Unit - 2 Principles of Ecology

Principles of Ecology

- **Segments of the Environment**
  - Atmosphere, Lithosphere, Hydrosphere, Biosphere
- **Ecosystem: Biotic and Abiotic Factors**
- **Organization of the Ecosystem**
- **Types of Ecosystems**
- **Structure of the Ecosystem**
  - Ecological Pyramids
- **Functions of Ecosystems**
  - Productivity
    - Food Production

- Energy Flow
  - Food Chain and Food Web
- Nutrient Recycling
  - Biogeochemical Cycles - Water Cycle, C, N, P, S Cycles
- Development and Stabilization
  - Community Associations
  - Community Adaptations
  - Ecological Succession

- **Ecosystems Services**
- **Economical values of Ecosystem Services**
- **Threats to Ecosystems**
- **Ecosystems Conservation**

Ecology - *Ikos*—dwelling; *Logos*—study

Study of the inter-relationships among living beings and their interactions with the physical environment[ref].

Autoecology - study of an individual species including behavior, adaptation and interaction with environment[ref]

Synecology - study of communities and their interactions with the environment[ref]

The Physical and biological habitat surrounding us is the in Environment, it has a four segments[ref]

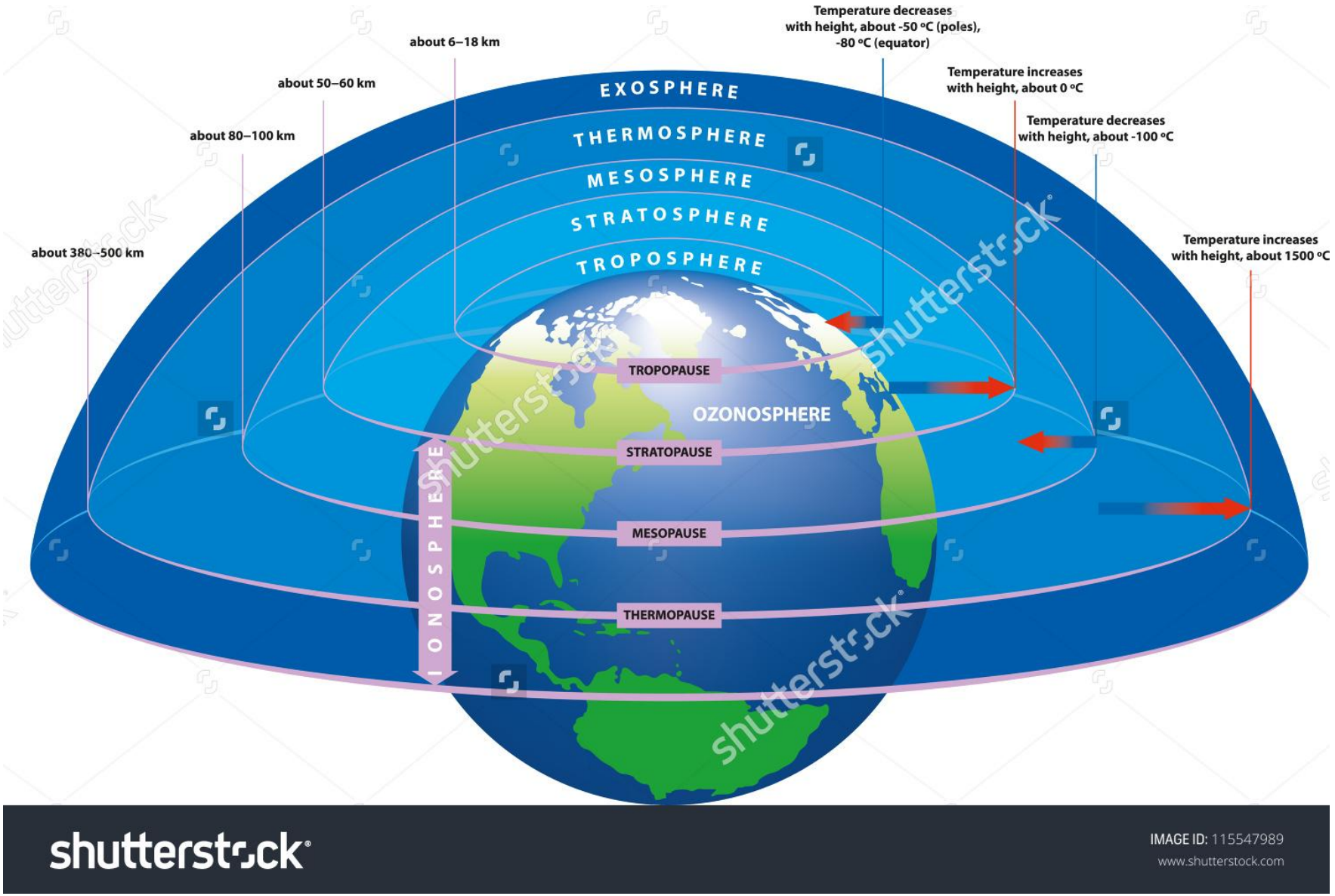
Atmosphere: small reservoir, efficient transporter.

Lithosphere: Earth's Crust, rocks, minerals. Huge reservoir, less transport (conveyer), Pedosphere: soil

Hydrosphere: oceans and water, huge reservoir and transporter

Biosphere: small reservoir, moderate transporter; huge impact on the environment.

Atmosphere



http://view.ge/page/sience/15-atmosphere-of-earth?lang=english

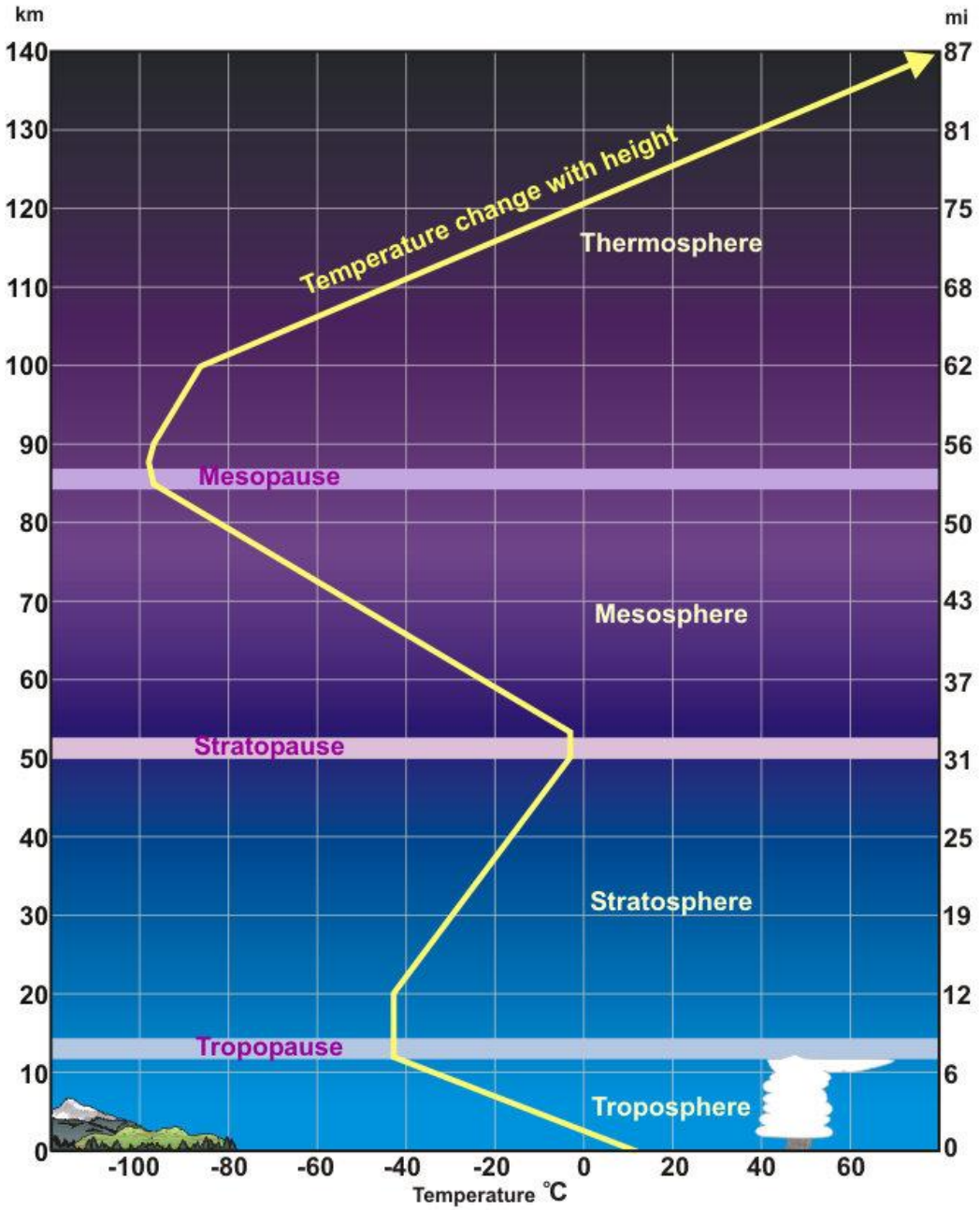
Exosphere: 500 – 1000 km up to 10,000 km,

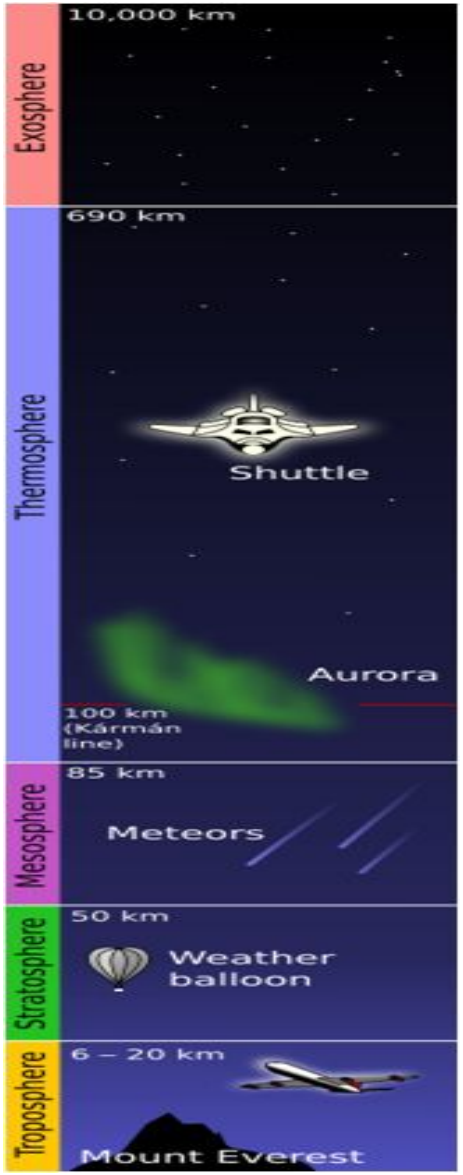
Thermosphere: from 80 – 85 km to 640+ km temperature increasing with height. **Ionosphere**: auroras, long distance radiowave propagation.

Mesosphere: 50 km to 80 to 85 km temperature decreasing with height. Meteors burn up when entering the atmosphere.

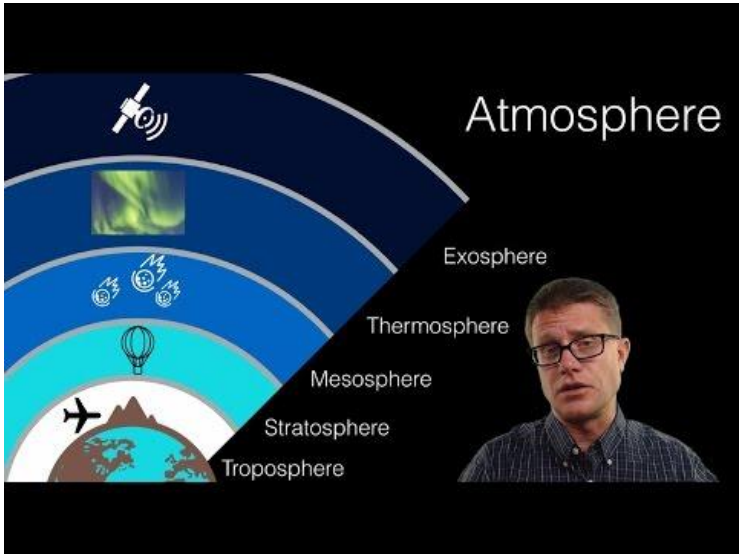
Stratosphere: 7 to 17 km range to about 50 km Temperature increases with height. Ozone—few ppm (Mainly 15 to 35 km)

Troposphere: Surface to between 7 km at the poles and 17 km at equator. Weather variations , vertical mixing

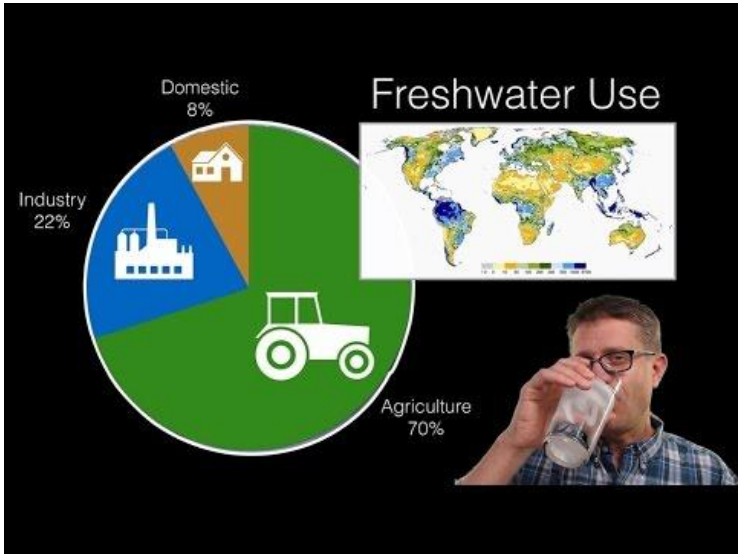




http://www.theozonehole.com/atmosphere.htm



[The Atmosphere](#) **(12.53min)**



[Water Resources](#) **(11.38min)**

[Inside the Earth](#)
(5.05min)

Credit:MT Paul, Bozeman Science, The Atmosphere. Source https://youtu.be/6LkmD6B2nc

Credit:MT Paul, Bozeman Science, Water Resources. Source https://youtu.be/IDAj5T1ST7o

Credit:Mexus Education Pvt.Ltd, Inside the Earth. Source https://youtu.be/N9ncfAsmiSg

Ecosystem

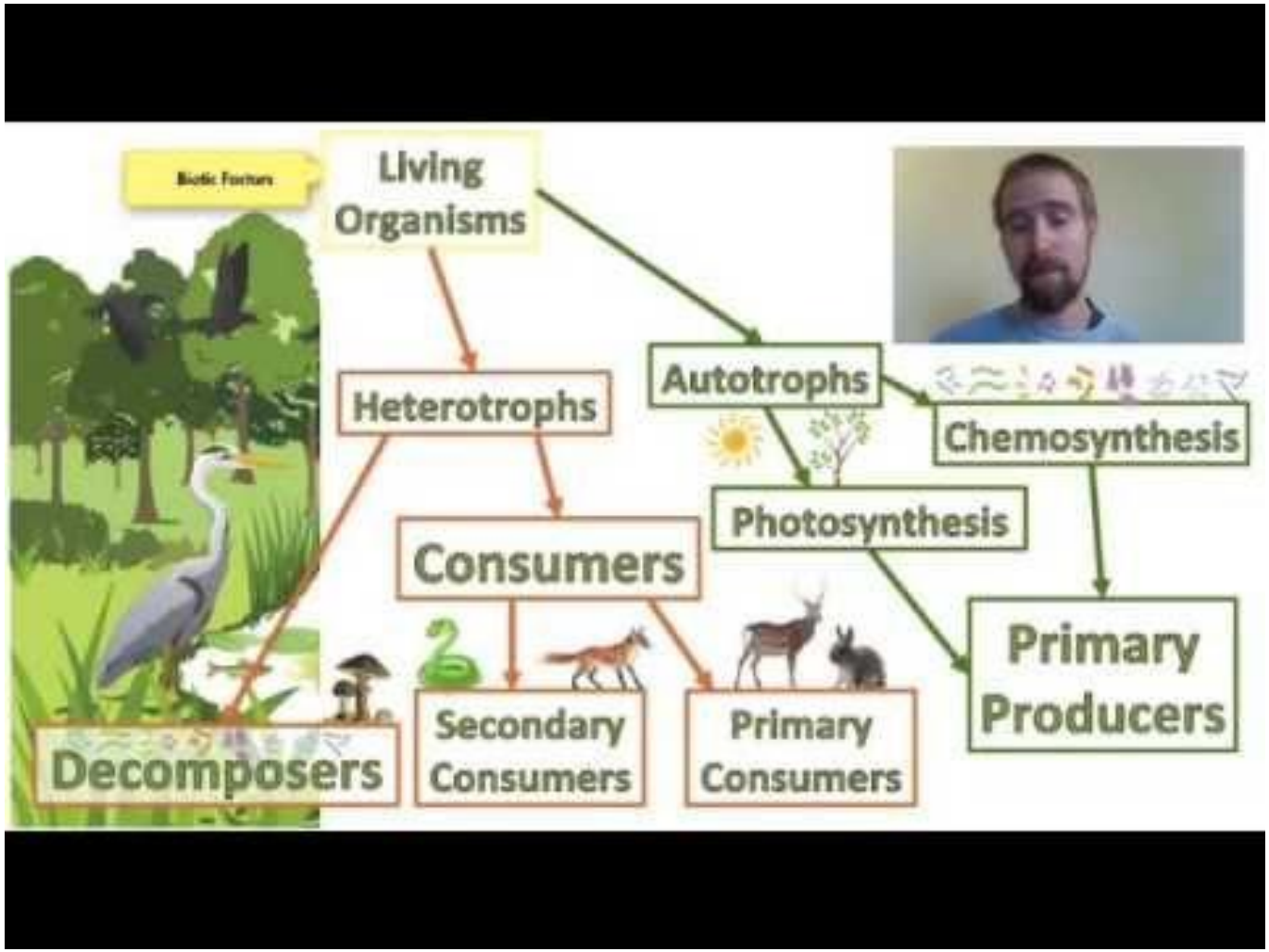
Ecosystem is a functional unit consisting of living and non-living components[ref].

Abiotic factors[ref]:

- Climatic: temperature, rainfall, snow, light levels, wind, humidity
- Edaphic (Soil) Factors: pH, mineral and organic matter, texture

Biotic Factors[ref]:

- Producers (Autotrophs): green plants; chlorophyll
- Consumers (Heterotrophs) pri., sec., ter. consumers
- Decomposers (Saprotrophs): Bacteria, fungi



Ecosystems: Biotic and Abiotic Factors (21.35min)

Credit: Sam Holloway Knowles Science Teaching Foundation, Ecosystems: Biotic and Abiotic Factors. Source: https://www.youtube.com/watch?v=NHetWkxhpAg

Organization of the Ecosystem ref

Individual, Species, Organism: An individual living thing, genetically similar enough to breed and produce live, fertile offspring in nature ref

Population: All members of a individual that live in the same area at the same time ref

Biological Community: All populations living and interacting in an area ref

Ecosystem: A biological community and its physical environment ref

Biome: is a set of ecosystems sharing similar characteristics with their abiotic factors adapted to their environments ref

Biosphere: A biosphere is the sum of all the ecosystems established on planet Earth. It is the living (and decaying) component of the earth system ref

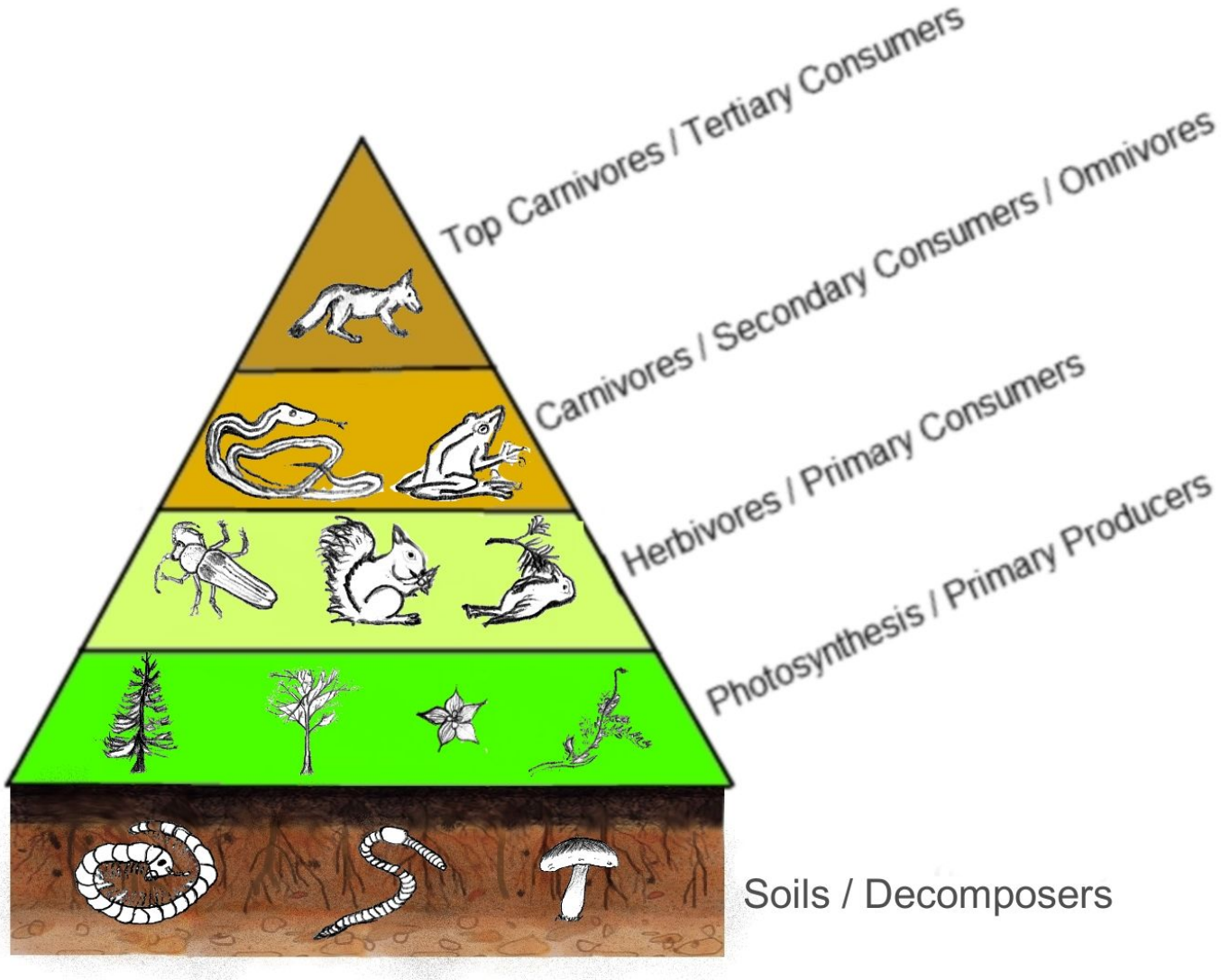
Types of Ecosystems ref

Natural, Artificial

Aquatic Ecosystem: An ecosystem which exists in a body of water is known as an aquatic ecosystem. Majorly two types, **Freshwater ecosystems** and **Marine ecosystems** ref

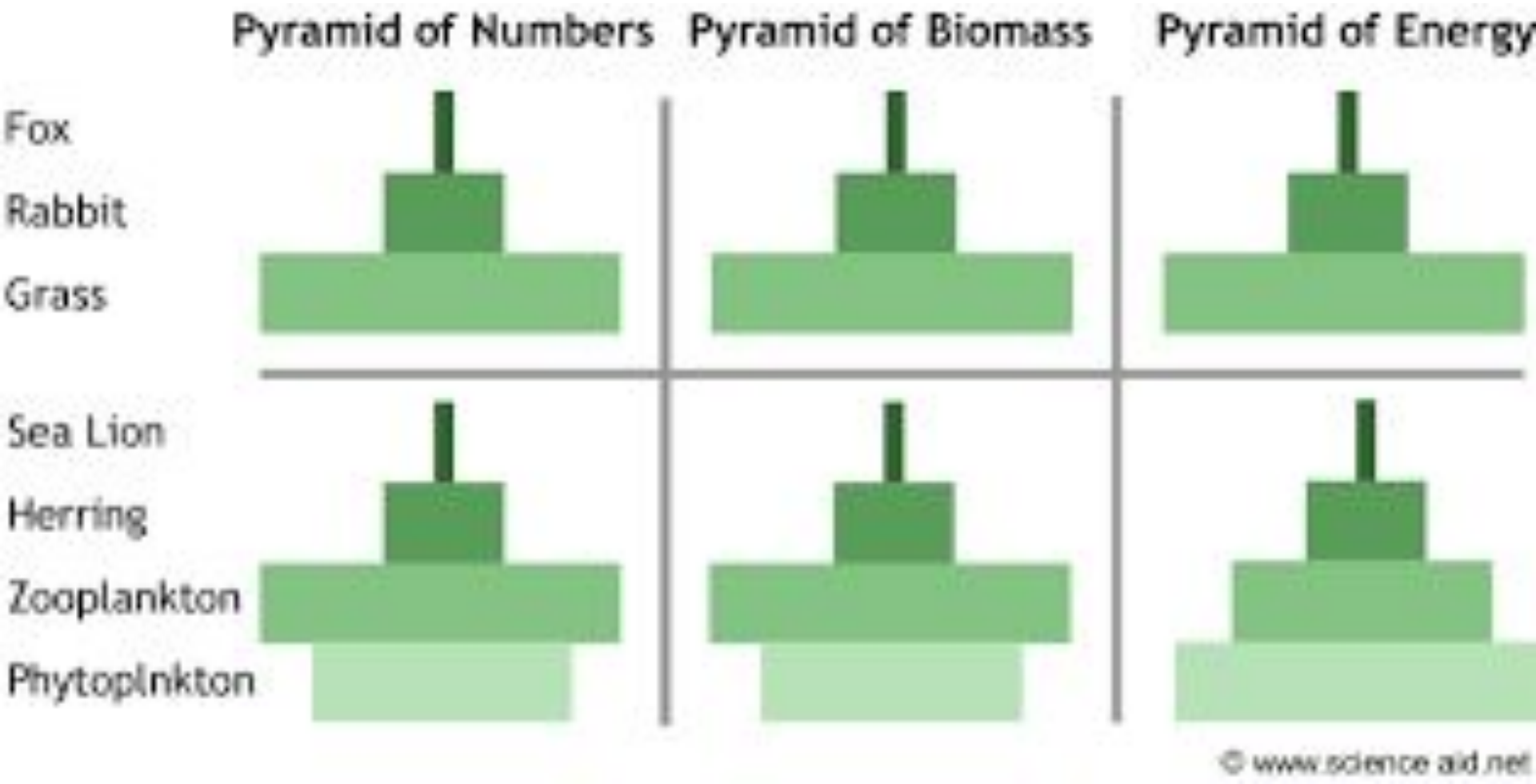
Terrestrial Ecosystem: The ecosystem which is found only on landforms is known as the terrestrial ecosystem. The main types of terrestrial ecosystems are **forest ecosystems, desert ecosystems, grassland ecosystems and mountain ecosystems.** ref

Structure of the Ecosystem - Ecological Pyramids or Trophic Pyramids



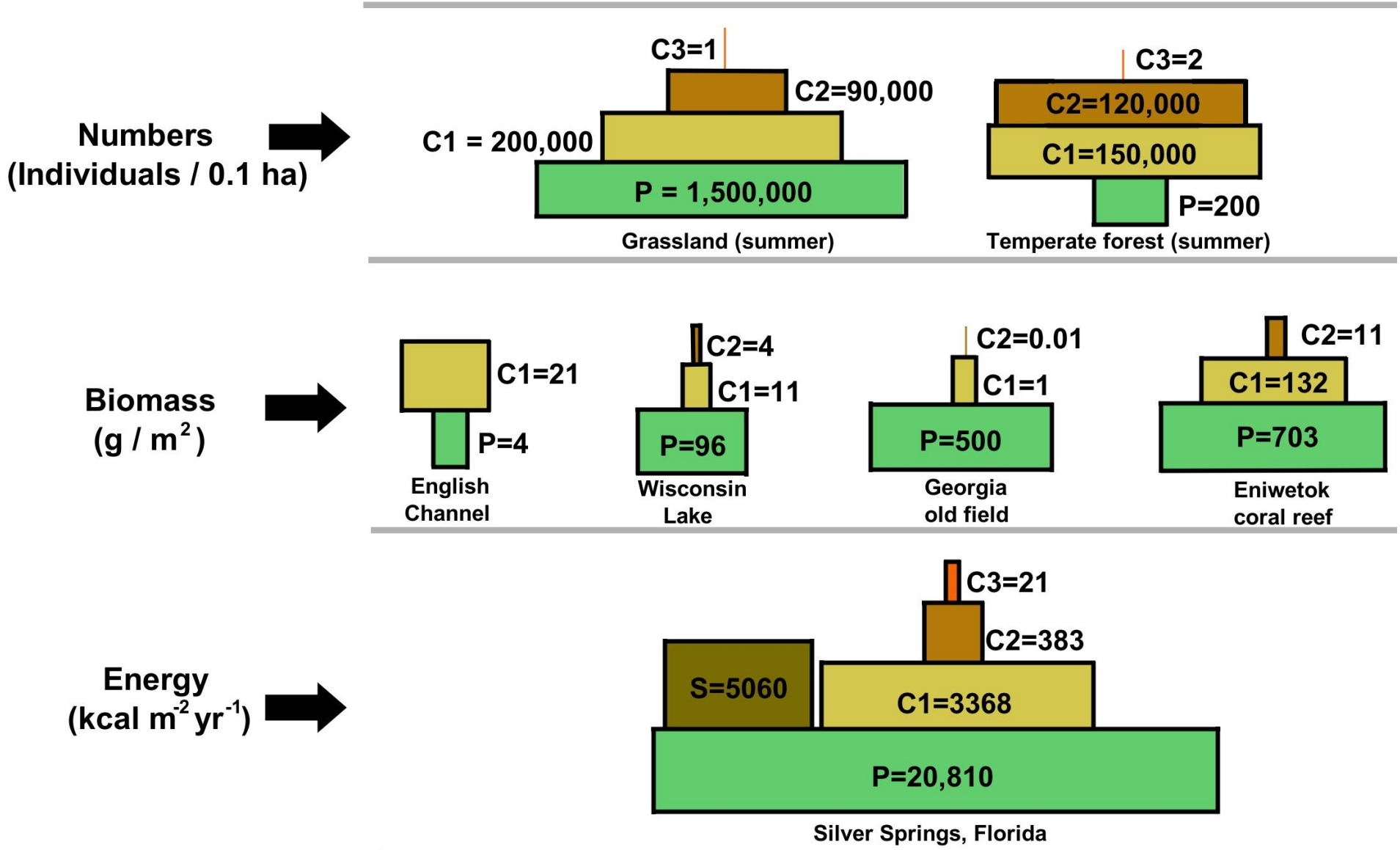
https://en.wikipedia.org/wiki/Food_web

Types of Ecological Pyramids or Trophic Pyramids: Terrestrial Vs Aquatic Ecosystem



http://scienceaid.co.uk/biology/ecology/food.html

Variations in Ecological Pyramid



https://en.wikipedia.org/wiki/Food_web

Ecosystem Functions[ref], [ref]

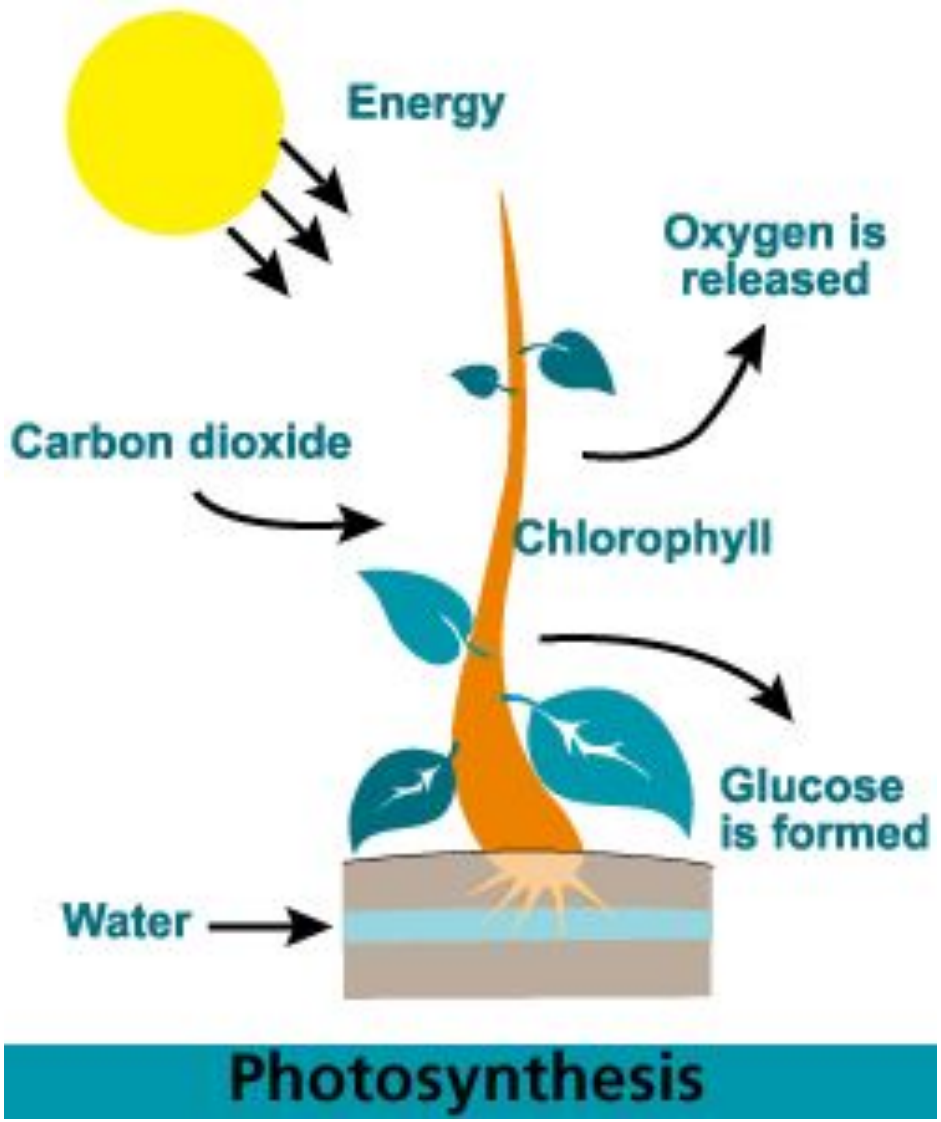
Productivity - Food Production

Energy Flow - Food Chain, Food Web

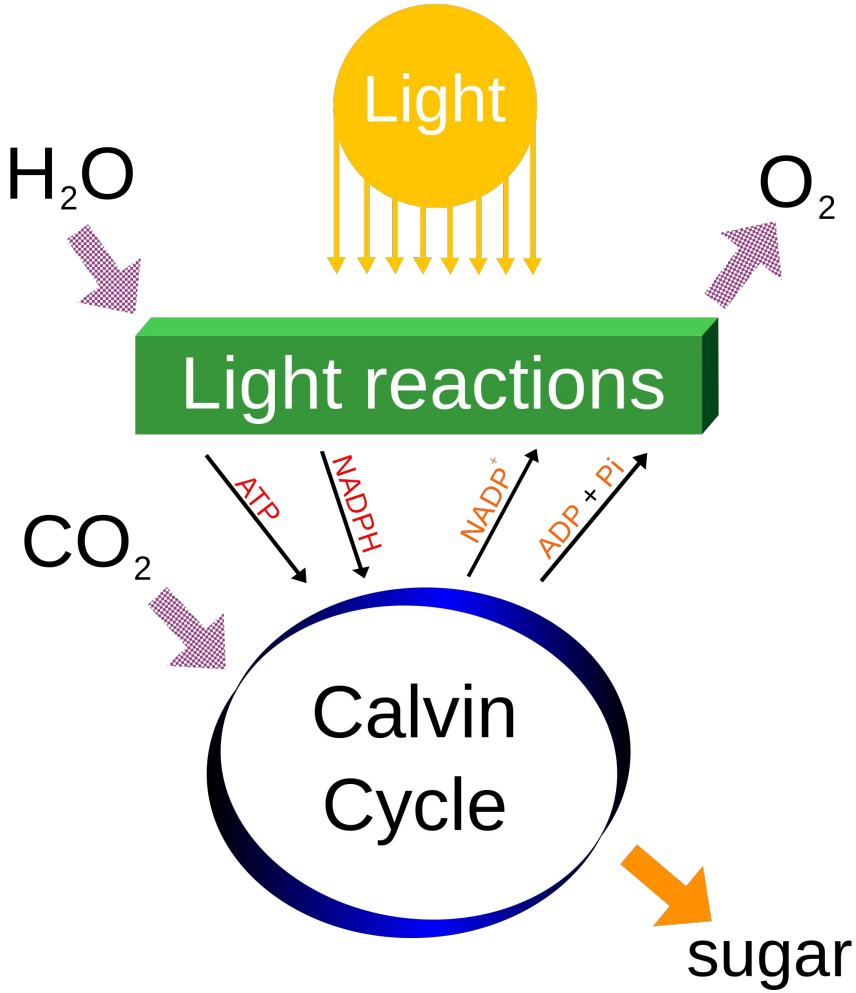
Nutrient recycling - Biogeochemical Cycles

Development and Stabilization - Associations, Adaptations, Succession

Productivity - Food Production

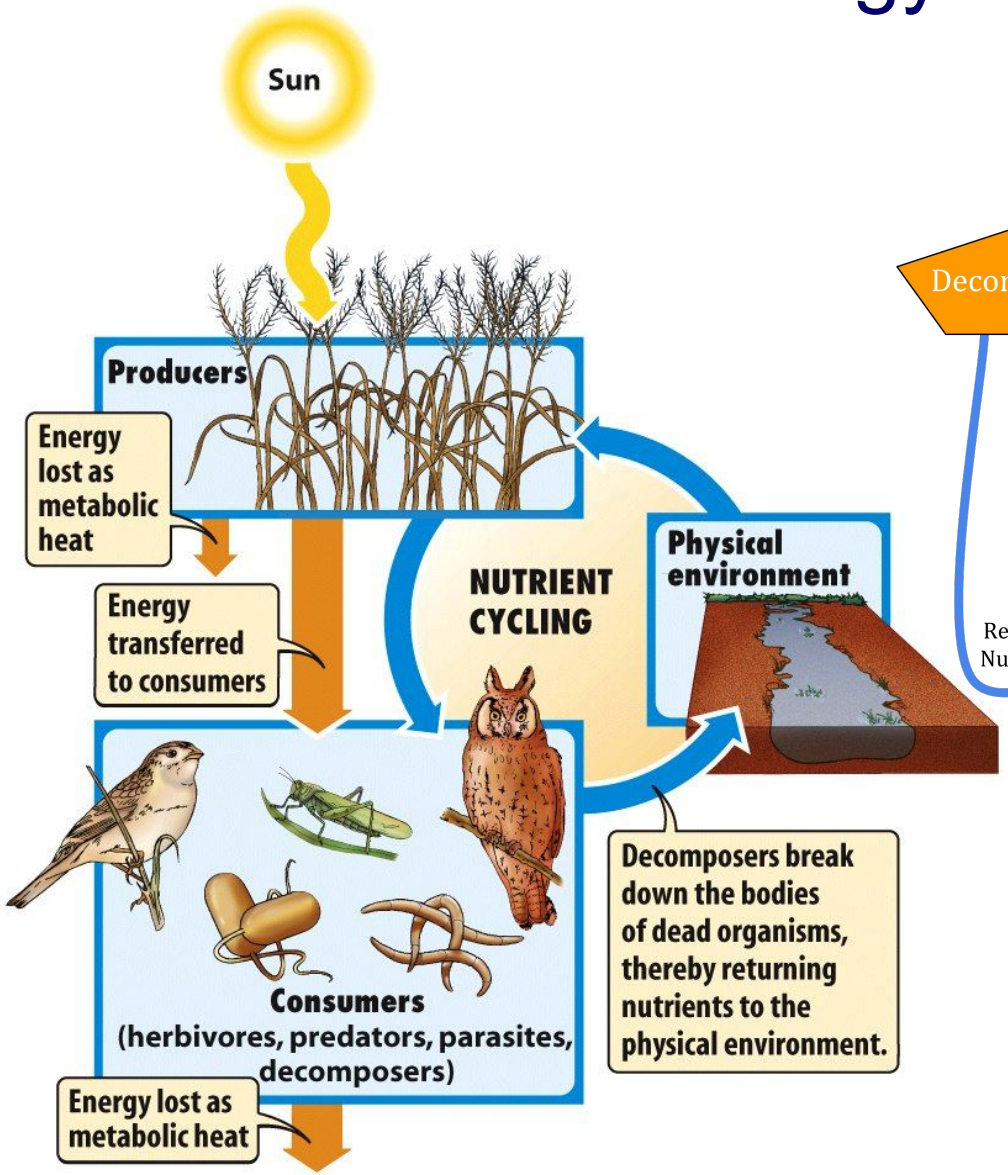


https://upload.wikimedia.org/wikipedia/commons/a/a2/Photosynthesis_Block_diag.gif



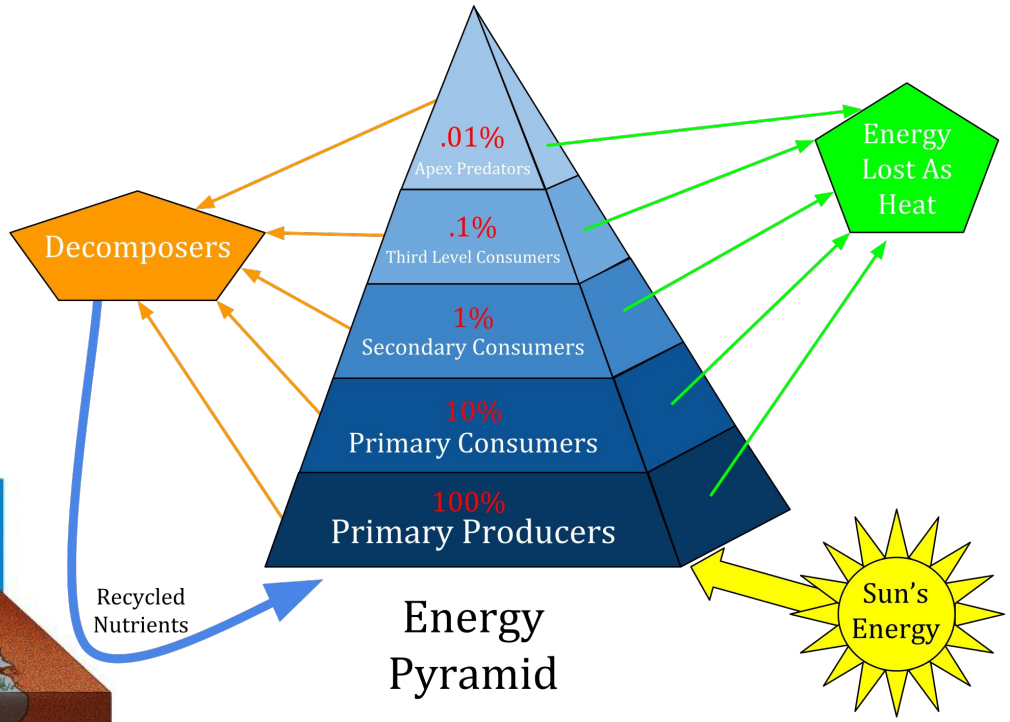
https://en.wikipedia.org/wiki/Photosynthesis

Energy Flow



ONE-WAY FLOW OF ENERGY THROUGH THE ECOSYSTEM

Figure 37-1 Discover Biology 3/e



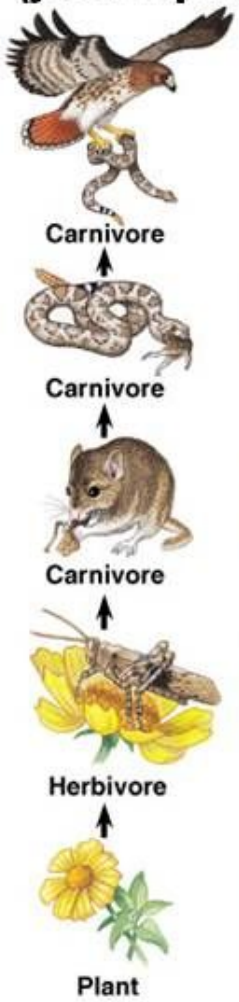
Energy Pyramid

https://upload.wikimedia.org/wikipedia/commons/thumb/3/3a/Ecological_Pyramid.svg/2000px-Ecological_Pyramid.svg.png

https://encrypted-tbn1.gstatic.com/images?q=tbn:ANd9GcRzjOz_0Z0hjtz-ioqM43GrS3M9qDzOnXmtwQPp0BA6TFDfDpFC7g

Food Chain

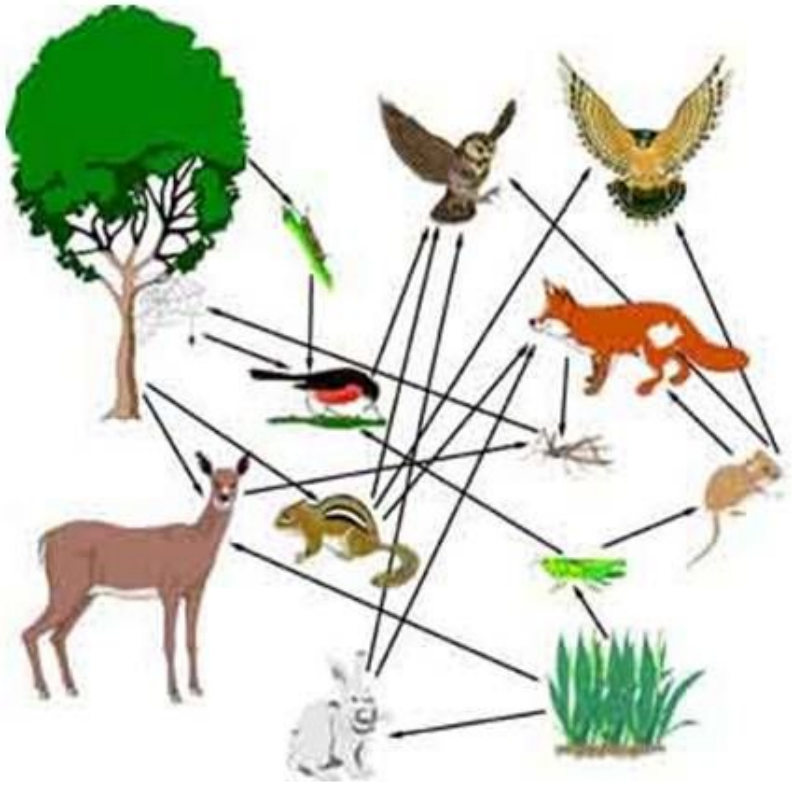
(just 1 path of energy)



Quaternary consumers	5th trophic level
Tertiary consumers	4th trophic level
Secondary consumers	3rd trophic level
Primary consumers	2nd trophic level
Primary producers	1st trophic level

Food Web

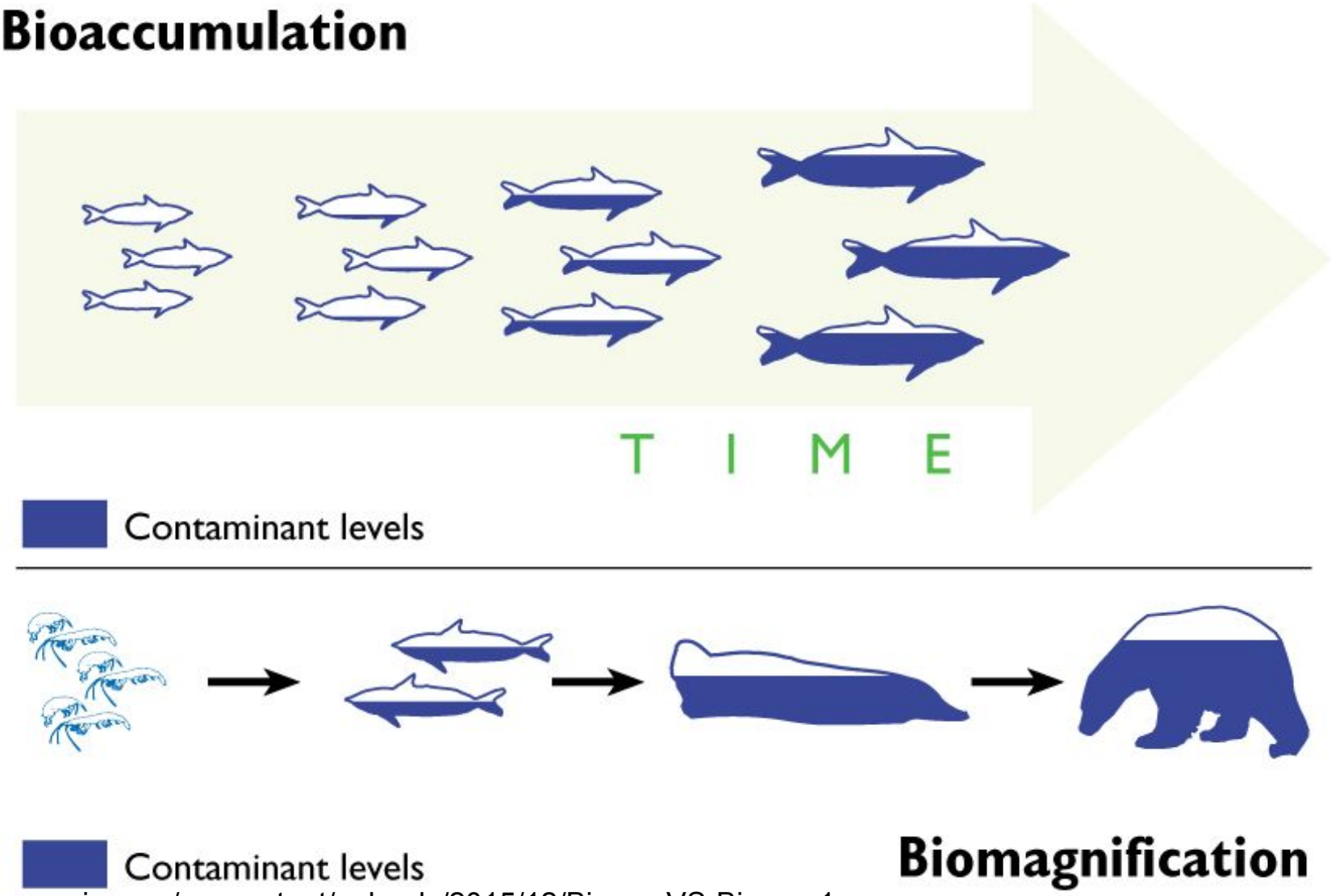
(all possible energy paths)



The *arrow* points to the eater and shows the transfer of energy.

https://encrypted-tbn1.gstatic.com/images?q=tbn:ANd9GcTsDoYoxXGLYH2SGytHwsD2fyUZEuA232wDRu4pn9AfnbGF-xRh8w

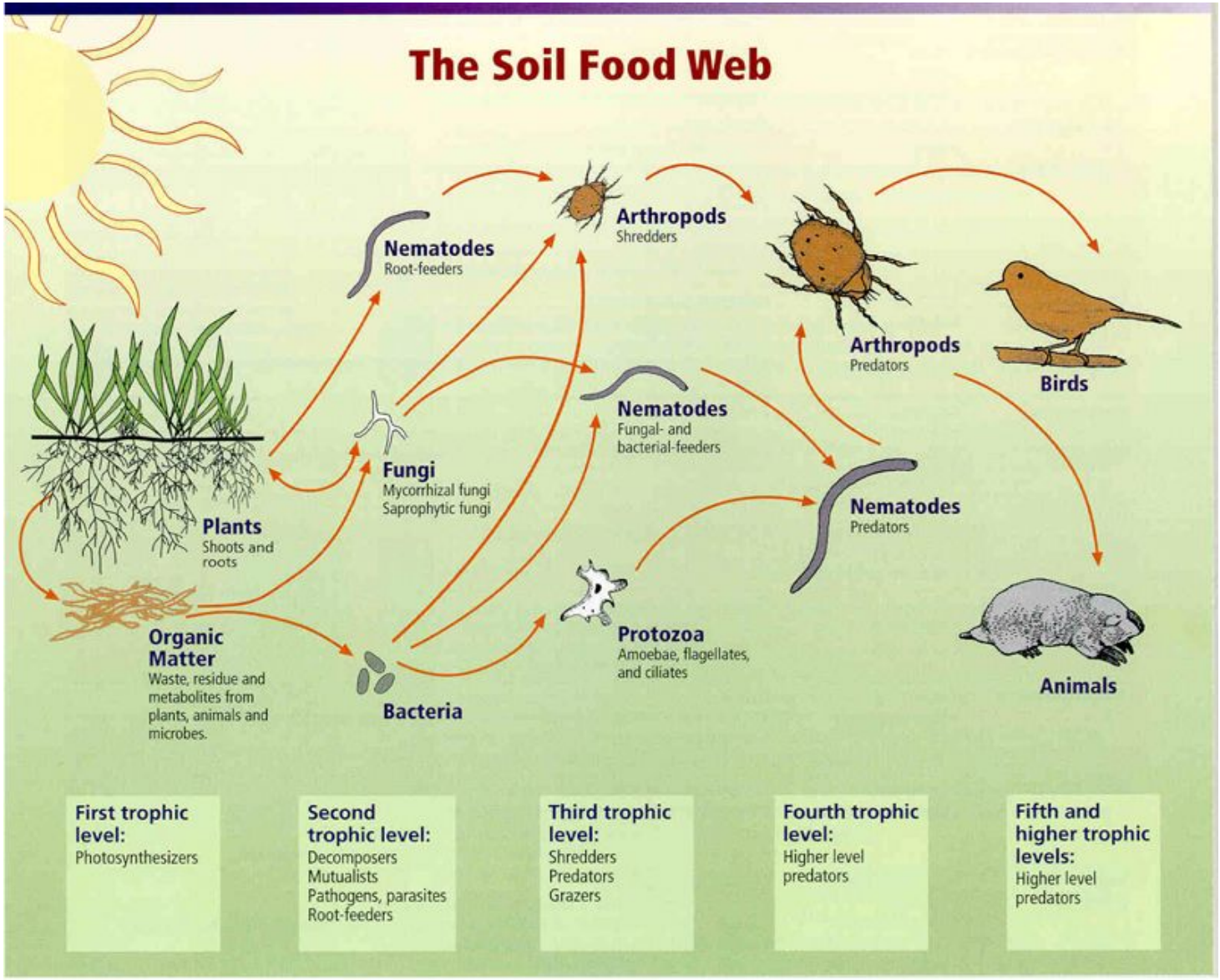
Flow of Chemical and Pollutants through Food Chain



http://iasmania.com/wp-content/uploads/2015/12/Bioacc-VS-Biomag1.png

Detritus Food Chain

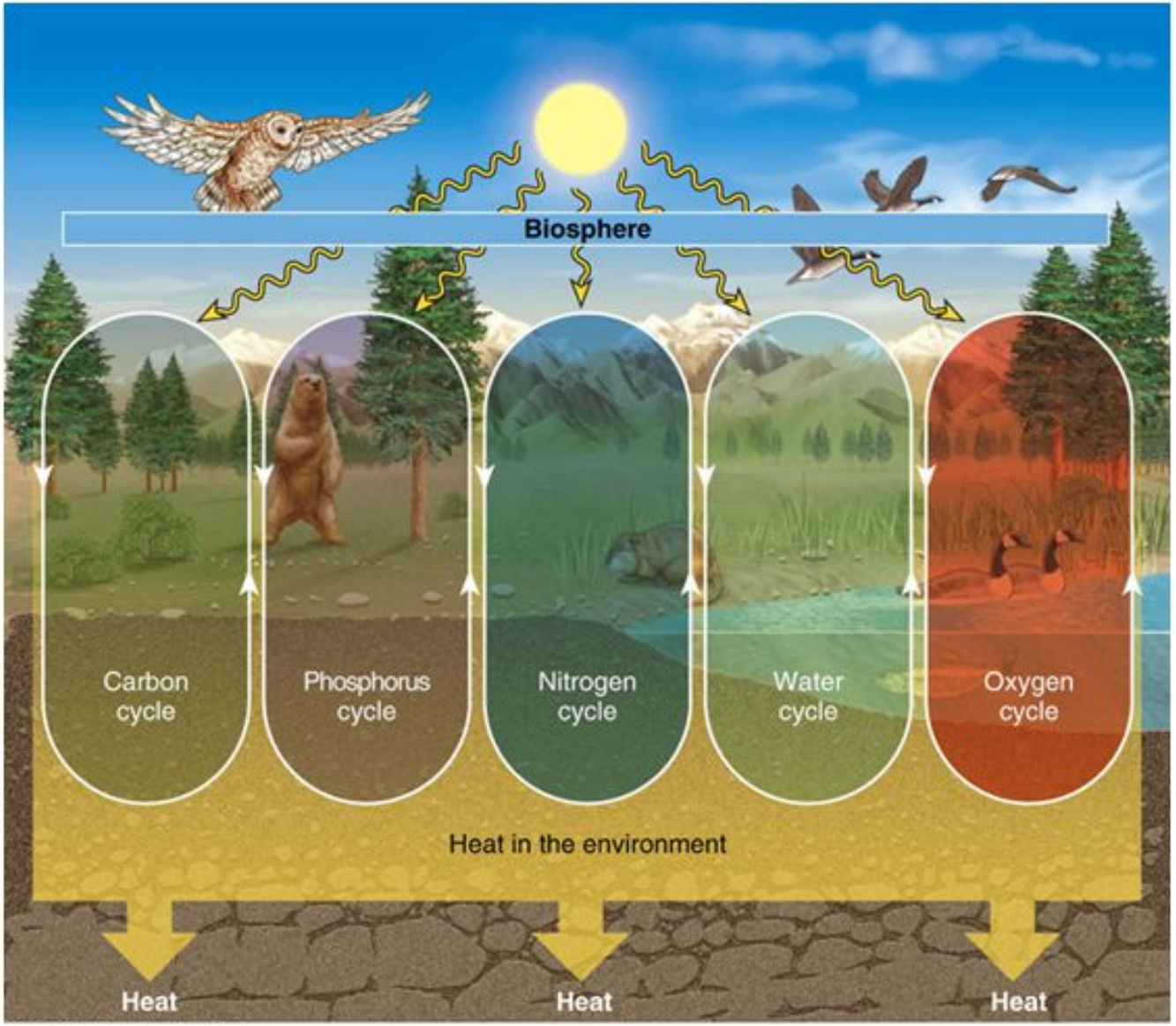
- Less dependent on direct sunlight
- Depends on influx of organic matter from another system
- Generally small
- E.g. Mangrove leaves (detritus)—microorganisms—crabs
- E.g. Caves: bat colonies—guano—organisms (salamanders)
- E.g. Ocean floor—dead carcasses—organisms feeding on it.



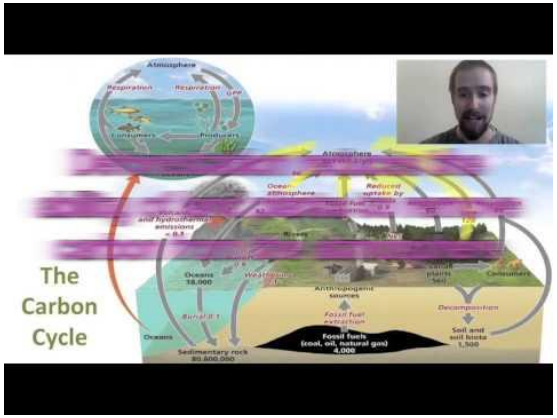
Relationships between soil food web, plants, organic matter, and birds and mammals
Image courtesy of USDA Natural Resources Conservation Service
http://soils.usda.gov/sqi/soil_quality/soil_biology/soil_food_web.html.

https://en.wikipedia.org/wiki/Food_web

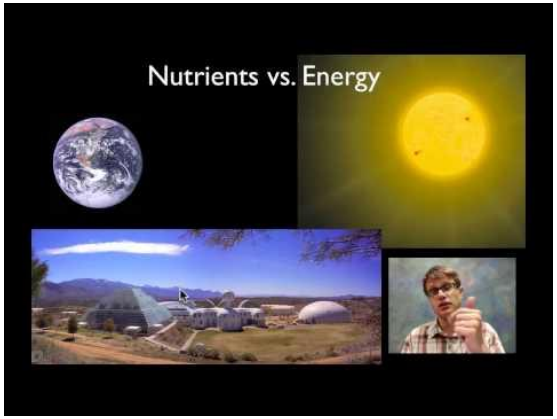
Nutrient recycling - Biogeochemical Cycles



http://1.bp.blogspot.com/-sSscHv8Kmtw/VUQHMBL1rSI/AAAAAAAAB18/YKOplqNSdTM/s1600/1A%2B-%2BBiogeochemical%2BCycle%2BComponents.jpg



Biogeochemical Cycles
(22.23min)



Biogeochemical Cycling
(10.04min)

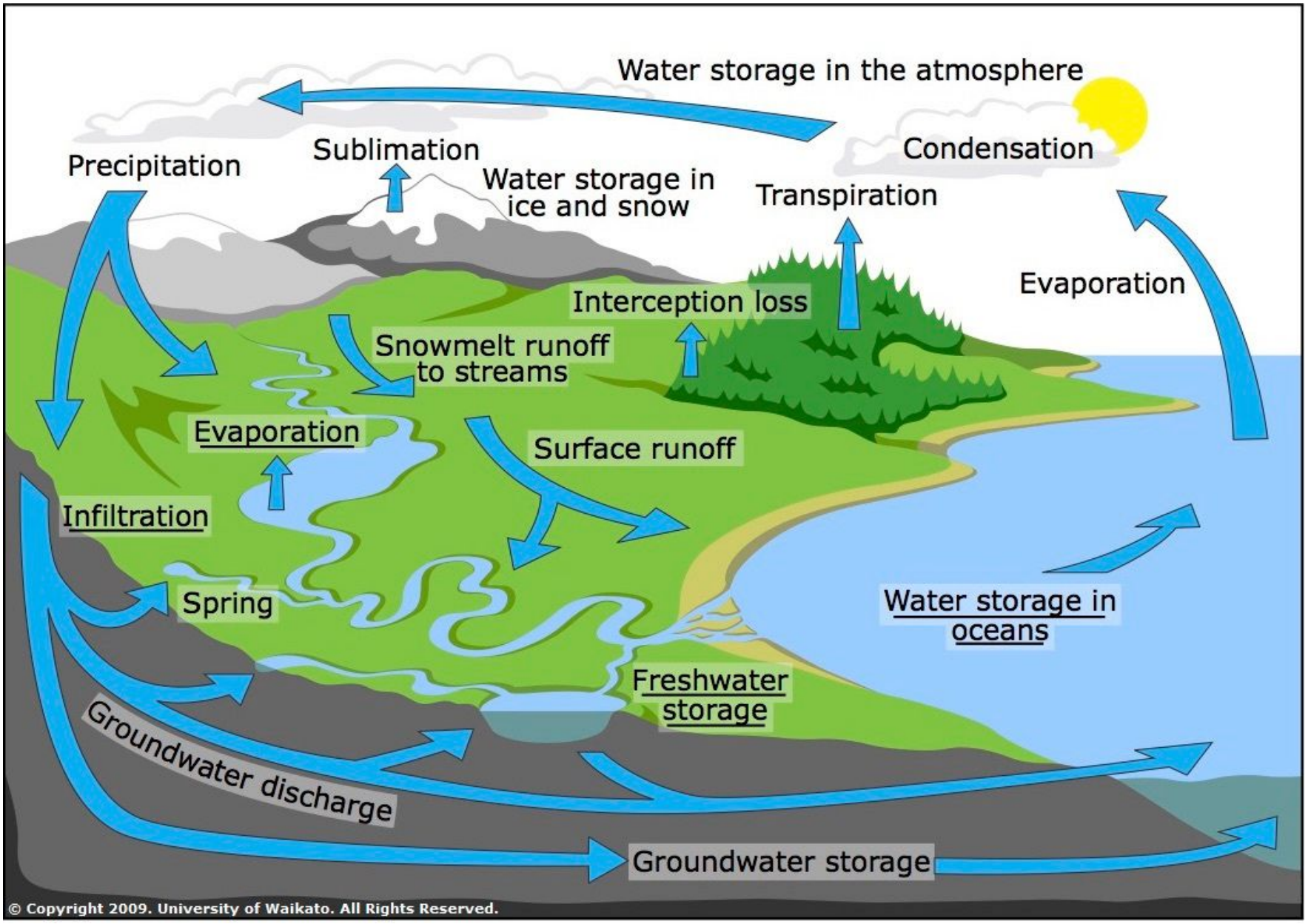
Jane Poynter: Life in Biosphere 2
(15.50min)

Credit:Sam Holloway Knowles Science Teaching Foundation, Biogeochemical Cycles. Source https://youtu.be/dJazhP4cnR8

Credit:MT Paul, Bozeman Science, Biogeochemical Cycling. Source https://youtu.be/09_sWPxQymA

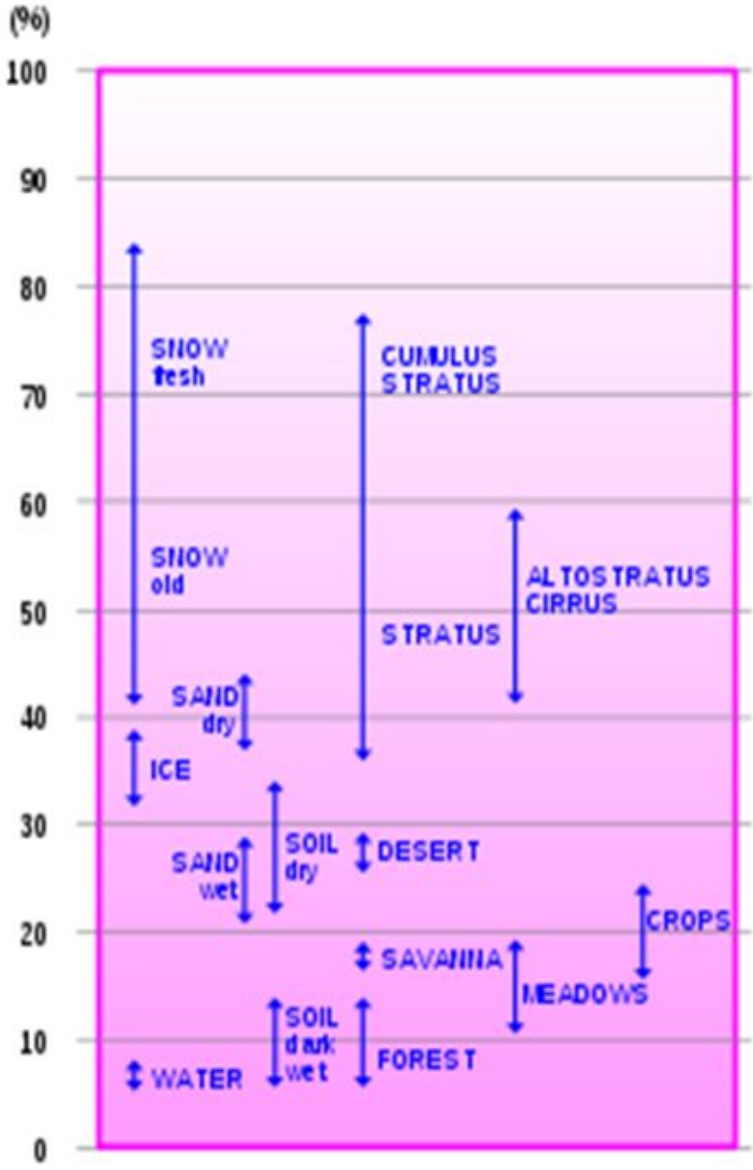
Credit:TED, Jane Poynter: Life in Biosphere 2. Source https://youtu.be/a7B39MLVeIc

Hydrological Cycle



Hydrological Cycle & Earth's Albedo

- Evaporation—cloud formation
- Increased albedo or *reflection coefficient* is a measure of the 'whiteness' of the earth when viewed through space.
- Greater the albedo→lower is the solar radiation absorbed by the earth→lower is the temperature of the globe (Greater cooling).



https://upload.wikimedia.org/wikipedia/commons/thumb/1/18/Albedo-e_hg.svg/549px-Albedo-e_hg.svg.png

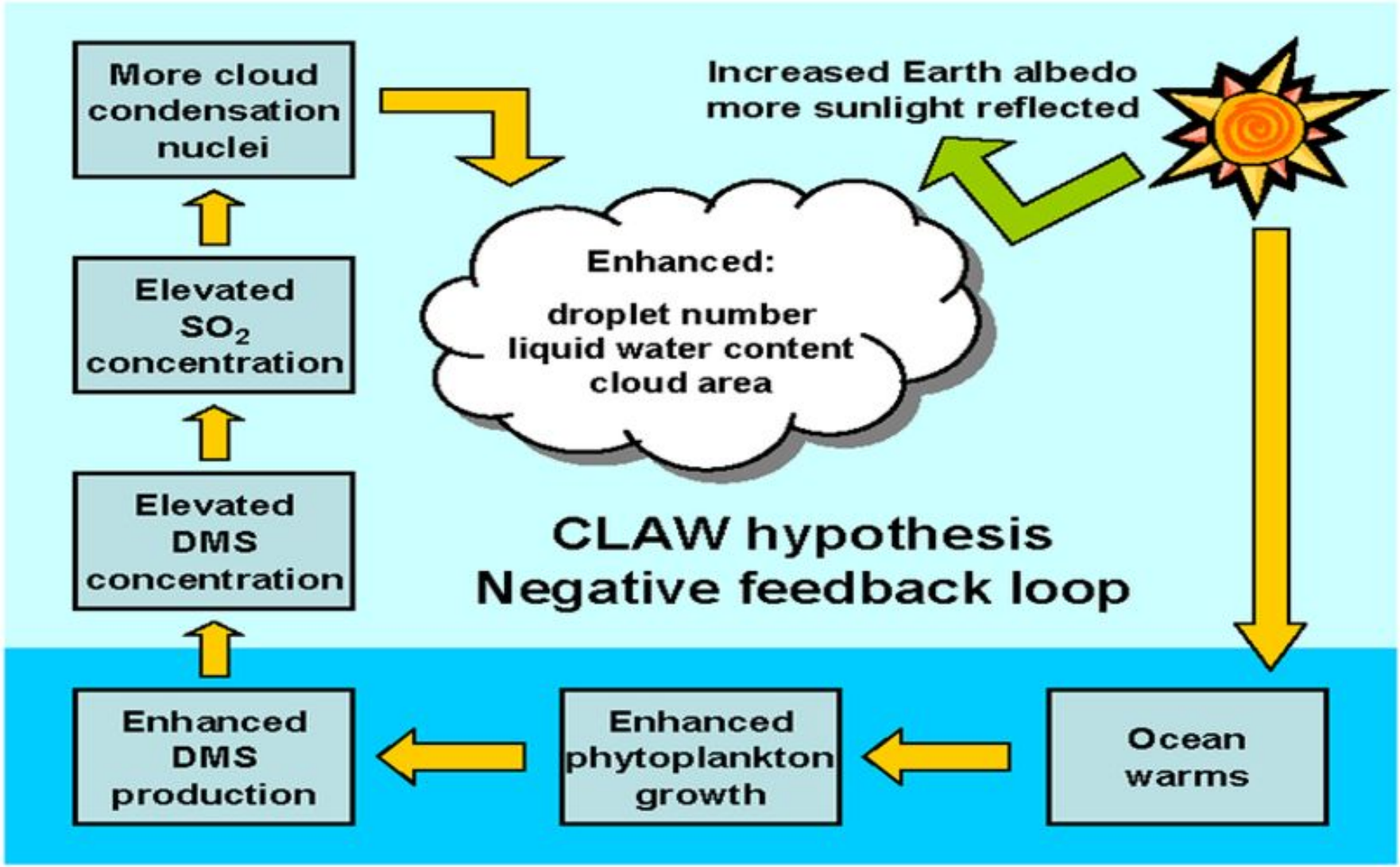
Albedo and Tree Cover

- Trees tend to have a low albedo
  - Deciduous trees: 0.15-0.18 (15-18%)
  - Coniferous trees 0.09-0.15 (9-15%)
- Hence, removing forests → increases albedo →localized climate cooling.
- However, trees also provide local evaporative cooling and carbon sequestration; loss of trees reduces these cooling effects.
- Cloud feedbacks and snow cover further complicate the issue.
- Studies of new forests indicate:
  - A net cooling effect in tropical and mid-latitude areas
  - A net neutral or slightly warming effect in high latitudes (e.g. Siberia)

•Betts, Richard A. (2000). "Offset of the potential carbon sink from boreal forestation by decreases in surface albedo". *Nature* **408** (6809): 187–190. doi:10.1038/35041545.PMID 11089969.

Phytoplankton, Clouds, Albedo

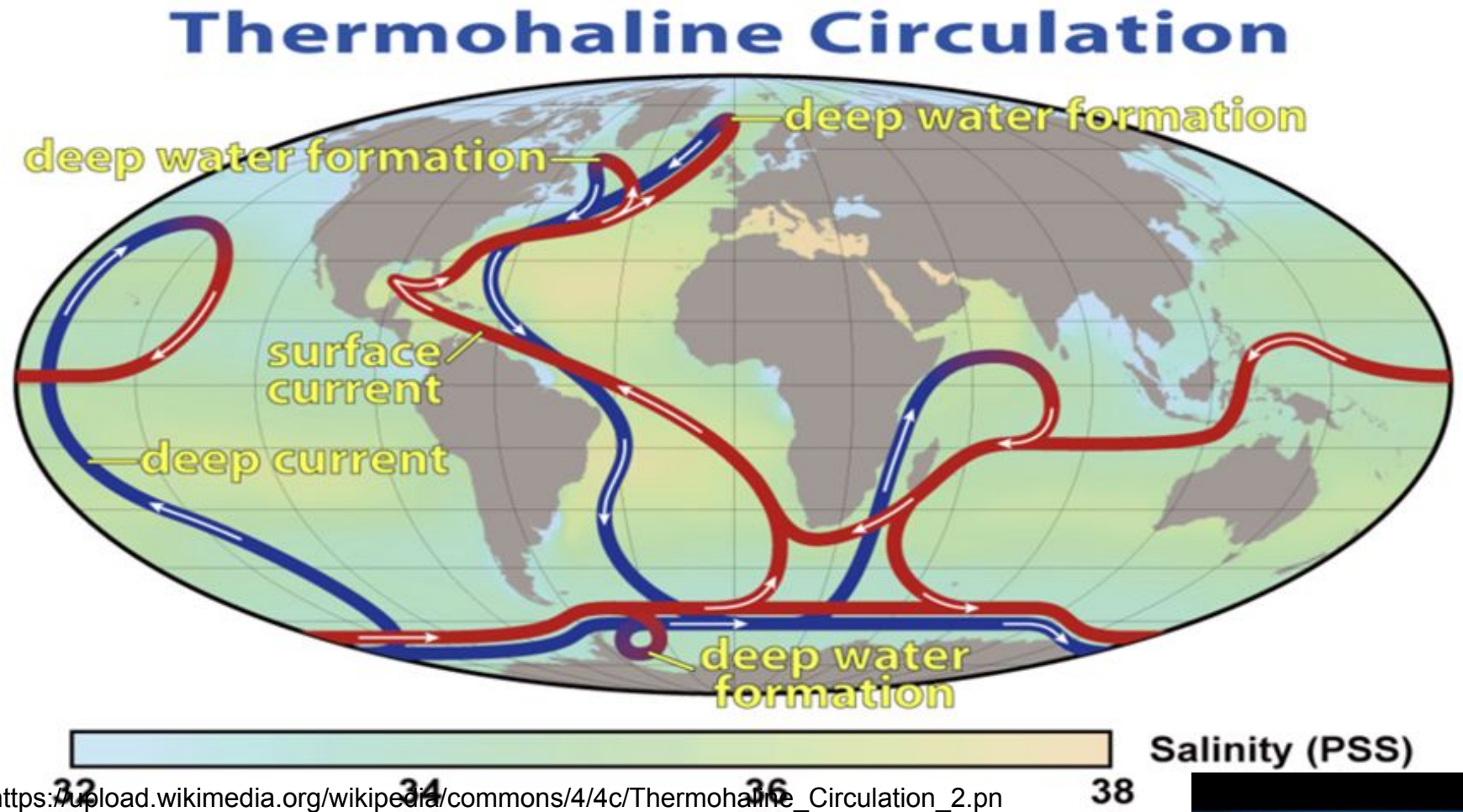
- Phytoplankton produce dimethylsulfoniopropionate (DMSP)
- Converted to Dimethyl sulfide (DMS) in ocean
- Escapes to atmosphere, oxidizes to SO_2 and nucleates clouds.
- This is an example of how the biosphere (plankton) regulates the hydrosphere (global precipitation), earth's albedo and global temperature.
- **CLAW Hypothesis:** negative feedback; regulation of global temperature.
- **Anti-CLAW Hypothesis:** positive feedback; escalation of global warming.



Mild warming due to CO_2 emissions → warmer oceans→ more phytoplankton → more DMS → More clouds → cooling (negative feedback; regulation)

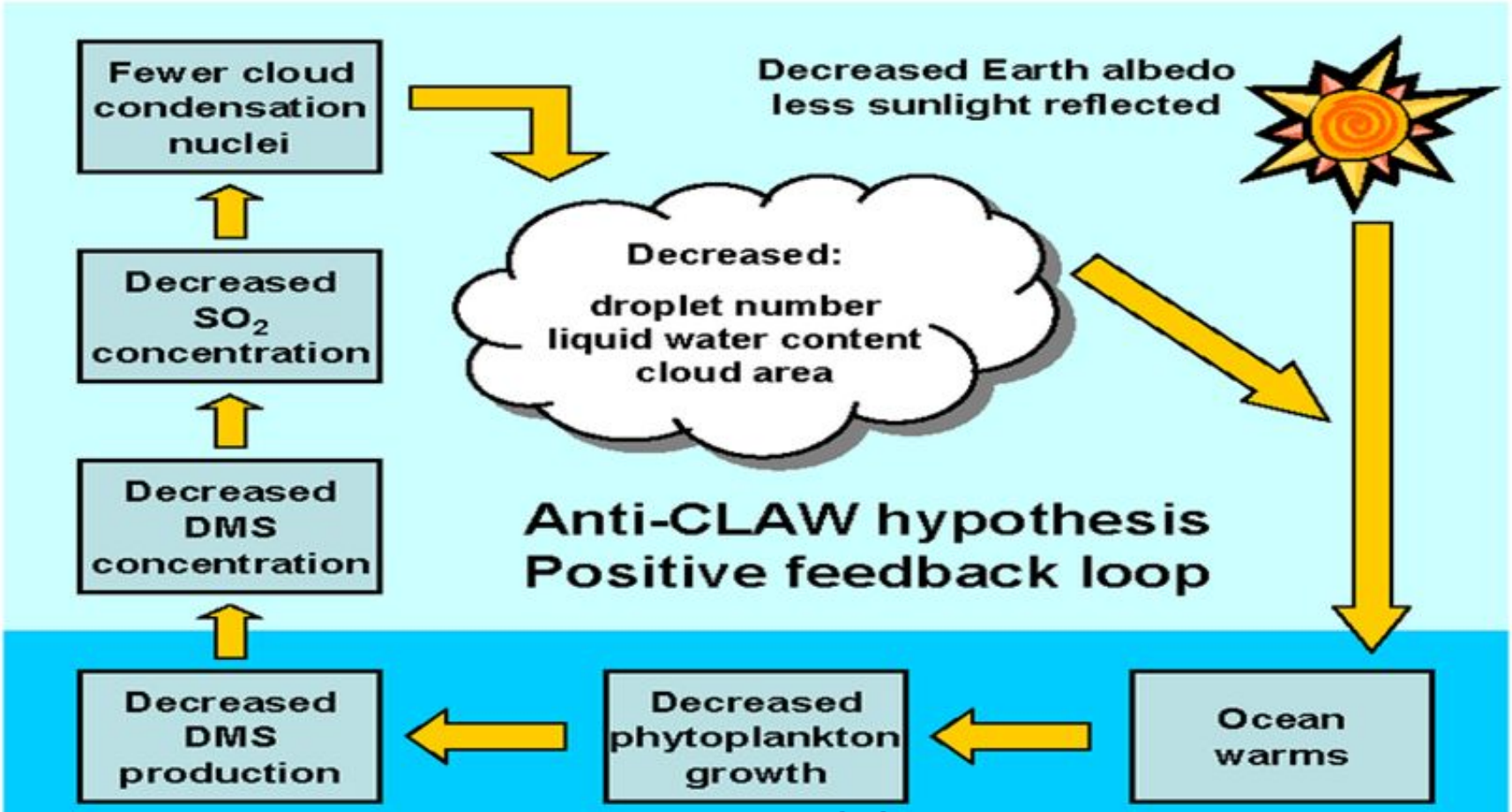
https://upload.wikimedia.org/wikipedia/en/thumb/f/f5/CLAW_hypothesis_graphic_1_AYool.png/598px-CLAW_hypothesis_graphic_1_AYool.png

Global Conveyer Belt



https://upload.wikimedia.org/wikipedia/commons/4/4c/Thermohaline_Circulation_2.png

Video: The Gulf Stream Explained (5 min)



Excessive warming due to massive CO_2 emissions → melting of ice caps → **Meltwater pouring into the oceans → stalling of thermohaline ocean currents → ocean stratification** → less transport of nutrients from ocean bottom to euphotic zone → less phytoplankton → less DMS → less clouds → more heating (positive feedback; escalation)

https://upload.wikimedia.org/wikipedia/en/c/cc/CLAW_hypothesis_graphic_2_AYool.png

Plants: Significance in Water Cycle

- Taproots go upto 100x deeper than canopy
- Short-circuit pathways for soil water redistribution
- In dry spells, water from below brought to surface, to increase nutrient extraction, photosysnthesis and transpiration.
- In wet spells, promote percolation

Plants: Significance in Water Cycle

- Plants pump huge quantities of water from soil to air.
  - 100s to 1000s L/day
  - Regulate T and humidity. In a clearing in Nigeria, soil T upto 5°C higher; humidity reduced by 50% compared to adjacent forest.
- Evapo-transpiration of trees—nature's pump and cooler
- Drop in Amazon's temperature in June/July is due to transpiration.
- Transpiration: 40% of Amazonian rain is from transpiration
- Afforestation efforts: appropriate types and density.

●/http://www.i-sis.org.uk/LOG4.php

Importance of Rainforests

- 25% of rain never reaches the ground.; wets canopy and evaporates
- 25% of total—runoff
- 50% of total pumped up and transpired by plants.
- 75% of rainwater is returned to the atmosphere; new clouds, new rain,
- Colossal heat pump—energy of six million atom bombs/day; redistributes energy to higher latitudes
- Up to 80% incident solar energy carried by hot, humid air;
  - rises rapidly and develops into thunder clouds that simultaneously
  - ater areas further downwind
  - releases latent heat

Importance of Rainforests

- Absorb 2 billion tonnes of CO_2/yr; about 20-30% of fossil C emissions
- Destruction of the Amazon:
  - May stall the heat pump
  - Accelerate drought and desertification (positive feedback)
  - Loss of CO_2 sink; accelerate global warming.
  - Reforestation cannot replace natural stands. Loss of soil carbon.

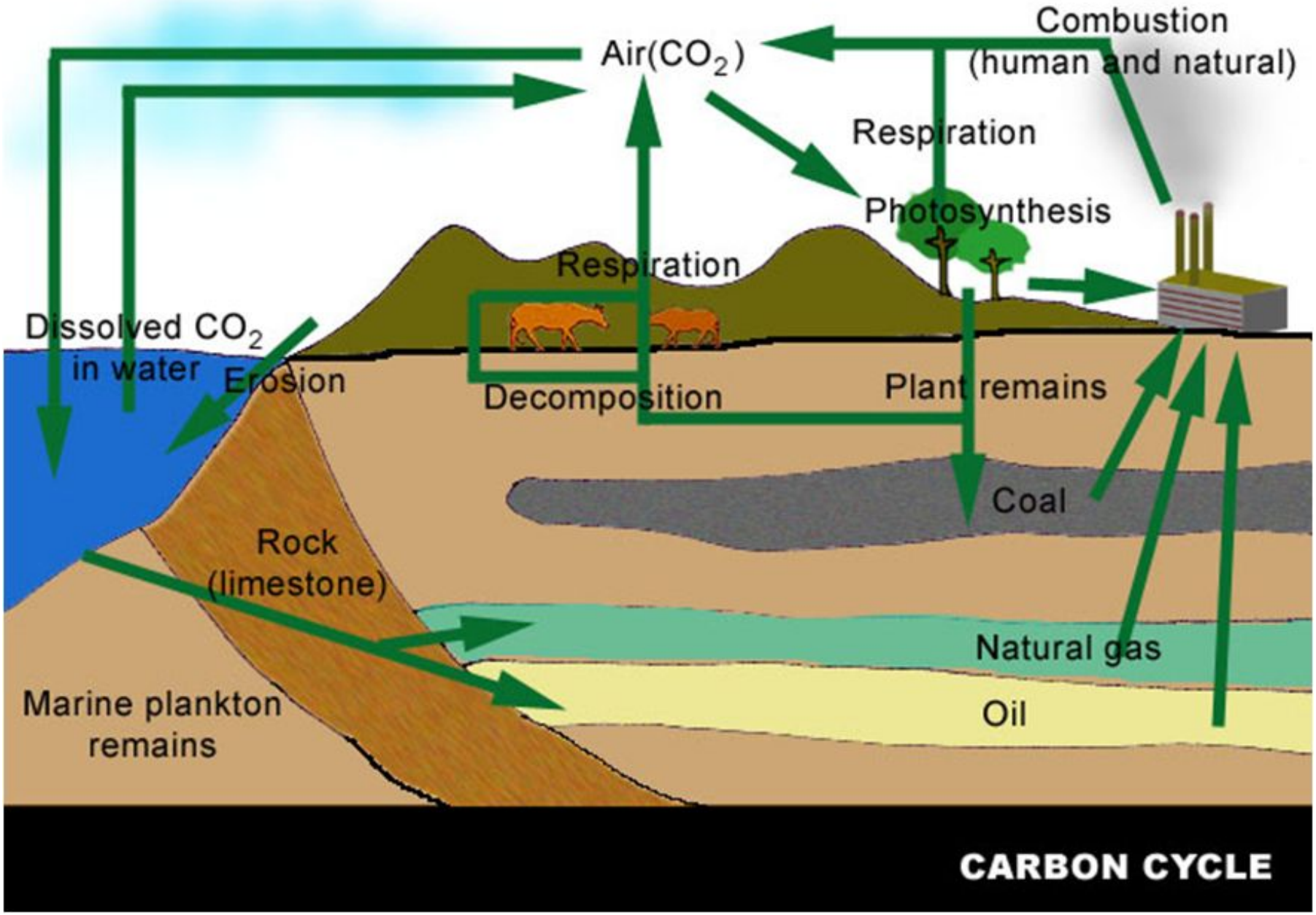
Sources:
Prof. Eneas Salati from the University of São Paulo, Piracicaba – Brasil
http://www.fgaia.org.br/texts/e-rainforests.html
http://www.hydrogen.co.uk/h2_now/journal/articles/1_global_warming.htm
http://www.hydrogen.co.uk/h2_now/journal/articles/2_global_warming.htm
http://www.greendiary.com/entry/increasing-global-warming-decreases-forests-co2-absorption-capacity
http://www.i-sis.org.uk/LOG4.php

Human impacts on hydrologic cycle

- Damming rivers increases evaporation and infiltration
- Altering the surface and vegetation increases runoff and erosion
- Spreading water on agricultural fields depletes rivers, lakes and streams
- Removing forests and vegetation reduces transpiration and lowers water tables
- Emitting pollutants changes the nature of precipitation
- The most threatening impact is overdrawing groundwater for drinking, irrigation, and industrial use

Availability of Carbon

- Earth's C content = 0.19% (0.032% in lithosphere)
- Atmospheric CO_2 is the main utilizable reservoir
- 18% in biomass
- Main reservoirs air, rocks (carbonates), oceans.



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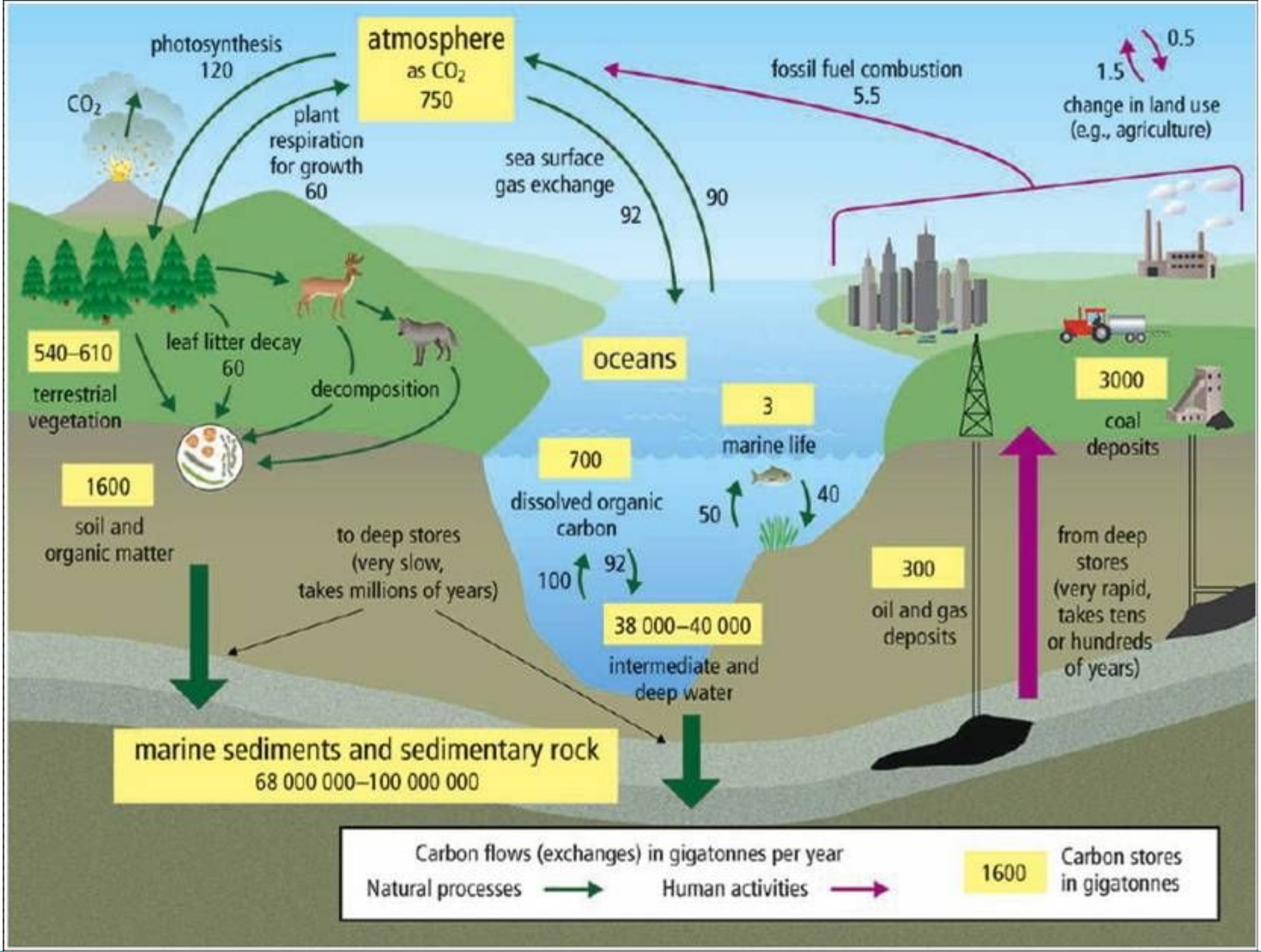

photosynthesis
120
atmosphere
as CO_2
750
CO_2
plant
respiration
for growth
60
fossil fuel combustion
5.5
1.5
0.5
change in land use
(e.g., agriculture)
sea surface
gas exchange
92
90
540–610
terrestrial
vegetation
leaf litter decay
60
decomposition
oceans
3
marine life
700
dissolved organic
carbon
50
40
100
92
1600
soil and
organic matter
to deep stores
(very slow,
takes millions of years)
38 000–40 000
intermediate and
deep water
300
oil and gas
deposits
3000
coal
deposits
from deep
stores
(very rapid,
takes tens
or hundreds
of years)
marine sediments and sedimentary rock
68 000 000–100 000 000
Carbon flows (exchanges) in gigatonnes per year
Natural processes
Human activities
1600
Carbon stores
in gigatonnes

Potential contributors to climate change

- Complex interactions in the climate puzzle
- Feedback mechanisms
- Some interesting twists
  - Increasing temp. reduces CO_2 solubility (reduced C-sink capacity of the ocean)
  - Ocean Acidification reduces C-sequestration in the form of $CaCO_3$
  - 740ppm CO_2 in water by 2100. Reduction in population of mussels by 25% and oysters by 10%
  - At 1800ppm, shells will dissolve

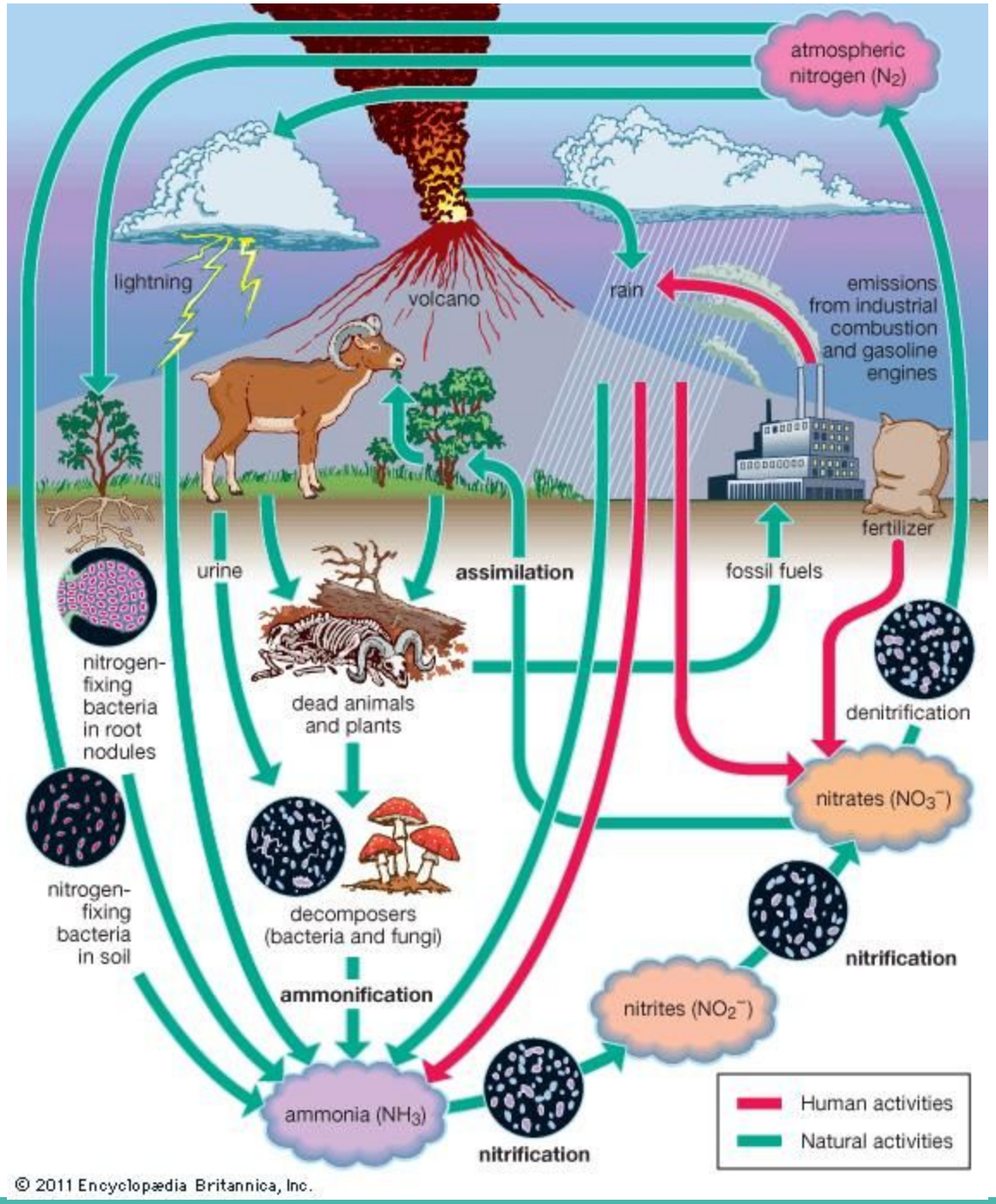
Human Impacts on Carbon Cycle

- Burning of Fossil fuels
- Deforestation and Poor Agricultural practices
- Increase in atmospheric greenhouse gasses

such as CO_2, methane, SO_X, NO_X, etc. leads to Greenhouse effect, global warming and climate change.

Nitrogen Reservoir

- N is an essential component of proteins, nucleic acids and other cellular constituents.
- **Reservoirs –** 79% of the atmosphere is N_2 gas.
- The N≡N triple bond is relatively difficult to break, requires special conditions. As a result most ecosystems are N-limited.
- N_2 dissolves in water, cycles through air, water and living tissue.


atmospheric nitrogen (N_2)
lightning
volcano
rain
emissions from industrial combustion and gasoline engines
fertilizer
urine
assimilation
fossil fuels
nitrogen-fixing bacteria in root nodules
dead animals and plants
denitrification
nitrates (NO_3^-)
nitrogen-fixing bacteria in soil
decomposers (bacteria and fungi)
nitrification
ammonification
nitrites (NO_2^-)
ammonia (NH_3)
nitrification
Human activities
Natural activities
© 2011 Encyclopædia Britannica, Inc.

Nitrogen Fixation

- Abiotic: lightning (very high T and P) 10^7 metric tons yr^{-1} ~ 5-8% of total annual N fixation. (weathering of rocks is insignificant)
- Biotic: Nitrogen fixation by microbes, 1.75 $x10^8$ metric tons yr^{-1} (symbiotic bacteria: *azobacter* or *rhizobium*- legumes
- Industrial: The Haber-Bosch process (1909) $5x10^7$ metric tons yr^{-1} – high P & T, Fe catalyst to convert N_2 to NH_3; & NH_4NO_3
- Combustion Side Effect: $2x10^7$ metric tons yr^{-1}. High T and P oxidizes N_2 to NO_x

Nitrification-Denitrification

- **Nitrification** by chemoautotrophs
  - Bacteria of the genus *Nitrosomonas* oxidize NH_3 to NO_2^-
  - Bacteria of the genus *Nitrobacter* oxidize the nitrites to NO_3^-
- **Denitrication** Anaerobic respiration of NO_3^- to dinitrogen gas by several species of *Pseudomonas*, *Alkaligenes*, and *Bacillus*

Human Impacts on Nitrogen Cycle

- Burning of Fossil fuels add Nitrogen Oxides (NO_2) and Nitric Acid vapor (HNO_3).
- Nitrous Oxide (N_2O) released by the action of anaerobic bacteria on Livestock waste.
- Nitrogen stored in Soil and Plants released by destruction of forestlands, grassland and wetlands.
- Upset the nitrogen cycle in aquatic ecosystem by adding excess of nitrates to the body
- Harvest nitrogen-rich crops, irrigate crops, wash out nitrogen from topsoils

Fate of N

- **Sources of anthropogenic N loads:** Fertilizers, Legume Crops, Combustion and forest burning, livestock.
- In most terrestrial and freshwater ecosystems N is a limiting nutrient, gets cycled efficiently.
- What happens when plants have enough N (i.e. greater 16:1 N:P ratio)?
- When N saturation of ecosystem occurs, excess N tends to leave the system in the form of nitrate.
- Flushing/erosion – dissolved and particulate matter in streamwater, (DIN, DON, TN, Org N)
- Leaching to groundwater – NO_3^- poor sorption to clays, highly water soluble.

Effects of Increased N loading

Since 1940s amount of N available for uptake has more than doubled. Anthropogenic N inputs are now equal to biological fixation.

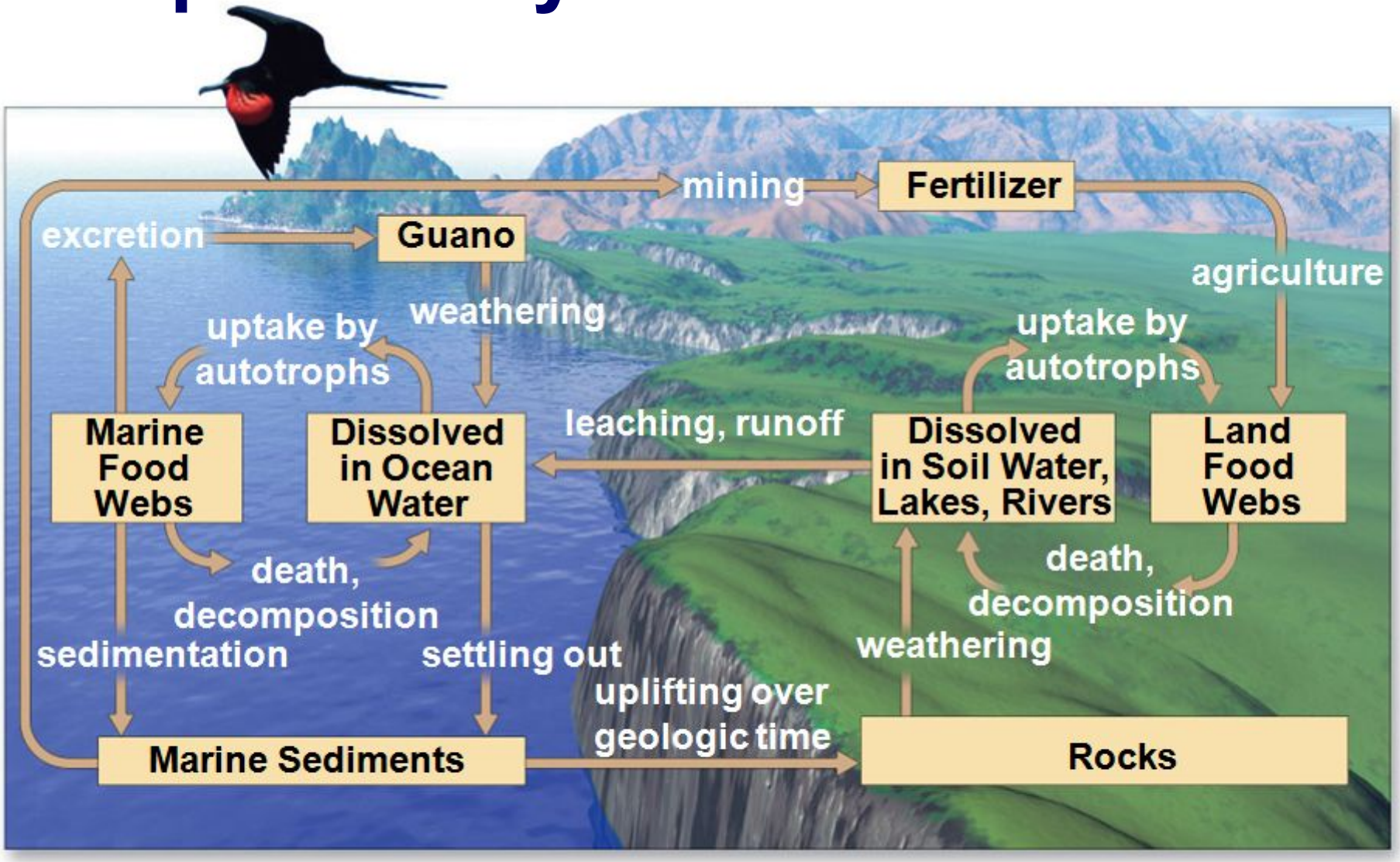
- Eutrophication in aquatic systems, coastal algal blooms and “Dead Zone”, fish kills, increased turbidity

Eutrophication
(1.54mm)

Credit:Fuse School - Global Education Source https://youtu.be/6LAT1gLMPu4

- Selective pressures in terrestrial systems favoring species-poor grasslands and forests
- Nitrate MCL – 10 mg/L …
- Nitric oxide – precursor of acid rain and smog
- Nitrous oxide – long lived greenhouse gas that can trap 200 times as much heat as CO_2

Phosphorus Cycle



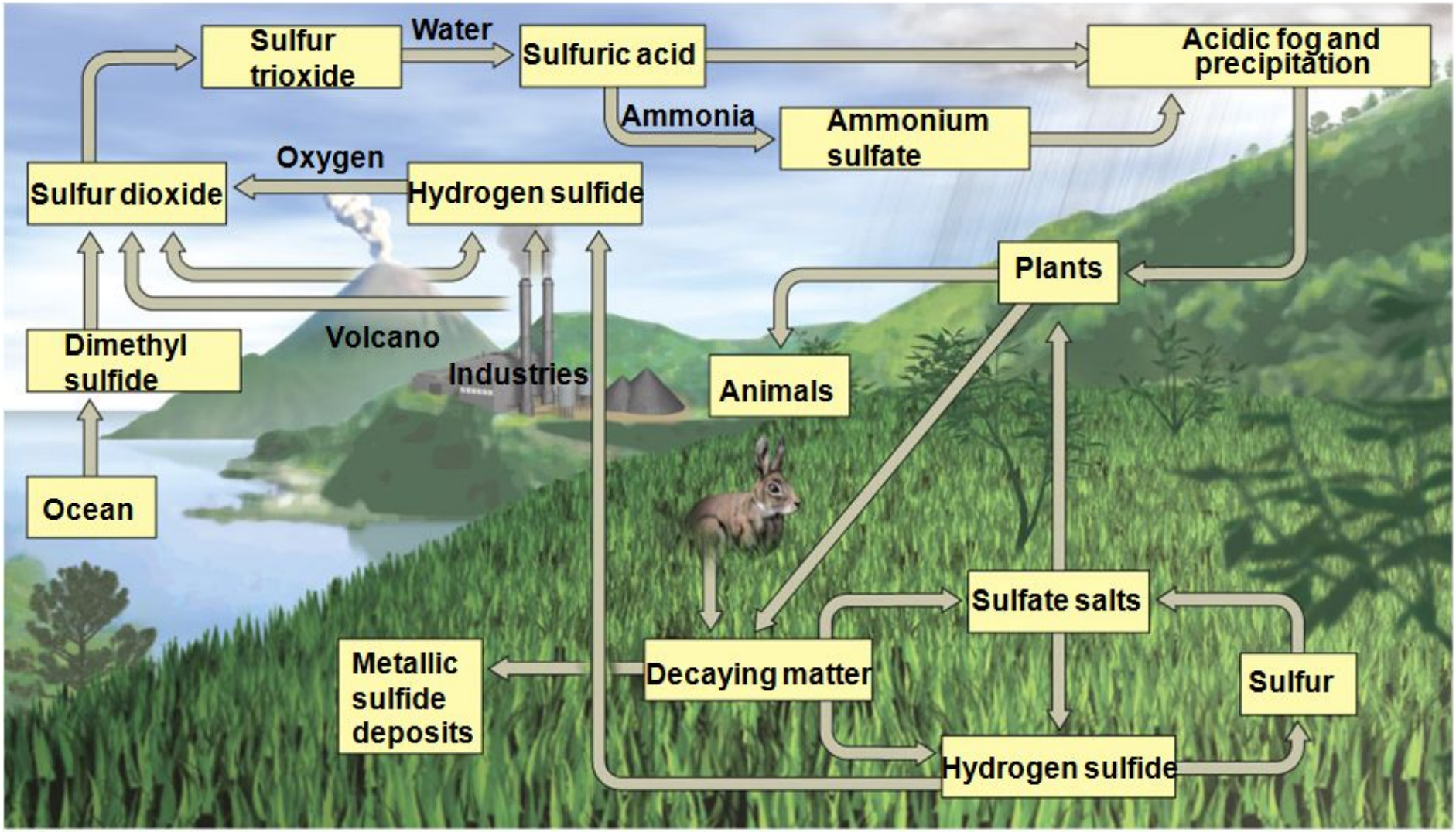
Ref

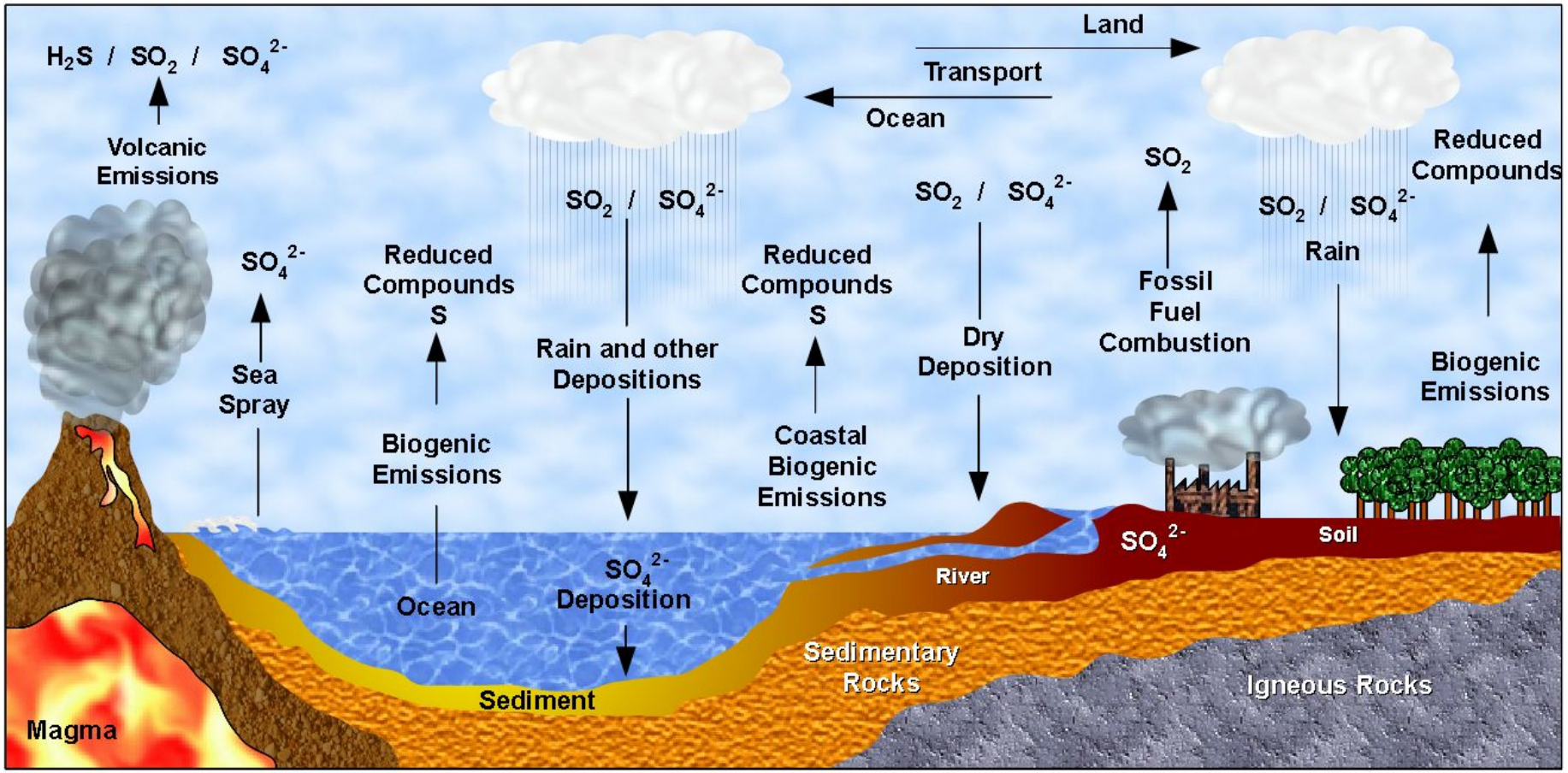
- One of the longest cycles
- Essential nutrient; DNA, ATP, ADP, fat, cell membranes

Human Impacts on Phosphorus Cycle

- P-containing detergents
- Mining phosphate rock
- P-containing fertilizer use
- P in water leads to eutrophication

Sulphur Cycle




H_2S / SO_2 / SO_4^{2-}
Volcanic Emissions
SO_4^{2-}
Sea Spray
Reduced Compounds S
Biogenic Emissions
SO_2 / SO_4^{2-}
Rain and other Depositions
Reduced Compounds S
Coastal Biogenic Emissions
Land
Transport
Ocean
SO_2 / SO_4^{2-}
Dry Deposition
SO_2
Fossil Fuel Combustion
SO_2 / SO_4^{2-}
Rain
Reduced Compounds
Biogenic Emissions
SO_4^{2-}
Soil
River
Ocean
SO_4^{2-} Deposition
Sediment
Sedimentary Rocks
Igneous Rocks
Magma

Human Impacts on Sulfur Cycle

- SO_2 from industry and combustion (e.g. coal, petrol).
- SO_2 from Refine industry convert the Petroleum

to Gasoline Products

- SO_2 from Metallic ore Industries.
- SO_2^2 from Mining industries - Acid mine drainage

Gaia Theory

- By James Lovelock; Greek Earth Goddess
- Earth with all intricate and interacting systems is like a Super-Organism

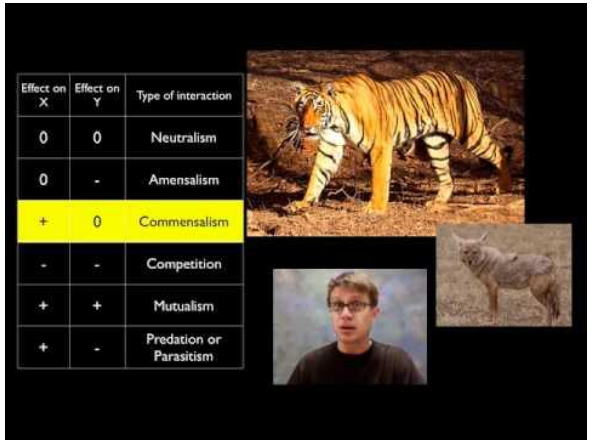
Gaia Hypothesis - James Lovelock
(4.29mm)

Credit:Naked Science. Source https://youtu.be/GIFRg2skuDI

- Self regulation: chemistry of oceans, atmosphere, temperature, living beings
- Earth behaves as if it had a purpose
- Purpose is to nurture life and maintain life-friendly conditions.
- This perspective brings a new awareness that can be the foundation of all future development
- It will enable the further evolution of mankind

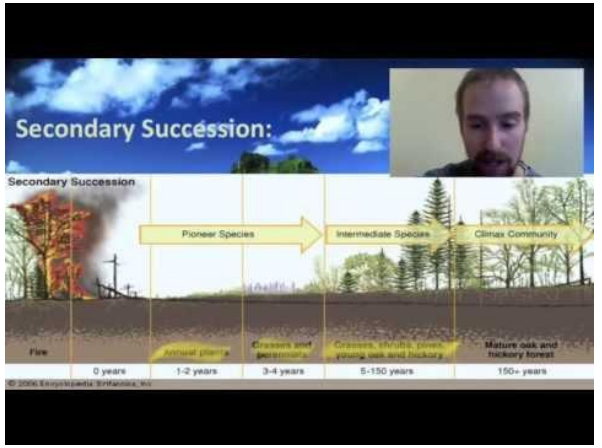
Development and Stabilization

Associations



[Populations](#) **(11.12mm)**

Succession



[Biology 2-01 Ecological Succession](#)
(21.05mm)

Adaptation

[Animal and plant adaptations](#) **(4.00mm)**

Credit:Bozeman Science Source https://youtu.be/KFViSog6ZJw
Credit:Holloway Science Source https://youtu.be/WyqCQq6SZKQ
Credit:MsBrewerFlipped Source https://youtu.be/5WECs5-jNlc

Ecosystem Services ref

Ecosystem ‘services’ are provided free-of-charge as a gift of nature.

- purification of air and water
- regulation of rainwater run-off and drought
- waste assimilation and detoxification
- soil formation and maintenance
- control of pests and disease
- plant pollination, seed dispersal and nutrient cycling

- maintaining biodiversity for agriculture, pharmaceutical research and development and other industrial processes
- protection from harmful ultraviolet radiation
- climate stabilization (for example, though carbon sequestration)
- moderating extremes of temperature, wind, and waves.

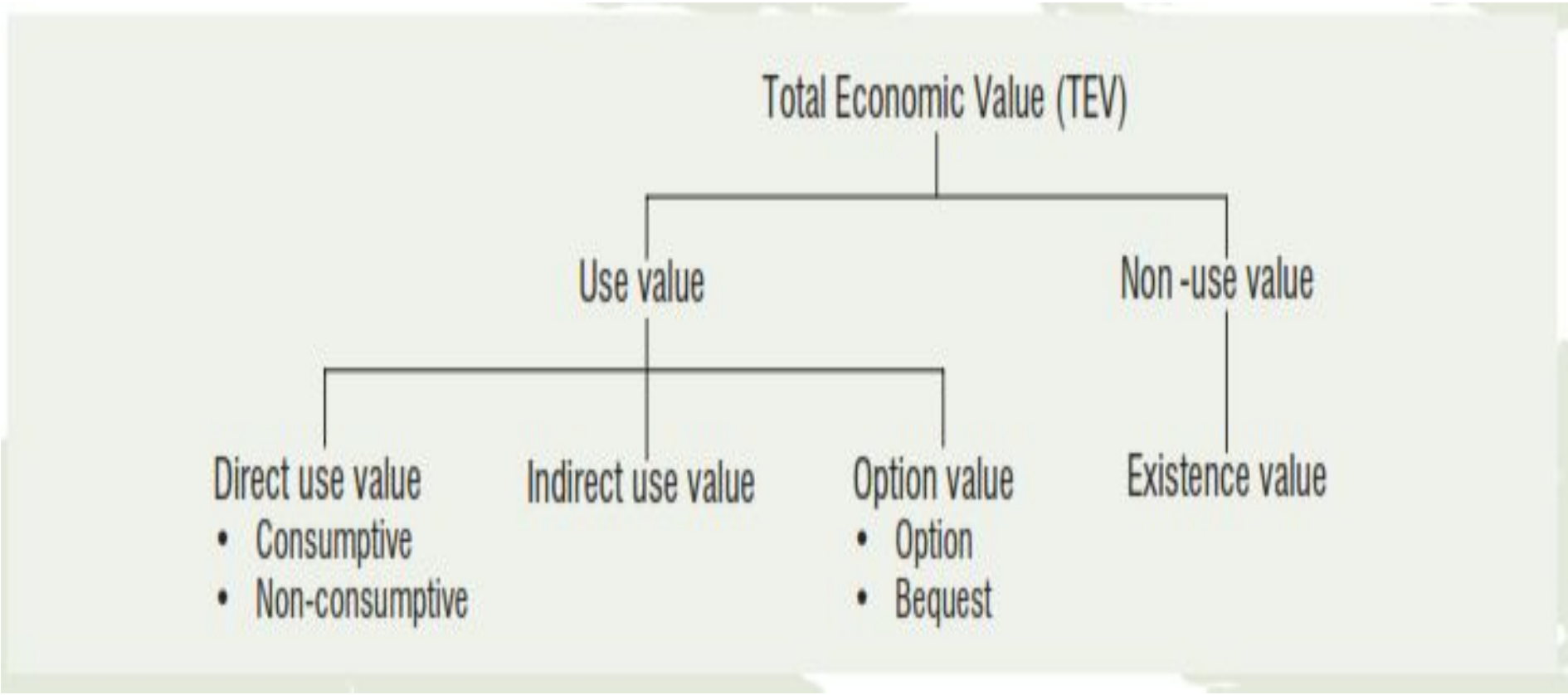
Major Ecosystem Types and Services ref

Ecosystem service	Ecosystem									
	Cultivated	*Dryland*	*Forest*	*Urban*	*Inland Water*	*Coastal*	*Marine*	*Polar*	*Mountain*	*Island*
Freshwater			•		•	•		•	•	
Food	•	•	•	•	•	•	•	•	•	•
Timber, fuel, and fiber	•		•			•				
Novel products	•	•	•		•		•			
Biodiversity regulation	•	•	•	•	•	•	•	•	•	•
Nutrient cycling	•	•	•		•	•	•			
Air quality and climate	•	•	•	•	•	•	•	•	•	•
Human health		•	•	•	•	•				
Detoxification		•	•	•	•	•	•			
Natural hazard regulation			•		•	•			•	
Cultural and amenity	•	•	•	•	•	•	•	•	•	•

Source: https://www.cbd.int/doc/case-studies/inc/cs-inc-iucn-nc-wb-en.pdf

Economic Value of Ecosystem Services ref

Economists typically classify ecosystem goods and services according to how they are used



Source: https://www.cbd.int/doc/case-studies/inc/cs-inc-iucn-nc-wb-en.pdf

Direct use values:

Consumptive uses ref

harvesting of food products

timber for fuel or construction

medicinal products

hunting of animals for consumption

non-consumptive uses ref

enjoyment of recreational and cultural activities

that do not require harvesting of products

Indirect use values ref**:** from ecosystem services

Natural water filtration - which often benefits people far downstream

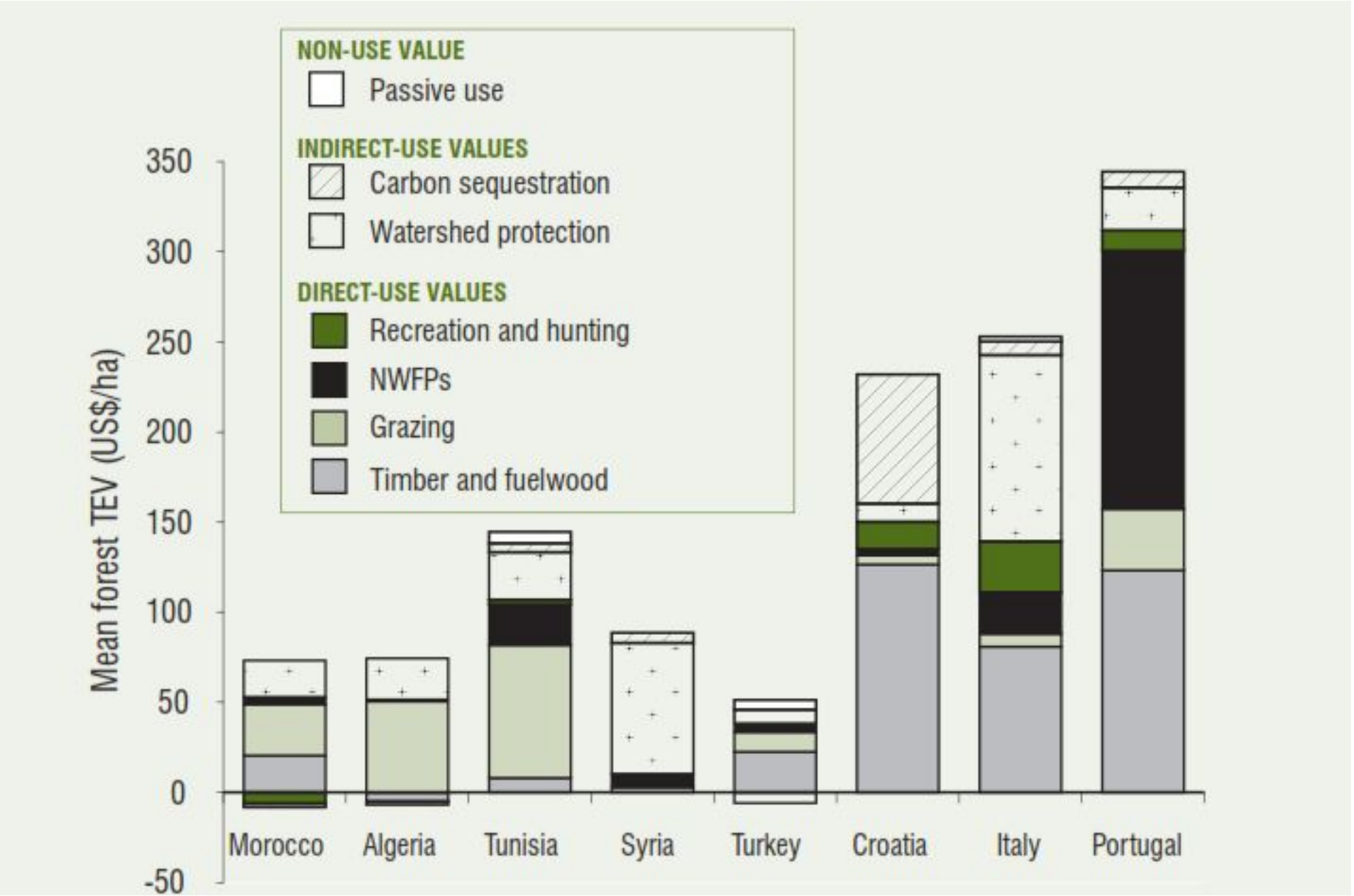
Storm protection - function of mangrove forests which benefits coastal properties and infrastructure

Carbon sequestration which benefits the entire global community by abating climate change.

Option values: preserving the option to use in the future ecosystem goods and services (provisioning, regulating, and cultural services) that may not be used at present ref.

Non-use values: refer to the enjoyment people may experience simply by knowing that a resource exists This kind of value is usually known as existence value (or, sometimes, passive use value) ref.

Benefits from forests in Mediterranean countries



Source: https://www.cbd.int/doc/case-studies/inc/cs-inc-iucn-nc-wb-en.pdf

Human System vs Ecosystem

Anthroposystem

- Very simple ecosystem; max. 3 trophic levels
- Open system; minimal recycling
- High efficiency of transfer of biomass to higher trophic level
- Monoculture; high density
- Few favored species encouraged; weeds destroyed
- Static, highly unstable
- Few people feed the rest-agriculture

Ecosystem

- Often highly complex food webs
- Often closed systems with significant recycling
- Low efficiency of transfer of biomass to higher trophic level
- High biodiversity
- Natural balance in species populations achieved adapted to conditions
- Robust, stable, dynamic, adaptable, evolving

Problems with Human Systems

- Dependent on very few species
  - 80% of world food from 15 species.
  - Human consume only 150 out of the estimated 50,000 edibles.
  - Out of 10,000 cereals, not one new has been cultivated in the past 2000 yrs.
- Inherently unstable
  - Irish Great potato famine (1845-47) wind-borne potato blight fungus; near total crop failure
  - 1 million dead due to starvation, typhoid and cholera
- Require constant inputs; pesticides, fertilizers, etc.
- Prone to pest attacks and failures
- Pollute soil, air, water
- Soil degradation and topsoil loss

Threats to Ecosystems

ref

- Habitat Destruction
- Pollution
- Eutrophication
- Invasive species
- Overharvesting
- UV Radiation

Ecosystems Conservation

ref

- Establishment of protected areas
- Rules that prohibit farming on sloping land or the use of pesticides
- Adopt more environmentally friendly land uses
- Discouraging them from adopting more harmful

Thank You

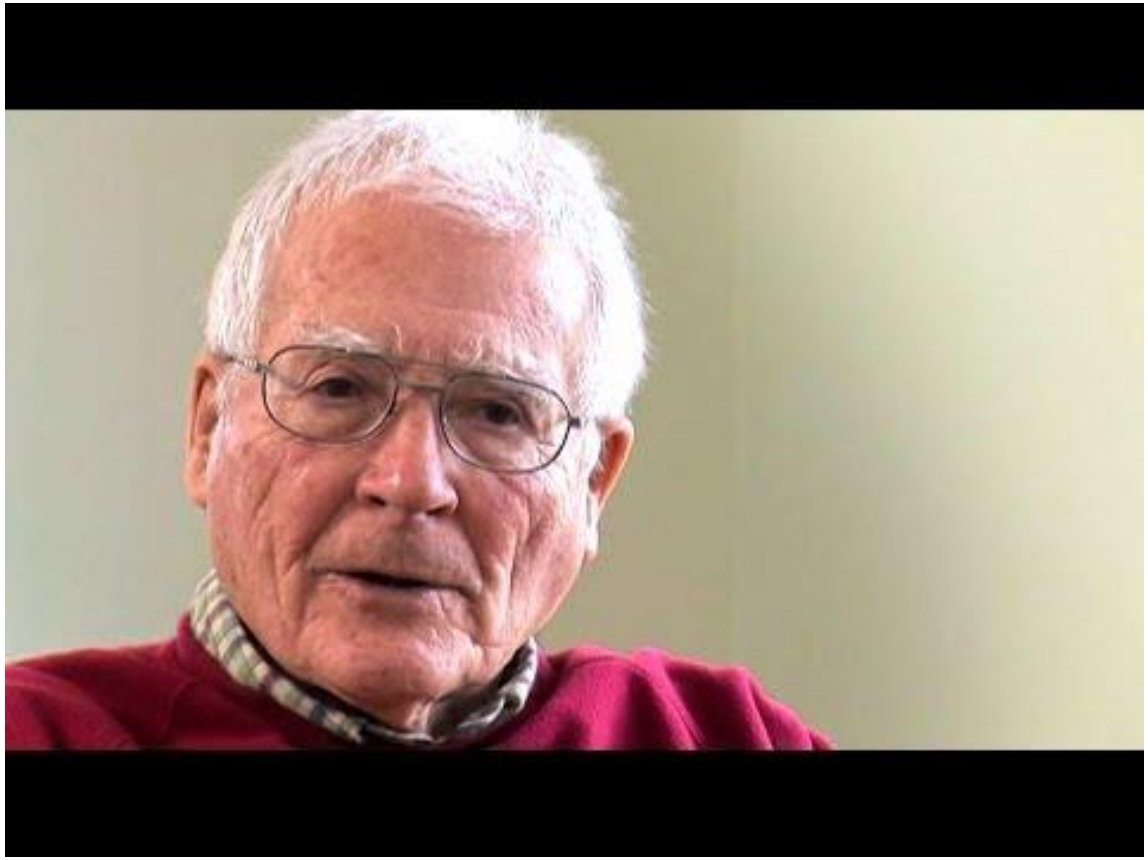
Extra Slides

Gaia Theory

- By James Lovelock; Greek Earth Goddess
- Earth with all intricate and interacting systems is like a Super-Organism

Gaia Hypothesis - James Lovelock

(28.46mm)



Credit:Naked Science. Source https://youtu.be/GIFRg2skuDI