Introduction in ecology science.

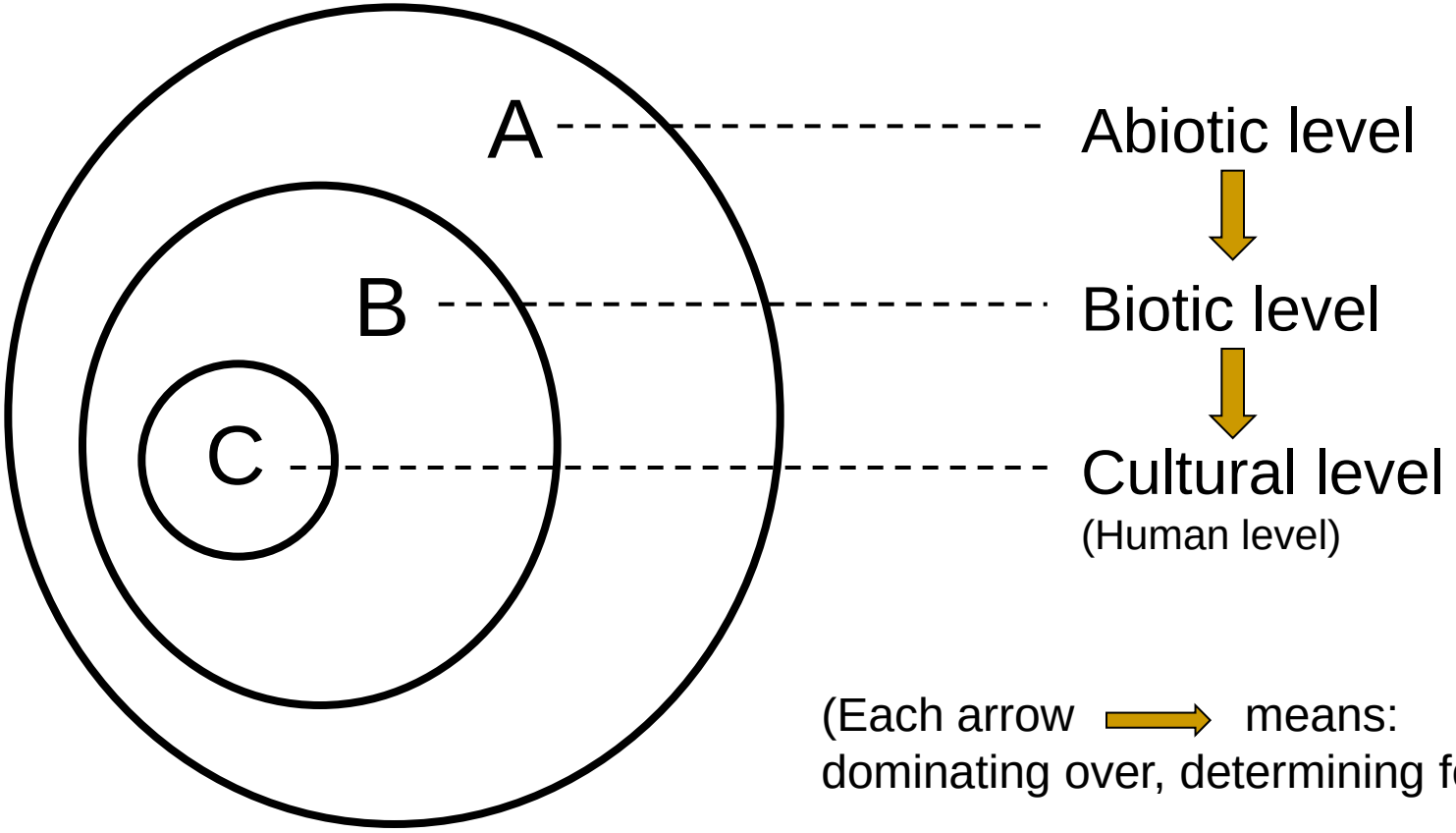
Erik P.C. ROMBAUT,Master in Biology , Asst. Prof. , LUCA.
Hoger Architectuurinstituut Sint-Lucas (LUCA, school of Arts),
Hoogstraat 51, B-9000 Gent / Paleizenstraat 65-67, B-1030 Brussels.
KaHo Sint-Lieven, Hospitaalstraat 23, B-9100 Sint-Niklaas.
+ 32 (0)3 7707147. erik.rombaut@scarlet.be

International Master in Architecture.

Course Environmental Sustainability. Theme 1.

HUMAN ACTIVITIES DEPEND ON AN INTACT BIOTIC AND ABIOTIC LEVEL.

VAN LEEUWEN (1979) EN SCHROEVERS (1982)



Cosmosphere (A) ⟶ *atmosphere (A)* ⟶ *hydrosphere(A)* ⟶ *lithosphere (A)*
⟶ *biosphere (B)* ⟶ *noosphere (C)*

HUMAN ACTIVITIES DEPEND ON AN INTACT BIOTIC AND ABIOTIC LEVEL.

VAN LEEUWEN (1979) EN SCHROEVERS (1982)

SOME CONSEQUENCES:

1. When species disappear (or occur), an exploration of possible causal changes in the abiotic conditions is desirable.

2. When we want to avoid species to extinct or if we want species to be introduced, then steering (managing) of the abiotic conditions is most efficient.

(O)ECOLOGY (Häckel, 1866)
deduction from Greek language:

oikos (home, dwelling) - **logos** (doctrine)

- Study of mutual relations between organisms.

  e.g.:

  To eat and to be eaten,

  Producing and consuming oxygen,

  Parasite versus host,

  …

- Study of the relations between organisms and their abiotic environment

  e.g.:

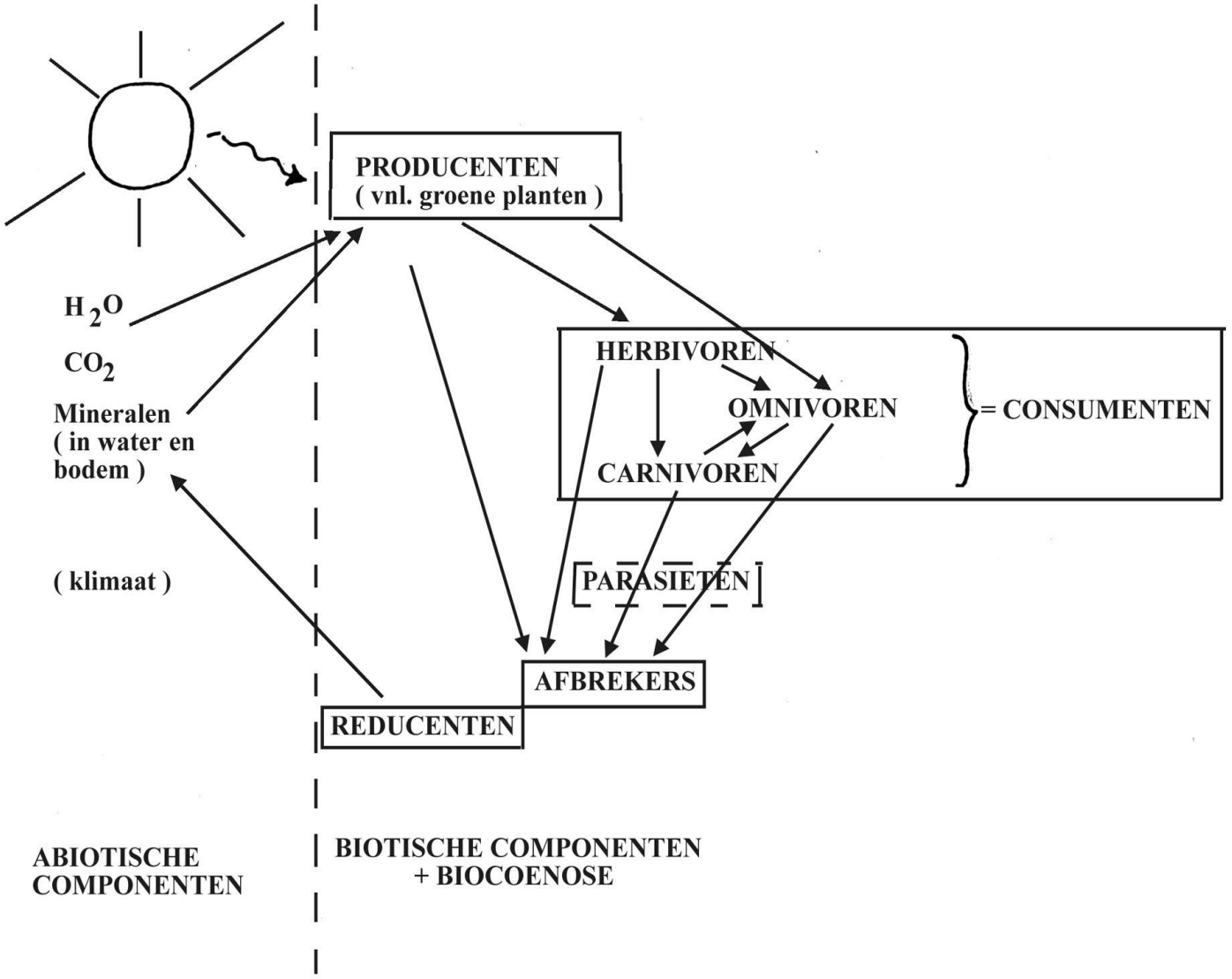
  Climate conditions,

  Soil fertility,

  topography,

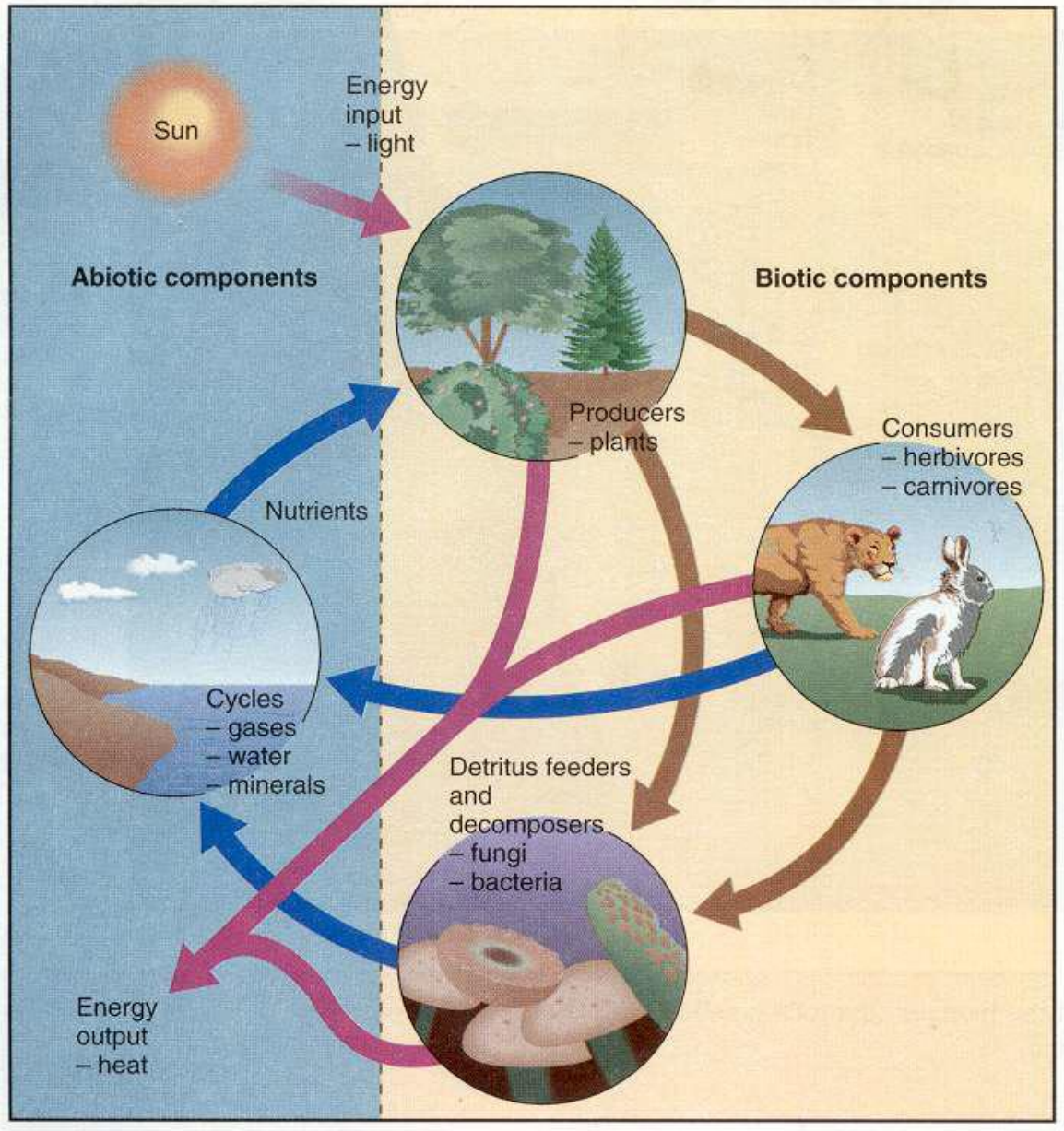
  …

(O)ECOSYSTEM (Tansley, 1935)



An ecosystem is a functional system of spatial and temporal relations between biotic and abiotic components. (This is a concept, has no scale).

Ecosystems


Sun
Energy input – light
Abiotic components
Biotic components
Producers – plants
Consumers – herbivores – carnivores
Nutrients
Cycles – gases – water – minerals
Detritus feeders and decomposers – fungi – bacteria
Energy output – heat

Energy Flows in an Ecosystem

ZON Sun radiation
stralingsenergie

1 FOTOSYNTHESE

Photosynthesis by cells with chlorophyll

O_2

Chemically bound energy
164 billion tons/year

Chemische energie
164 miljard ton/jaar
$C_6H_{12}O_6$

2 ADEMHALING

Respiration by all living cells

CO_2

H_2O

biologically usable energy
ATP

3 verrichten van arbeid (labouring)

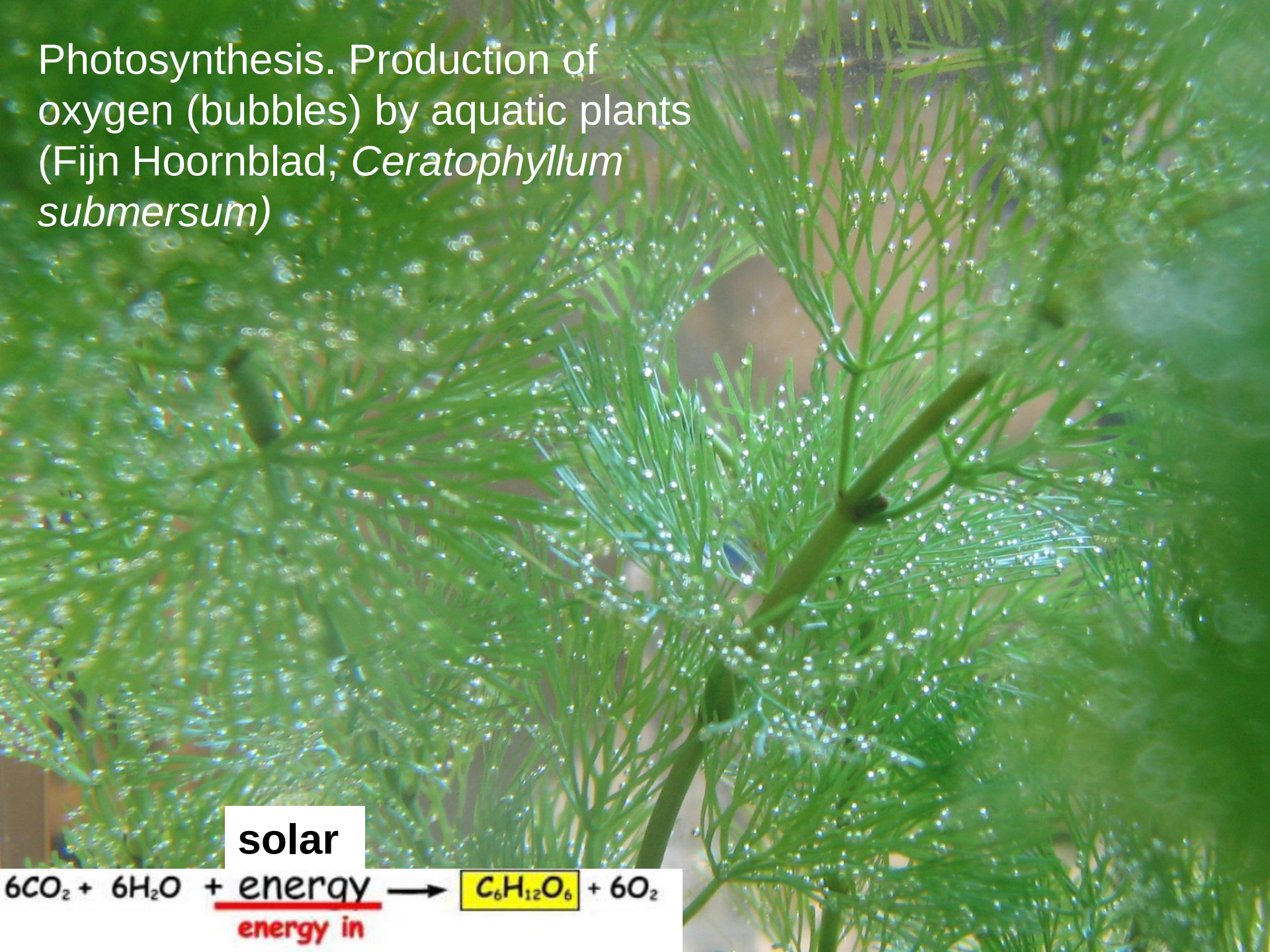
sun

$$6\,CO_2 + 6\,H_2O \xrightarrow[\text{chlorophyll}]{} C_6H_{12}O_6 + 6\,O_2$$

$$C_6H_{12}O_6 + 6\,O_2 \longrightarrow 6\,CO_2 + 6\,H_2O + 38\,ATP\ (\text{energie})$$

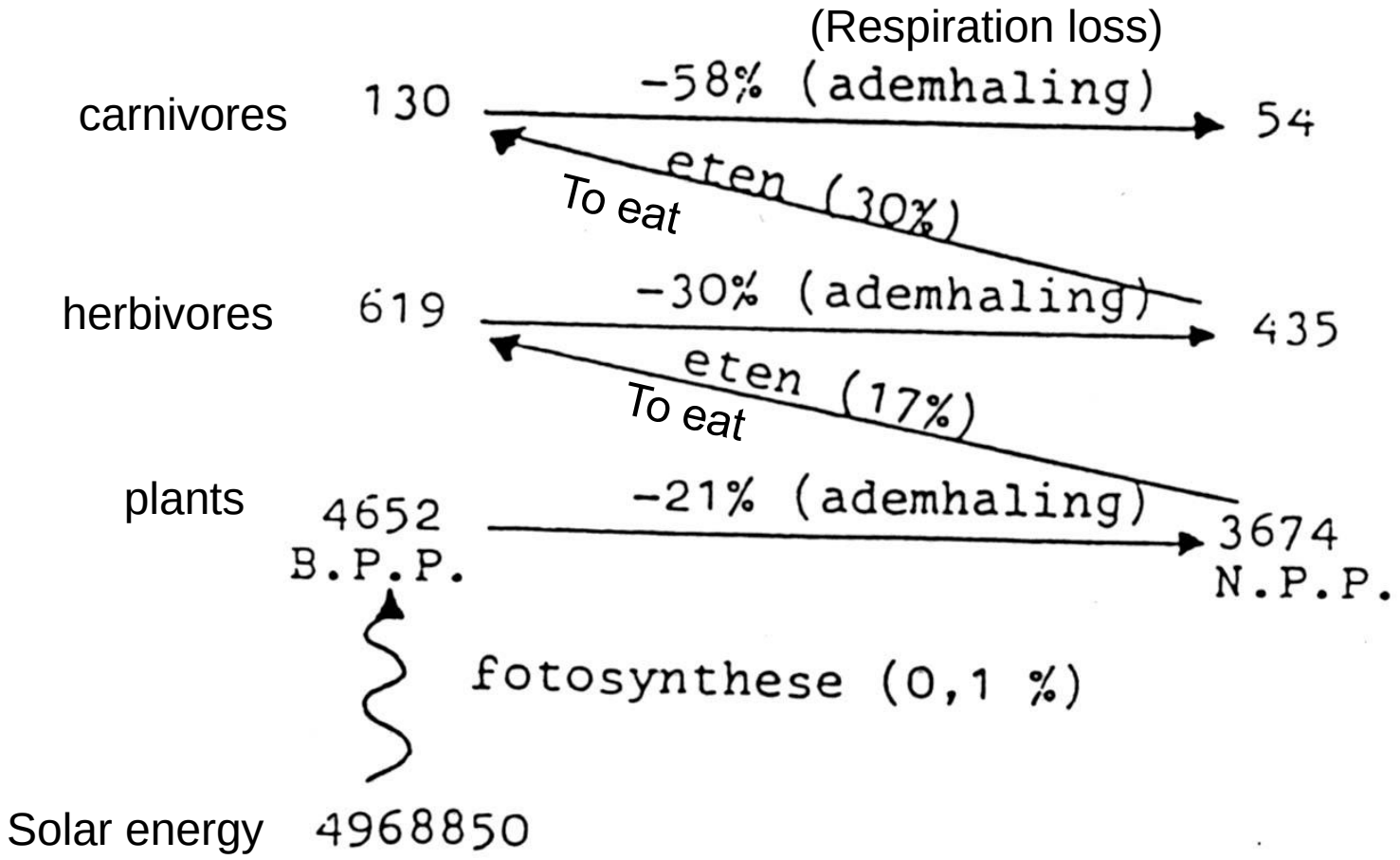
$$ATP \longrightarrow ADP + \text{fosfaat} + \text{energie}$$

Photosynthesis. Production of oxygen (bubbles) by aquatic plants (Fijn Hoornblad, *Ceratophyllum submersum)*



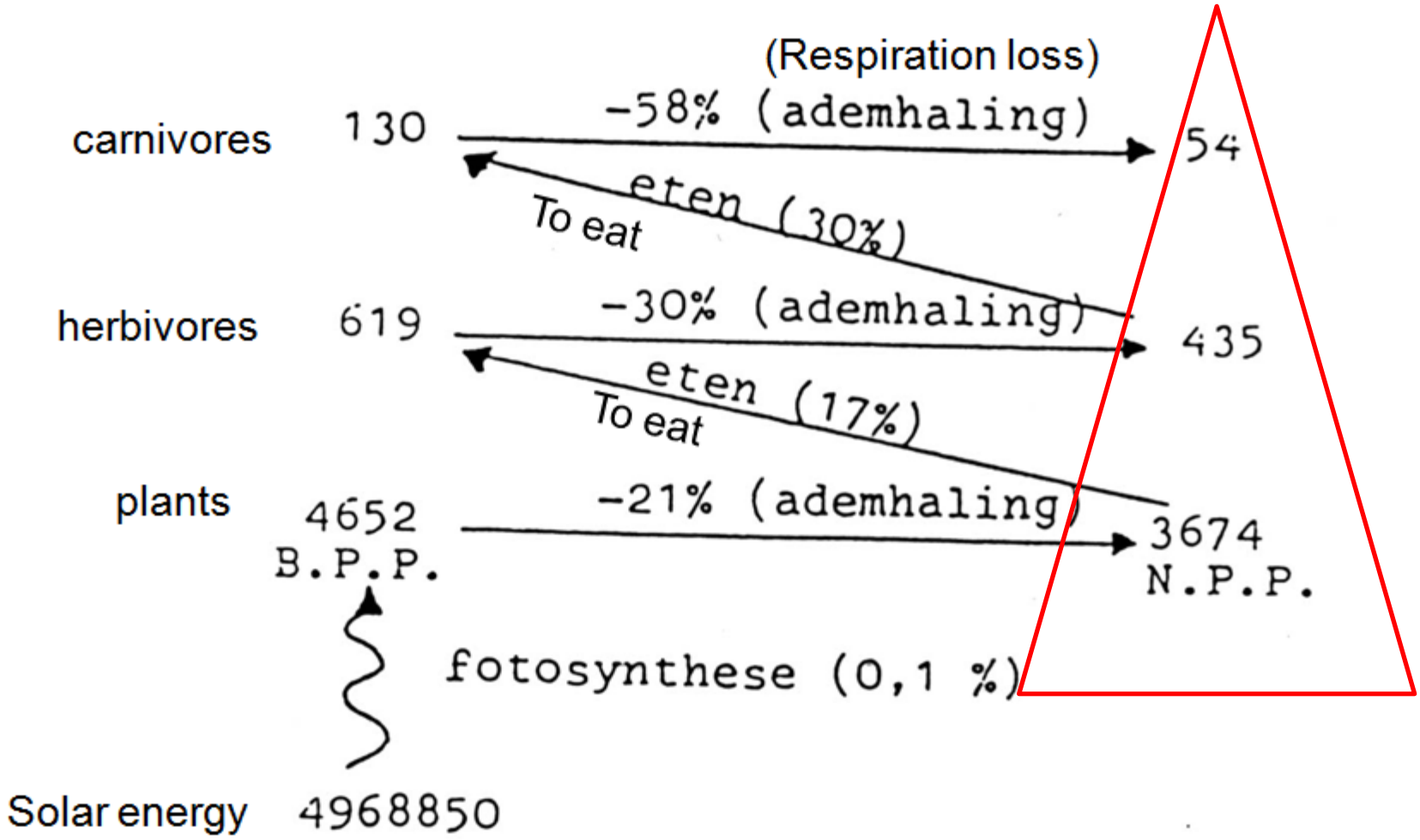
ENERGY FLOWS IN AN ECOSYSTEM.

Solar constant: 21 . 10 ^{20} kJ/jaar



Energy budget of Cedar Bog Lake, Minnesota.
Figures in kJ/m^2/year (after LINDEMAN, 1942)

Energy Flows in ecosystems: The energy pyramid

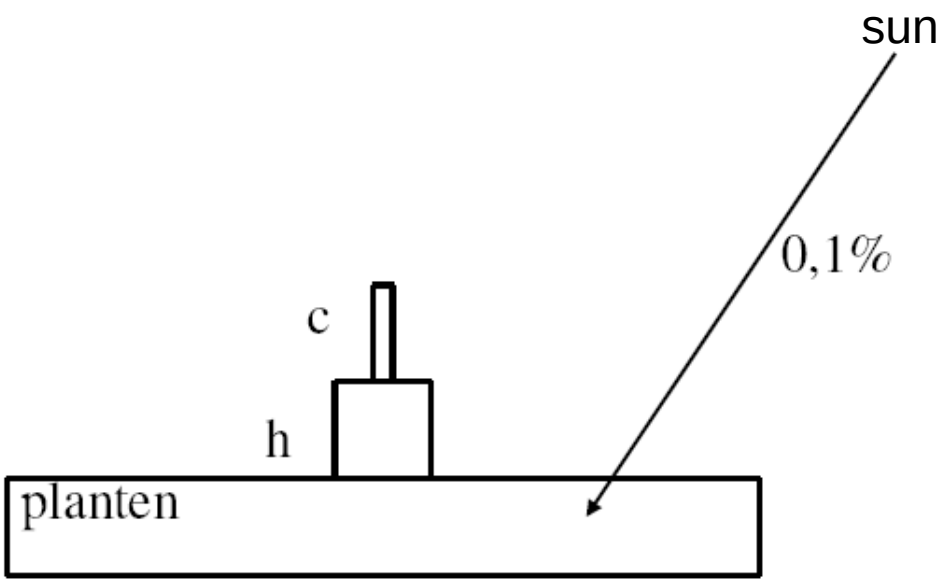


Energy budget of Cedar Bog Lake, Minnesota.
Figures in kJ/m^2/year (after LINDEMAN, 1942)

Concept : ENERGY PYRAMID

Principe: zie les

P: PRODUCENTEN
H: HERBIVOREN
C: CARNIVOREN



Ca 10 % van de energie wordt doorgegeven, 90 % gaat verloren per trofisch niveau.

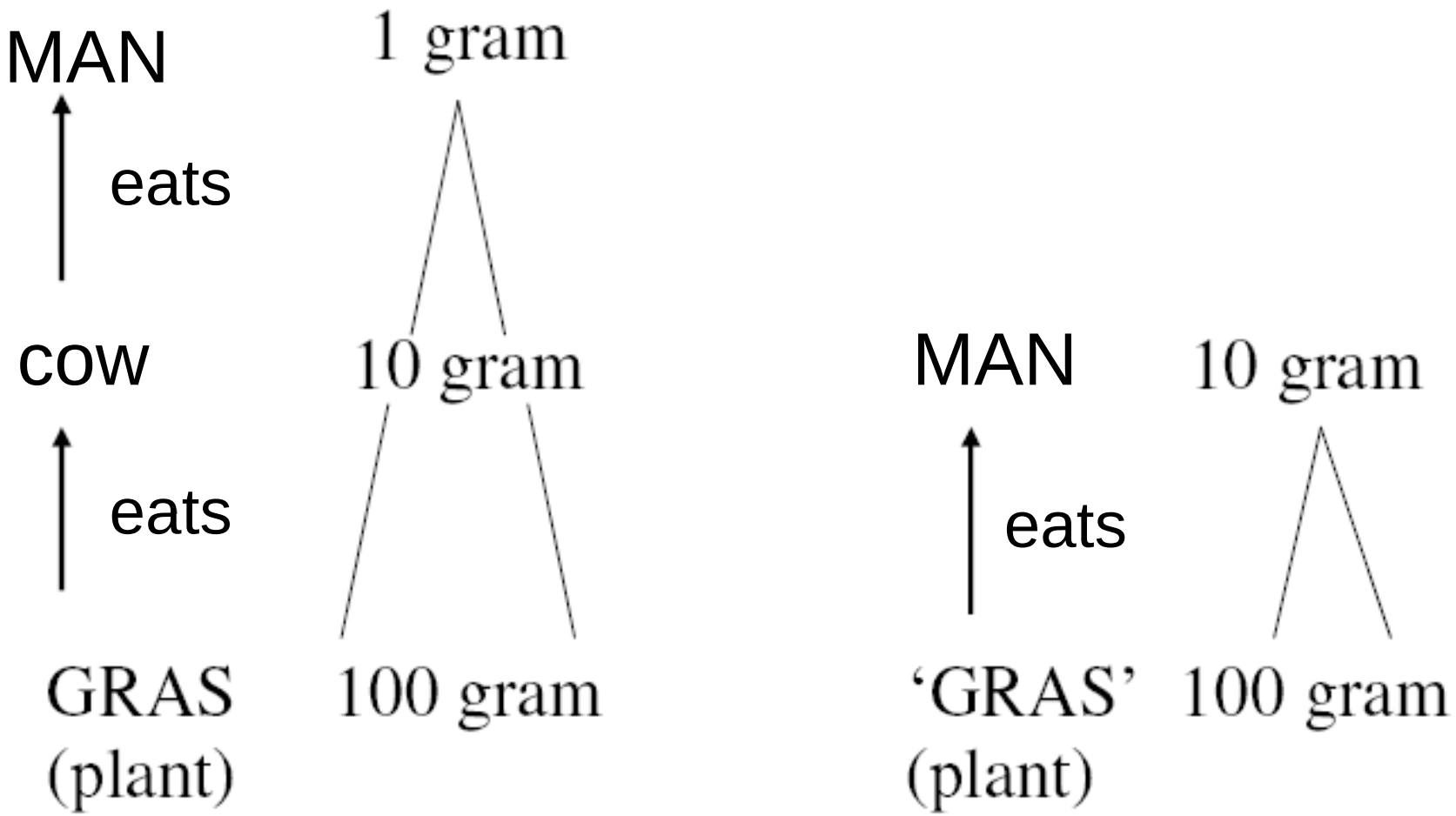
Approximately 10% of the energy is passed (up to the next level) , the rest (90 %) is lost in each trophic level.

consequences:

- Control biomass (number) from top to bottom and bottom to top within the pyramid.
- The production of 1 gram animal material costs up to 10 grams of plant material.

  This is for many people a motivation for **vegetarianism**.

Compare these two food pyramids.



The water footprint of a cow

Food

► 1300 kg of grains
(wheat, oats, barley, corn, dry peas, soybean, etc)

► 7200 kg of roughages
(pasture, dry hay, silage, etc)

99%

Water

► 24000 litres for drinking

► 7000 litres for servicing.

1%

[Hoekstra & Chapagain, 2008]

[Hoekstra & Chapagain, 2008]

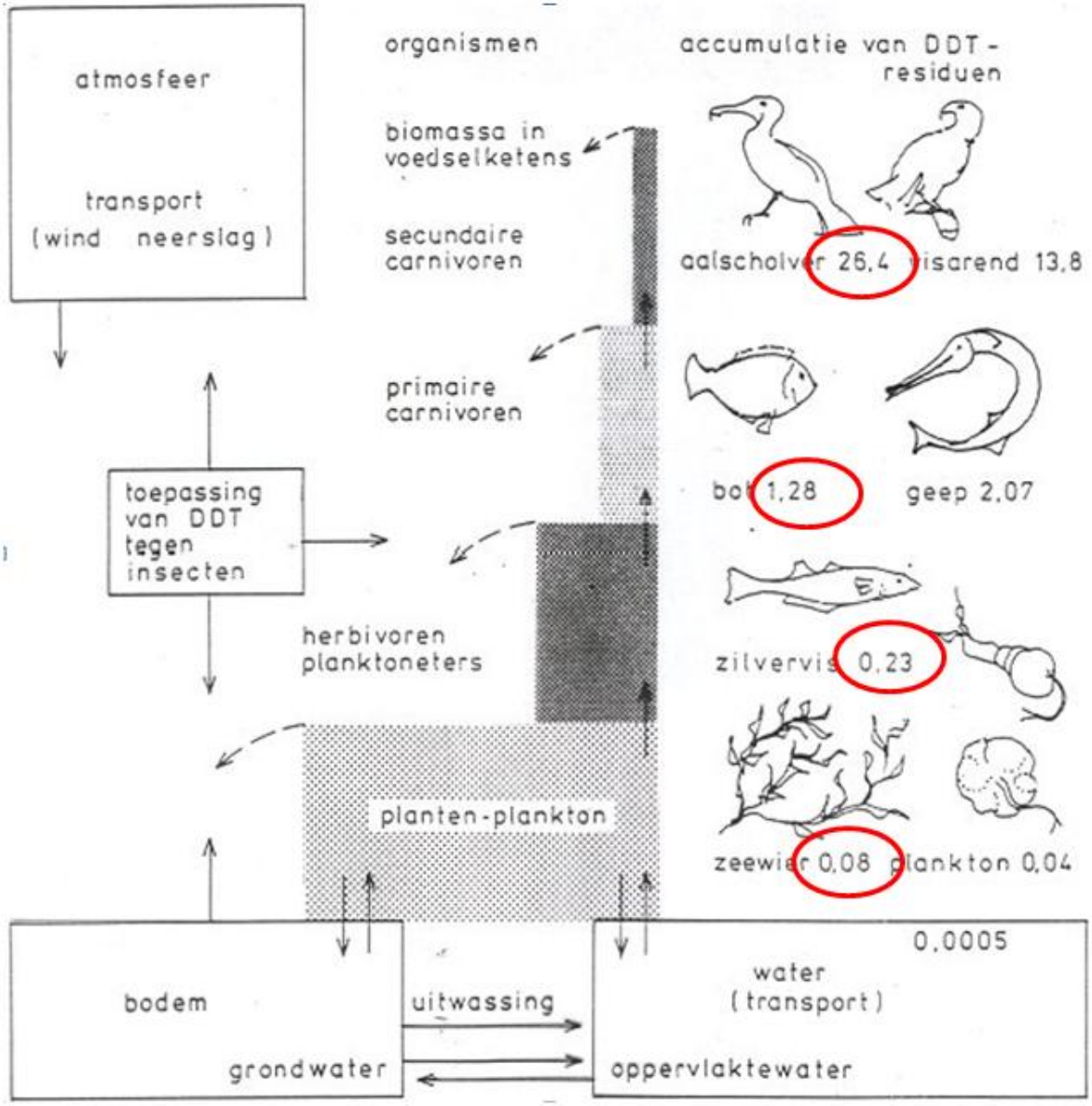
Conclusions:

- When people eat plants directly instead of meat, 10 times more people can feed themselves with the same amount of plants.
- So from the same area, 10 times more people can find food.
- Or the same number of people need 10 times less surface for food.

Cl-compounds such as DDT and dioxins are soluble in fat and accumulate in the food chain.

In organisms at the top of food chains (such as humans), high chlorine concentrations are found in fat-rich tissues (such as female breast tissue)
and
liquids rich with fat (such as breast milk).

Increase by a factor of 10 in each step of the food chain



Estimated productivity, production and biomass of the main ecosystems on Earth (data from WHITTAKER in OWEN, 1977)

	gebied (mln. km^2)	gemiddelde netto prim. produktivit. (droog gew. gram/m^2/j.)	netto prim. wereldprod. (mrd.droog gewicht in ton/jaar)	gemidd. biomassa (droog gewicht kg/m^2)	wereld biomassa (droog gewicht mrd.ton)	
rivieren en meren	2	500	1.0	0.02	0.04	*rivers and lakes*
moeras en veen	2	2000	4.0	12	24	*swamps and peatland*
tropisch woud	20	2000	40.0	45	900	*tropical rainforest*
gematigd loofbos	18	1300	23.4	30	540	*temperate deciduous forest*
noordelijk pijnbos	12	800	9.6	20	240	*taiga*
bosjes en struikgewas	7	600	4.2	6	42	*groves and scrub*
savanne	15	700	10.5	4	60	*savannah*
grasland	9	500	4.5	1.5	14	*grassland*
toendra en hoogge-bergte	8	140	1.1	0.6	5	*tundra and high mountains*
woestijnsteppe	18	70	1.3	0.7	13	*desertsteppe*
rotsen en woestijn	24	3	0.07	0.02	0.5	*rocks and deserts*
bouwland	14	650	9.1	1	14	*manmade fields*
totaal land en zoetwater	149	730	109	12.5	1852	***total land and fresh water***
open oceaan	332	125	41.5	0.003	1.0	*open ocean*
kontinentaal plat	37	350	9.5	0.01	0.3	*continental shelves*
zeearmen	2	2000	4.0	1	2.0	*estuaries*
totaal oceaan	361	155	55	0.009	3.3	***total salt water***
totaal aarde	510	320	164	3.6	1855	***Total Earth***

Analysing the Table (Owen, 1977)

- Column 3 = 2 x 1
- Column 5 = 4 x 1
- Discuss the special position of the tropical rainforest (regard primary production and biomass).
- Discuss the low importance of arable land (bouwland in Dutch).
- Explain the increased primary production (plants, algae) in seas on the continental shelf near the coast.
- Explain the extremely low productivity and biomass in the oceans.
- Consider column 5 as capital and column 3 as annual interest.
- Define over-exploitation (overfishing) in relation to harvesting (removal) more than the annual growth.