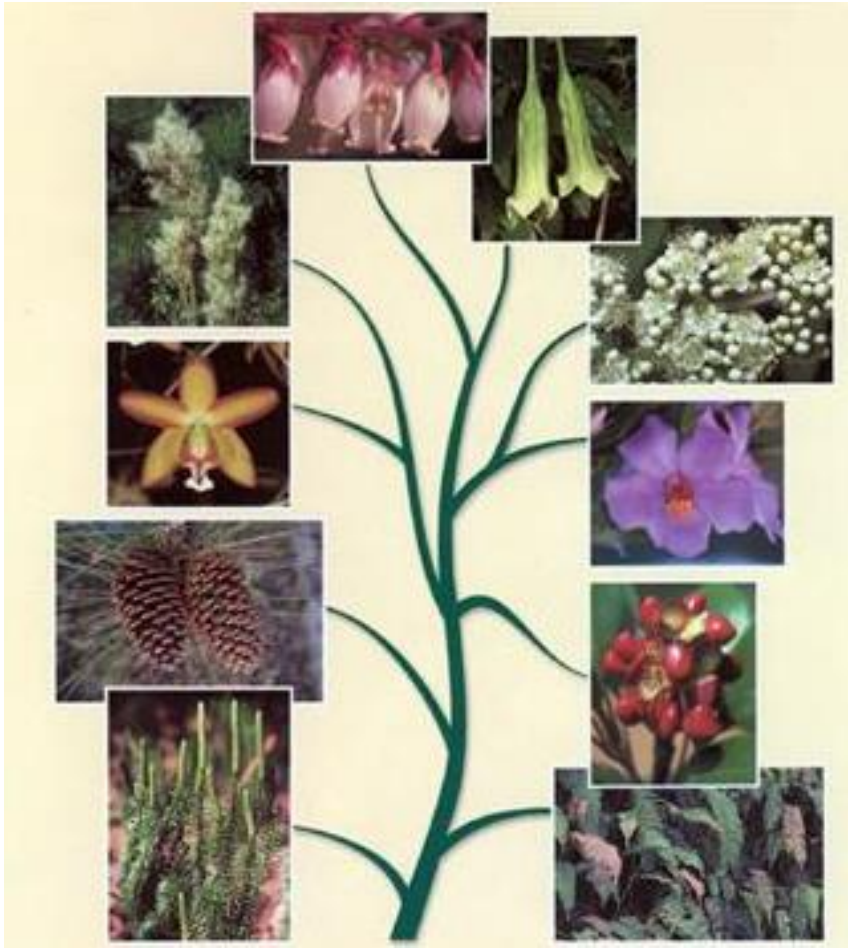
http://www.press.uchicago.edu/Misc/Chicago/468283.html

http://yale1962.org/speakout/?p=3

http://www.sunstreakbooks.com/Swift%20Guide%20to%20the%20Butterflies%20of%20Mexico.html

Megadiversity: Flowering Plants

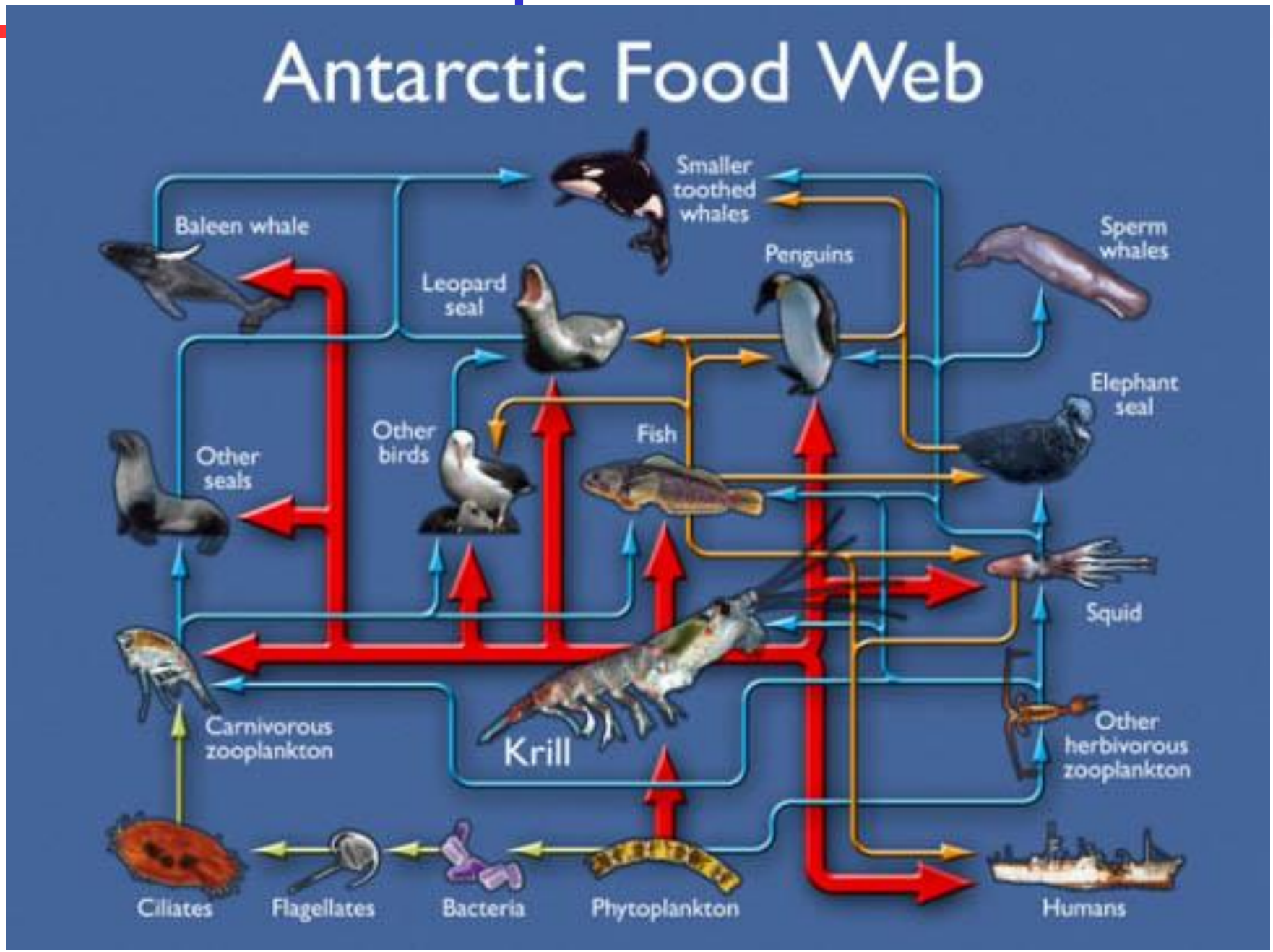
Brasil	55,000
Colombia	45,000
China	27,000
México	25,000
Australia	23,000
Sudáfrica	21,000
Indonesia	20,000
Venezuela	20,000
Perú	20,000
USSR (antigua)	20,000



http://www.env.go.jp/en/wpaper/1992/eae210000000005.html

http://web.pdx.edu/~mfish/index.php?go=courses
http://www.estrellamountain.edu/faculty/farabee/biobk/BioBookDiversity_6.html

Trophic Web!



Simplified picture of the Southern Ocean food web, showing the importance of krill in supporting directly and indirectly (via the fish link in food chains) a diverse and abundant range of higher predators, as well as several major human fisheries. These short food chains (shown in red) link microscopic plants (phytoplankton) at the base of the food chain, via krill to large predator species.

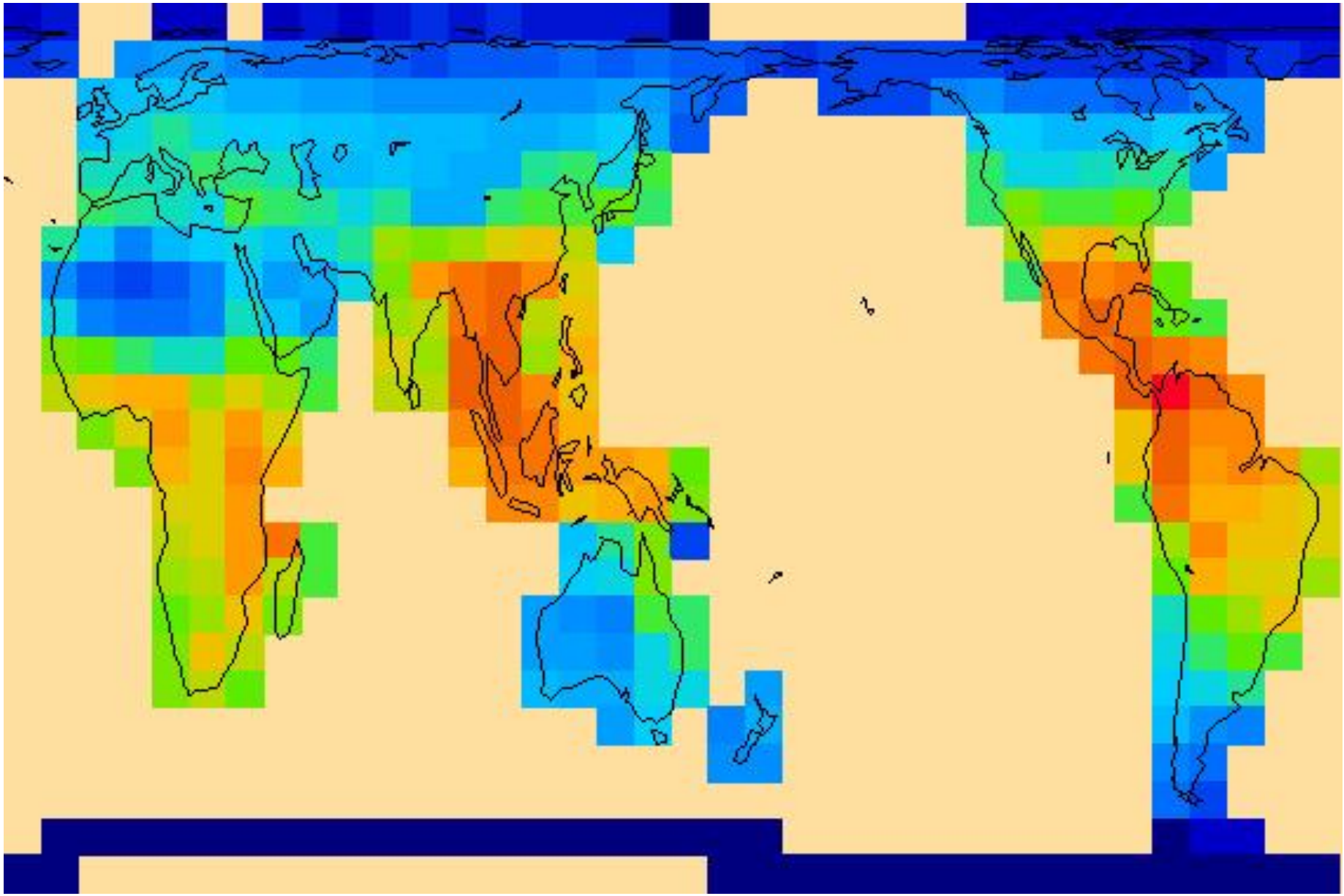
http://www.classroomatsea.net/JR161/about.html

Megadiverse contries

There are 175 million identified species (from bacteria to mammals) (Heywood et al, 1995), 70% of the species are distributed in only 12 of the 170 countries.

http://www.biogrid.cn/megadiversity.jpg

Megadiversity



Human dependency

40% of the world economy

80% of the needs of companies

A greater biological wealth:

- More sources of possible medical, industrial discoveries
- More source of possible foods
- Greater possibility of economic development
- Greater possibility of adaptation to the challenges of climate change

Human dependency

100 YEARS OF AGRICULTURAL CHANGE: SOME TRENDS AND FIGURES RELATED TO AGROBIODIVERSITY

* Since the 1900s, some 75 percent of plant genetic diversity has been lost as farmers worldwide have left their multiple local varieties and landraces for genetically uniform, high-yielding varieties.
* 30 percent of livestock breeds are at risk of extinction; six breeds are lost each month.
* Today, 75 percent of the world's food is generated from only 12 plants and five animal species.
* Of the 4 percent of the 250 000 to 300 000 known edible plant species, only 150 to 200 are used by humans. Only three - rice, maize and wheat - contribute nearly 60 percent of calories and proteins obtained by humans from plants.
* Animals provide some 30 percent of human requirements for food and agriculture and 12 percent of the world's population live almost entirely on products from ruminants.

Source: FAO. 1999b

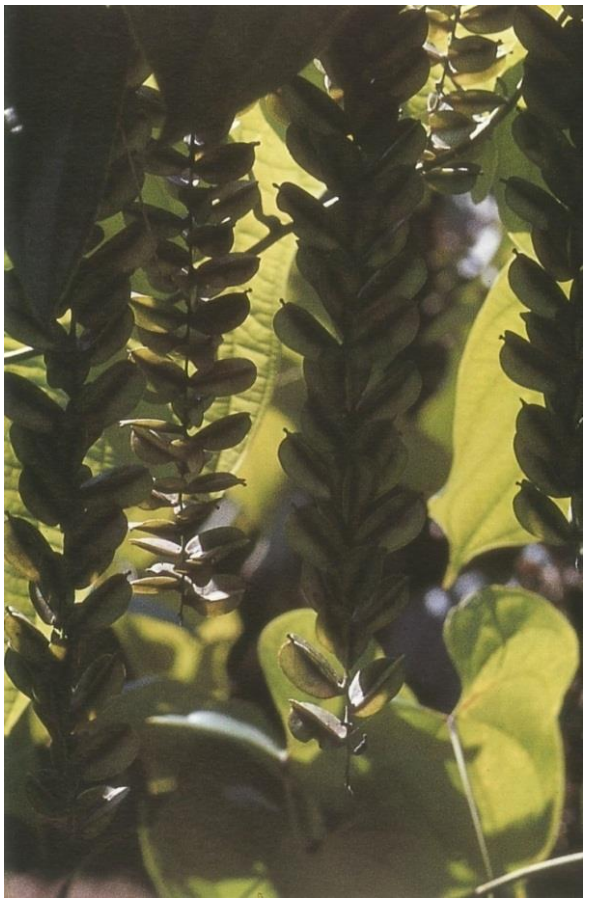
Decline in Biodiversity

Throughout the 20th century, agrobiodiversity has decline steadily, why?

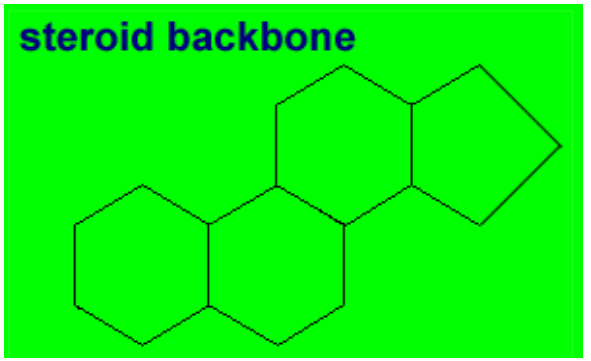
- The rapid expansion of industrial and Green Revolution agriculture.
- Globalization of the food system and marketing
- Replacement of local varieties by improved or exotic varieties and species
- Greater possibility of adaptation to the challenges of climate change

http://www.fao.org/docrep/007/y5609e/y5609e02.htm

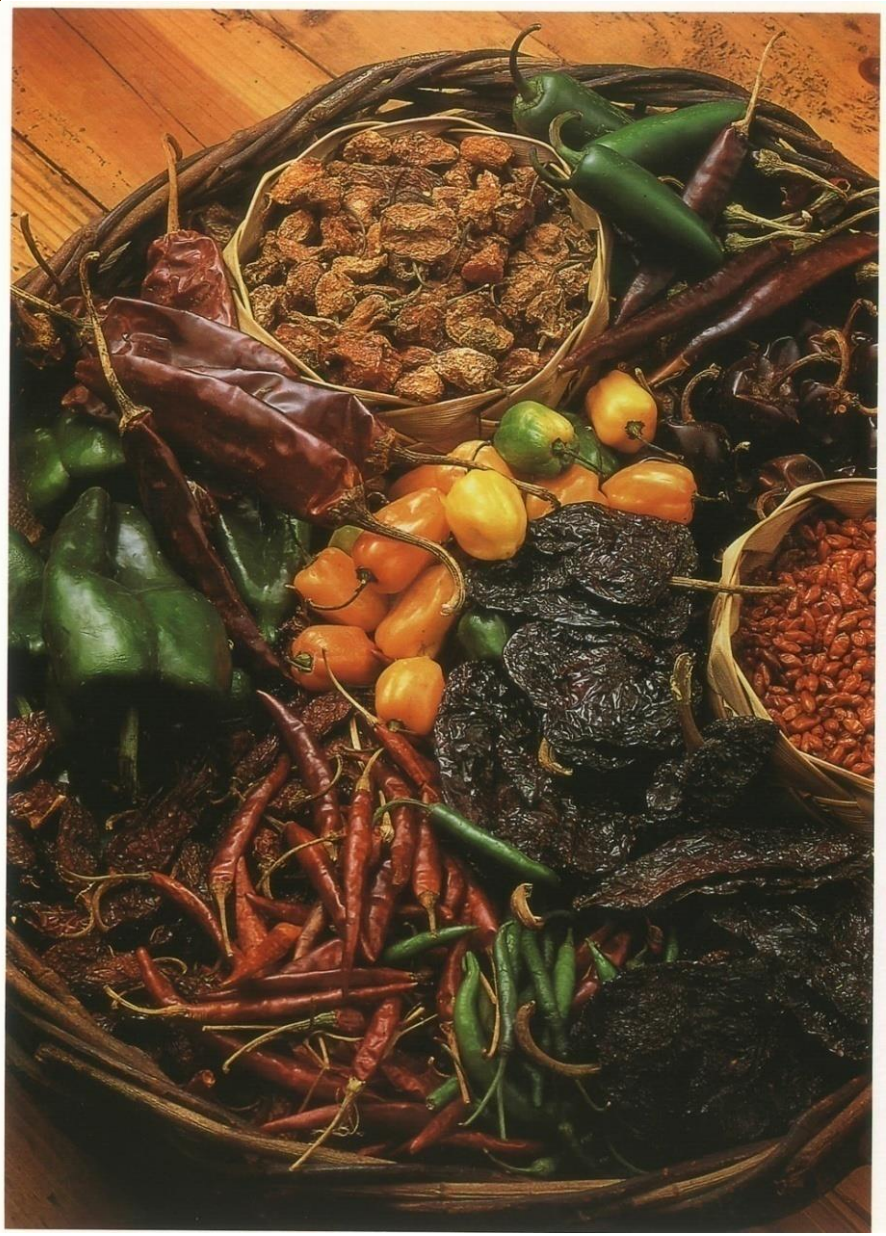
Medicinal



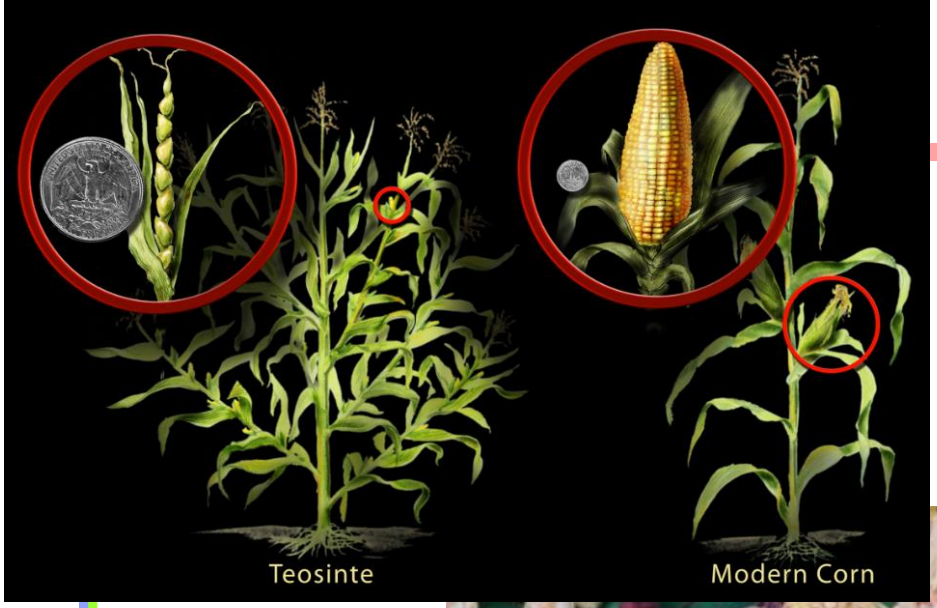
Dioscorea composita.
Diosgenina. Endemica to the tropical forest of Mexico.
Steroids. Testosterone, Progesterone
Contraceptives, anti-inflammatory, Autoimmune treatment, etc.



Cultural



Economic



http://oer.uaf.edu/learn/nrm101-v1/2010/07/12/a-history-of-corn/
https://www.iucn.org/news/commission-environmental-economic-and-social-policy/201711/public-and-private-sector-engagement-agrobiodiversity-conservation

Modern varieties are dangerously suspended by a very thin rope. The larger the bag, the more likely it is that the rope will break.

New Varieties

In 1970 a plague caused by a fungus (*Heminthosporium maydis*) reduced more than half of the corn crops in the USA. In the last and desperate moment an improvised technical remedy was to introduce resistant varieties of Mexico "their place of origin".

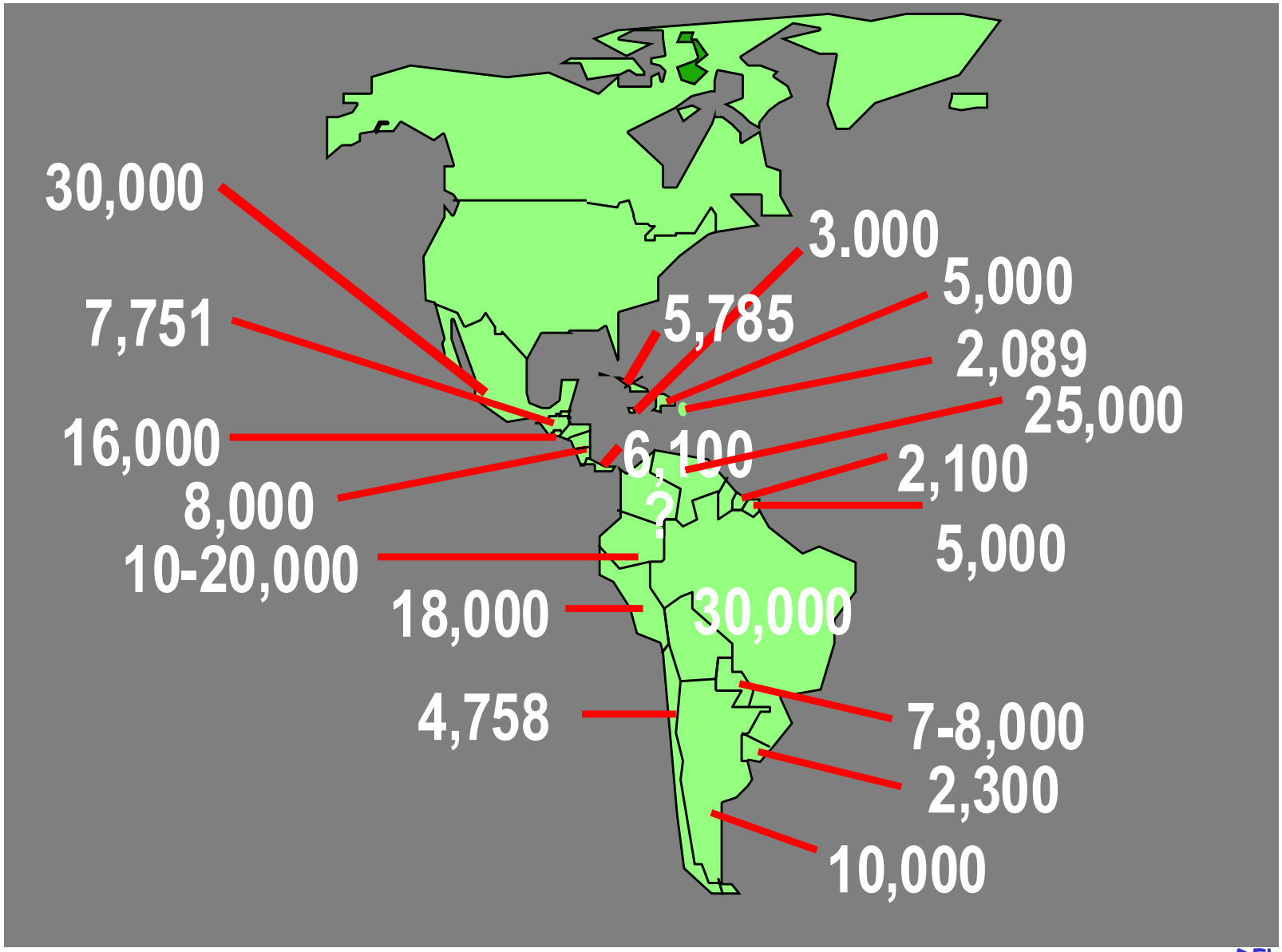
https://docs.lib.purdue.edu/cgi/viewcontent.cgi?referer=https://www.google.com/&httpsredir=1&article=1003&context=larstechhttp://myveritas.ca/northern-corn-leaf-blight/
http://myveritas.ca/northern-corn-leaf-blight/

Peoples and believes

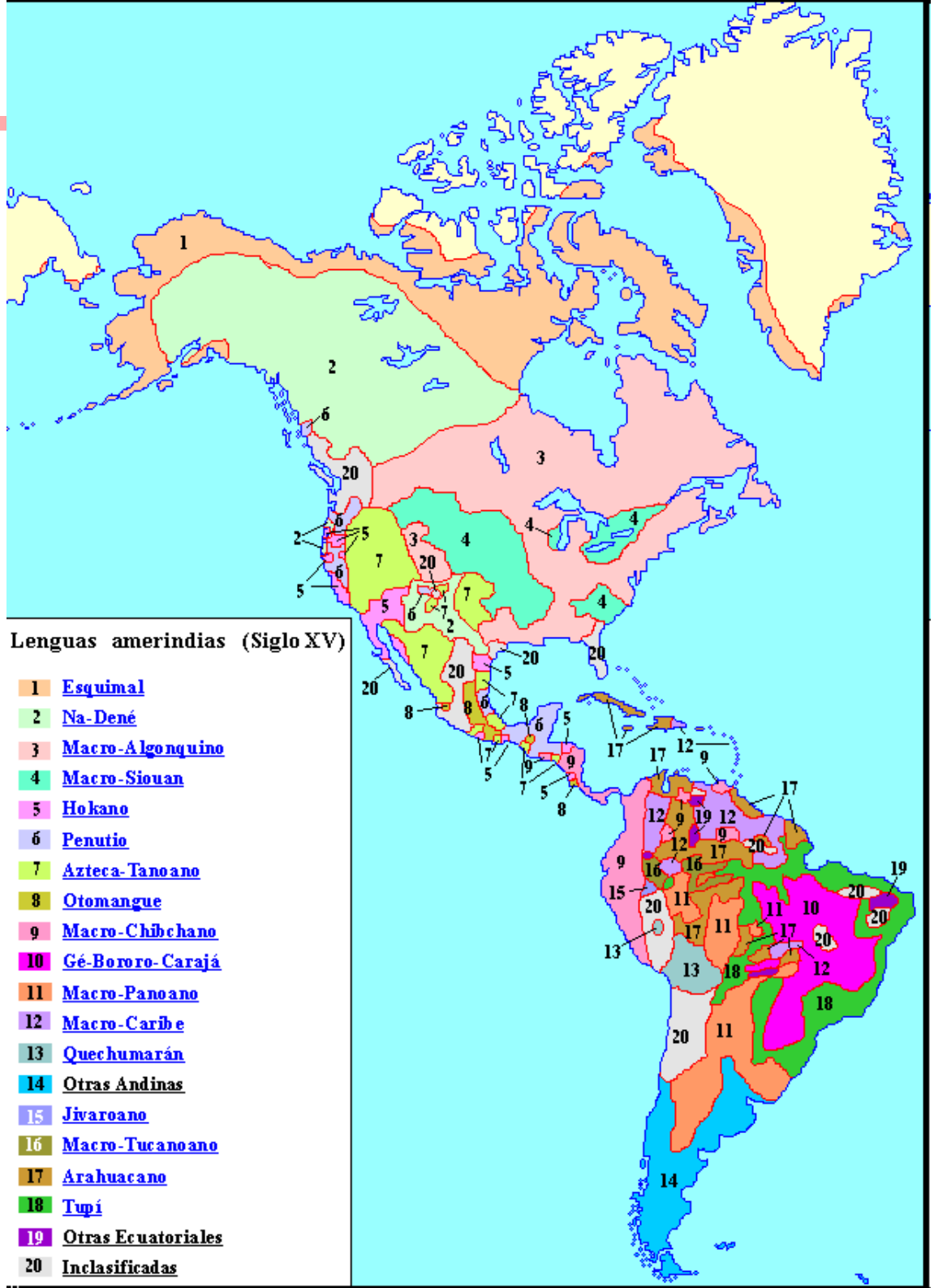
http://peacemonger.org/faqs.html

http://www.eco-pros.com/biodiversity-genetic.htm

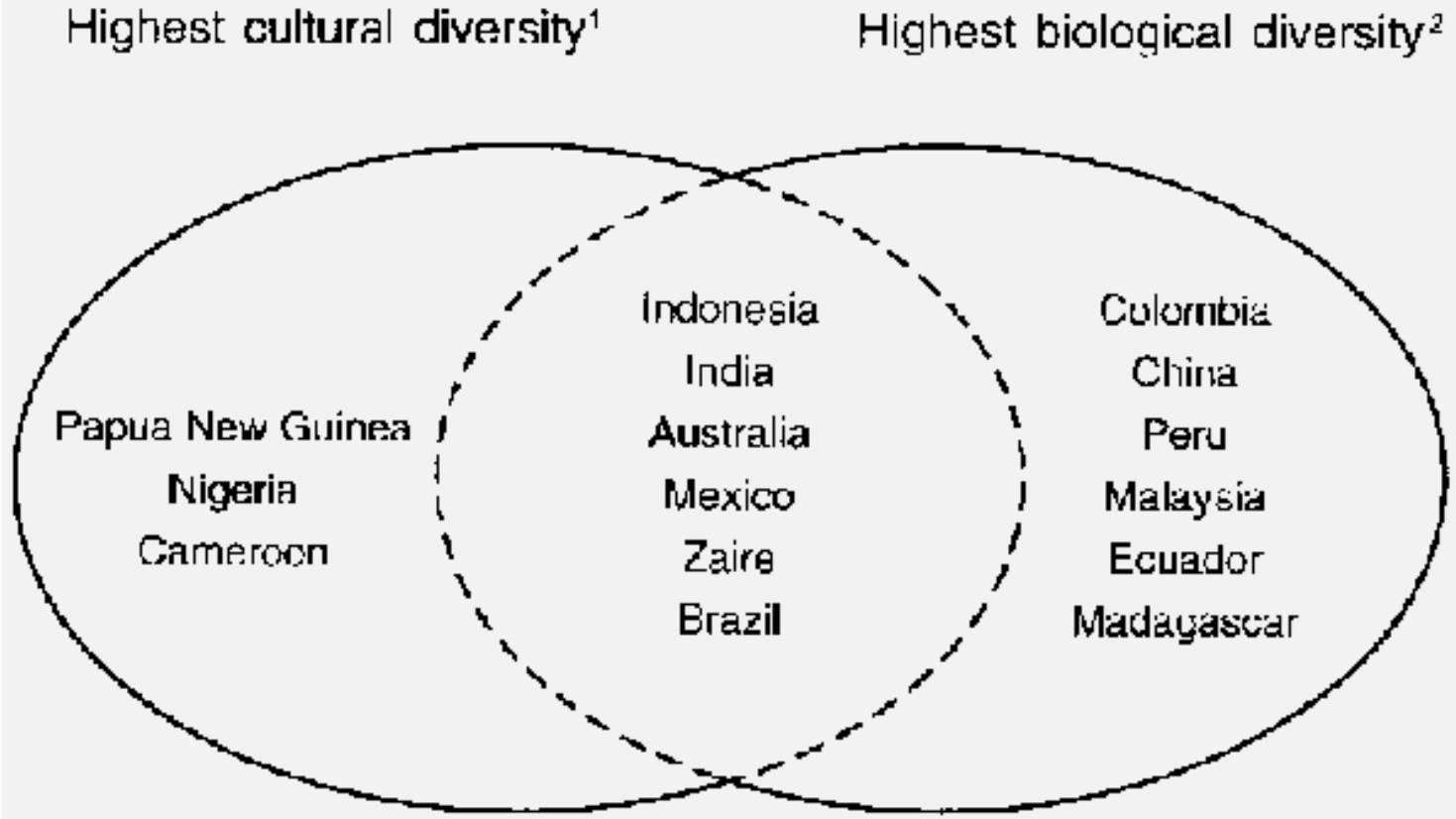
Number of flowering plants in Latin-American



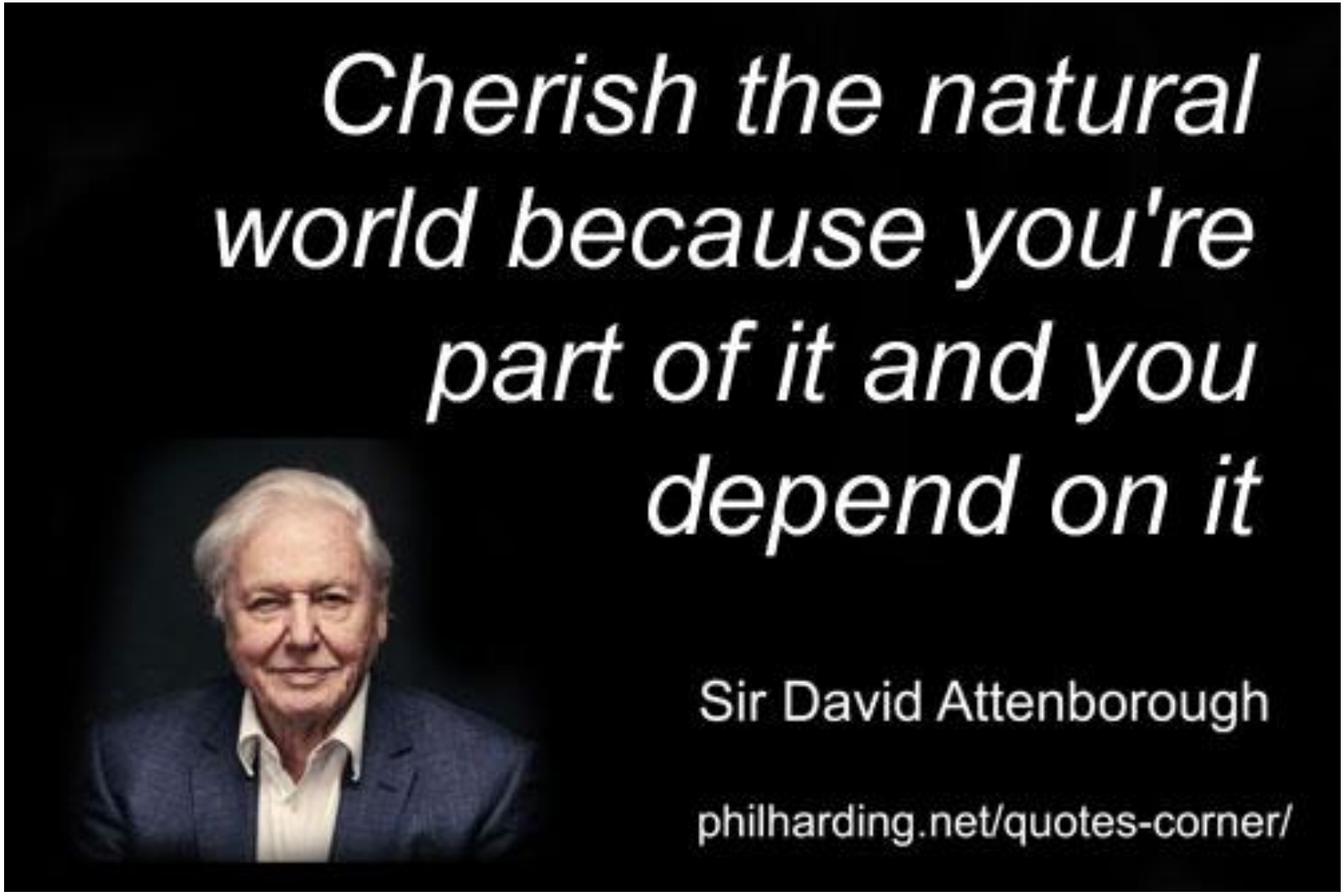
Ethnolinguistic groups



Megadiversity
Cultural and Biological



http://www.fao.org/docrep/w1033E/w1033e09.htm


Cherish the natural world because you're part of it and you depend on it
Sir David Attenborough
philharding.net/quotes-corner/

Lidership on Sustainable Development

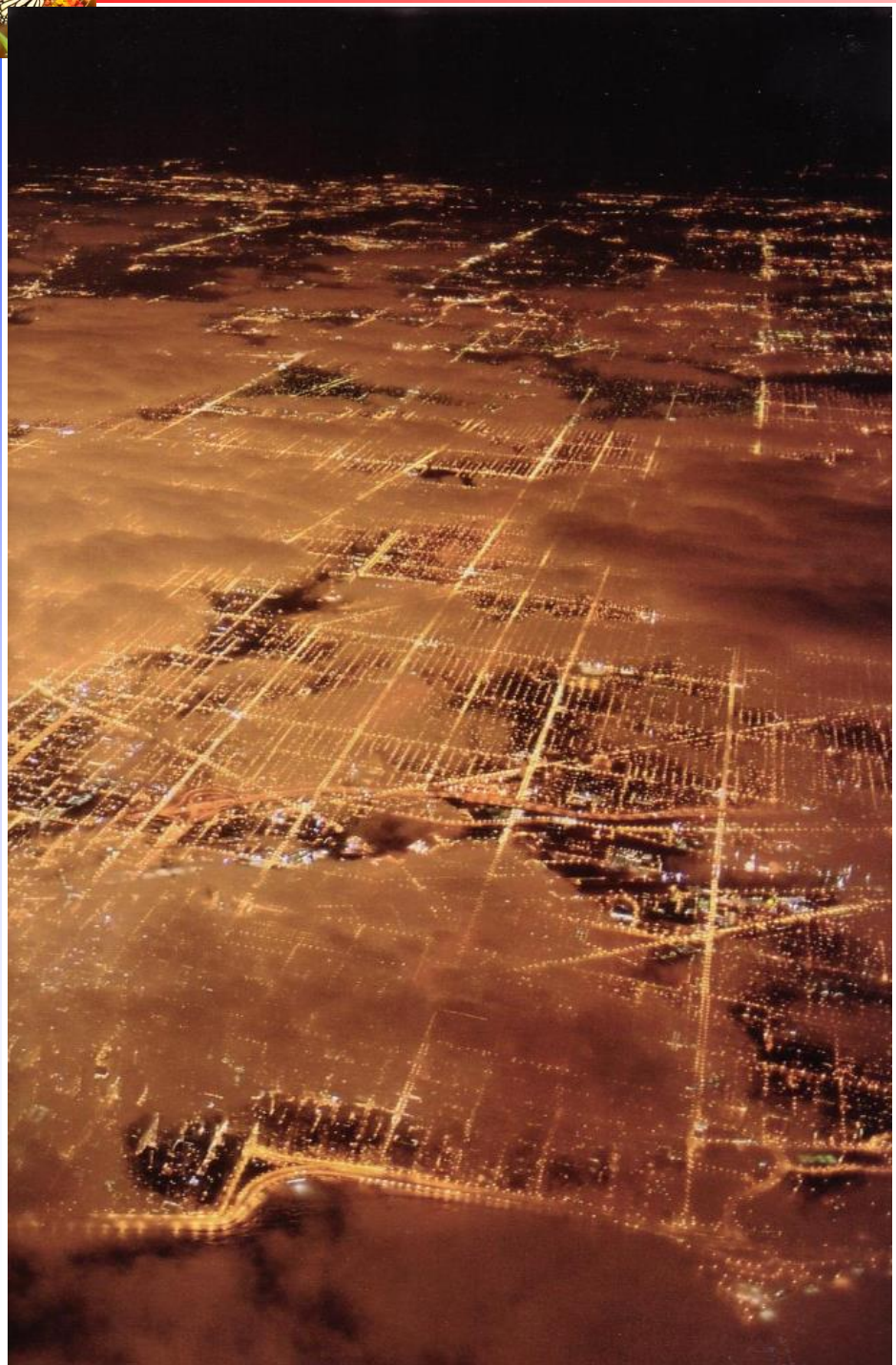
Human Impacts

Sea of Trash

Video de Charles Moore

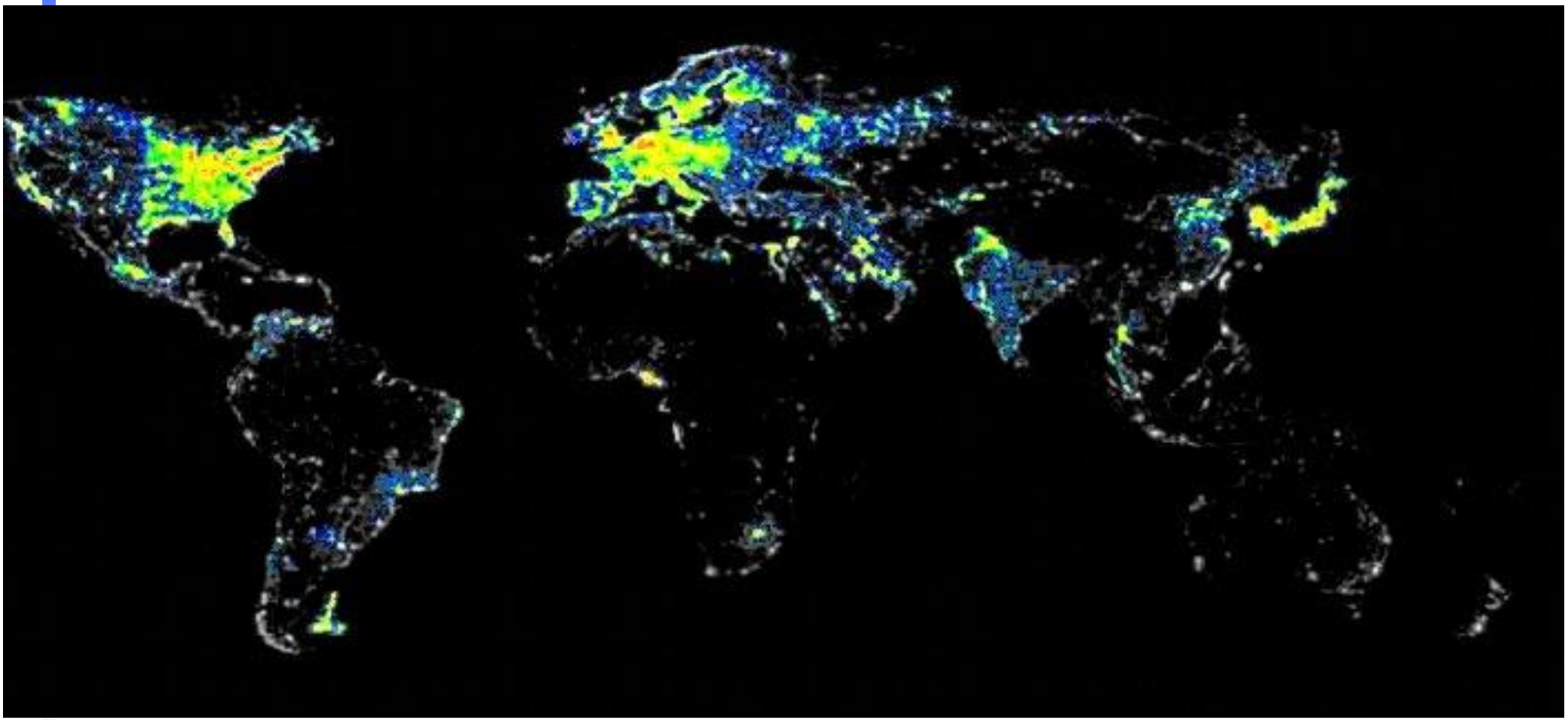
https://www.ted.com/talks/capt_charles_moore_on_the_seas_of_plastic

Chicago, IL



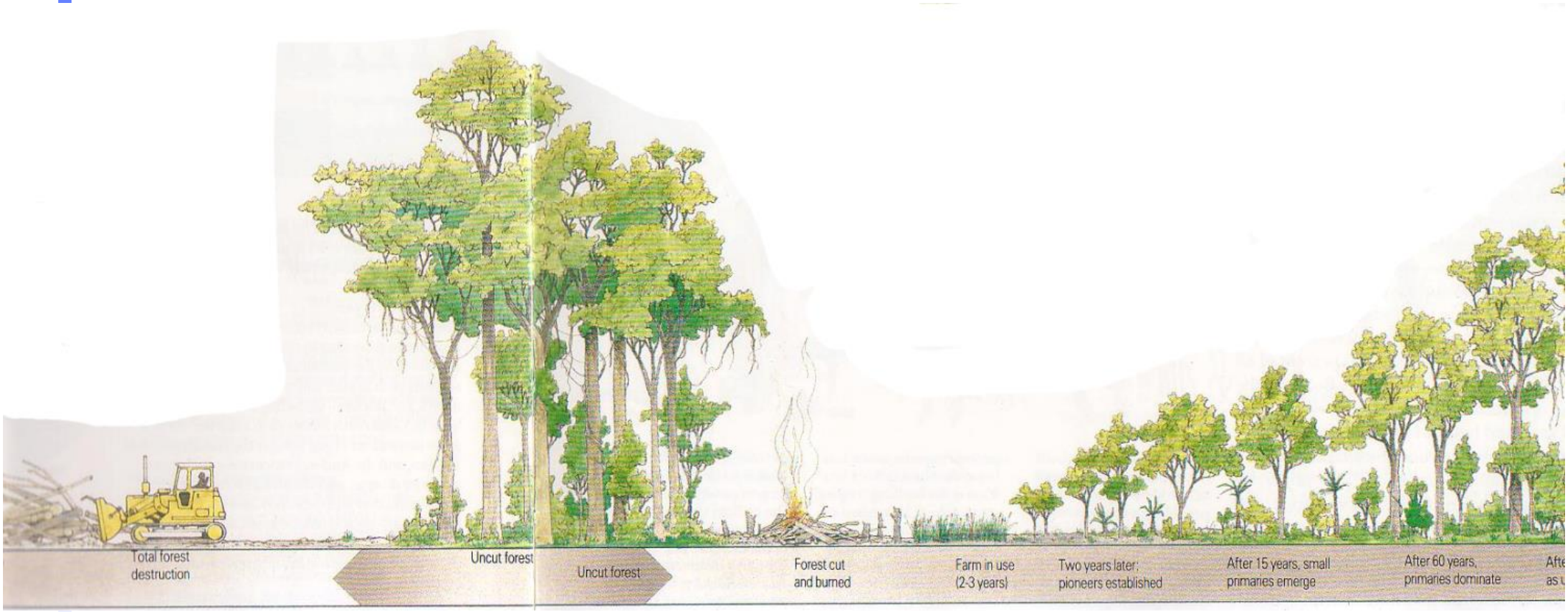
Sydney, Aus.

The night in planet earth

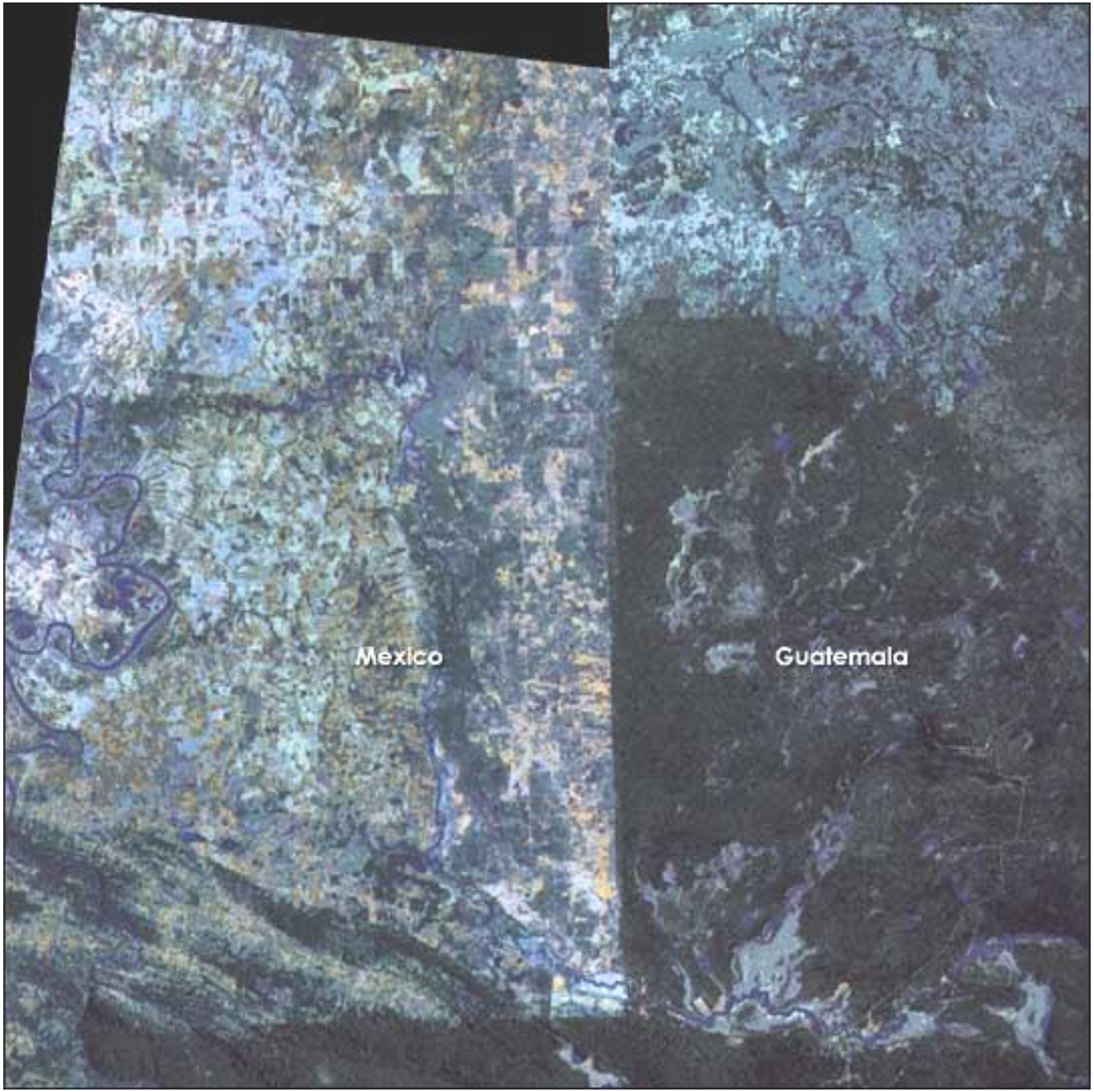


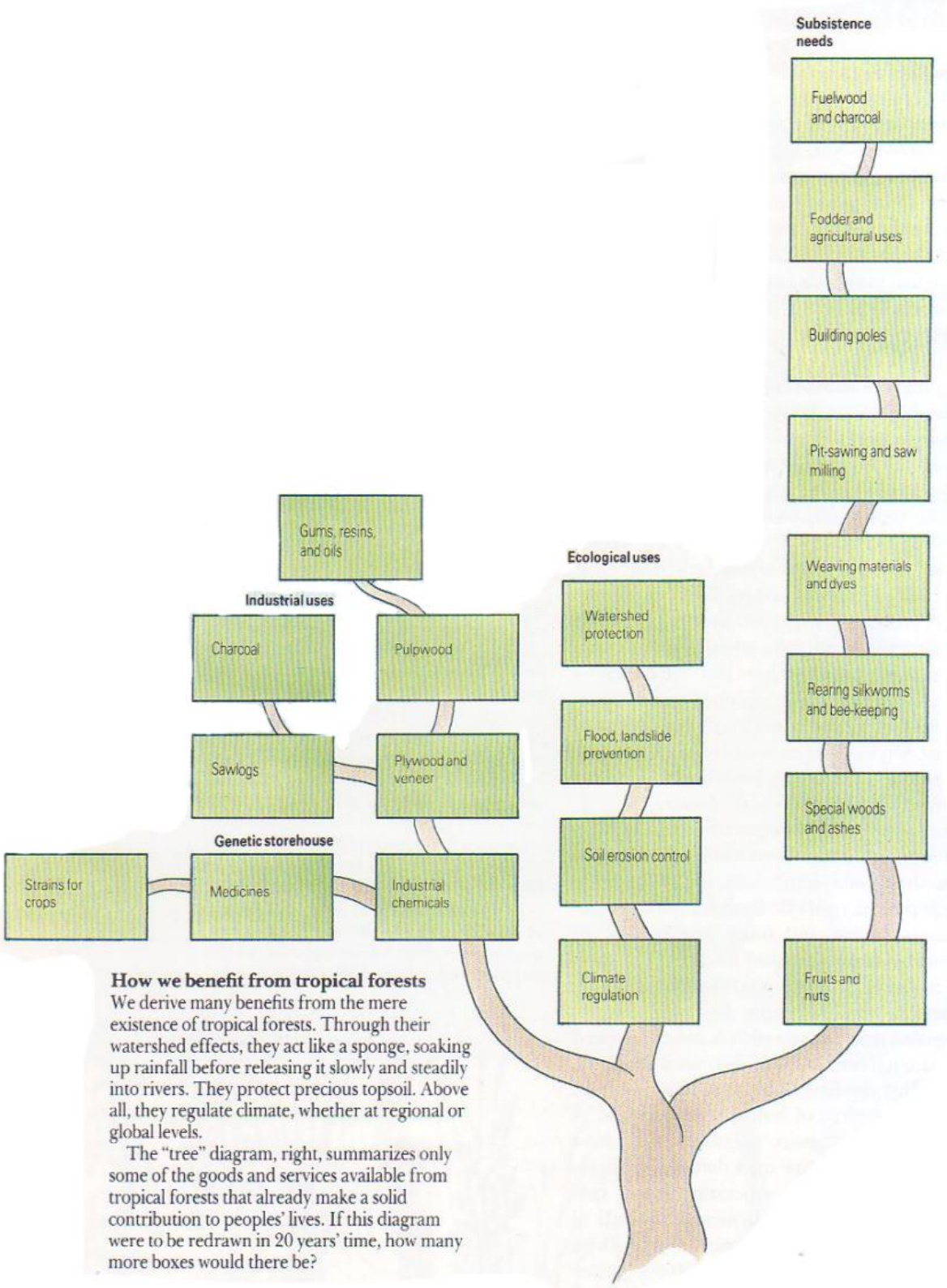
Map produced by Light Poluttion Science & Technology Institute

Deforestation in the tropics



Deforestation in the tropics
Mexico-Guatemala border



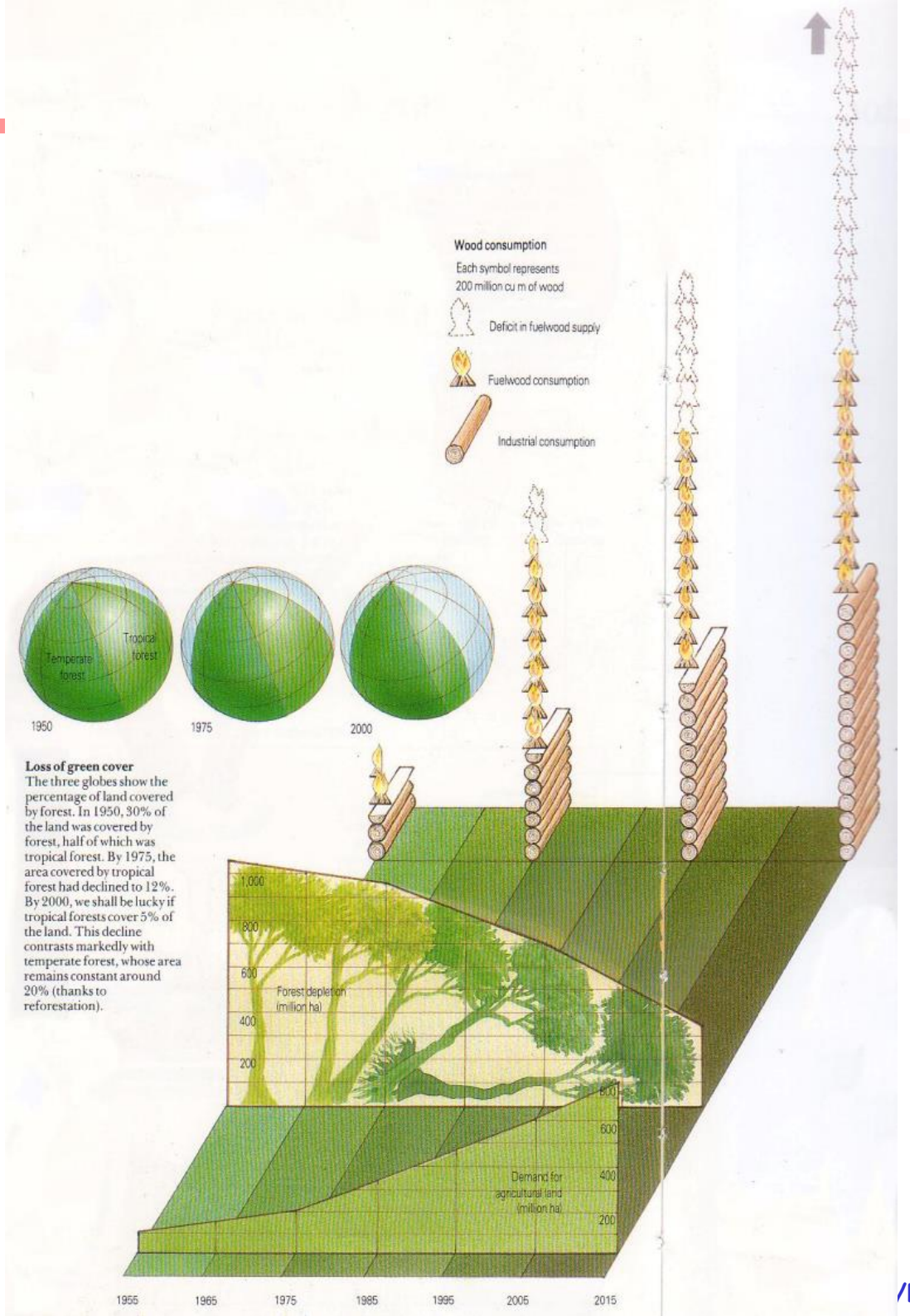


How we benefit from tropical forests
We derive many benefits from the mere existence of tropical forests. Through their watershed effects, they act like a sponge, soaking up rainfall before releasing it slowly and steadily into rivers. They protect precious topsoil. Above all, they regulate climate, whether at regional or global levels.

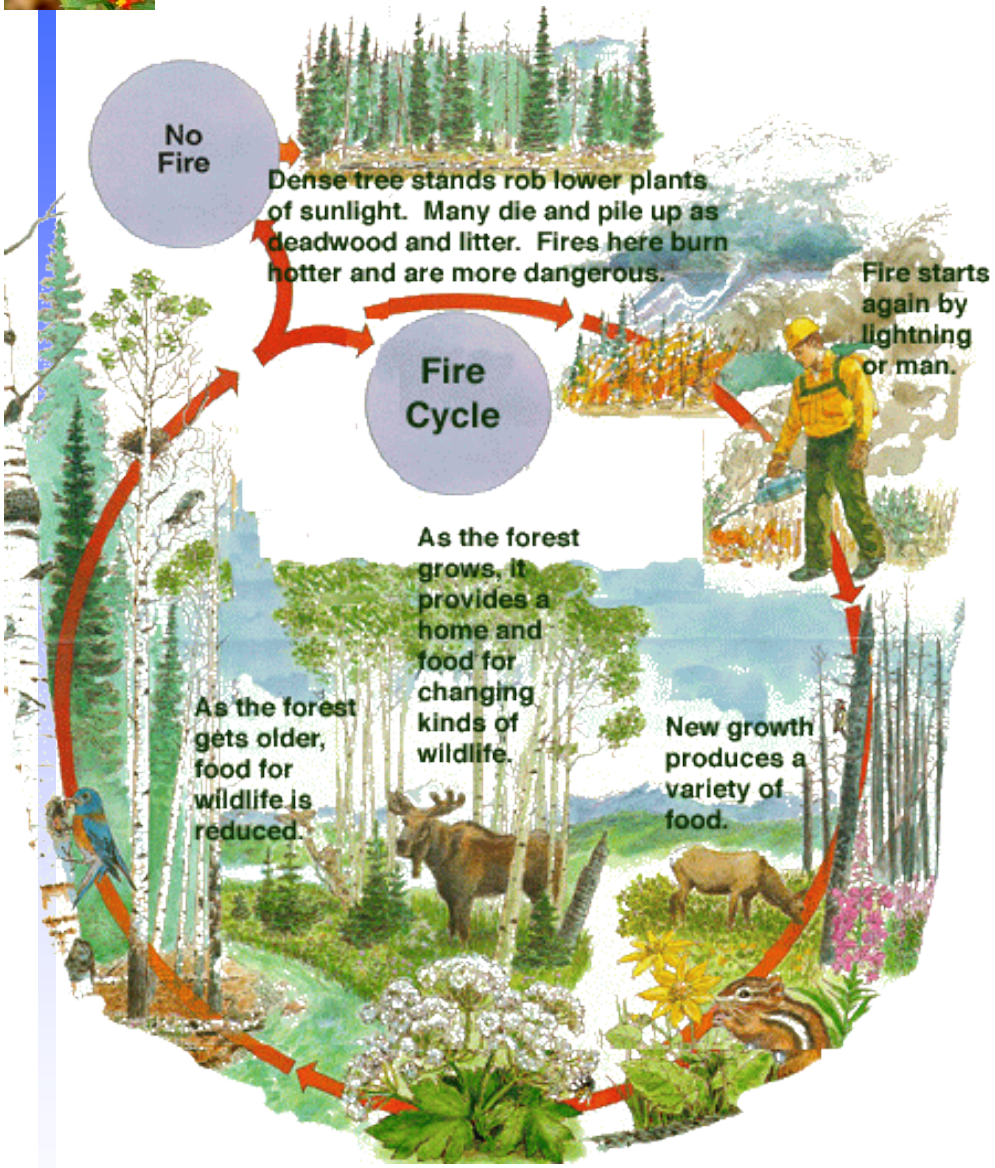
The "tree" diagram, right, summarizes only some of the goods and services available from tropical forests that already make a solid contribution to peoples' lives. If this diagram were to be redrawn in 20 years' time, how many more boxes would there be?

Benefits from the tropical forest

Recursos Forestales



Ecosystems & Fire



http://people.eku.edu/ritchisong/317notes1.html & http://sfrc.ufl.edu/distance/mseronline/

Rondonia, Brazil

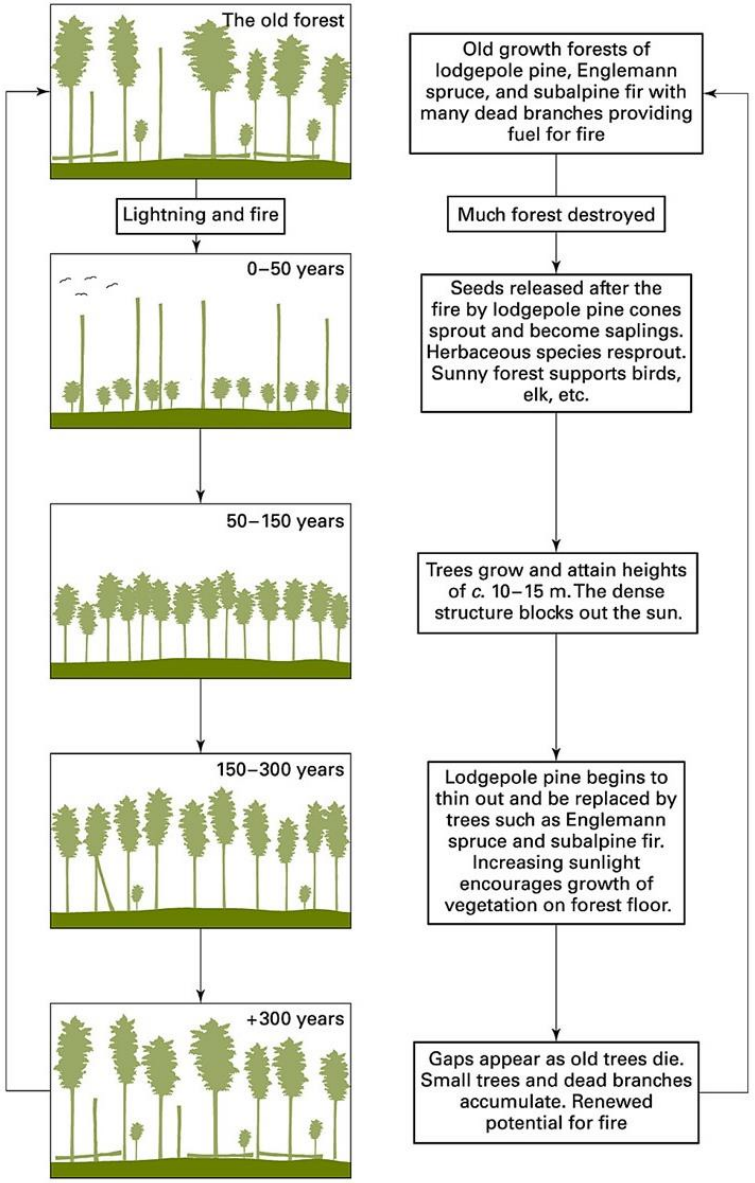
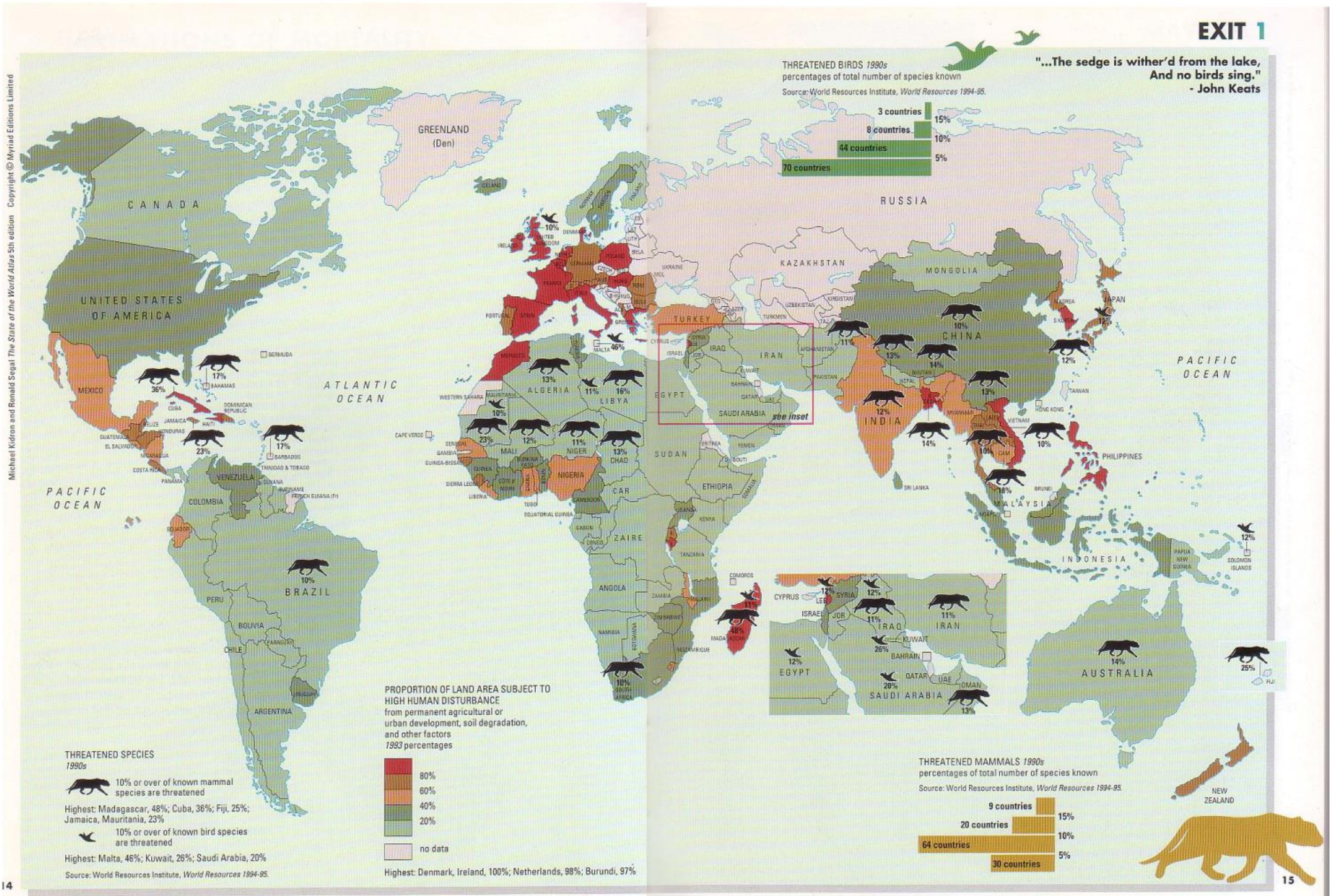


Figure 2.4 Ecological succession in response to fire in Yellowstone National Park (after Romme and Despain, 1989: 24–25, heavily modified).

Threatened biodiversity

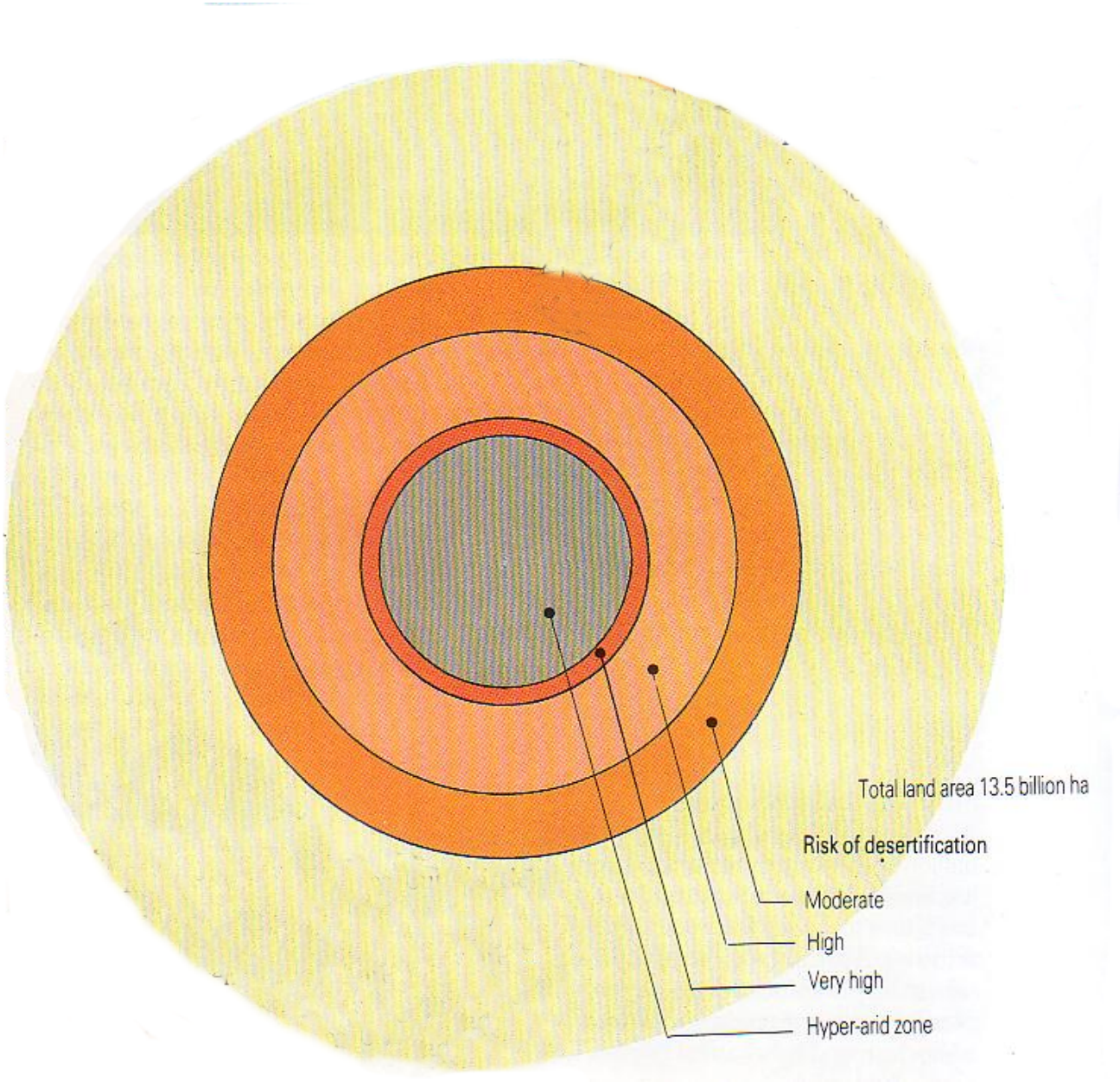


The role of biodiversity

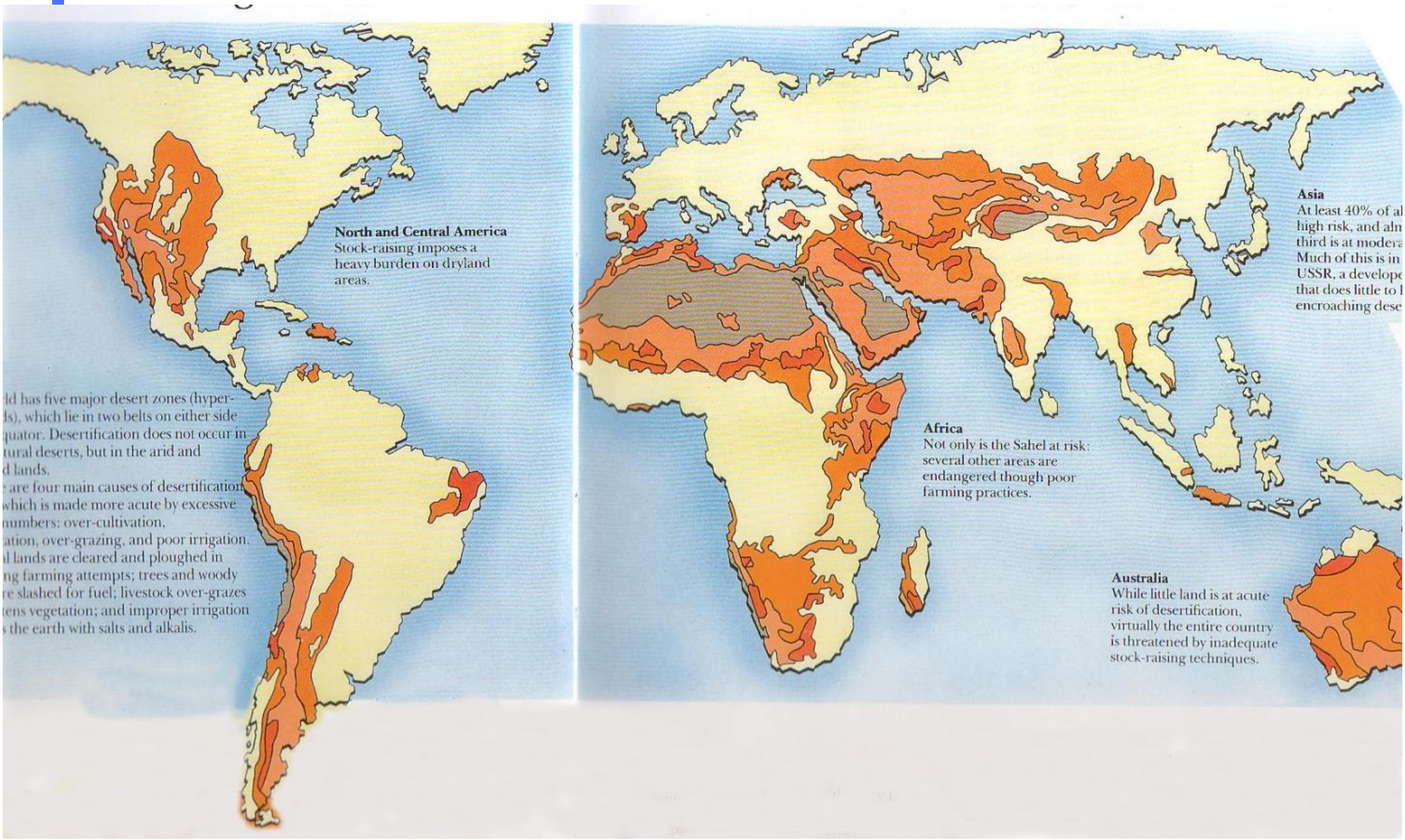
Wolfs in Yellowstone National Park

https://saywhat.news/wolf-facts-70-uncanny-facts-about-wolfs/

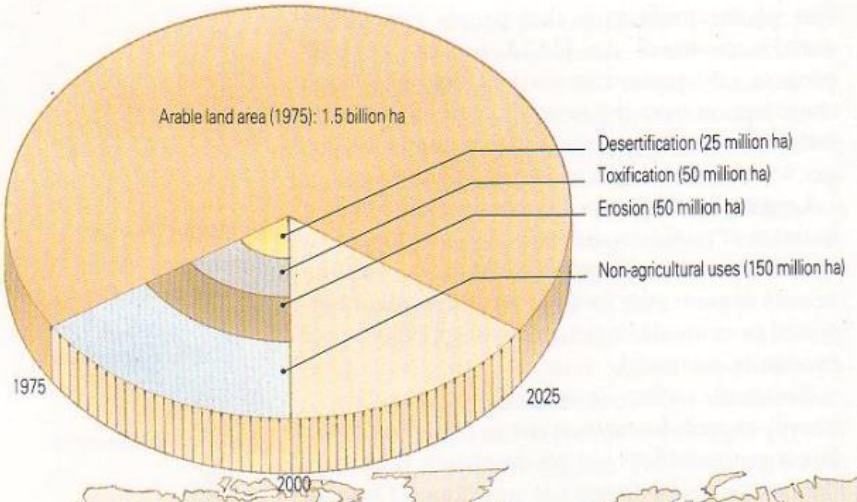
Desertification



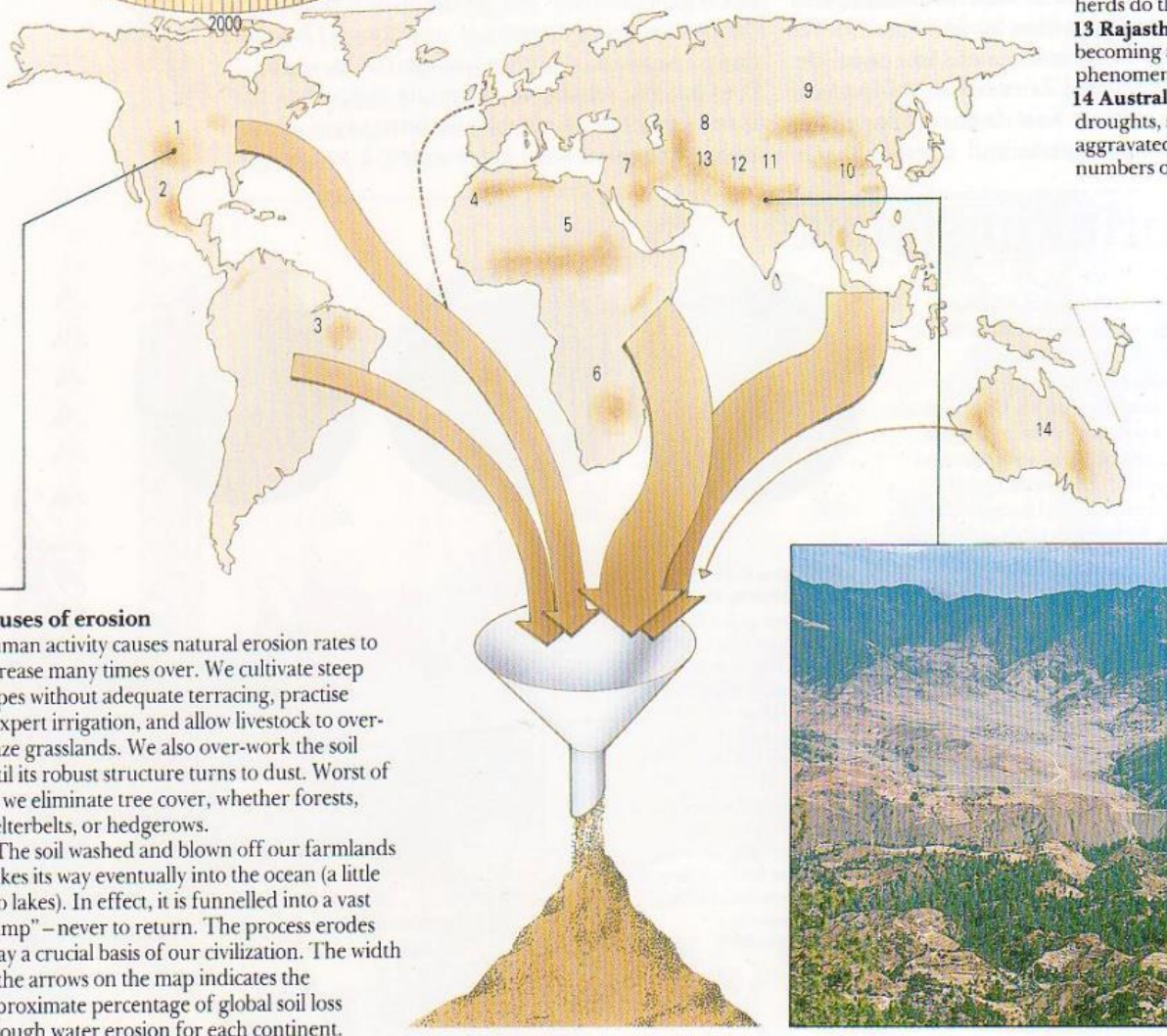
Desertification



Soil Erosion



Erosion hotspots
Areas of severe erosion are listed below.
1 US Unsustainable pressure on soils in the grain lands.
2 Mexico Experiencing erosion and droughts.
3 NE Brazil 40 million people grossly over-load fragile lands.
4 N Africa Much erosion, despite attempts to halt the desert through tree belts.
5 Sahel Probably the worst wind erosion area on Earth.
6 Botswana – Namibia Excessive livestock herds accelerate erosion.
7 Middle East Erosion, a problem for centuries, now spreading faster than ever.
8 Central Asia Again, too many livestock, too little careful management.
9 Mongolia Growing numbers of people and growing herds over-burden the environment.
10 Yangtse China is reported to lose 5 billion tonnes of fine "loess" soil annually.
11 Himalayan foothills The worst erosion hotspot (see below).
12 Baluchistan Traditional stock-raising and large herds do the damage.
13 Rajasthan Droughts are becoming a permanent phenomenon.
14 Australia Long droughts, sometimes aggravated by excessive numbers of stock.



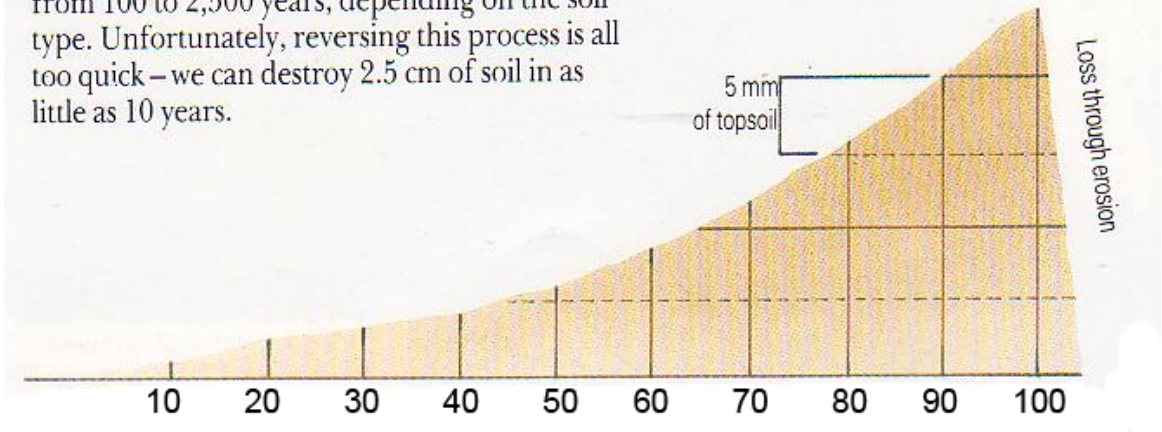
Causes of erosion
Human activity causes natural erosion rates to increase many times over. We cultivate steep slopes without adequate terracing, practise inexpert irrigation, and allow livestock to over-graze grasslands. We also over-work the soil until its robust structure turns to dust. Worst of all, we eliminate tree cover, whether forests, shelterbelts, or hedgerows.

The soil washed and blown off our farmlands makes its way eventually into the ocean (a little into lakes). In effect, it is funnelled into a vast "sump" – never to return. The process erodes away a crucial basis of our civilization. The width of the arrows on the map indicates the approximate percentage of global soil loss through water erosion for each continent.

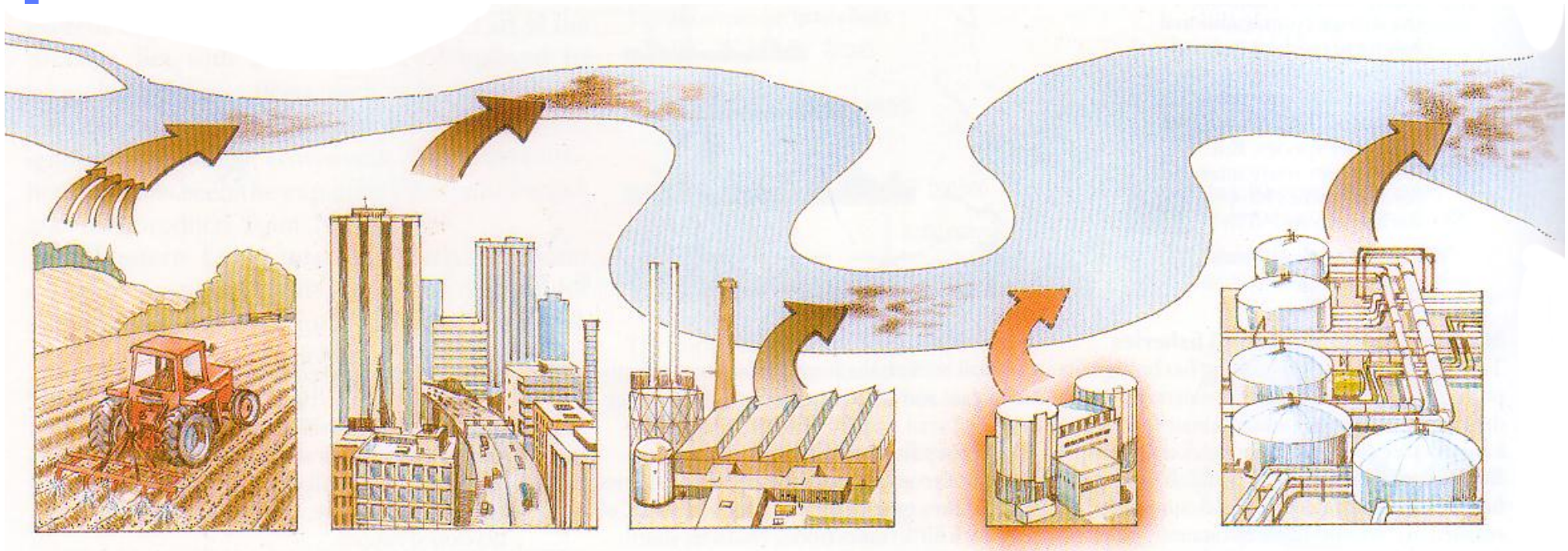
Soil Formation

Soil timescales

Formation of 2.5 cm of topsoil can take anything from 100 to 2,500 years, depending on the soil type. Unfortunately, reversing this process is all too quick – we can destroy 2.5 cm of soil in as little as 10 years.



Ocean Pollution



Agricultural run-off
Pesticides and herbicides, not readily bio-degradable, are persistent pollutants. As they pass through marine food chains, their effect is concentrated. Nitrates from fertilizers over-enrich water, causing algal growth and eventual deoxygenation.

Urban centres
Municipal drainage systems pour out domestic and industrial sewage, contaminated with toxic chemicals, heavy metals, oil, and organic nutrients. Construction sites release enormous amounts of sediment into rivers.

Industry
Much of the complex mix that goes into industrial waste ends up in the sea. Included in this mélange are partially bio-degradable food wastes, heavy metals, and persistent pesticides. It often takes a human casualty to alert us to the source of the pollution.

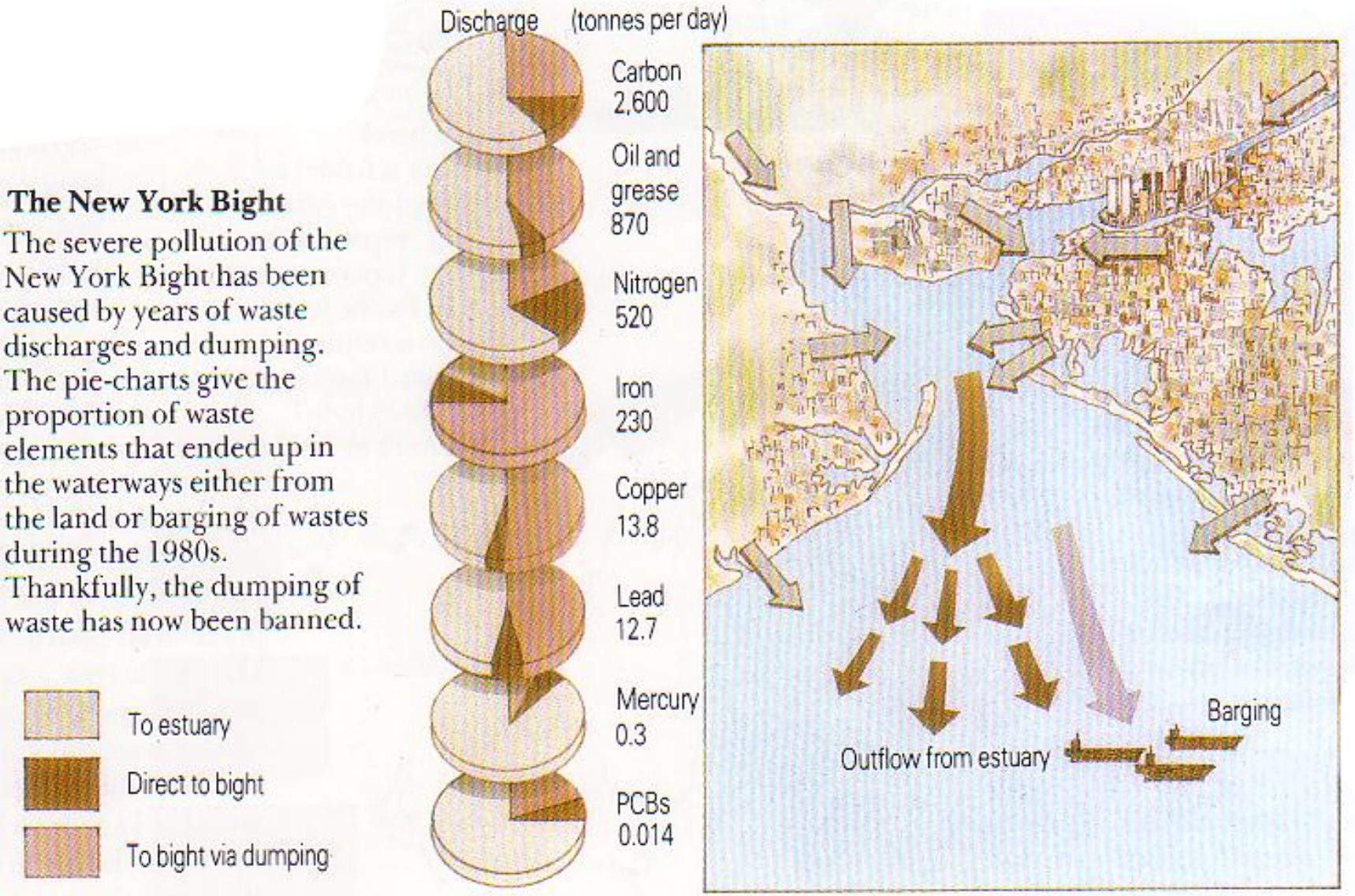
Nuclear facilities
Radioactive effluent is discharged into coastal waters from nuclear-fuel reprocessing plants such as those at Sellafield (UK) and Cap de la Hague (France). Both facilities have been implicated in sickness and deaths of local people.

Oil refineries
Oil terminals tend to be sited along coasts, often built on valuable saltmarsh or near productive estuaries. Accidental oil loss and seepage from refineries contribute some 100,000 tonnes of oil annually to ocean pollution.

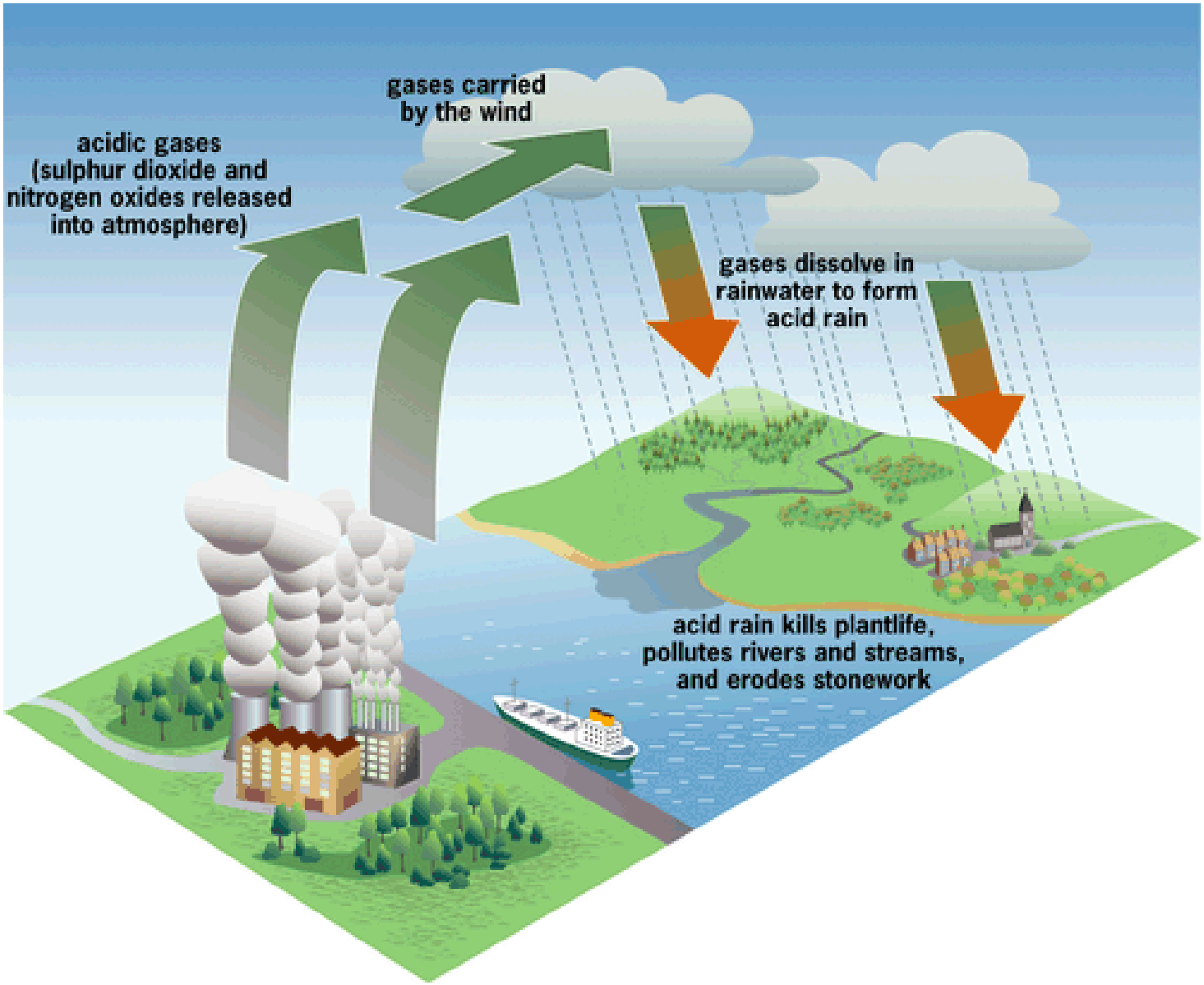
New York Bay pollution

The New York Bight

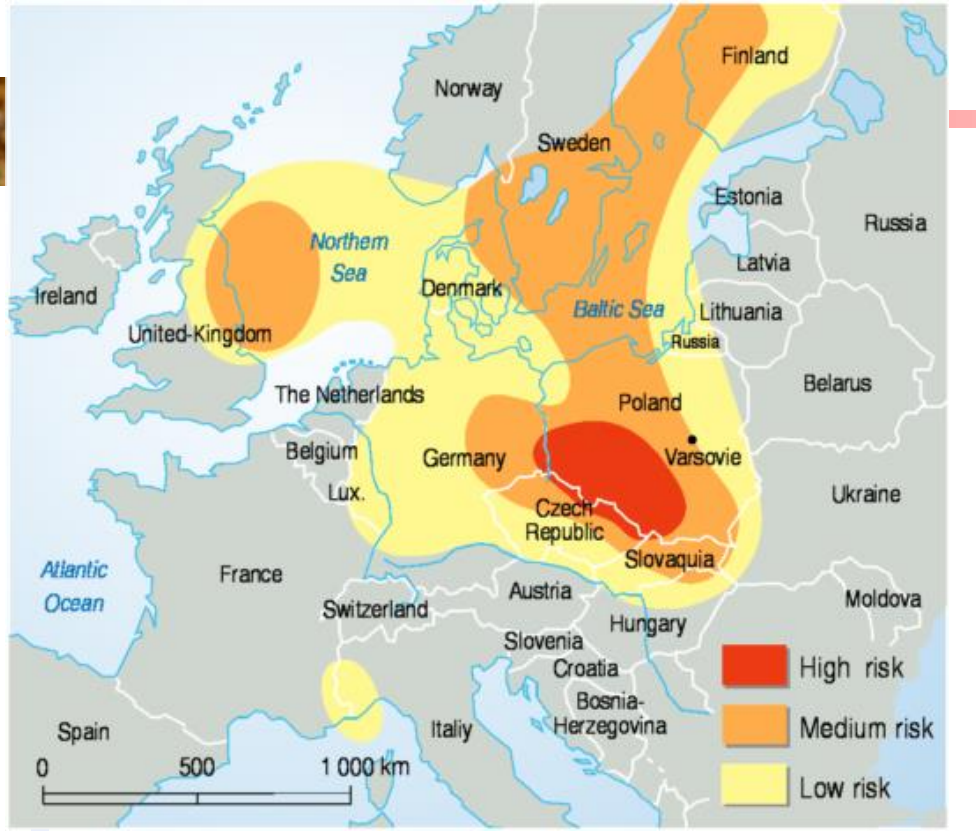
The severe pollution of the New York Bight has been caused by years of waste discharges and dumping. The pie-charts give the proportion of waste elements that ended up in the waterways either from the land or barging of wastes during the 1980s. Thankfully, the dumping of waste has now been banned.

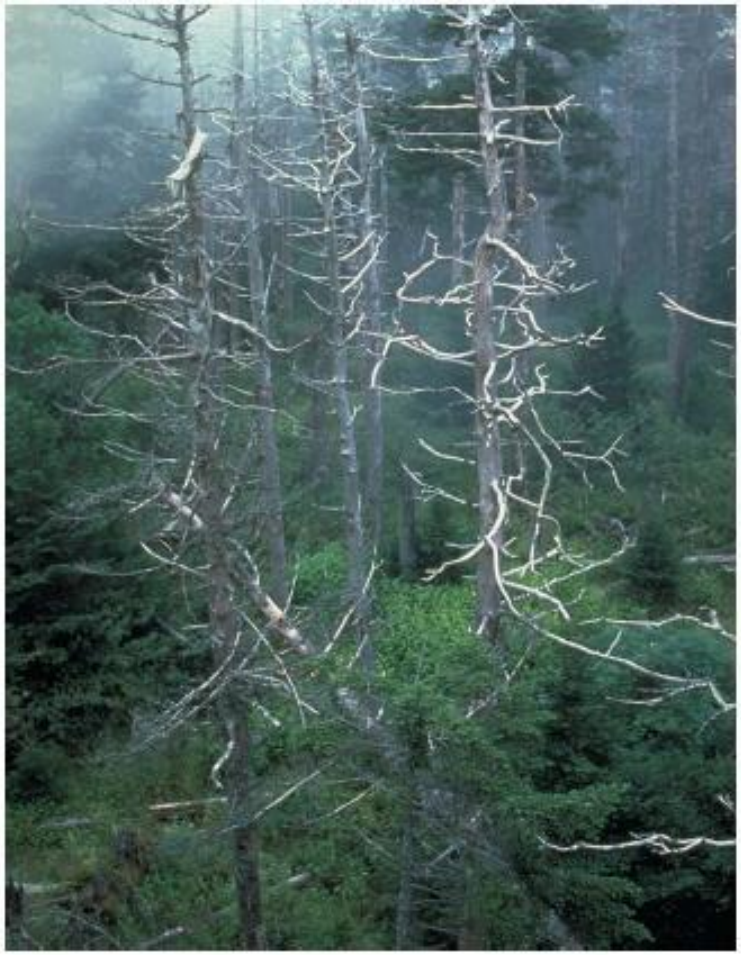


Acid Rain


gases carried
by the wind
acidic gases
(sulphur dioxide and
nitrogen oxides released
into atmosphere)
gases dissolve in
rainwater to form
acid rain
acid rain kills plantlife,
pollutes rivers and streams,
and erodes stonework

Acid Rain


Finland
Norway
Sweden
Estonia
Russia
Northern Sea
Latvia
Ireland
Denmark
Baltic Sea
Lithuania
United-Kingdom
Russia
Belarus
The Netherlands
Poland
Belgium
Germany
Varsovie
Lux.
Ukraine
Czech Republic
Slovaquia
Atlantic Ocean
France
Austria
Moldova
Switzerland
Hungary
Slovenia
Croatia
High risk
Bosnia-Herzegovina
Medium risk
Spain
Italiy
Low risk
0
500
1 000 km

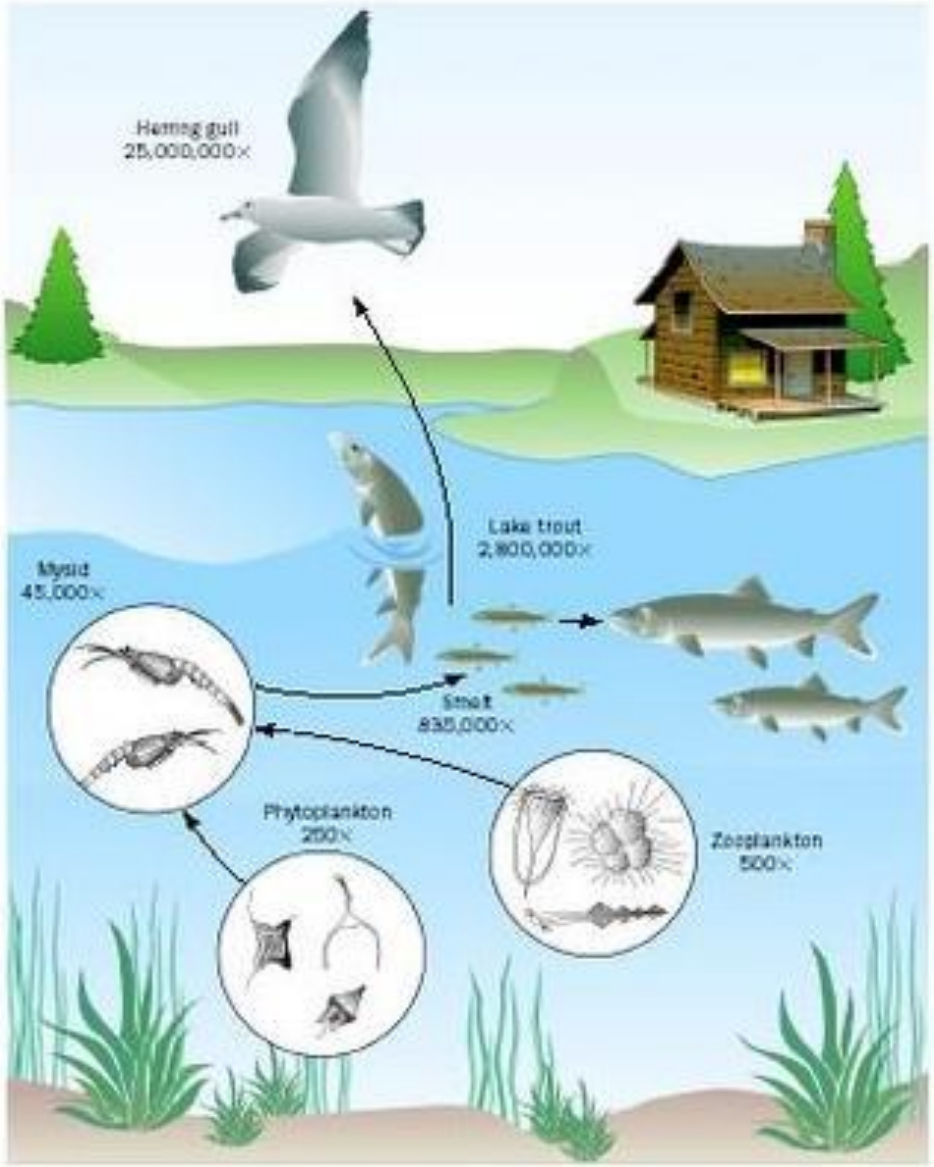


Lluvia ácida

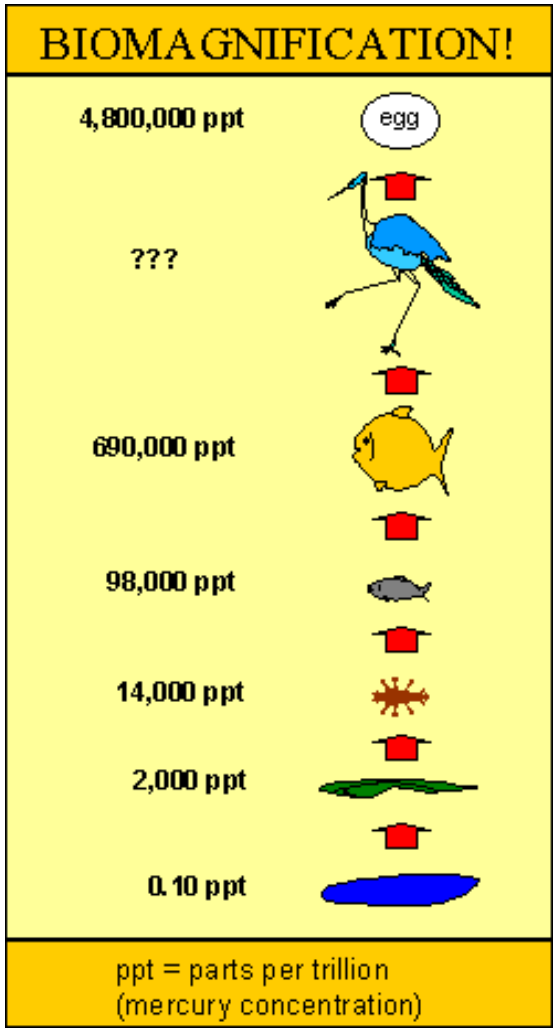
Use of Agrochemicals

Use of Agrochemicals

Eutrophication

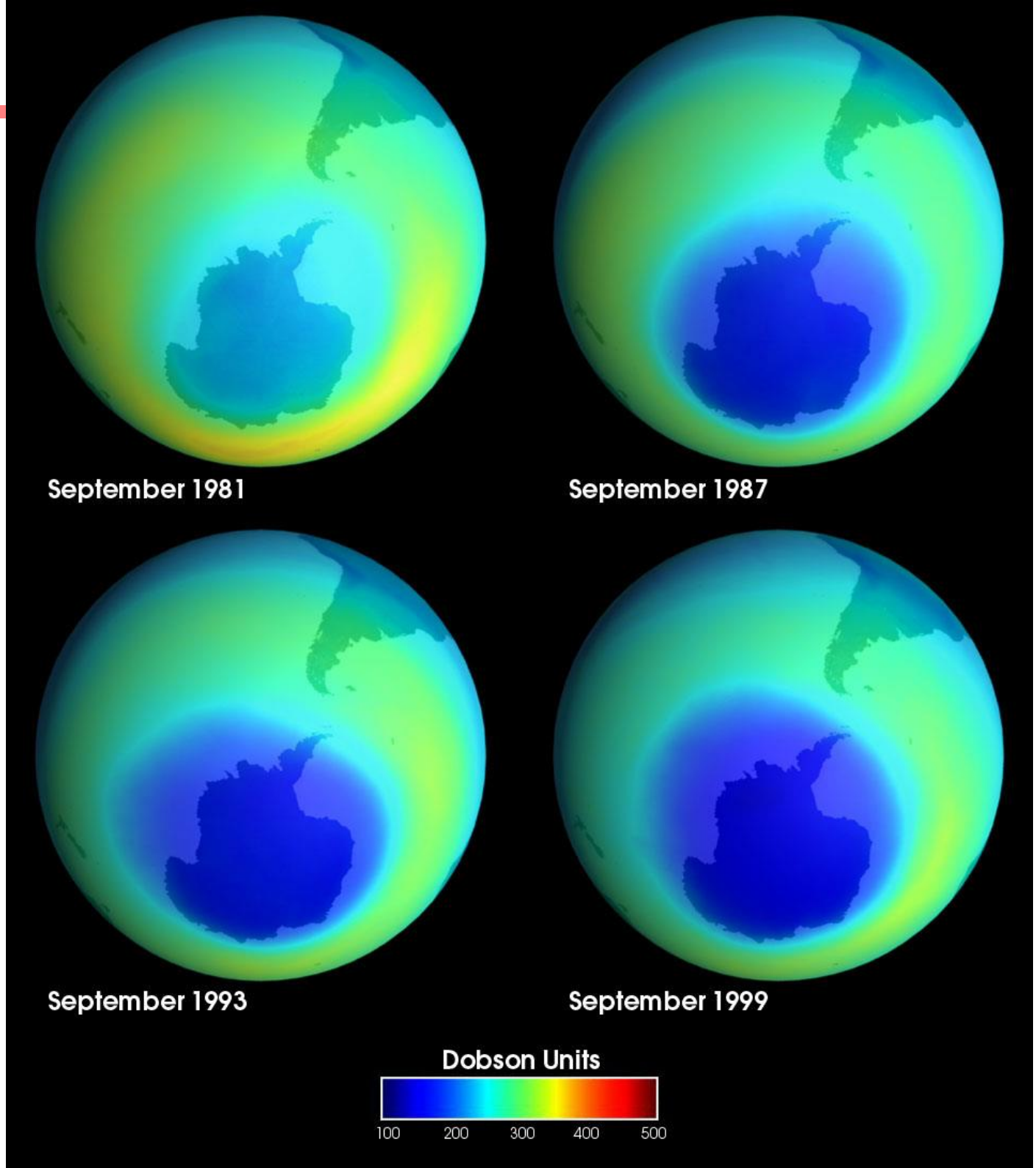


Bioacumulation

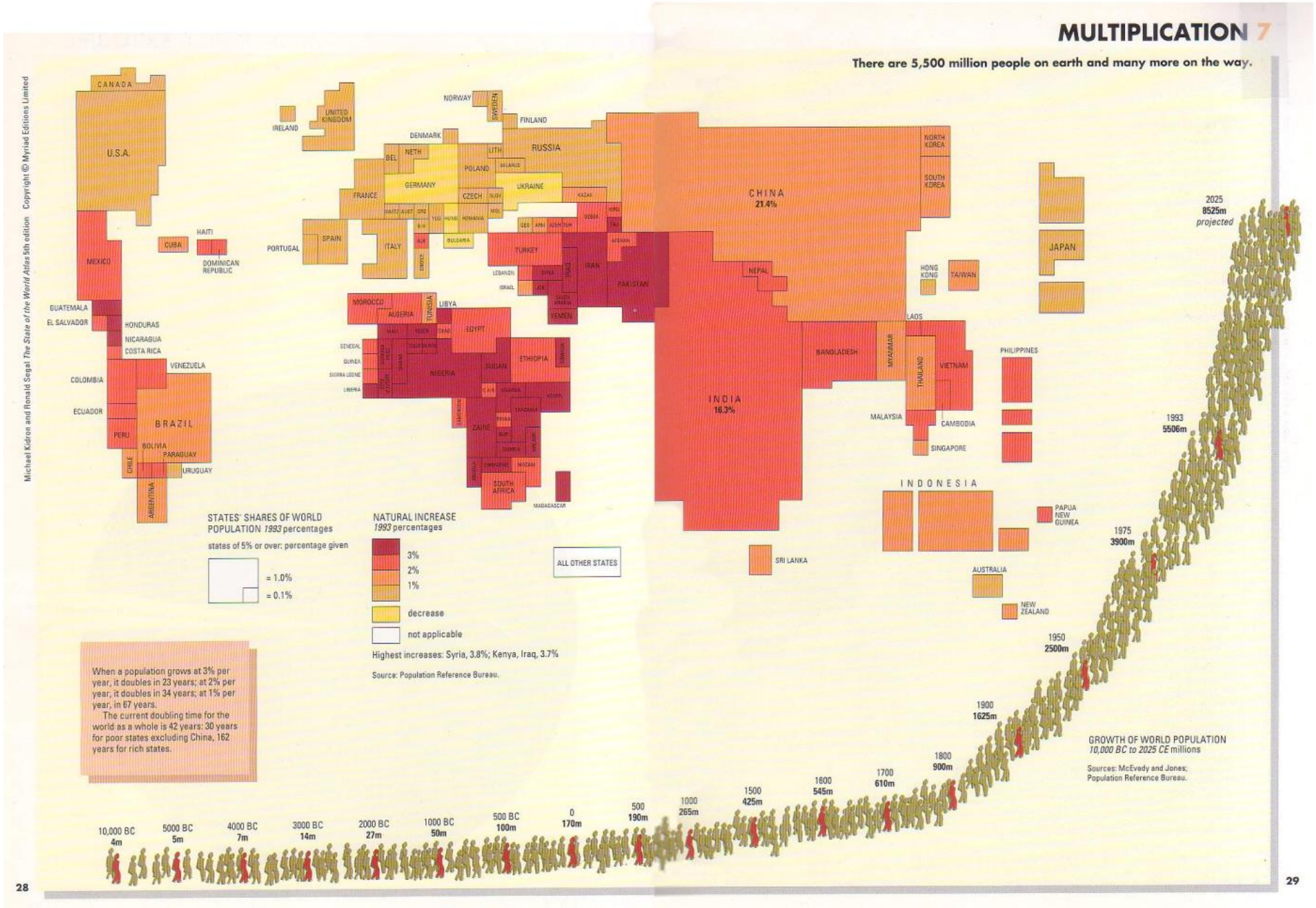


Atmospheric Pollution

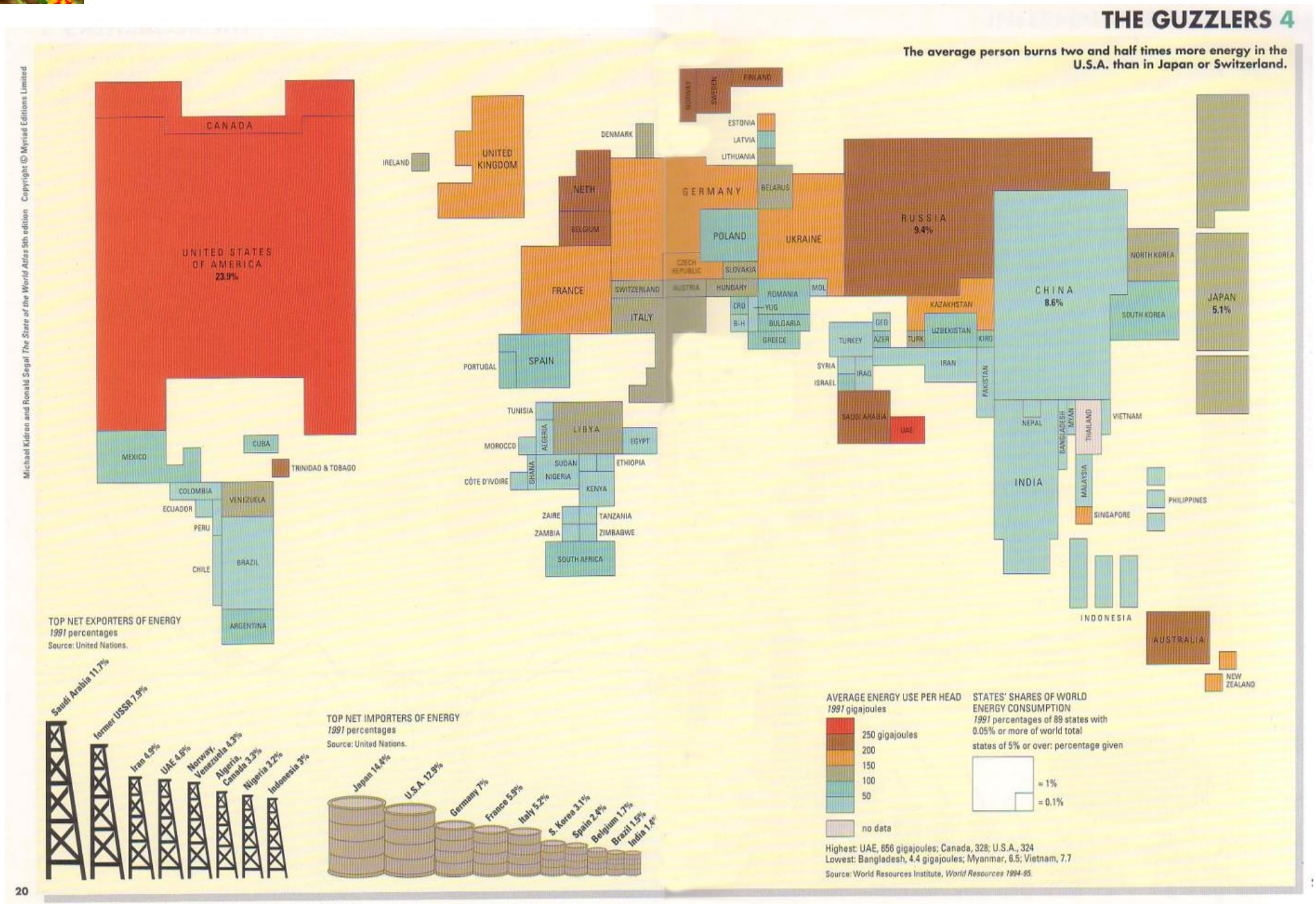
Ozone layer depletion



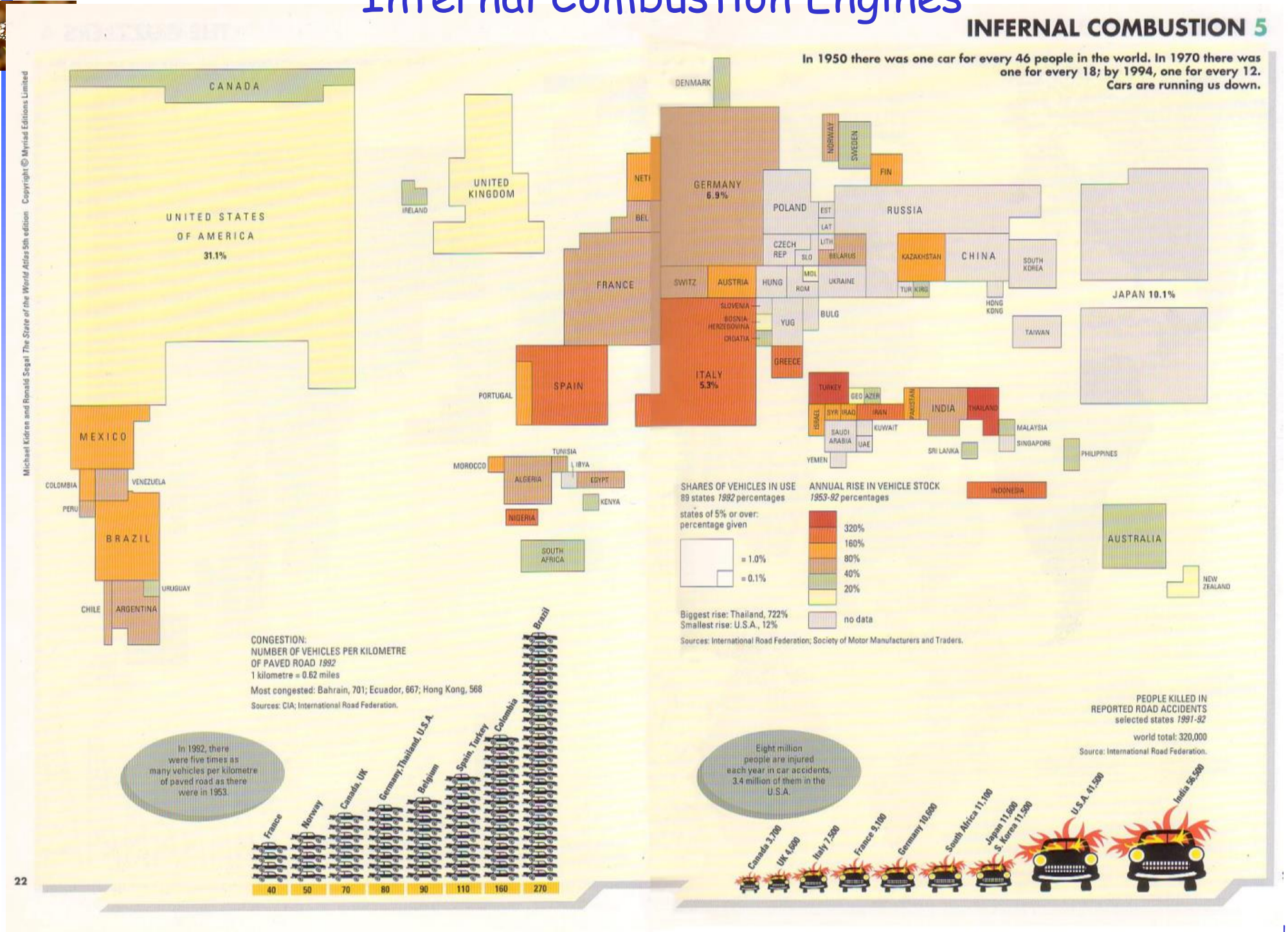
Population Growth



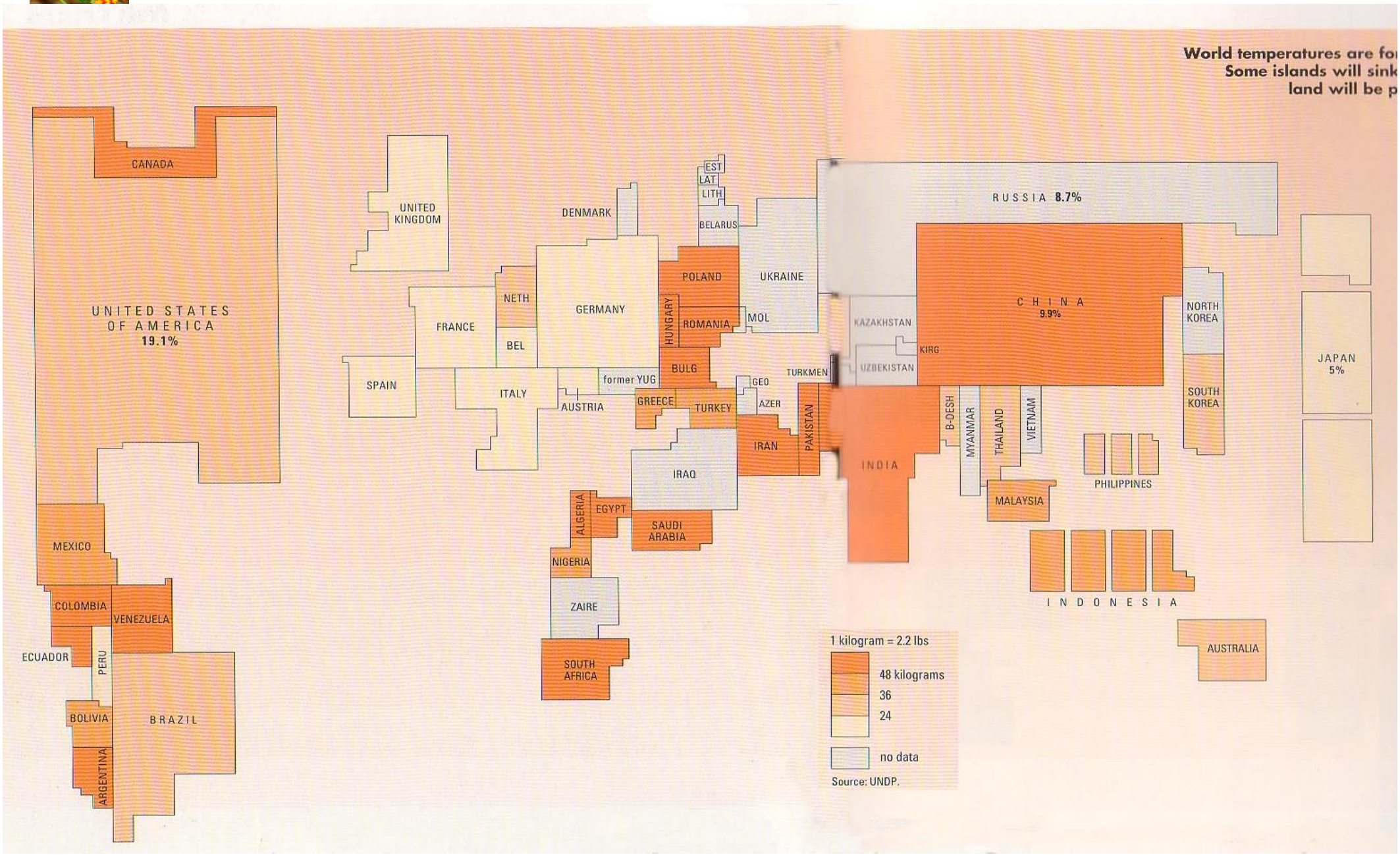
Fossil Fuels Consumption



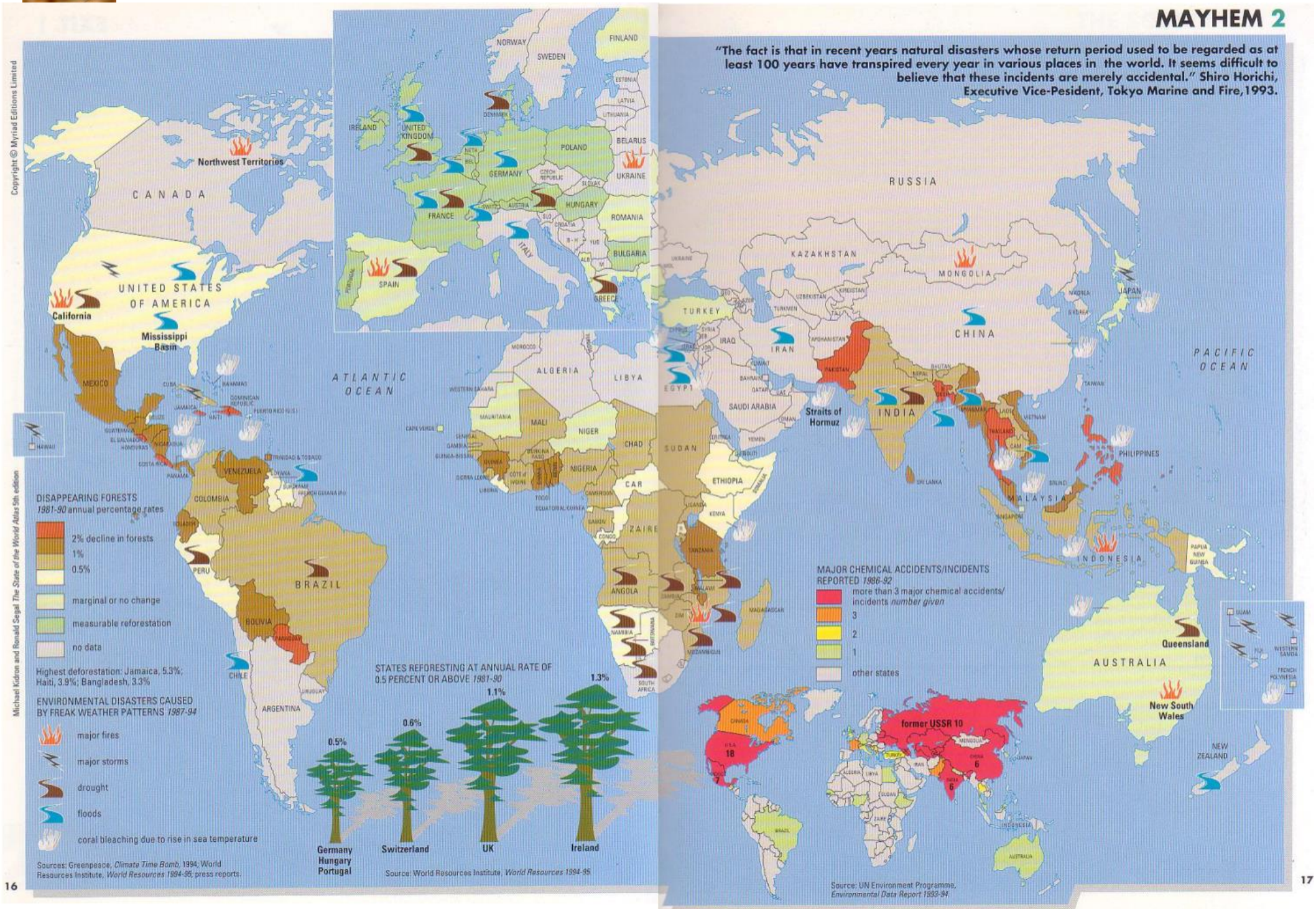
Internal Combustion Engines



Global Warming



Natural Risks



Poor environmental management leads to violent conflict and the brink of collapse.

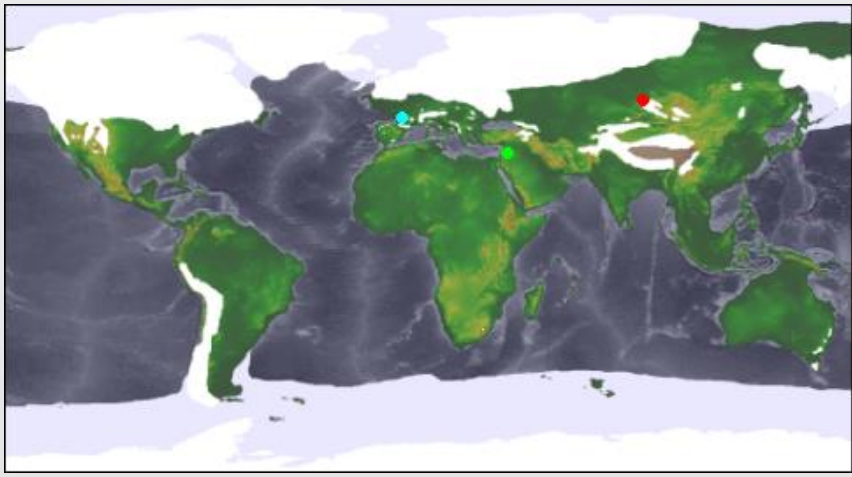
J. Diamond

¿Climate Change?

The earth will not continue to offer its harvest, except with faithful stewardship. We cannot say we love the land and then take steps to destroy it for use by future generations.

John Paul II

Some definitions



- ‘Climate’ it refers to long-term atmospheric conditions.
- ‘Weather’ refers to short-term weather conditions that vary in a short period of time.
- Changes in climate are natural, during the last glaciation (occurred 11,500 years ago), global temperatures were 5 ° C lower than they are today.
- We are experiencing unprecedented changes (increases) in temperature in recent times.
- There is a consensus among scientists that this change is due to human activities.

Some definitions

Both, weather and climate are affected by many factors; in particular, climate is affected by:

Abiotic factors

Latitude

Altitude

Ocean currents

Topography

Solar radiation

Evaporation

Orbital variations

Volcanic activity

Biotic factors

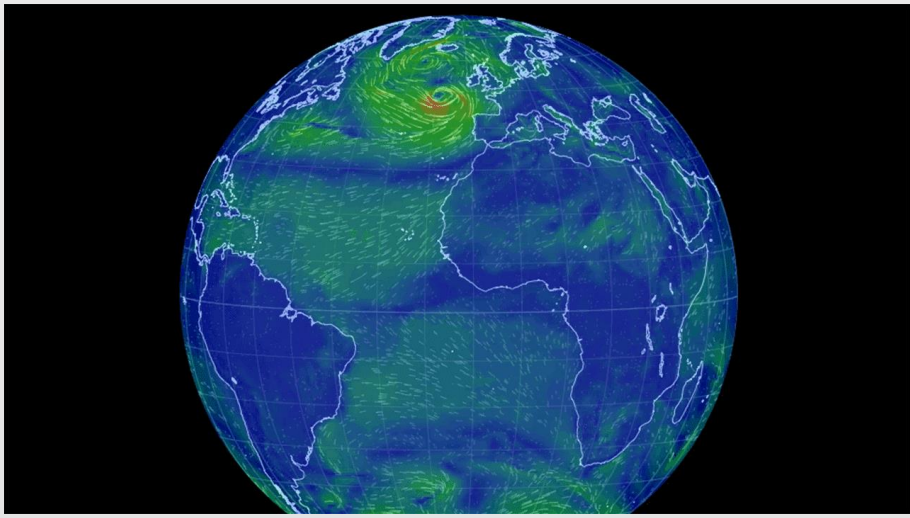
Transpiration

Respiration

Photosynthesis

Decomposition

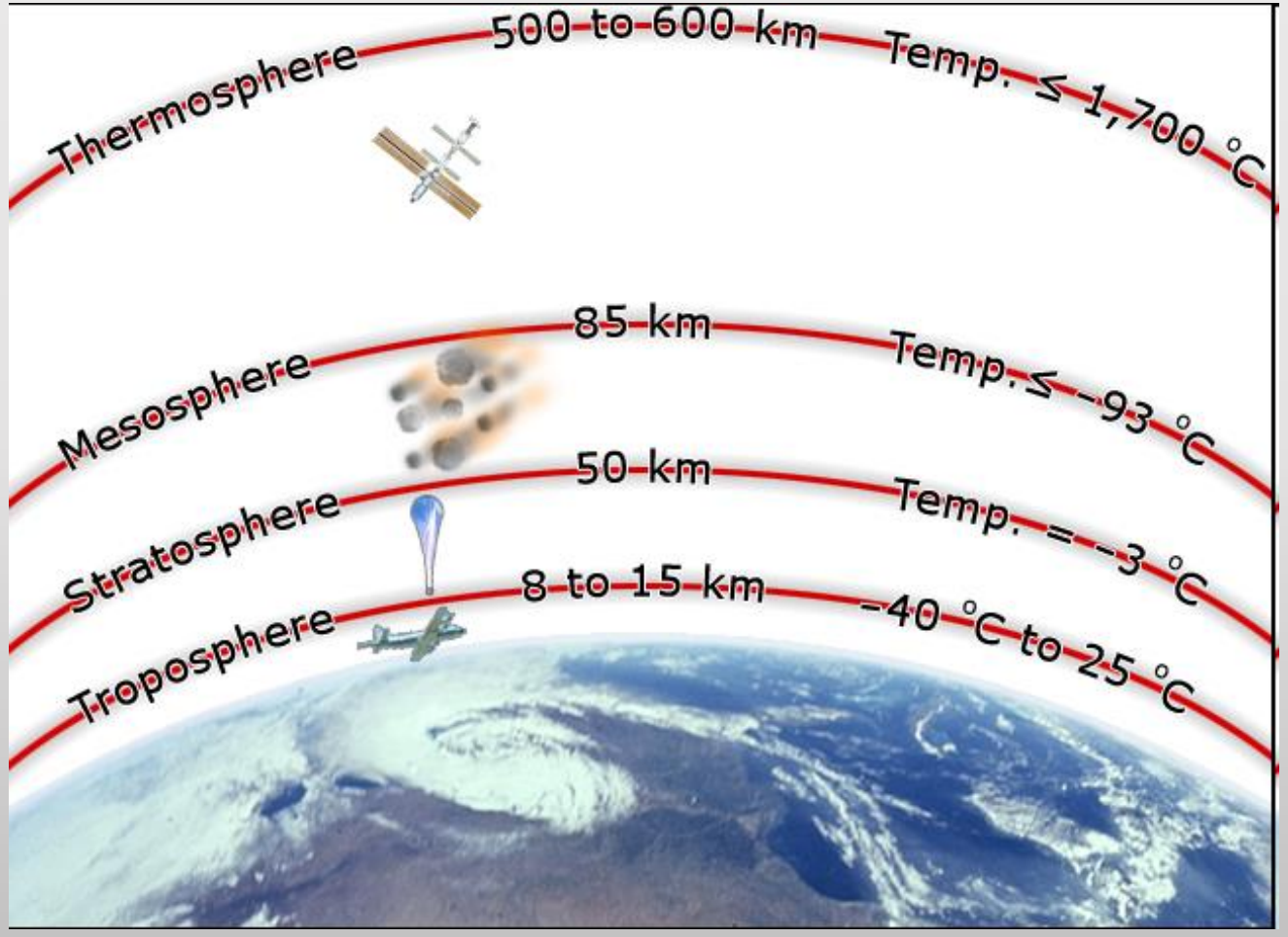
Digestion



https://gifer.com/en/Bj4h

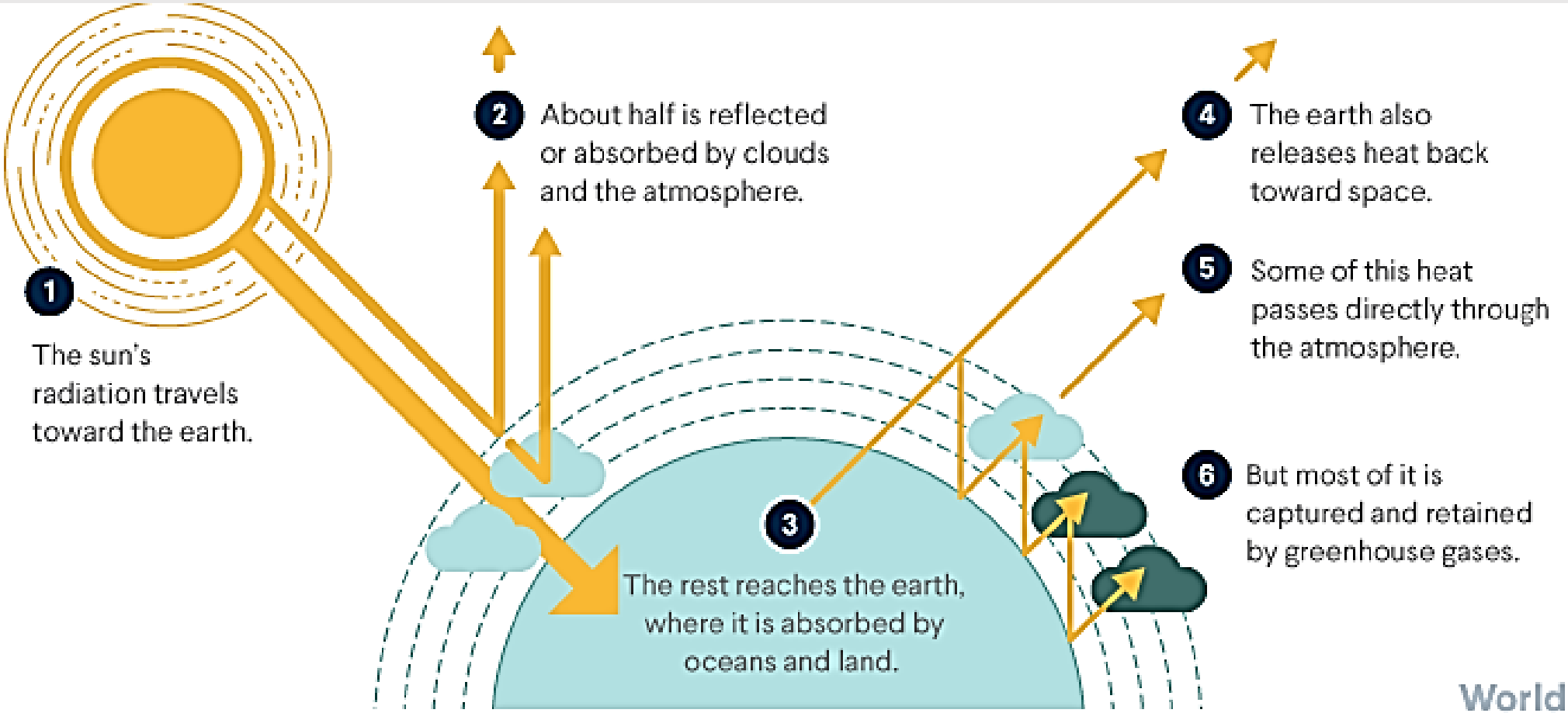
http://clipart-library.com/clipart/BTgraAXec.htm

Earth’s atmosphere: temperature ranges



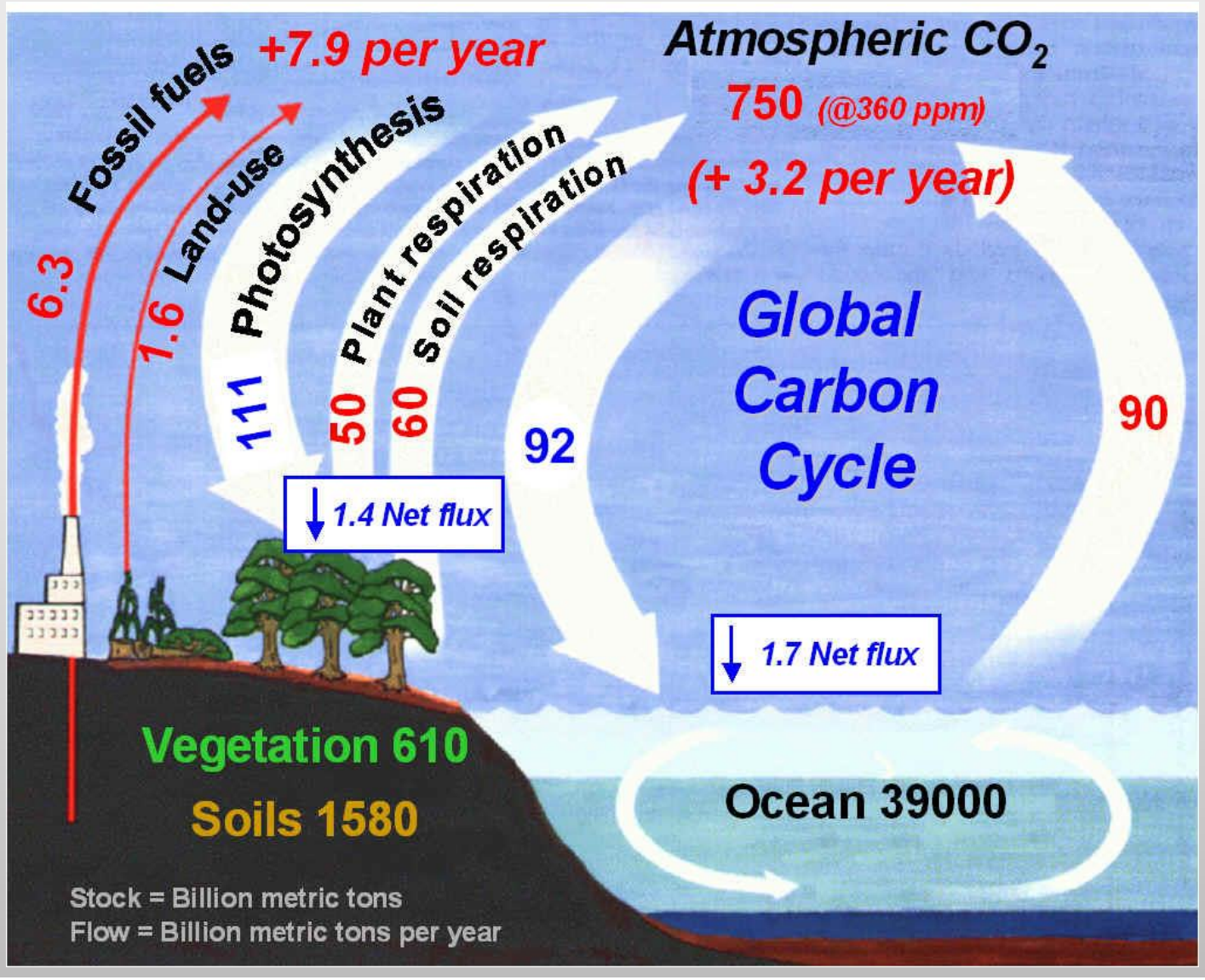
http://www.space.gc.ca/asc/img/spacesuit_2_2_2_A.jpg

Greenhouse effect



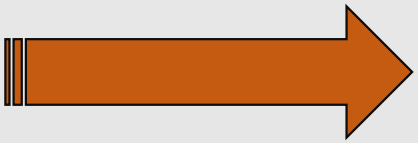
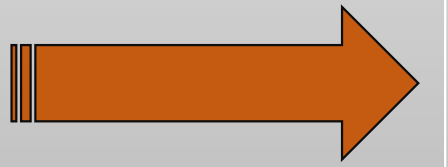
https://world101.cfr.org/climate-change/greenhouse-effect

Greenhouse effect



http://www.globalchange.umich.edu

Green House Gasses (GHG)

Carbon dioxide (CO_2)		Burning of coal, generation of energy by burning oil and gas, transport and air conditioning of buildings.
Nitrogen oxide (N_2O) Methane (CH_4)		Sanitary landfills, agriculture and livestock digestion.
Methane (CH_4)		Decomposition of organic matter (rice fields, wetlands, digestion of ruminants, forest fires, microbial activity in wastewater).
Hydrofluorocarbons (HFCs) Perfluorocarbons (PFCs) Sulfur hexafluoride (SF6)		Used in refrigeration systems, air conditioners and other industrial activities.

Why is the balance important?

With no greenhouse gases in the atmosphere, scientist estimate that Earth's average atmospheric temperature would be about -18°C

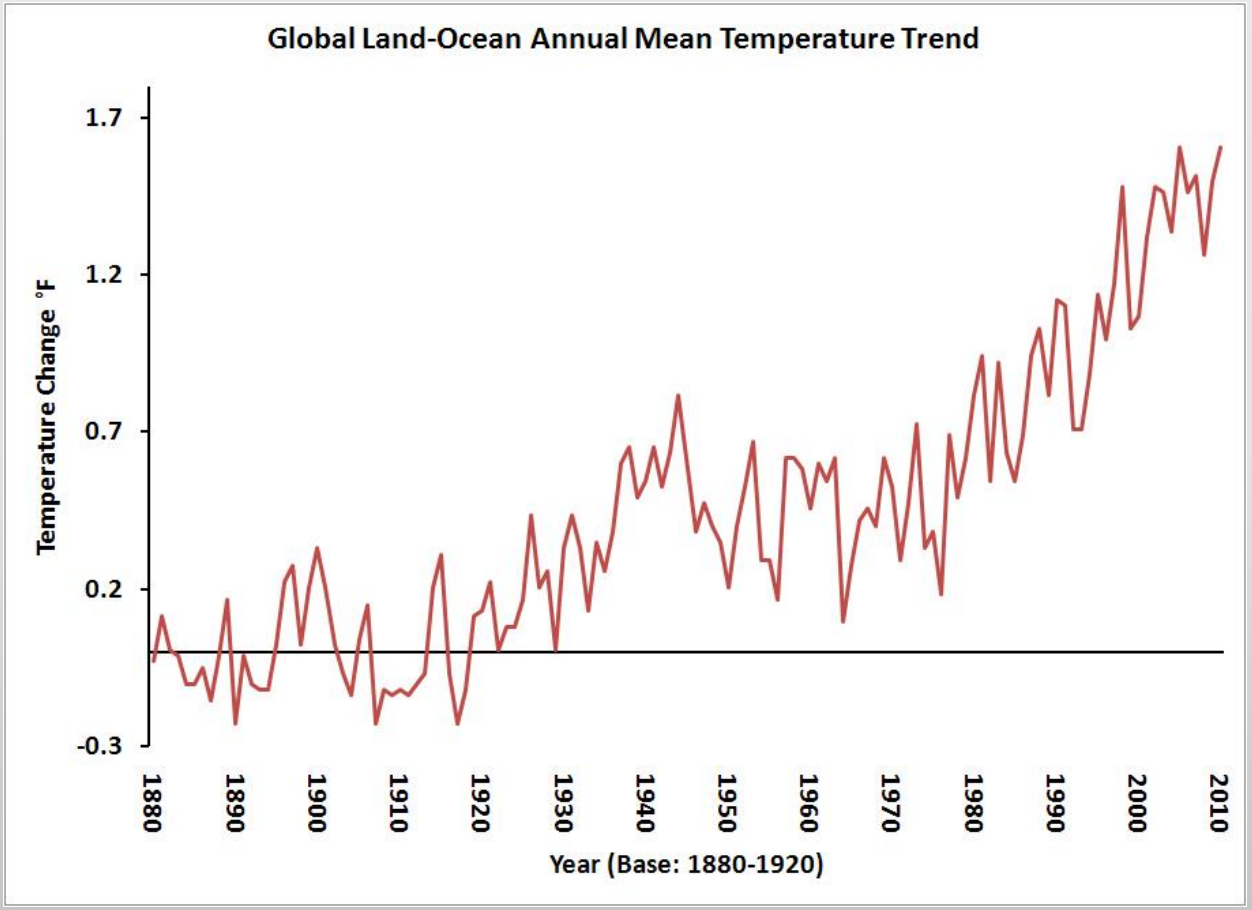
http://www.lifeboxset.com/nota/181766/hands-off-the-antartic-es-la-cancion-que-thom-yorke-escribio-para-apoyar-a-greenpeace-y-la-antartida/

http://justfunfacts.com/interesting-facts-about-the-arctic/

Too much GHG

Planet Venus

Some relevant data

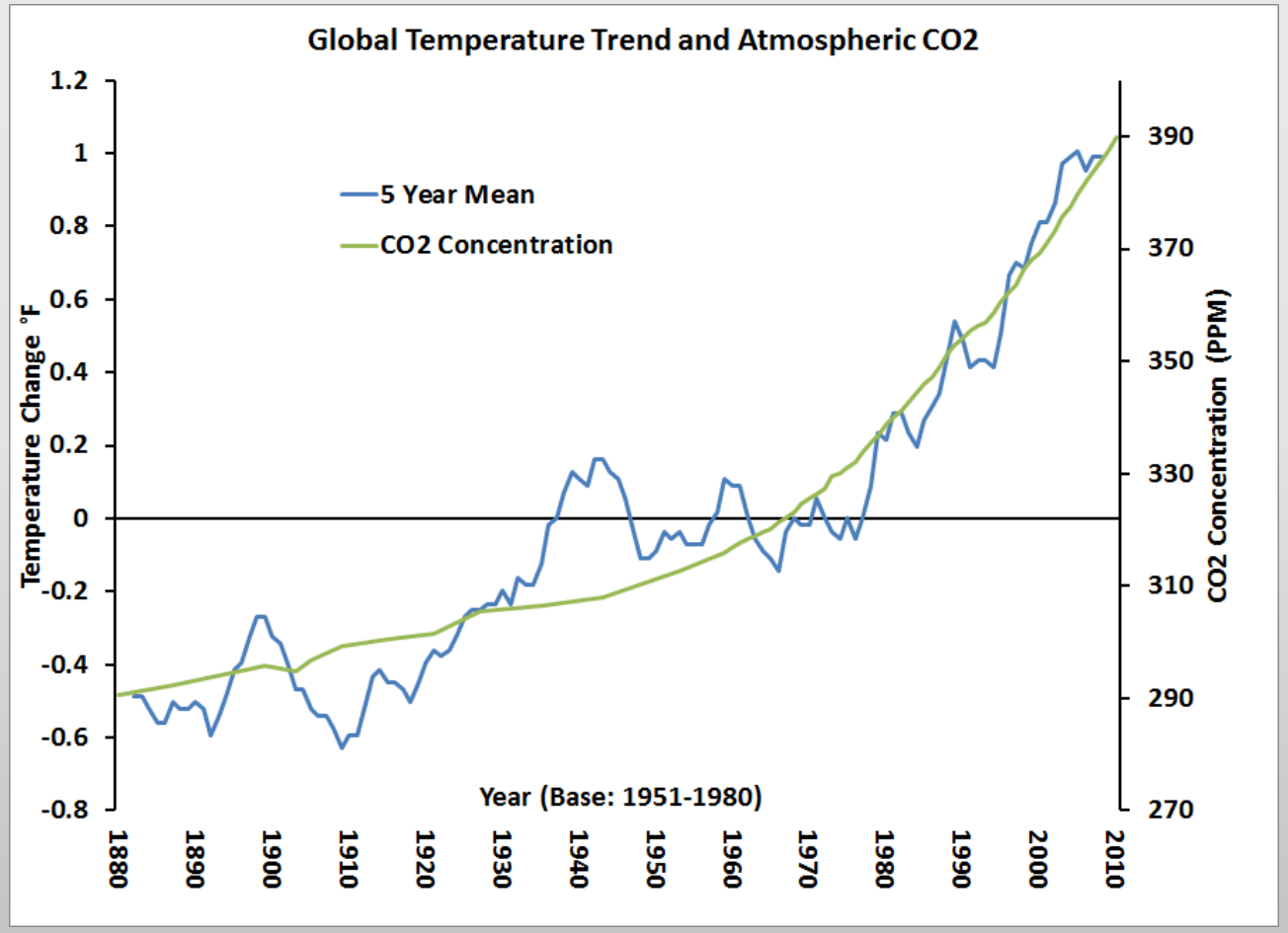


The global average surface temperature fluctuates over time, but recently it has increased dramatically. From 1920 to the present, the Earth's average surface temperature has increased by around 1.4 °F. The current warming trend is proceeding at a rate that is unprecedented in at least the past 1,300 years. (IPCC AR4)

The sharpest rise occurred between 1975 and 2010, when temperature rose steadily by over 1 °F. The graph below holds 1880-1920 as the baseline climate period and temperatures are expressed as the difference from that era.

http://www.c2es.org/facts-figures/trends

Some relevant data

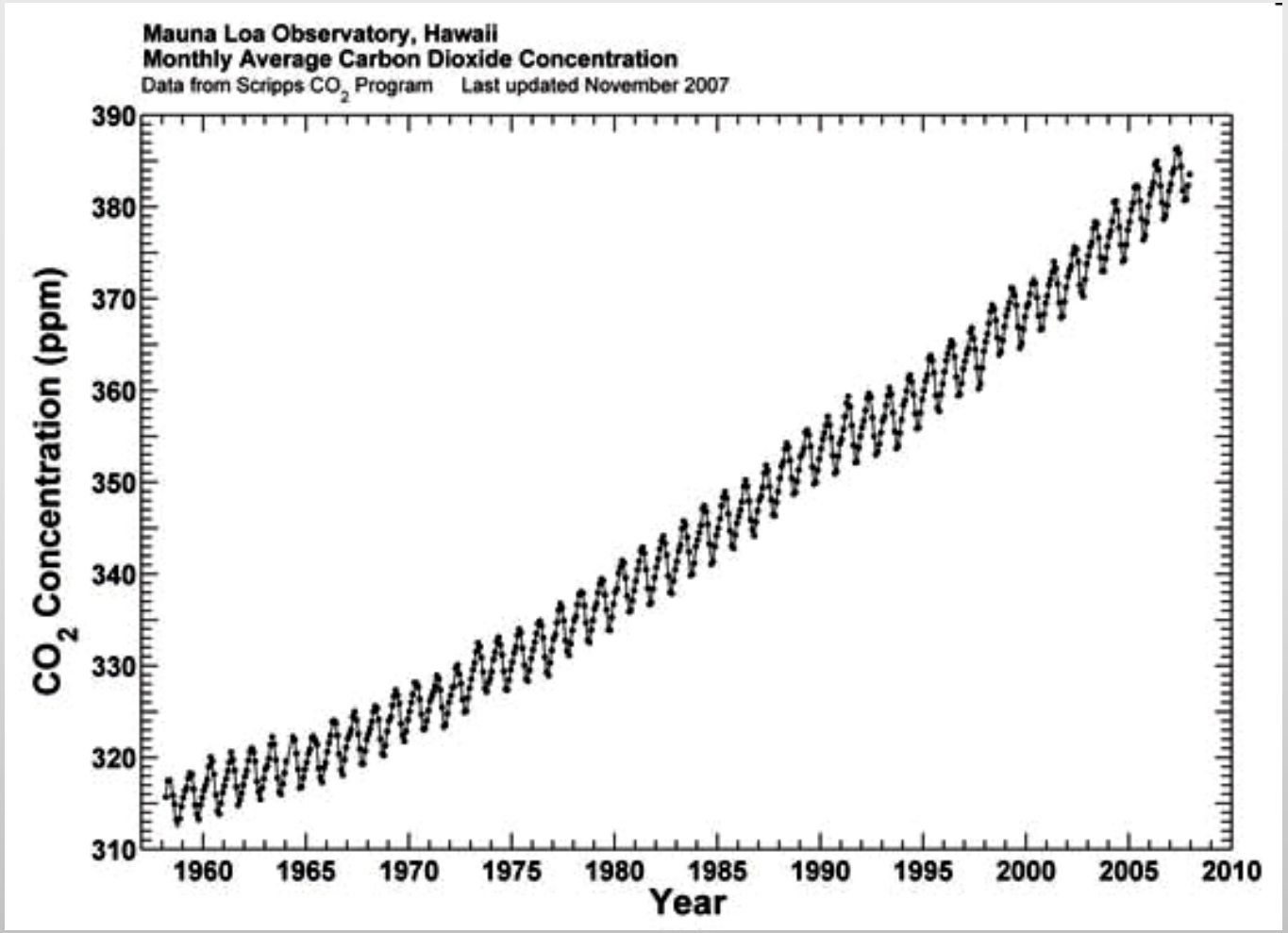


The recent increase in concentration of carbon dioxide in the atmosphere is the result of human activities, mainly the burning of fossil fuels. As the concentration of CO_2 in the atmosphere has increased, so has the average surface temperature of the Earth.

The relationship between atmospheric CO_2 concentration and surface temperature is shown here for the past 130 years.

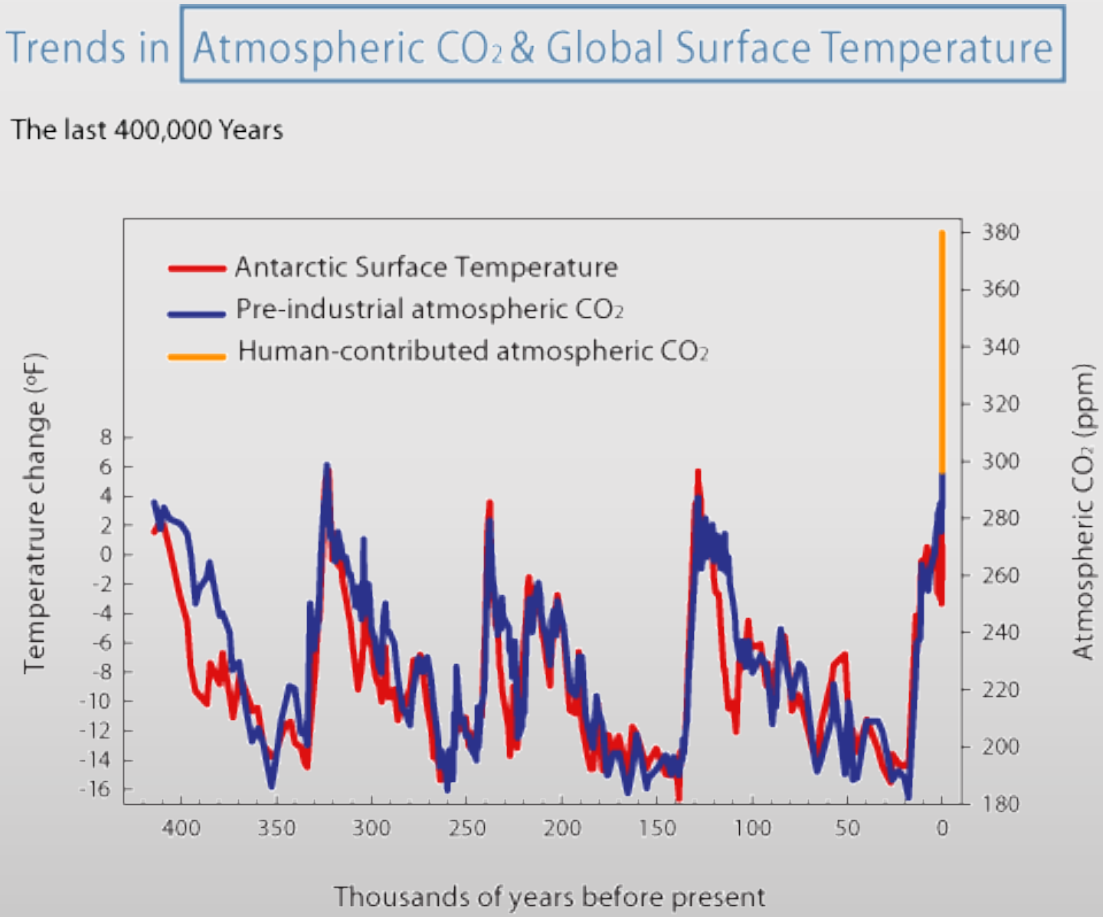
http://www.c2es.org/facts-figures/trends

Some relevant data



Mauna Loa Observations of recent increases on atmospheric CO_2.
Note the trend of increasing concentration, and the effect of the seasonal changes of CO_2 assimilation by hemispheric vegetation.

http://www.c2es.org/facts-figures/trends



Some relevant data

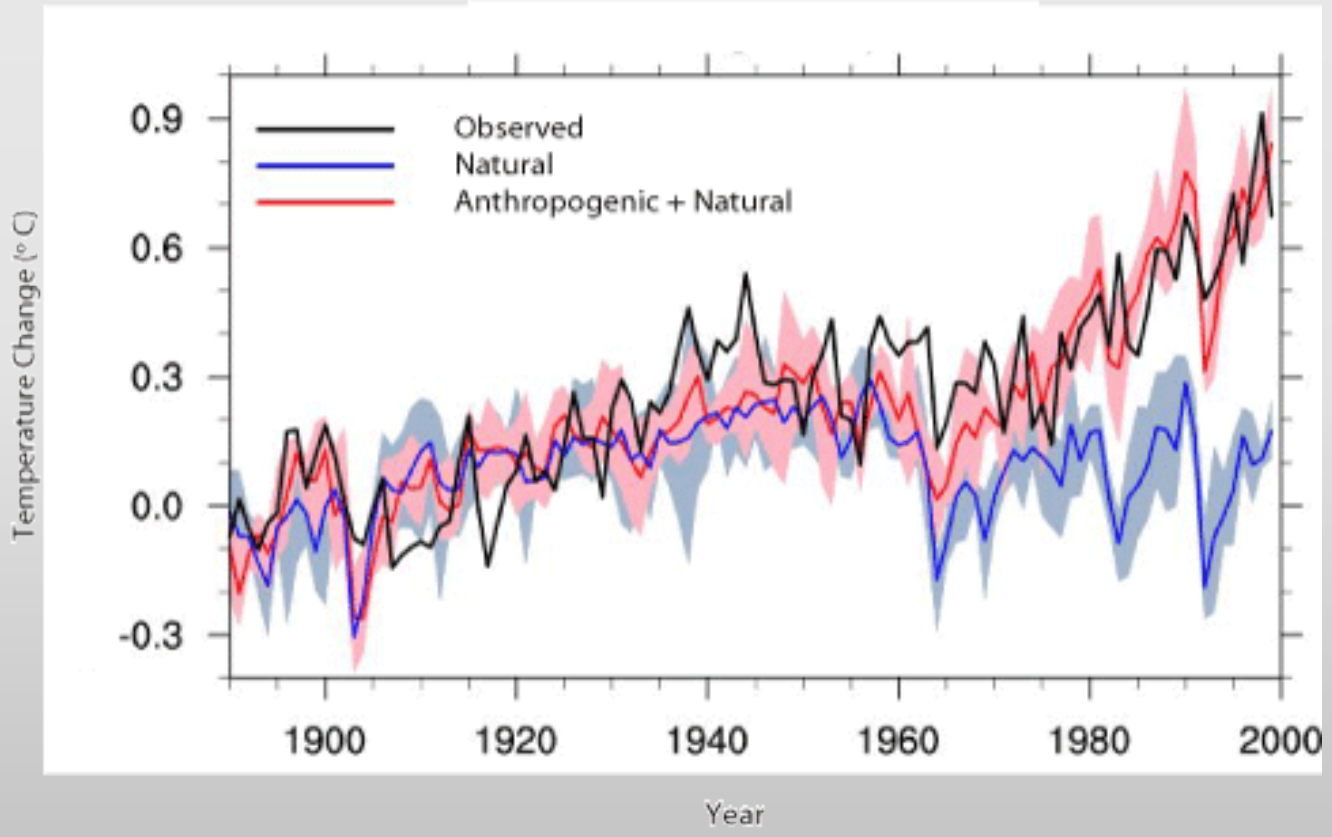
Throughout the millennia, there has been a clear correlation between carbon dioxide levels and average global surface temperatures. This provides strong evidence that CO_2 is a major driver of global temperatures. Scientists say the world is entering largely uncharted territory as atmospheric levels of greenhouse gases continue to rise. Today's carbon dioxide levels are substantially higher than anything that has occurred for more than 400,000 years.

http://www.c2es.org/facts-figures/trends

Some relevant data

Comparison of Modeled and Observed Temperature

1890 - 2000

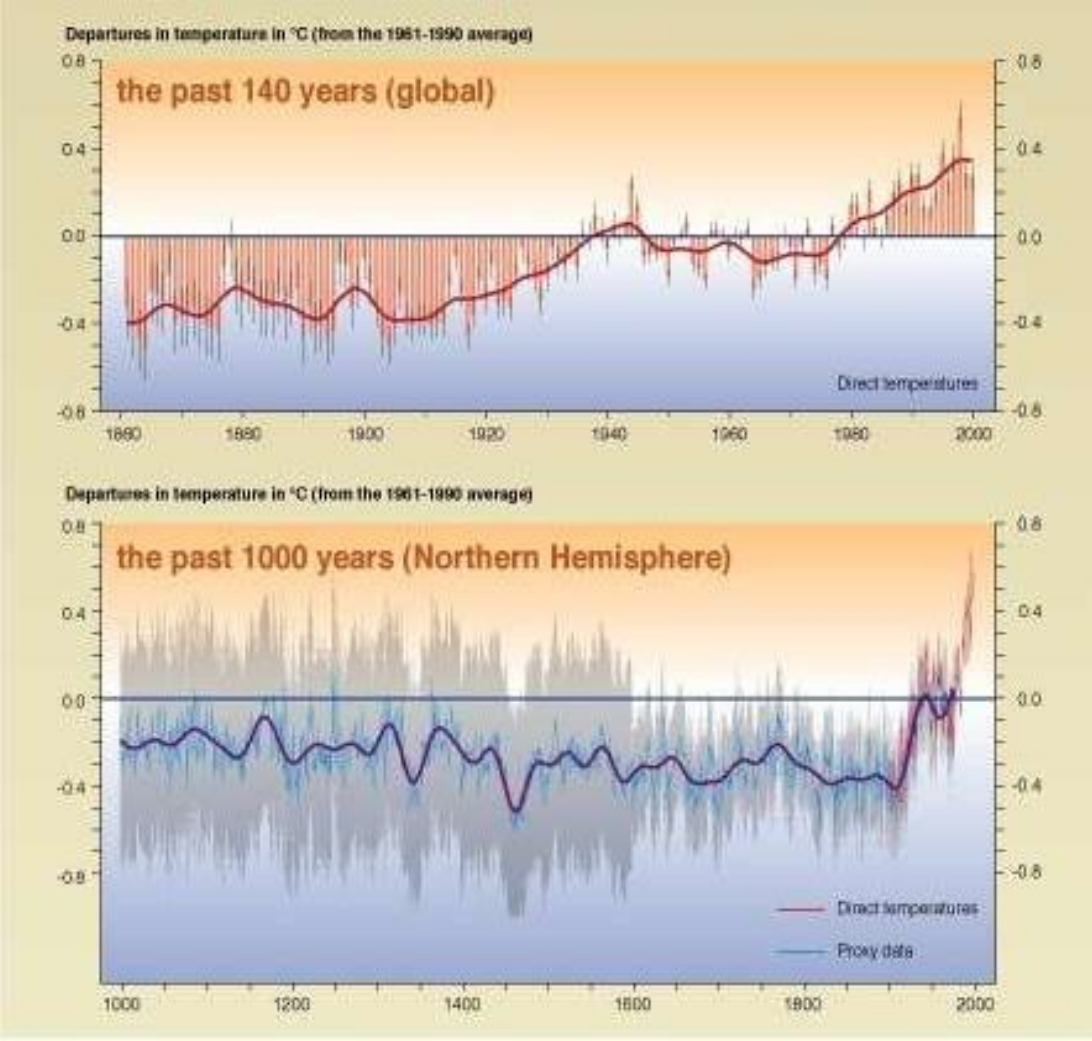


Graph Source: Meehl, G. A., W. M. Washington, C. M. Ammann, J. M. Arblaster, T. M. L. Wigley, and C. Tebaldi. 2004.

http://www.c2es.org/facts-figures/trends

Comparison of the Earth's past temperature variations (shown by the black line) with computer model simulations of past temperature variations (shown by the red and blue lines) in order to determine whether the major changes in temperature were caused by natural or human-caused factors

Temperature

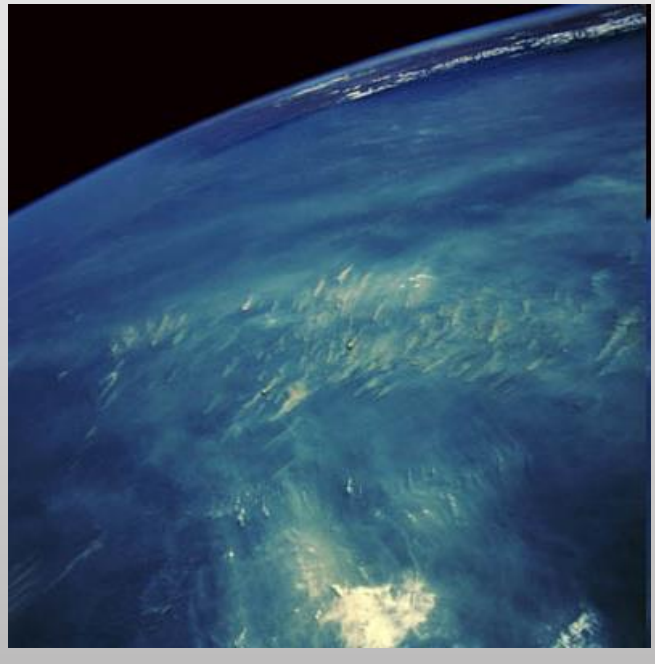


Variations of temperature of the surface of the planet in the last 140 years

Variations of temperature of the surface of the Northern hemisphere in the last 1,000 years

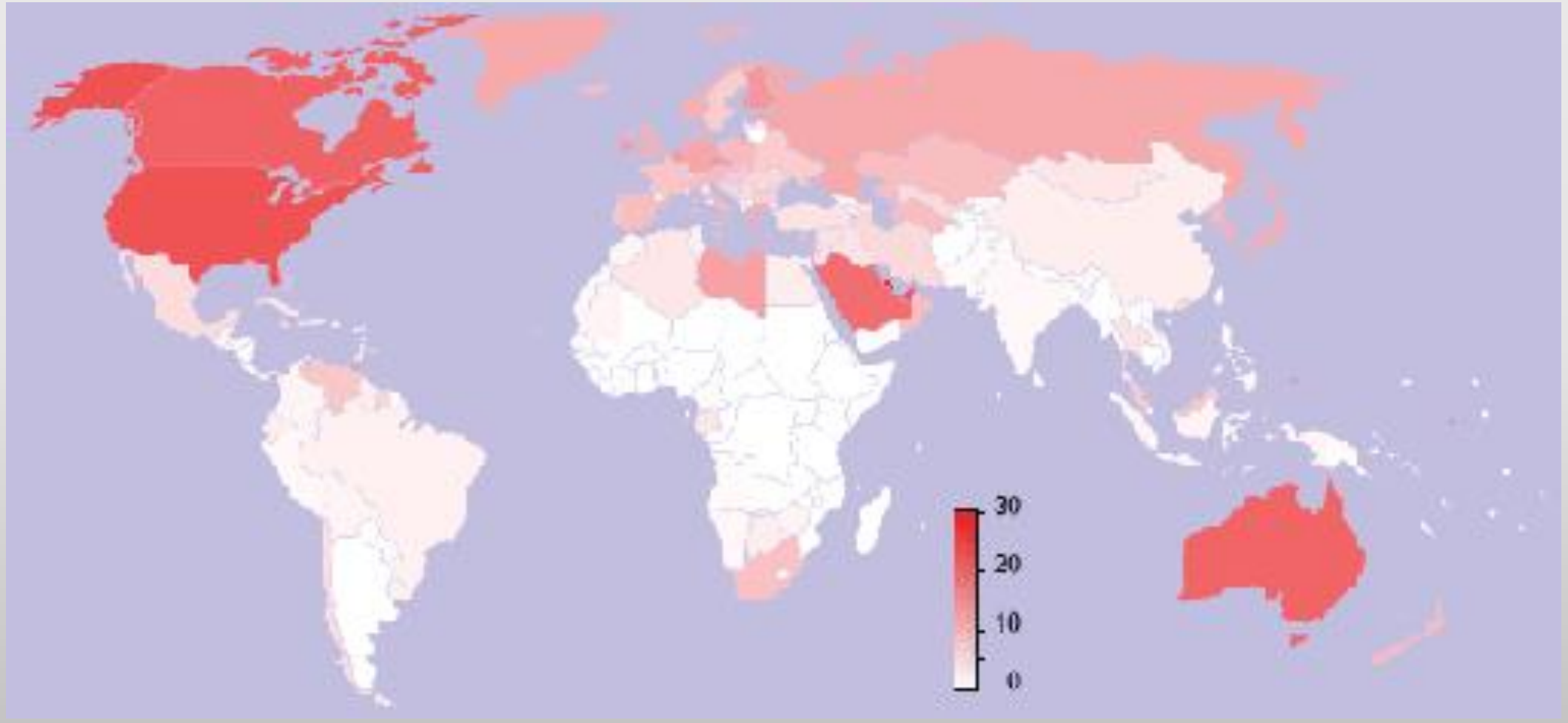
http://www.global-greenhouse-warming.com/climate.html

CO_2 Emissions



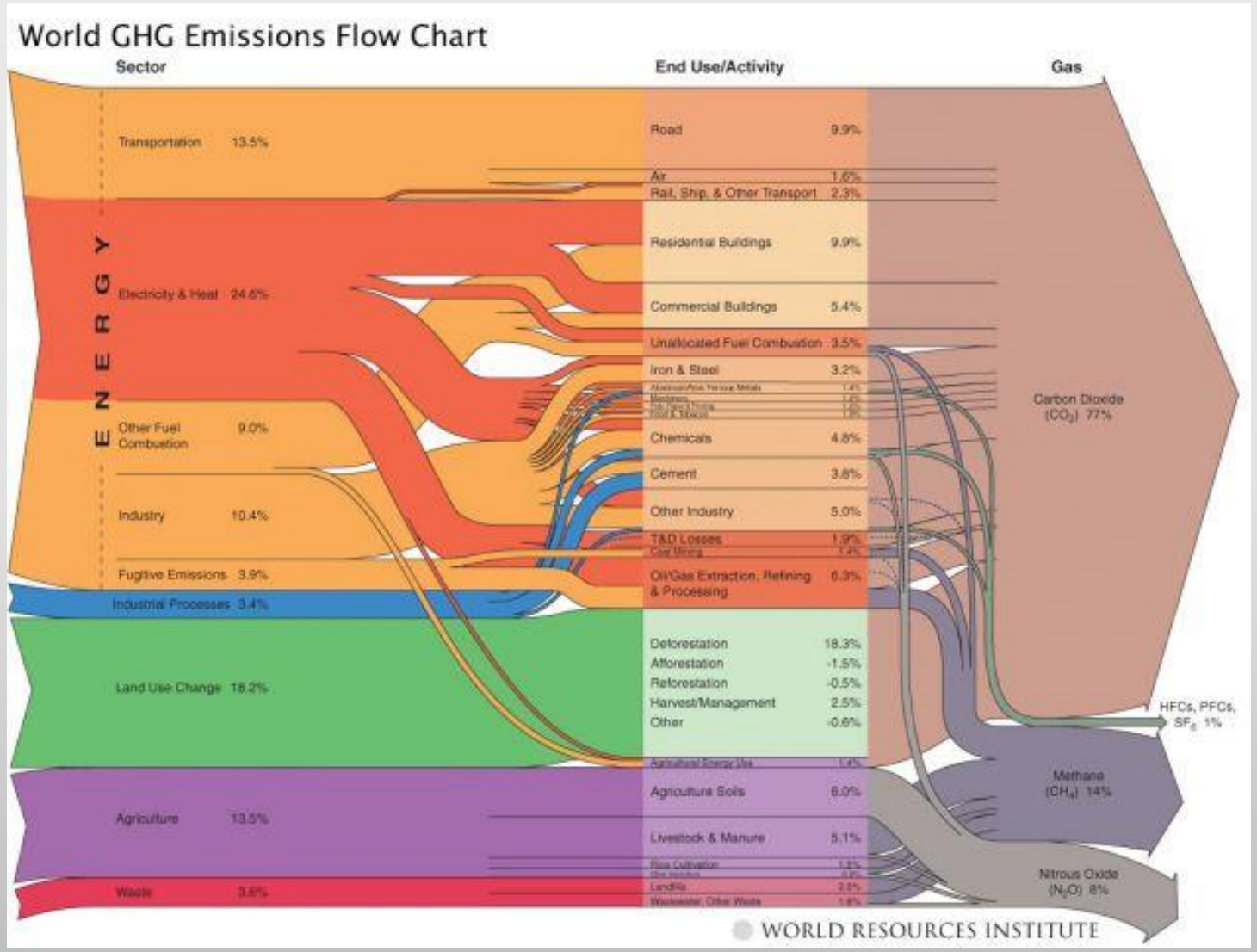
http://www.eco-logic-systems.com/ELS/images/Amazon_burning.jpg
http://www.nasaimages.org/luna/servlet/detail/nasaNAS~10~10~68377~173316:Fires-in-Central-South-America

CO_2 Emissions (Tons per capita per annum)



http://www.global-greenhouse-warming.com/greenhouse-gas.html

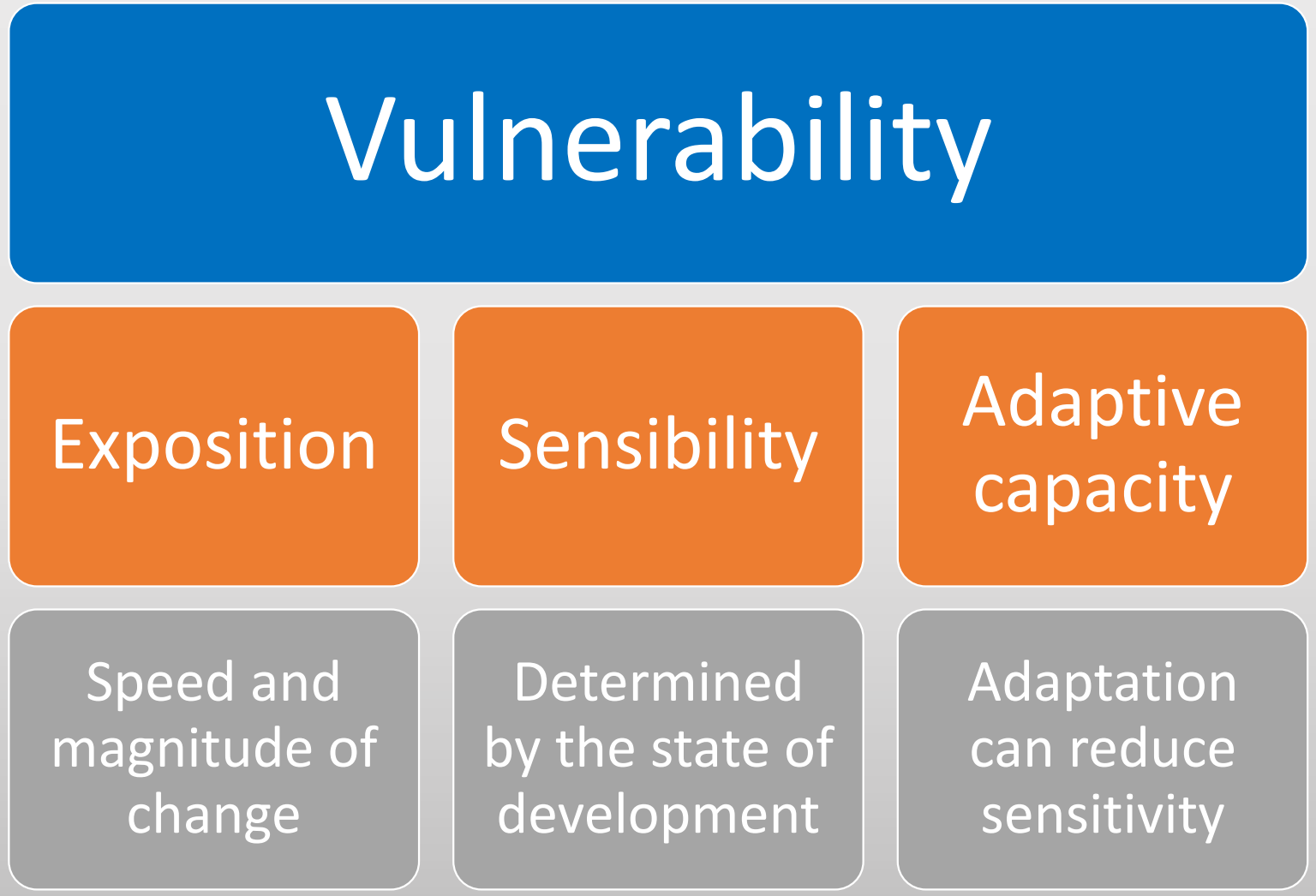
Where do they come from?



https://www.wri.org/resources/charts-graphs/world-greenhouse-gas-emissions-2000

Vulnerability

Degree to which systems are susceptible to adverse impacts and unable to cope.


Vulnerability
Exposition
Sensibility
Adaptive capacity
Speed and magnitude of change
Determined by the state of development
Adaptation can reduce sensitivity

What is expected from climate change?

Changes	Confidence in the projected changes
Temperature increase	Highly probable
Changes in the rainfall patterns	Highly probable
More intense rainfall events	Probable
Increase in hurricane intensity	Probable
Increase in dry summer conditions with the risk of long intense droughts	Probable

https://inhabitat.com/mit-engineers-devise-algorithm-to-identify-warning-signs-of-extreme-weather-events/
https://www.sciencenews.org/article/these-weather-events-turned-extreme-thanks-human-driven-climate-change
https://www.ecowatch.com/scientists-find-extreme-weather-events-fueled-by-climate-change-1881957644.html

Risk is the combination of a threat (climate change) and vulnerability. The recent history shows that we are very vulnerable to extreme weather conditions

Threat
Natural processes
Probability that an event occurs in time and space, with sufficient intensity

Vulnerability
Degree of exposition and fragility, economic value
Probability that, due to the intensity of the event and the fragility of the exposed elements, will damage the economy, human life and the environment

Risk
f(tv)
Combined probability of the occurrence of both Threat and Vulnerability

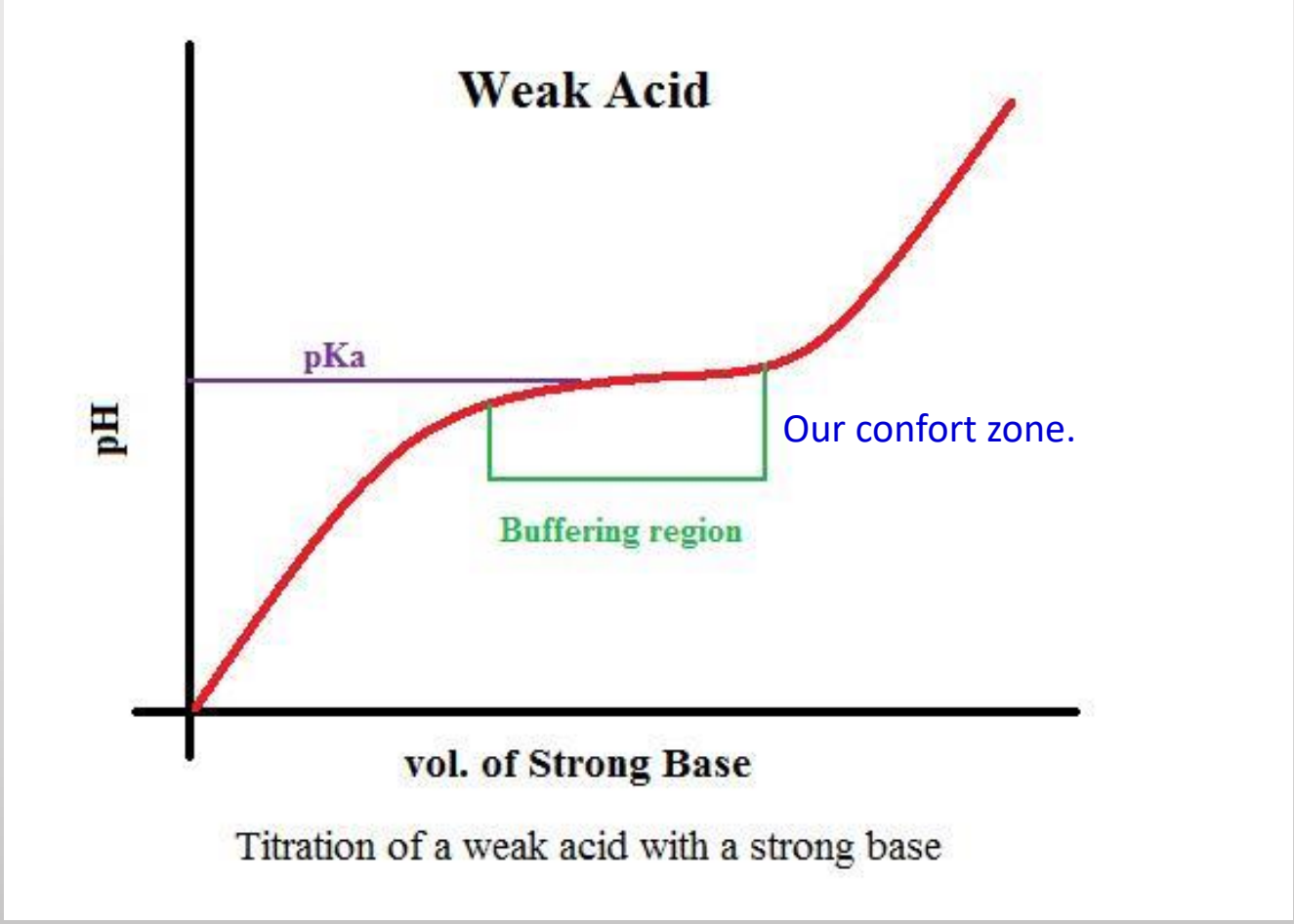
Who is vulnerable to climate change?

Who?	To what?	Why?
Agriculture	Droughts and flooding	Dry land agriculture, eroded soils, scarce economic supports
Urban populations	Heat waves, water availability	Aging of the population, water deficit
Ecosystems	Climate change, wildfires, pests	Slash and burn agriculture, deforestation, desertification
Coastal areas	Increase in sea level, hurricanes	Coastal urbanization, poor planning
Tourism	Hurricanes	Changes in beaches

Sector	Event	Impact
Forests	Drought 1997-1998	New record of wildfires
Water	Dry period during the 90's	Water conflicts in the northern border
Agriculture	Delay of rains during 2005	Lost of agricultural revenue (13%)
Tourism	Hurricanes Stan & William in 2005	Economic losses estimated in around 30,000 million pesos

https://www.google.com/search?q=extreme+weather+events&source=lnms&tbm=isch&sa=X&ved=0ahUKEwjIjKGdzrvgAhVgHTQIHXkICWIQ_AUIDigB&biw=1562&bih=874#imgrc=sjjpyW2XL5EY9M:
http://hardenup.org/climate-change/extreme-weather-events.aspx

The buffer experiment…



Titration of a weak acid with a strong base

https://chem.libretexts.org/Bookshelves/Physical_and_Theoretical_Chemistry_Textbook_Maps/Supplemental_Modules_(Physical_and_Theoretical_Chemistry)/Acids_and_Bases/Buffers/How_Does_A_Buffer_Maintain_Ph%3F

What can be done?

First we must recognize that climate change is everyone's problem. No agency, government, or scientist can "fix it" for us. We are all in this together.

We are here because of our lifestyle, so that is what need to change.

What can you do?

Small actions can have a significant effect!

Heating and cooling?

- ✓ Install programmable thermostats.
- ✓ Check and repair weather striping on doors and windows.
- ✓ Adjust your clothing instead of the thermostat.
- ✓ Keep the AC filters clean.
- ✓ Install insulated drapes.
- ✓ Plant deciduous trees on the sunny side of your home.

✓*More ideas??*

Water?

- ✓ In the average home, 17% of energy is used to heat water.
- ✓ Take shorter showers.
- ✓ Install low flow shower heads.
- ✓ Insulate hot water pipes.
- ✓ Wash laundry in cold water.
- ✓ Install low water consumption WC's.
- ✓ Only run the dishwasher if it's full.
- ✓ Fix leaky faucets.
- ✓ *Any other ideas?*

In the car?

- ✓ Plan ahead, do several errands in a single trip.
- ✓ Walk or bike, it's healthier anyway.
- ✓ Clean out the trunk of your car. Lighter cars get better mileage.
- ✓ Make sure your engine is properly tuned.
- ✓ Keep your tires properly inflated.
- ✓ Carpool or ride the school bus.
- ✓ Support public transportation.
- ✓ Consider a smaller car or a hybrid for your next vehicle.

- ✓ *Any other ideas?*

Electricity?

- ✓ Unplug chargers for cell phones and other appliances when not in use.
- ✓ Get in the habit of turning lights and appliances off.
- ✓ Vacuum the coils on the back of the fridge monthly.
- ✓ Change to compact fluorescent bulbs, or better yet to LED.
- ✓ Make your next computer a laptop.
- ✓ Install timers or motion sensors on outdoor lights.

- ✓ *Any other ideas?*

Waste?

- ✓ Recycle and buy recycled products.
- ✓ Choose products that have less packaging.
- ✓ Reuse, repair, or donate.
- ✓ Don’t buy it unless you really need it.
- ✓ Carry cloth bags when shopping.
- ✓ Use a refillable travel mug or water bottle.
- ✓ Give your time instead of material gifts, or donate to a charity in the recipient’s name..

- ✓ *Any other ideas?*

Nature?

- ✓Plant a tree, or better yet, many trees.
- ✓Clean your mess, or nature will have to clean it for you!
- ✓ Composte your organic waste

- ✓*Any other ideas?*

Climate Change & Human Rights

Mary Robinson served as president of Ireland from 1990 to 1997, and as UN High Commissioner for Human Rights from 1997 to 2002. She now leads a foundation devoted to climate justice.

https://www.ted.com/talks/mary_robinson_why_climate_change_is_a_threat_to_human_rights?referrer=playlist-climate_change_oh_it_s_real#t-358476

21 minutes

Recommended films

An Inconvenient Truth 2006 Directed by Davis Guggenheim, presented by US Vice-president Al Gore

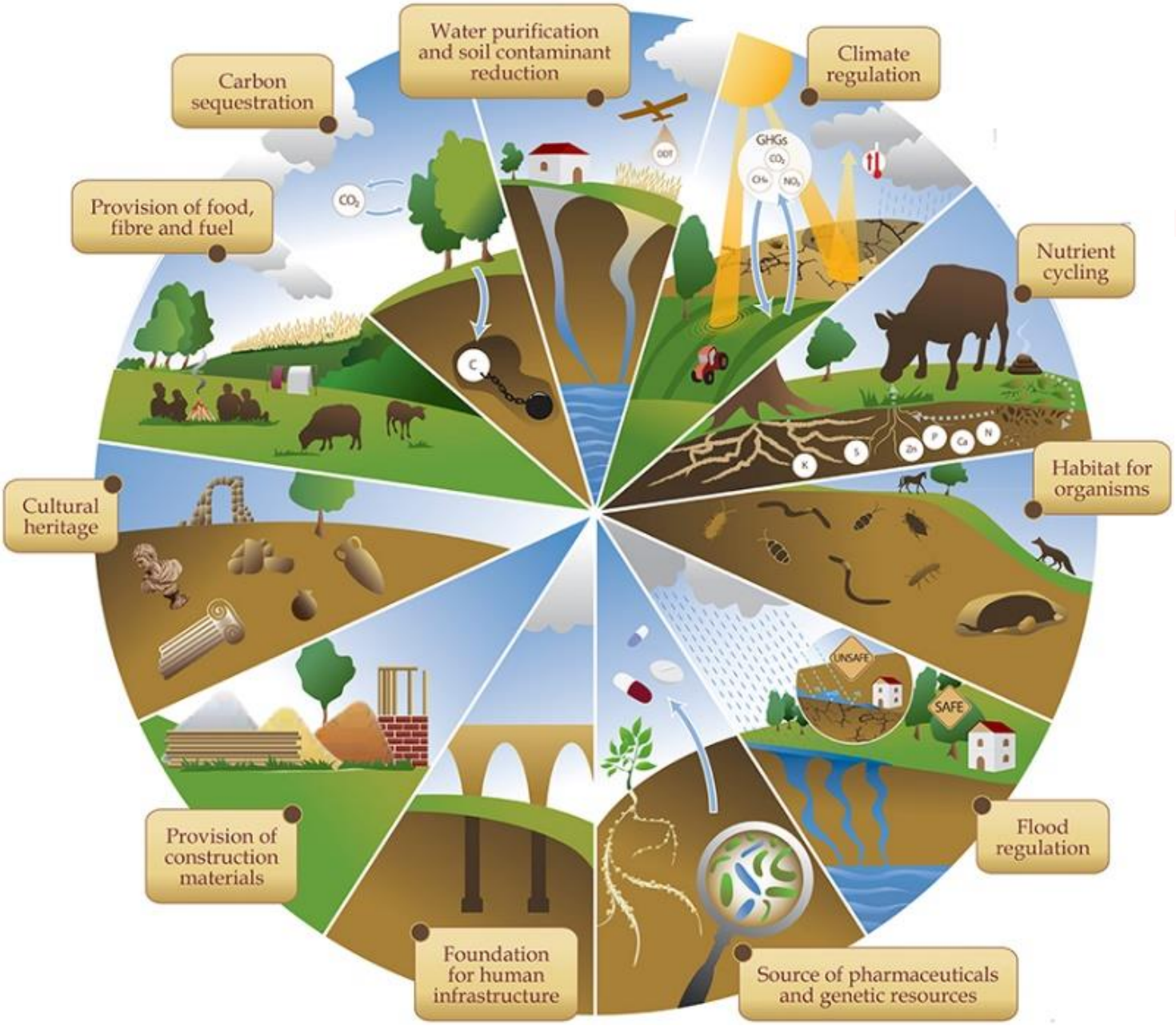
Before the flood 2016 Directed by Fisher Stevens, presented by Leonardo DiCaprio, Netflix.

Sustainable Development Goals (UN)

Please visit this site and read about each goal:

https://www.un.org/sustainabledevelopment/sustainable-development-goals/

Ecosystem Services Valuation

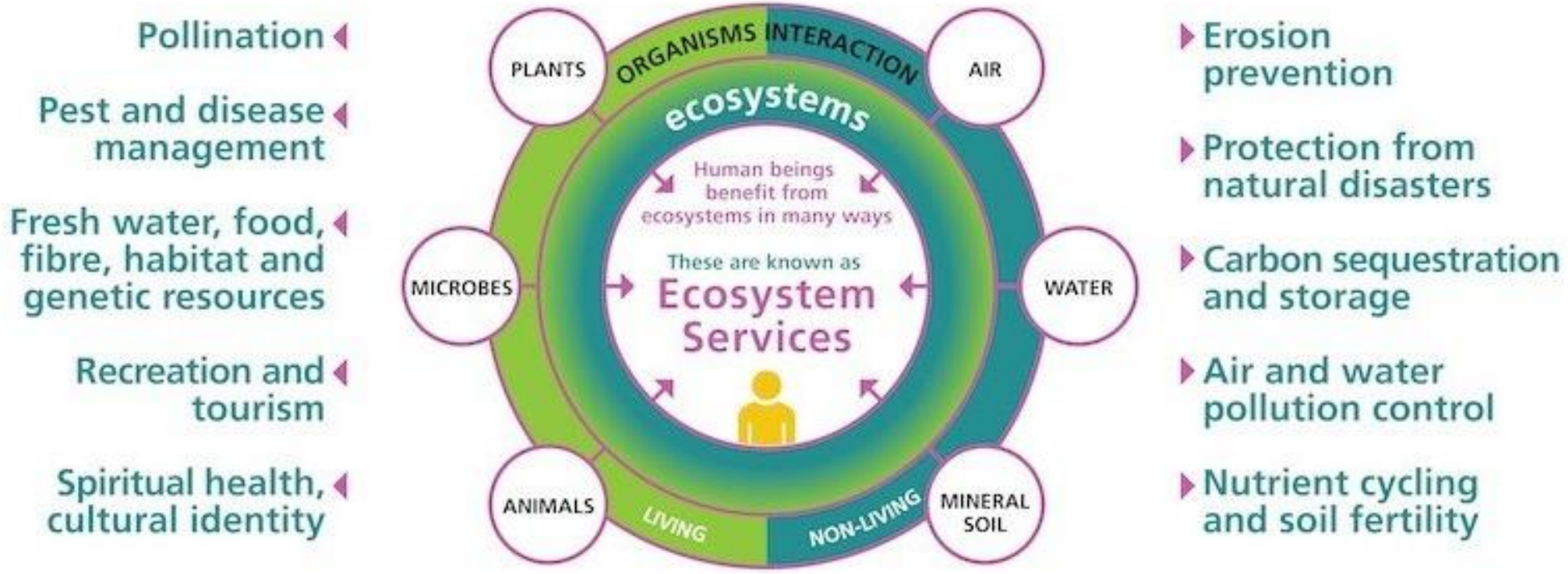


Based on Maggie Winslow, Ph.D. Fall 2013 presentation and
Millennium Ecosystem Assessment: www.milleniumassessment.org

Ecosystem services

Walter Westman, Nature, 1977. Nature services.
Ehrlich & Ehrlich, 1981. How much are Nature´s services worth?

Ecosystems are communities formed by the interaction of the living (plants, animals, microorganisms) and not living factors (air, water, mineral soil). Human beings are part of the ecosystems and benefit from them.

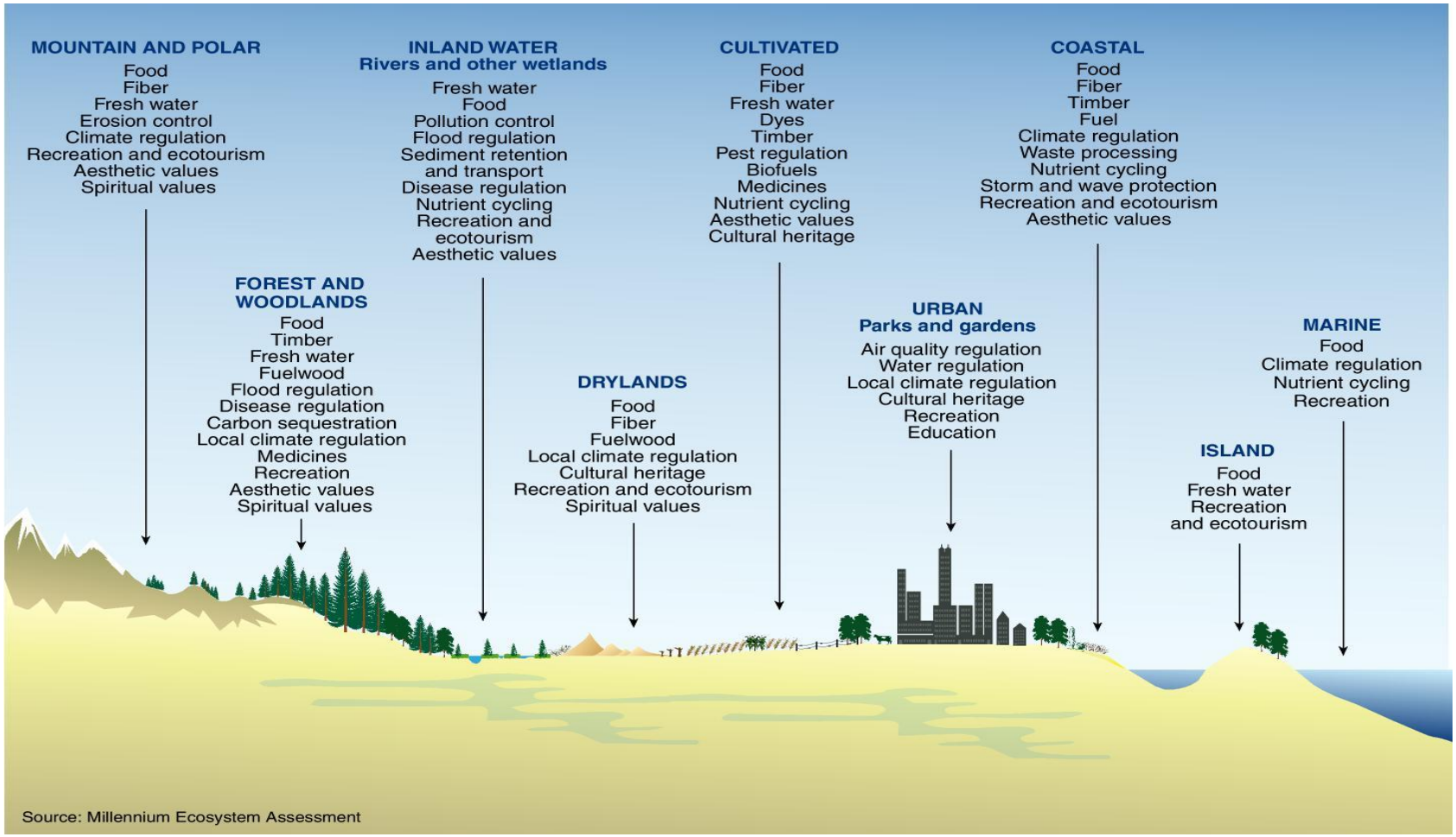


https://wle.cgiar.org/content/what-are-ecosystem-services

Ecosystem Services

All human beings depend on nature and the ecosystem services that provide the conditions for a healthy, adequate and safe life.

Ecosystem services are "The benefits that humans receive from the natural functioning of healthy ecosystems" (Jeffers et al., 2015),



https://www.unpei.org/sites/default/files/PDF/ecosystems-economicanalysis/MEA-A-Toolkit.pdf

Ecosystems services

PROVISIONING SERVICES

Products obtained from ecosystems

- Energy
- Seafood
- Biomedial
- Transportation
- National defense

REGULATING SERVICES

Benefits obtained from the regulation of ecosystem processes

- Flood prevention
- Climate regulation
- Erosion control
- Control of pests and pathogens

CULTURAL SERVICES

Nonmaterial benefits obtained from ecosystems

- Educational
- Recreational
- Heritage
- Spiritual

SUPPORTING SERVICES

Services necessary for the production of all other ecosystem services

- Biological diversity maintenance
- Nutrient recycling
- Primary productivity

source: *Final Recommendations of the Interagency Ocean Policy Taskforce, 2010*

Natural resources and processes from which humanity benefits directly or indirectly and which are vital for the survival of humanity, and yet we waste or overuse them.

https://roa.midatlanticocean.org/ocean-ecosystem-and-resources/characterizing-the-mid-atlantic-ocean-ecosystem/ecosystem-services/

Ecosystems services and ecosystem functions

Ecosystem service	Ecosystem functions	Examples
Gas regulation	Regulation of atmospheric chemical composition	CO_2/O_2 balance, O_3 for UVB protection, and SO_x levels
Climate regulation	Regulation of global temperature, precipitation, and other biologically mediated climatic processes at global or local levels	Green-house gas regulation, DMS production affecting cloud formation
Disturbance regulation	Capacitance, damping, and integrity of ecosystem response to environmental fluctuations	Storm protection, flood control, drought recovery, and other aspects of habitat response to environmental variability mainly controlled by vegetation structure
Water regulation	Regulation of hydrological flows	Provisioning of water for agricultural (e.g., irrigation) or industrial (e.g., milling) processes or transportation
Water supply	Storage and retention of water	Provisioning of water by watersheds, reservoirs, and aquifers
Erosion control and sediment retention	Retention of soil within an ecosystem	Prevention of loss of soil by wind, runoff, or other removal processes, storage of silt in lakes and wetlands
Soil formation	Soil formation processes	Weathering of rock and the accumulation of organic material
Nutrient cycling	Storage, internal cycling, processing, and acquisition of nutrients	Nitrogen fixation, N, P, and other elemental or nutrient cycles
Waste treatment	Recovery of mobile nutrients and removal or breakdown of excess or xenic nutrients and compounds	Waste treatment, pollution control, detoxification
Pollination	Movement of floral gametes	Provisioning of pollinators for the reproduction of plant populations
Biological control	Trophic-dynamic regulations of populations	Keystone predator control of prey species, reduction of herbivory by top predators
Refugia	Habitat for resident and transient populations	Nurseries, habitat for migratory species, regional habitats for locally harvested species, or over wintering grounds
Food production	That portion of gross primary production extractable as food	Production of fish, game, crops, nuts, fruits by hunting, gathering, subsistence farming, or fishing
Raw materials	That portion of gross primary production extractable as raw materials	The production of lumber, fuel, or fodder
Genetic resources	Sources of unique biological materials and products	Medicine, products for materials science, genes for resistance to plant pathogens and crop pests, ornamental species (pets and horticultural varieties of plants)
Recreation	Providing opportunities for recreational activities	Eco-tourism, sport fishing, and other outdoor recreational activities
Cultural	Providing opportunities for non-commercial uses	Aesthetic, artistic, educational, spiritual, and/or scientific values of ecosystems

See next slide...

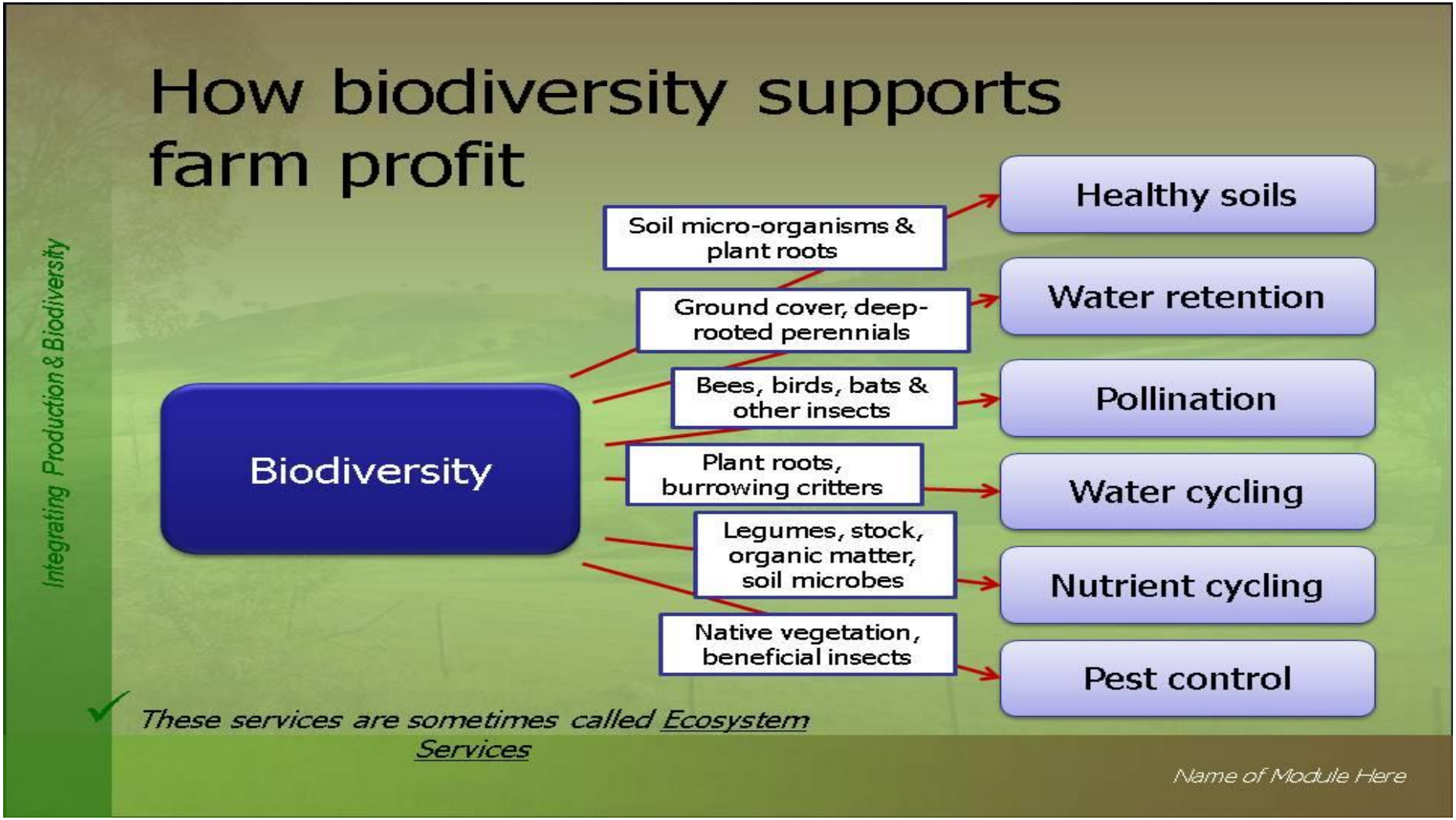
From: Constanza et al. 2017

Ecosystems services and ecosystem functions

Ecosystem Service	Ecosystem functions	Examples
Water regulation	Regulation of hydrological flows	Provisioning of water for agriculture (e.g. irrigation) industrial (milling), processes or transportation
Erosion control and sediment retention	Retention of soil within the ecosystem	Prevention of loss of soil by wind, runoff, or other removal processes, storate of silt in lakes and wetlands

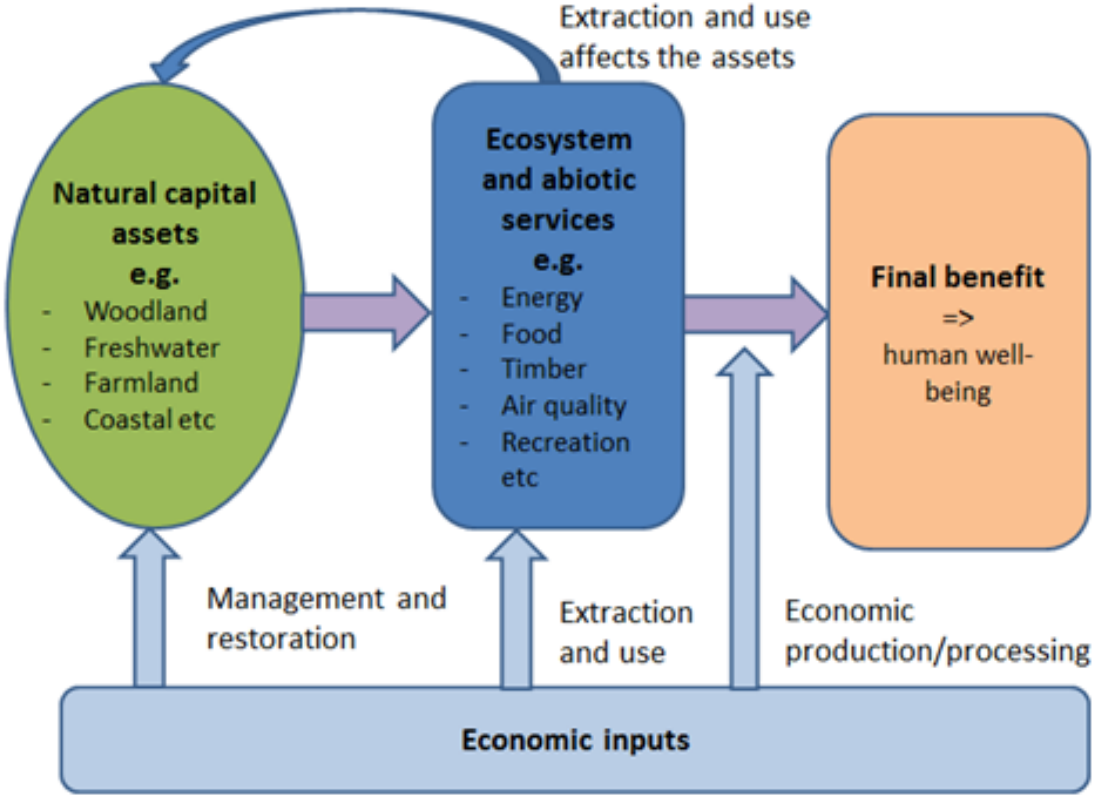
From: Constanza et al. 2017

Example:
Ecosystem services that impact on agricultura production



http://agbiodiversity.com/AgBiodviersityProject/Howbiodiversitysupportsfarmprofits/tabid/133/Default.aspx

Ecosystem services & natural capital



Natural capital: the ecosystems that provide the services.

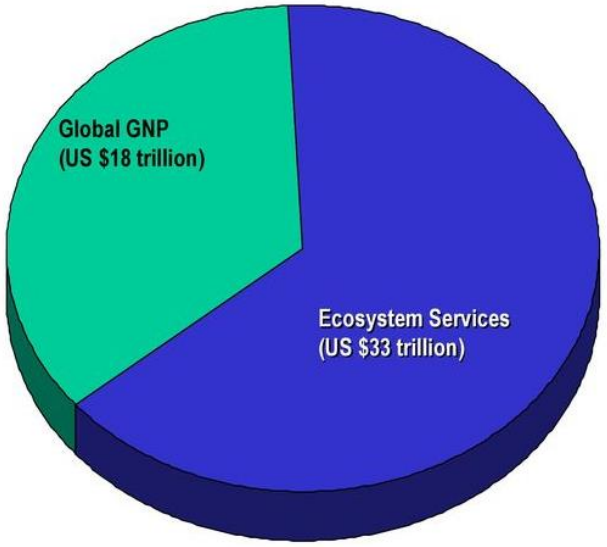
During the second half of the 20th Century, it became more apparent the non-market value of natural amenities.
For some time they were two parallel worlds: the ecosystems and the economy-social aspects.
Now we understand the societal dependence on natural ecosystems: assets, services and final benefits.

https://www.ons.gov.uk/economy/environmentalaccounts/methodologies/principlesofnaturalcapitalaccounting

How much are nature's services worth?

ECOSYSTEM SERVICES	VALUE (trillion $US)
Soil formation	17.1
Recreation	3.0
Nutrient cycling	2.3
Water regulation and supply	2.3
Climate regulation (temperature and precipitation)	1.8
Habitat	1.4
Flood and storm protection	1.1
Food and raw materials production	0.8
Genetic resources	0.8
Atmospheric gas balance	0.7
Pollination	0.4
All other services	1.6
Total value of ecosystem services	**33.3**

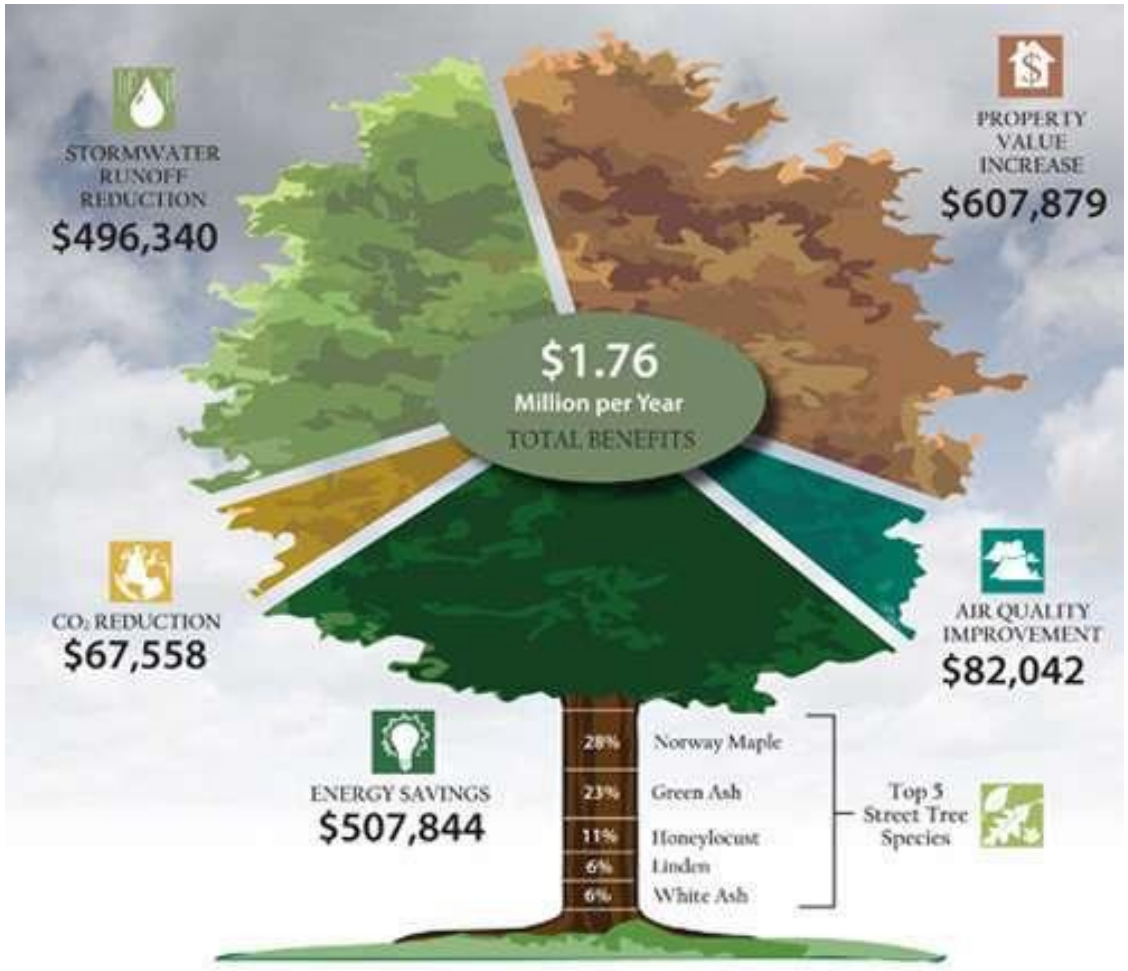
Source: Adapted from R. Costanza *et al.*, "The Value of the World's Ecosystem Services and Natural Capital," *Nature*, Vol. 387 (1997), p. 256, Table 2.



It is very difficult to set numbers, this is just a shy approximation, but human societies put a price tag on everything. However, it is an interesting exercise to have an approximate idea on how much ecosystem services could cost.

https://www.griequity.com/resources/Environment/Valuing%20Ecosystem%20Services.htm

How much are tres really worth?



The idea was to demonstrate that ecosystems services are much more important to human wellbeing than conventional economic thinking.

We probably will never know its real $ value.

Scientists demonstrate the need for more research and highlights the importance of ecosystems services and its impact on human welfare.

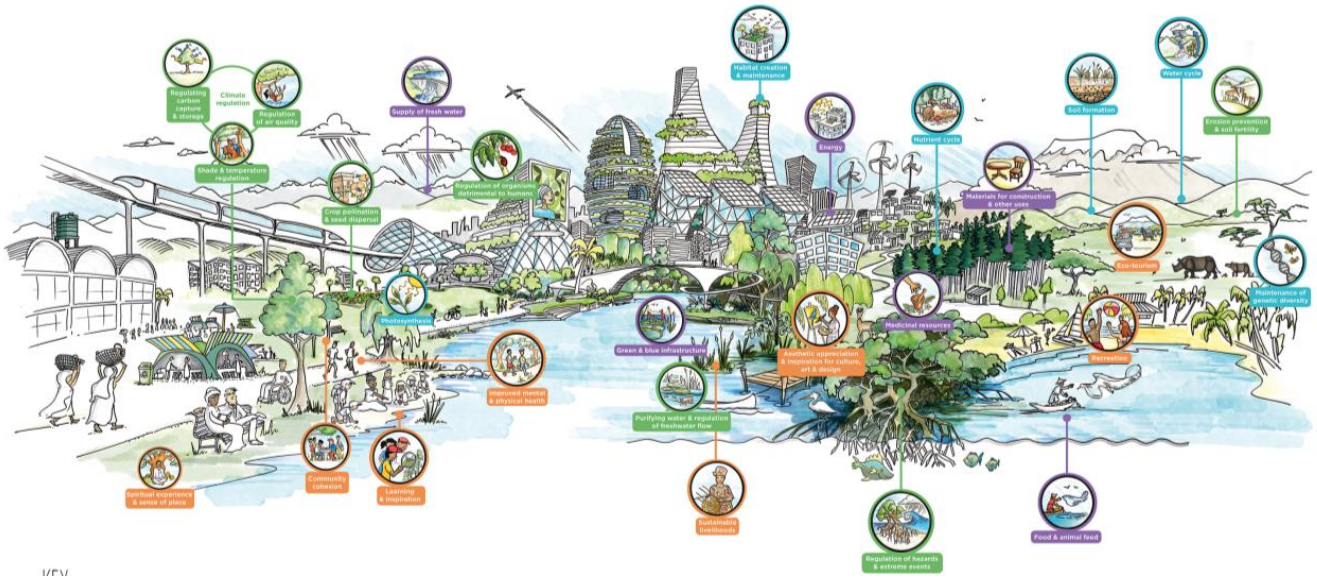
https://www.totallandscapecare.com/landscaping-business/feature-article/how-much-are-trees-really-worth/

Nature's worth…

In 1966, scientist made a meta-analysis of existing literature on the 16 biomes and using a basic value transfer technique, they assumed a constant value/ha for each biome:

The entire biosphere value (obviously, outside of market) is estimated between US$ 16-54 trillion (10^{12}).

If ecosystems services were added to the real cost in terms of the added value to the global economies, the actual price system would be very different nowadays.



https://cbc.iclei.org/value-nature-urban-life/

A typical day on planet earth, humans will:

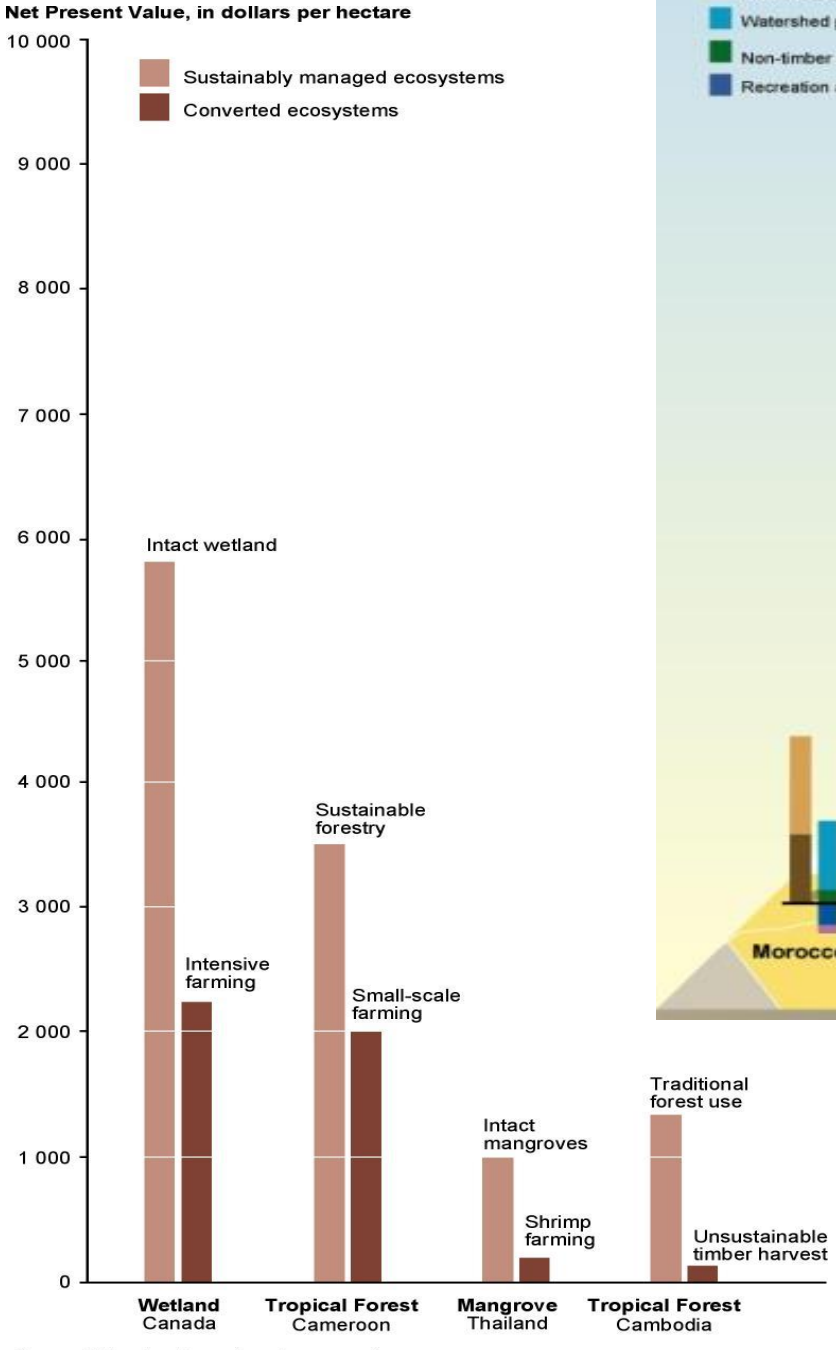
- add 15 million tons of carbon to the atmosphere
- destroy 115 square miles (297 square kilometers)
- create 72 square miles of desert (186 square kilometers)
- eliminate between 40 – 100 species
- erode 71 million tons of top soil
- add 2,700 tons of CFCs to the stratosphere
- increase the population by 263,000 (360,000 in 2019) every day

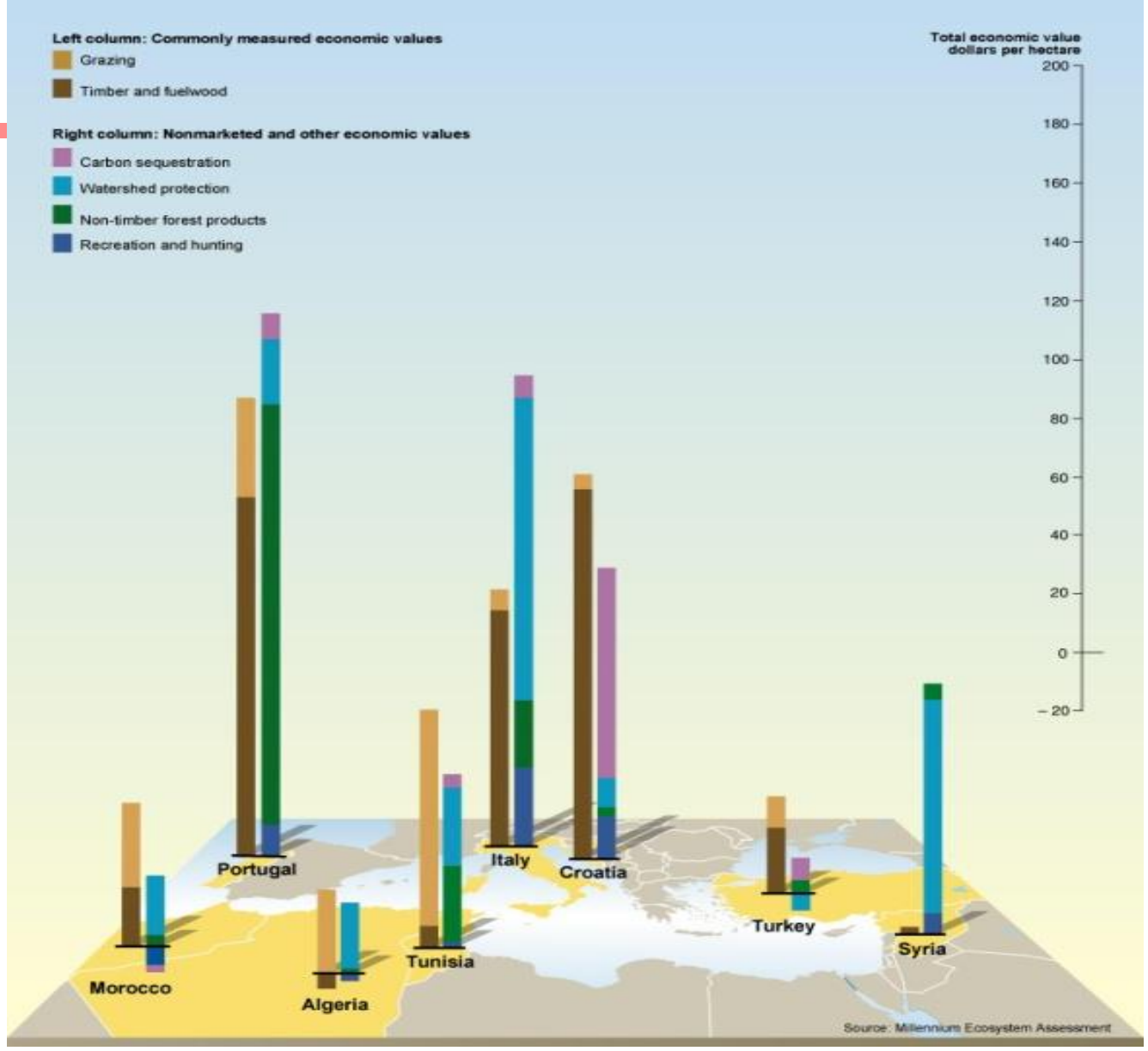
David Orr, Ecological Literacy, 1992

Unprecedented change…

- Human beings are adding dramatic changes to the planet ecosystems to satisfy their own needs (food, energy, minerals, etc.).
- These changes had improved the life of millions of people. However we have debilitated the nature's capacity to keep providing the required services such as clean water, clean air, disaster protection, medicines, etc.
- The pressure on the ecosystems are a global phenomenon that will worsen in the next few decades unless we change our attitude and the way we take for granted the ecosystem services.
- Politicians and entrepreneurs did not take into account the ecosystems services, nor their value.

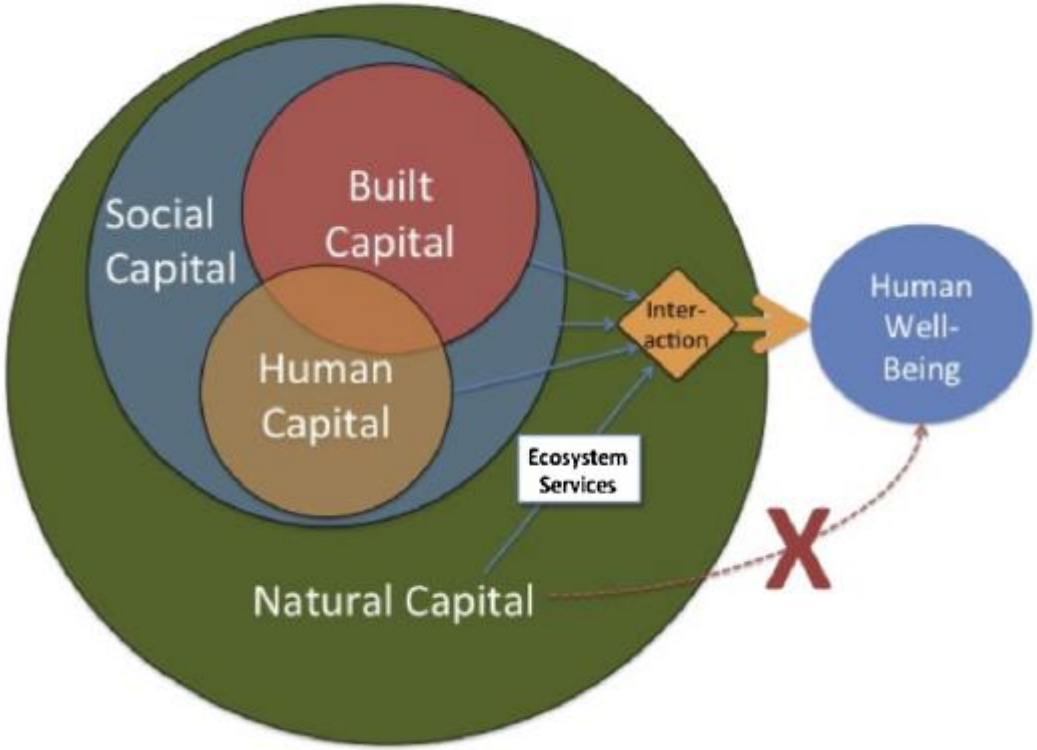
Consequences





The loss of ecosystem services represent a major obstacle to reach the *Millennium Development Goals* needed to reduce poverty, hunger and diseases.

Human wellbeing



Human wellbeing is based on the built capital and the human capital (which is the economy).

They are embedded in a society, that it is embedded in the nature (natural capital) and contribute to the human wellbeing.

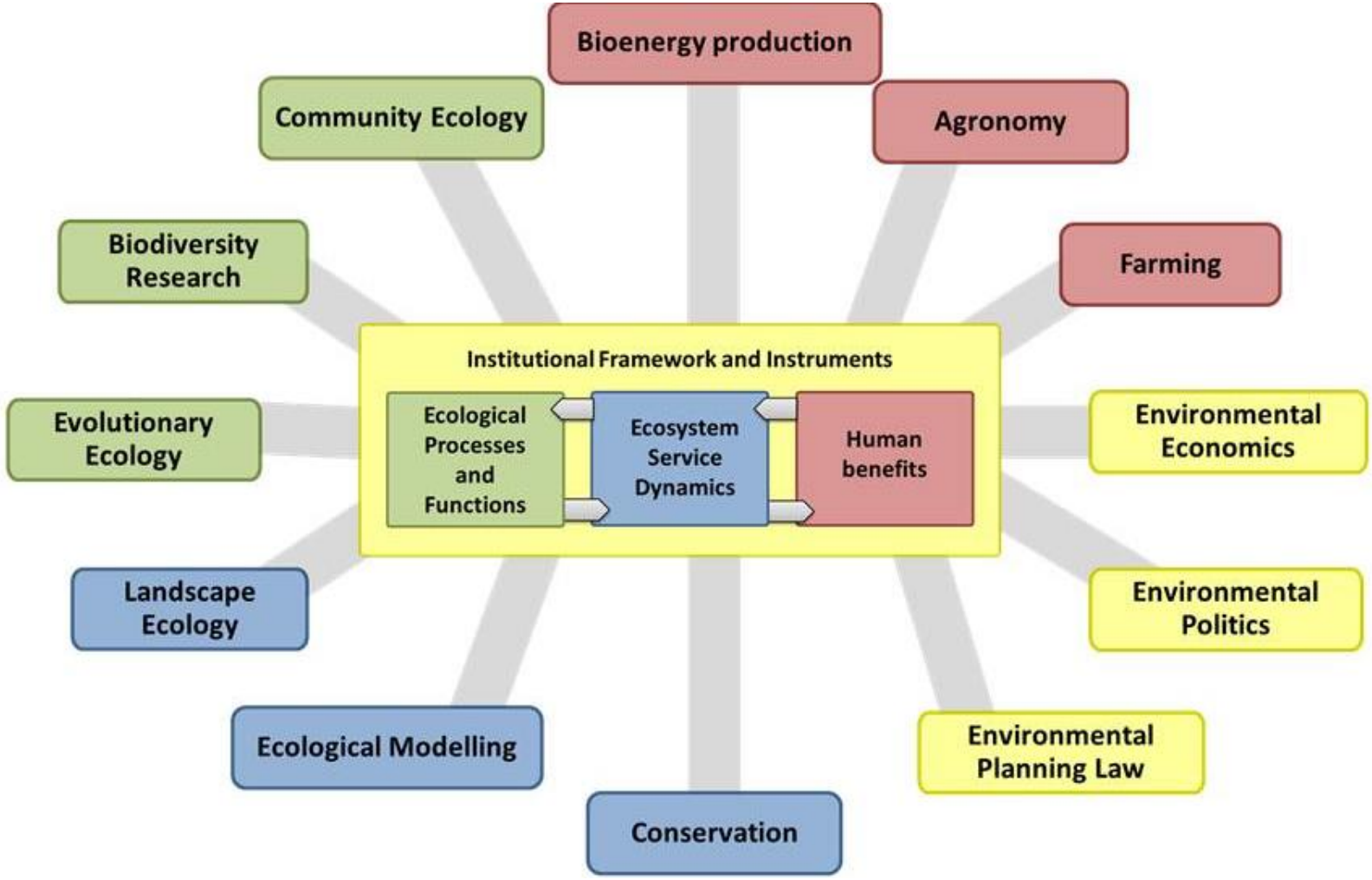
Human wellbeing do not flow directly from the natural capital. It is a result of the interactions of all these capitals.

We must take this transdisciplinary perspective, in order to address and value the ecosystems services.

Linking Ecosystem Services & Human Well-being. Millennium Ecosystem Assessment

https://www.robertcostanza.com/wp-content/uploads/2017/02/2017_J_Costanza-et-al.-20yrs.-EcoServices.pdf

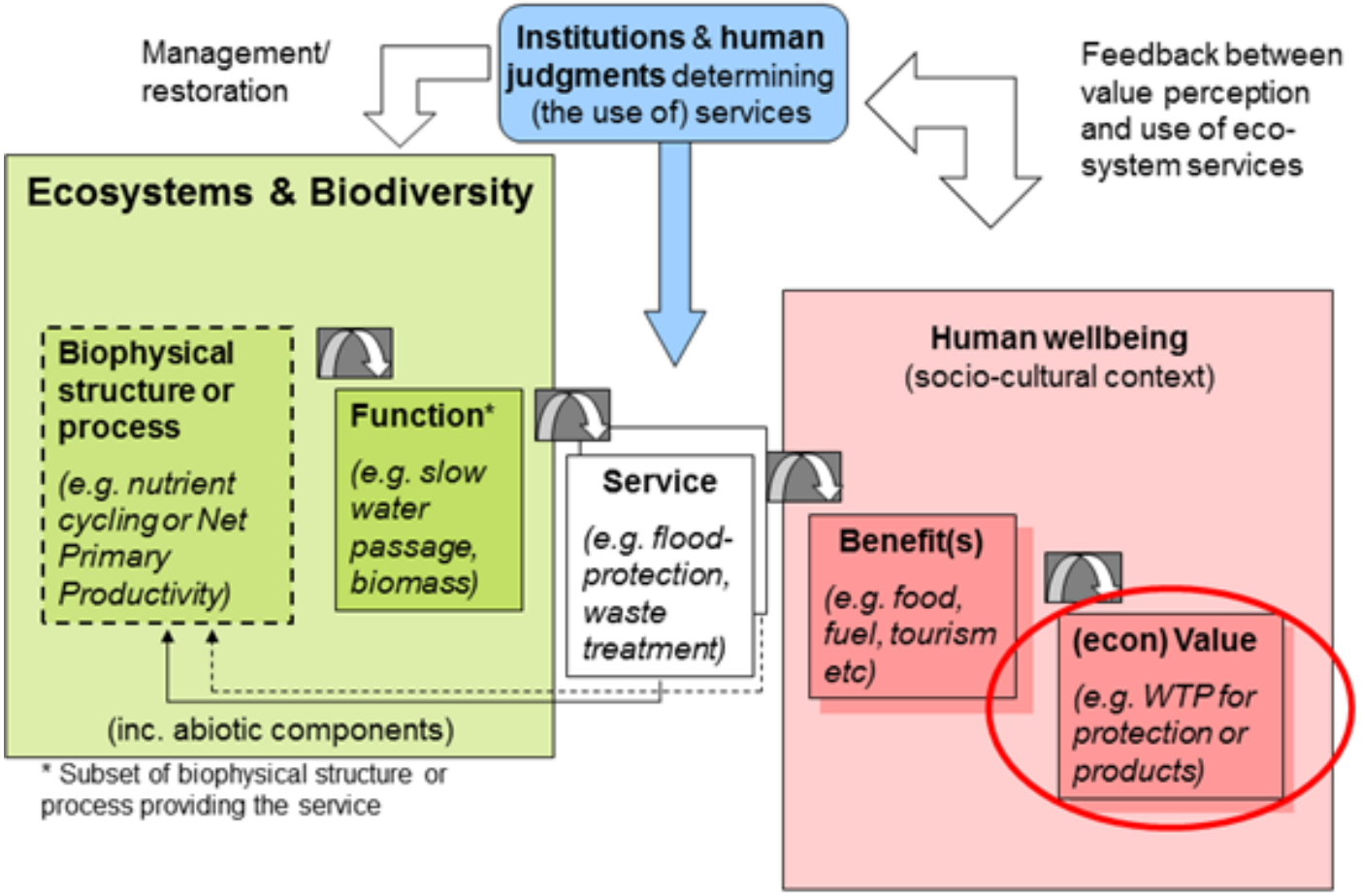
Ecosystems services framework and instruments



The way that we care or not care for some of these aspects, impacts directly on the human wellbeing.

https://www.ufz.de/index.php?en=43685

The cascade of services



Provision of service

Regulation of service

Cultural service

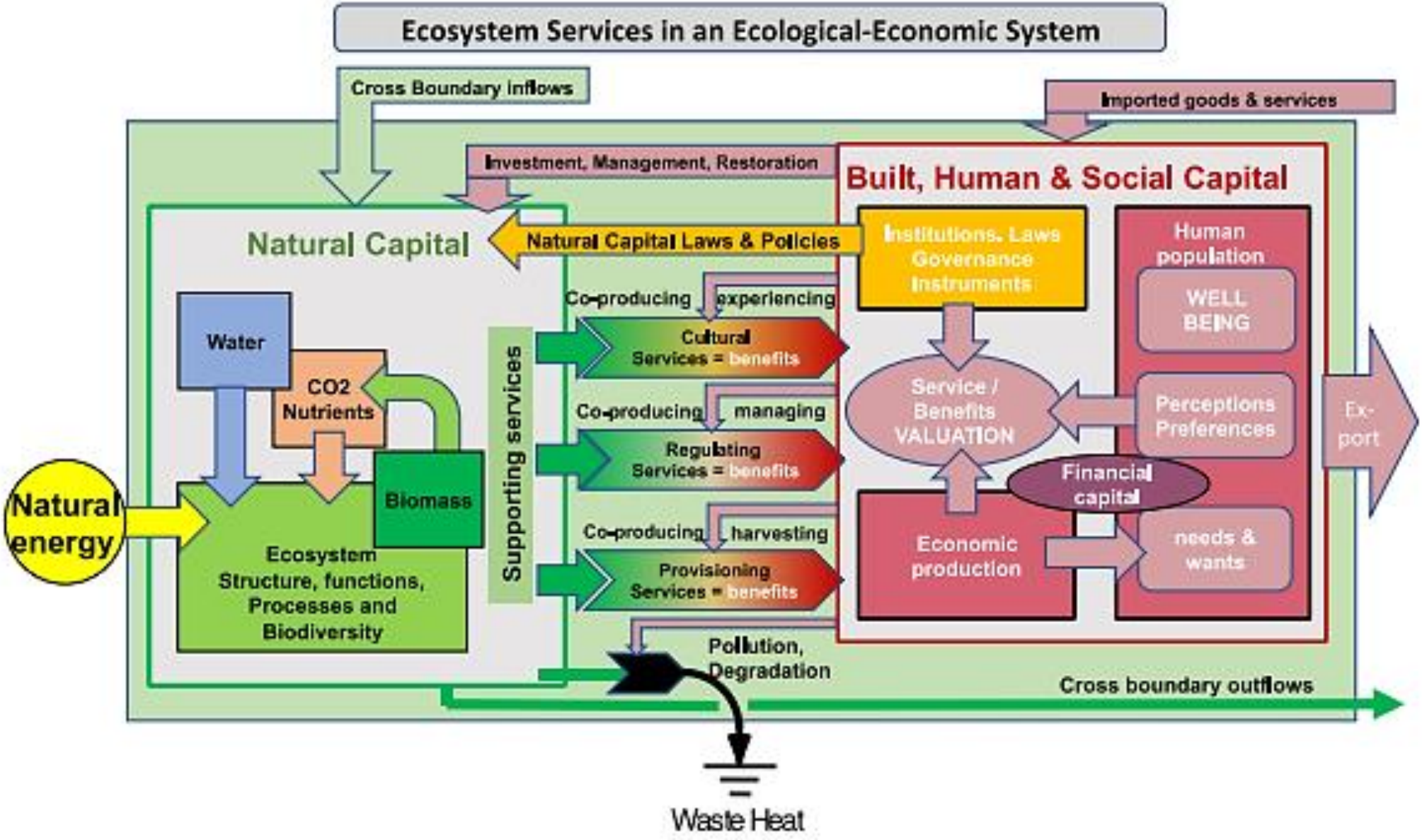
Supporting service

The way that we care or not care for some of these aspects, impacts directly on the human wellbeing.

WTP – willingness to pay

http://www.marine-vectors.eu/Landing_pages/Ecosystem_services

Beyond the cascade, more complex…



From: Constanza et al. 2017

Changes in cost of ecosystem services

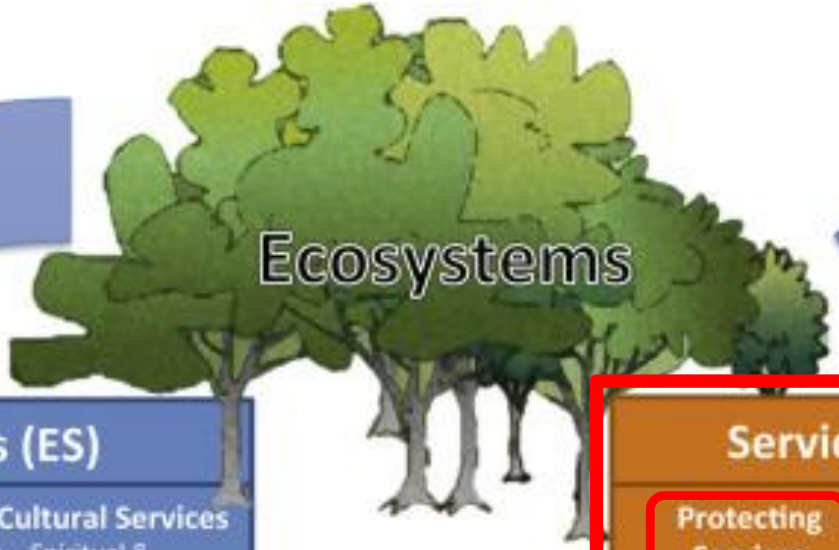
Changes in area, unit values and aggregate global flow values from 1997 to 2011.

Biome	Area (e6 ha) 1997	Area (e6 ha) 2011	Area Change 2011-1997	Unit values 2007$/ha/yr 1997	Unit values 2007$/ha/yr 2011	Unit values Change 2011-1997	A. Original: Assuming 1997 area and 1997 unit values — Aggregate Global Flow Value e12 2007$/yr 1997	B. Change unit values only: Assuming 1997 area and 2011 unit values — Aggregate Global Flow Value e12 2007$/yr 2011	C. Change area only: Assuming 2011 area and 1997 unit values — Aggregate Global Flow Value e12 2007$/yr 2011	D. Change both unit values and area: Assuming 2011 area and 2011 unit values — Aggregate Global Flow Value e12 2007$/yr 2011	E. Column C - Column A: 2011-1997 Change in Value e12 2007$/yr 1997 unit values	F. Column D - Column B: 2011-1997 Change in Value e12 2007$/yr 2011 unit values
Marine	**36,302**	**36,302**	0	796	1,368	572	**28.9**	**60.5**	**29.5**	**49.7**	0.6	(10.9)
Open Ocean	**33,200**	**33,200**	0	348	660	312	11.6	21.9	11.6	21.9	-	-
Coastal	**3,102**	**3,102**	0	5,592	8,944	3,352	17.3	38.6	18.0	27.7	0.6	(10.9)
Estuaries	180	**180**	0	31,509	28,916	-2,593	5.7	5.2	5.7	5.2	-	-
Seagrass/Algae Beds	200	**234**	34	26,226	28,916	2,690	5.2	5.8	6.1	6.8	0.9	1.0
Coral Reefs	62	**28**	-34	8,384	352,249	343,865	0.5	21.7	0.2	9.9	(0.3)	(11.9)
Shelf	2,660	**2,660**	0	2,222	2,222	0	5.9	5.9	5.9	5.9	-	-
Terrestrial	**15,323**	**15,323**	0	1,109	4,901	3,792	**17.0**	**84.5**	**12.1**	**75.1**	(4.9)	(9.4)
Forest	**4,855**	**4,261**	-594	1,338	3,800	2,462	6.5	19.5	4.7	16.2	(1.8)	(3.3)
Tropical	1,900	**1,258**	-642	2,769	5,382	2,613	5.3	10.2	3.5	6.8	(1.8)	(3.5)
Temperate/Boreal	2,955	**3,003**	48	417	3,137	2,720	1.2	9.3	1.3	9.4	0.0	0.2
Grass/Rangelands	**3,898**	**4,418**	520	321	4,166	3,845	1.2	16.2	1.4	18.4	0.2	2.2
Wetlands	**330**	**188**	-142	20,404	140,174	119,770	6.7	36.2	3.4	26.4	(3.3)	(9.9)
Tidal Marsh/Mangroves	165	**128**	-37	13,786	193,843	180,057	2.3	32.0	1.8	24.8	(0.5)	(7.2)
Swamps/Floodplains	165	**60**	-105	27,021	25,681	-1,340	4.5	4.2	1.6	1.5	(2.8)	(2.7)
Lakes/Rivers	**200**	**200**	0	11,727	12,512	785	2.3	2.5	2.3	2.5	-	-
Desert	**1,925**	**2,159**	234	-	-	0	-	-	-	-	-	-
Tundra	**743**	**433**	-310	-	-	0	-	-	-	-	-	-
Ice/Rock	**1,640**	**1,640**	0	-	-	0	-	-	-	-	-	-
Cropland	**1,400**	**1,672**	272	126	5,567	5,441	0.2	7.8	0.2	9.3	0.0	1.5
Urban	**332**	**352**	20	-	6,661	6,661	-	2.2	-	2.3	-	0.1
Total	51,625	51,625	0				45.9	145.0	41.6	124.8	(4.3)	(20.2)

(Green values that increased, red, values that have decreased)

Costanza, et al. 2014.

Ecosystem services and/or services to ecosystems



Ecosystem Services (ES)

Provisioning Services
- Food
- Fresh water
- Fuelwood
- Fiber
- Biochemicals
- Genetic resources

Regulating Services
- Climate regulation
- Disease regulation
- Water regulation
- Water purification
- Pollination

Cultural Services
- Spiritual & religious
- Recreational
- Ecotourism
- Aesthetic
- Inspirational
- Educational
- Sense of place
- Cultural heritage
- S2E

Supporting Services
Ecosystem functions: Nutrient cycling, Evolution, Soil formation, Spatial structure, Primary production

Reciprocity

Services to Ecosystems (S2E)

Protecting Services
- Habitat protection
- Weeding/ culling
- Ritual regulation
- Cultural prohibitions & prescriptions on species and habitats

Enhancing Services
- Cultivation
- Domestication
- Trait selection
- Translocation, range spreading
- Pruning
- Fertilizing
- Nutrient (re)cycling

Restoring Services
- Improving soil / water/air quality
- Habitat/niche (re)construction
- Nutrient release (burning)
- Planting, sowing
- Revitalisation of eco-cultural harvesting

Supporting Services
Enhancing cultural-ecological integrity, symbiotic actions, cultural beliefs, Indigenous worldviews, TEK

https://www.sciencedirect.com/science/article/pii/S0959378015300145

So far, ecosystems services…

- have not only become popular, but they have entered into the economic business equation.
    - Dow Chemical $10 million collaboration with The Nature Conservancy to evaluate cost/benefits of every business decision

- have inconsistent approaches per countries, companies, governments, etc. So it makes it difficult to standardize cost of services.

- generate relevant ecological-social knowledge for stakeholders and policy decision makers.

- accounting and assessment need to be developed to reach and standard social-ecological lens.

- must have a broad range of scales in space, time or governance. These disparities, may impact in different ways to different countries, mainly between rich and poor countries.

The Outcome

Environmentalists can study, not value
Economists can value, not study

- Findings weighted more heavily in creating policy

Class, what would you do….?

Video

Sir Partha Dasgupta:

Measuring wealth "Beyond GDP

https://www.youtube.com/watch?v=8uGPthIEWTE

(4'26")

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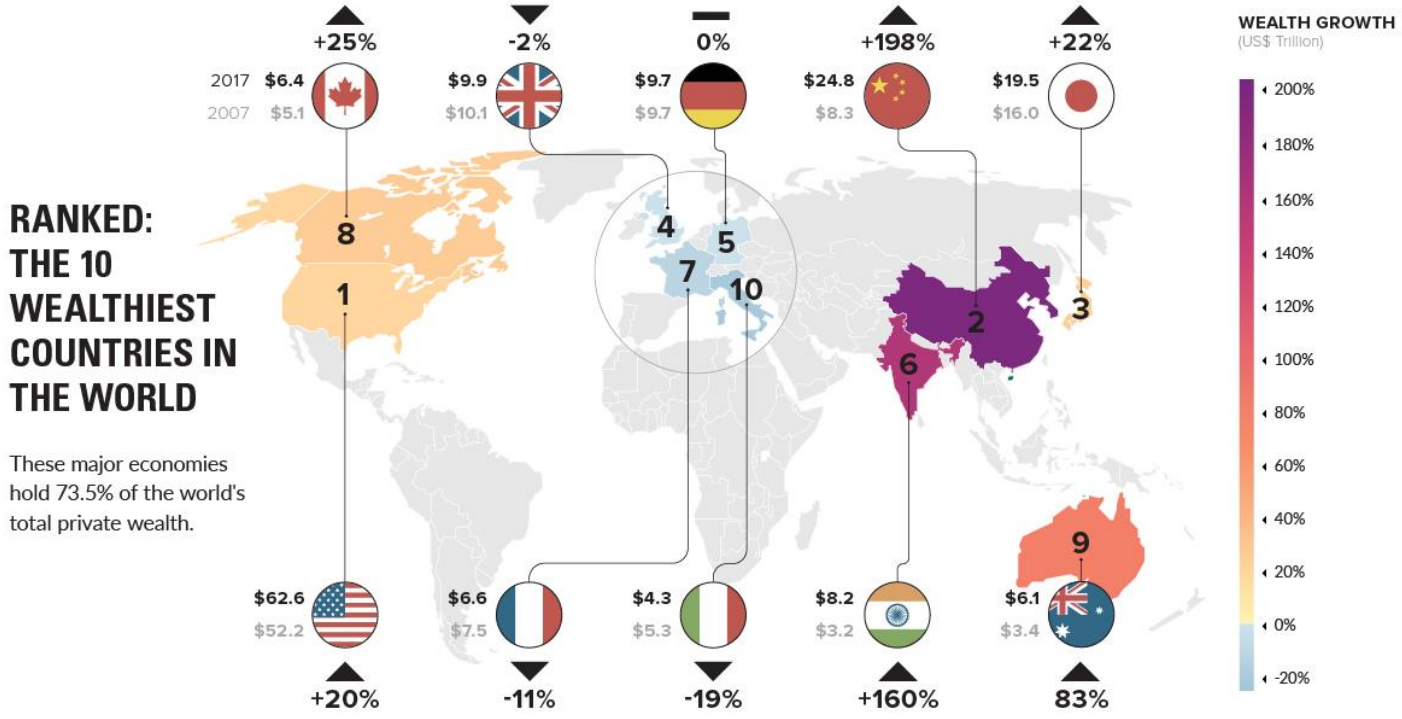
Richness of Nations

The wealth of the Nation by Symour Fogel

Richness of Nations

A central presumption in modern development discourse is the significance of income growth for human betterment. By income, in the context of a country, we mean gross domestic product (GDP), which is the market value of the flow of final goods and services in a given year. GDP is a measure of economic activity..



http://mgiep.unesco.org/article/wealth-well-being-and-the-sustainable-development-goals
https://www.visualcapitalist.com/chart-the-10-wealthiest-countries-in-the-world/

Richness of Nations

The rogue word in GDP is "gross", which signals that GDP does not deduct the depreciation of capital goods that accompany their usage. Just as a household can increase its disposable income by running down its bank balance and selling off its material assets, a country can achieve high growth rates by depleting its productive capital. The problem is that income would not be sustainable under those circumstances. At some point in the future, GDP would simply have to decline.

The Idea of Wealth

For a household, income growth is a means of improving quality of life. However, because the household cares about its future, income figures are only relevant once the depreciation of assets has been taken into account. Economic betterment for the household requires that it consumes less than its net income. In simpler terms, a household should not live beyond its means. That, in turn, means that the household accumulates wealth.

The Breadth of Capital Goods

A brief tour of an economy's stock of assets would uncover three categories:

1. Reproducible (or manufactured) capital (roads, buildings, ports, machines, equipment)

2. Human capital

    A. personal character, knowledge, and skills (aptitude, self-awareness, sociability, education, tacit knowledge)

    B. health (body mass index, life expectancy)

3. Natural capital (agricultural land, forests, grasslands, coastal fisheries – more generally, ecosystems; the atmosphere; the oceans; sub-soil resources).

.

Why it is necessary…

1. To modify the accounting systems in order to include the value of the services, ecosystems and human and natural capital.

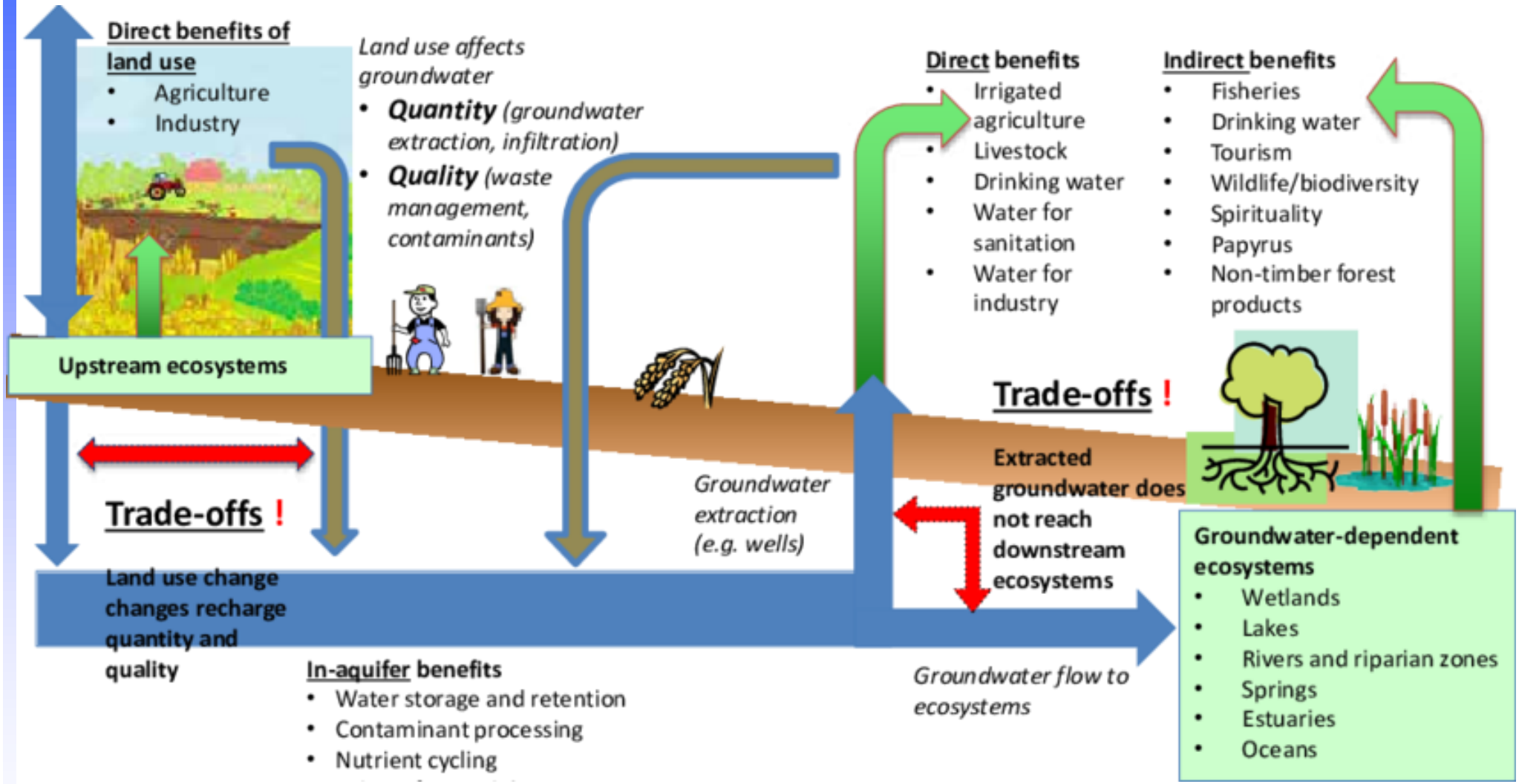
2. To evaluate projects for recovery of lost ecosystems natural and contrast them vs. other projects.

Because the capital services of natural ecosystems will be under much more stress in the future, we can only expect that their value will increase.

Costanza et al. (2014) conclude that the accounting value of ecosystem services expressed in monetary units are quite useful to raise awareness on: the magnitude of the services provided.

In other words, "it helps to build a more comprehensive and balanced picture of the assets that support human wellbeing and human's interdependence between wellbeing and life on the planet."

Why it is necessary…



https://www.researchgate.net/publication/301650568_Groundwater_and_ecosystem_services_a_framework_for_managing_smallholder_groundwater-_dependent_agrarian_socio-ecologies/figures?lo=1

International Space Station

There are sleeping quarters for six astronauts, however, astronauts have been known to just tie their sleeping bag to a bulkhead.

https://www.nasa.gov/mission_pages/station/images/station_post_construction/index.html

International Space Station (ISS)

Dimensions:
171 ft. long, 240 ft. wide, 90 ft. high (109 X 73 m aprox),

Living space: 15,000 ft^3 (424 m^3) .

Weight: 477,000 lbs (202 metric ton).

Altitude: Approximately 220 miles above earth (354 km aprox)

Orbital inclination/path:
51.6 degrees, covering 90% of the world's population.

Speed:
17,500 miles per hour (28,163.5 km per hour), orbiting the Earth 16 times a day.

https://www.nasa.gov/mission_pages/station/main/s114e7221_feature.html

NASA ISS Control Center

Johnson Space Center – Houston
Shuttle Mission Control Room

Johnson Space Center – Houston
ISS Mission Control Room

NASA ISS Control Center

Kennedy Space Flight Center –
Cape Canaveral, Florida
Shuttle Firing Room

Marshall Space Flight Center –
Huntsville, Alabama
Payload Operations
& Integration

NASA ISS Control Center

Korolev, Russia
ISS Mission Control Center

Tsukuba Space Center – Japan
JEM Mission Control Room

International ISS Control Center

St. Hubert, Canada
MSS Control Center

Columbus Control Center -
Oberpfaffenhofen, Germany
Main Control Room

ISS by the numbers

961 Hours of spacewalks
110 Launches
32,033 Cubic feet of pressurized volume
827,794 Pounds on-orbit
23,000 Meals eaten
1,800,000 Lines of software code
90 Kilowatts of power
100,000 People worldwide on the team

150 billion USD, Estimated cost
3 billion USD per year, current cost by NASA
7.5 million USD, per day spending on one occupant in ISS

Estimated cost for all humans today (around 7,687,877,900 humans):
5.7659 e16 or 57,659,000,000,000,000 USD

GDP of the world: 80,738 Trillion/year or 80,738,000,000,000

https://www.quora.com/What-is-the-cost-of-ISS, http://www.worldometers.info/world-population/
https://data.worldbank.org/indicator/NY.GDP.MKTP.CD?locations=1W