

Cause of soil degradation

- Forest clearing (Land establishment ▪ Slash and burn)
- Over-grazing
- Plowing ▪ Agricultural practices
- Soil erosion (water ▪ air)
- Desertification (Changes in climate, temperature and moisture regimes)
- Salt accumulation
- Human caused pollution (Industrial ▪ Agricultural ▪ Accidents)

Cause of soil degradation (% of degrading land)

area	Forest clearing	Fuel woods cutting	Over grazing	Agriculture	Industry
Europe	38	-	23	29	9
Africa	14	13	49	24	-
N. America	4	-	30	66	-
C. America	22	18	15	45	-
S. America	41	? 5	28	26	-
Asia	40	? 6	26	27	-
Oceania	12	-	80	8	-
World	30	7	35	28	1

Source: World Resources Institute, 1990. & L R Oldeman et al, Wageningen, Holland, 1990.

How about in Japan?

Soil degradation (Physical processes)

- Destruction of soil aggregates
- Destruction of soil structure
- Soil hardening
- Moisture and temperature regime deterioration
- Formation of soil coating (Crust)
- Kneading of soil (Slaking)
- Drying and wetting of soil
- Soil erosion
- Inferior soil aeration

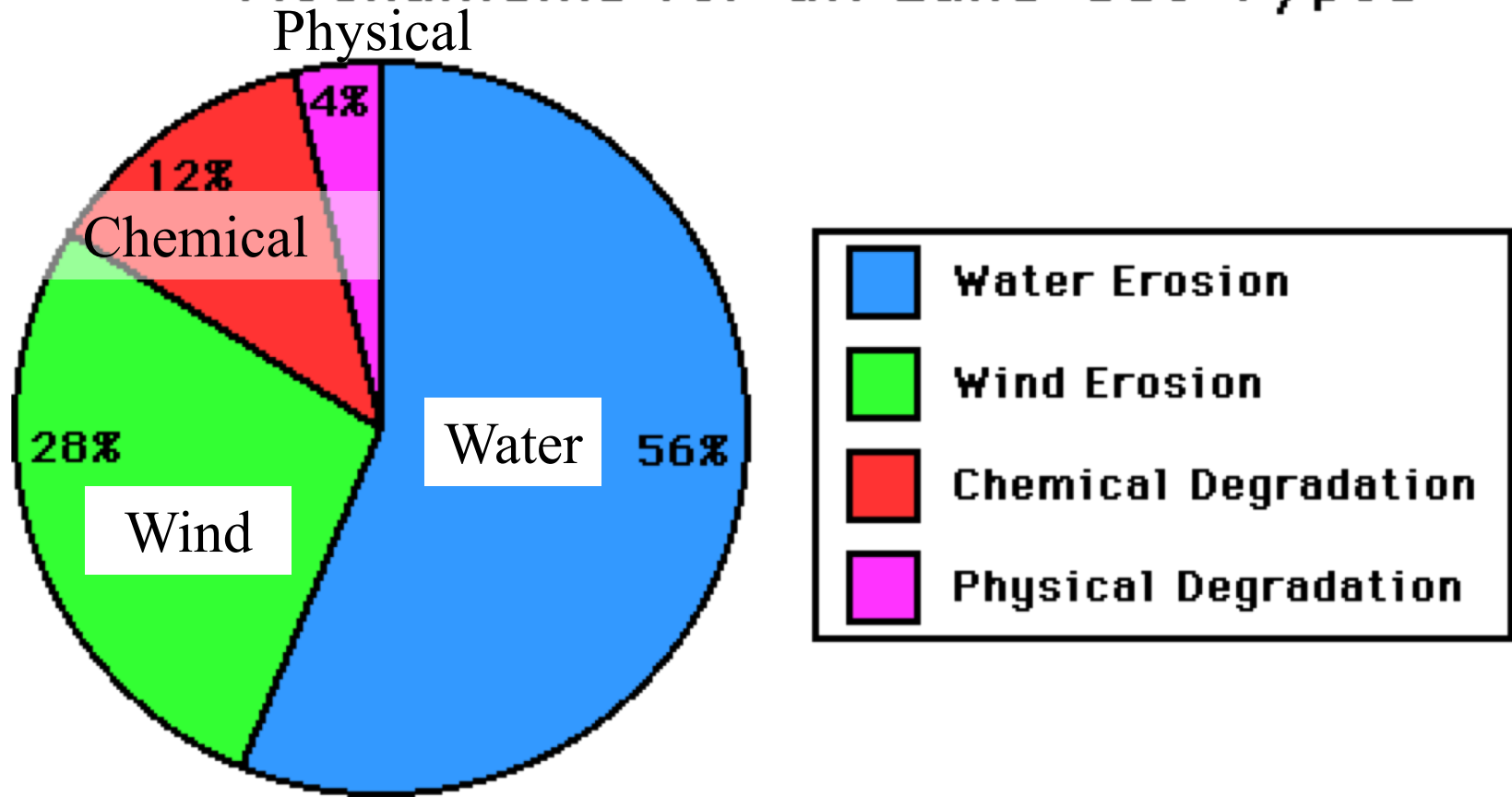
Soil degradation (Chemical processes)

- Leaching and biased balance of nutrients
- Acidification
- Decrease in soil fertility
- Eutrophication of aquatic area on lands
- Salinization
- Alkalization
- Laterite formation (Red soil weathering)
- Radio active pollution ^{137}Cs , ^{131}I , ^{239}Pu

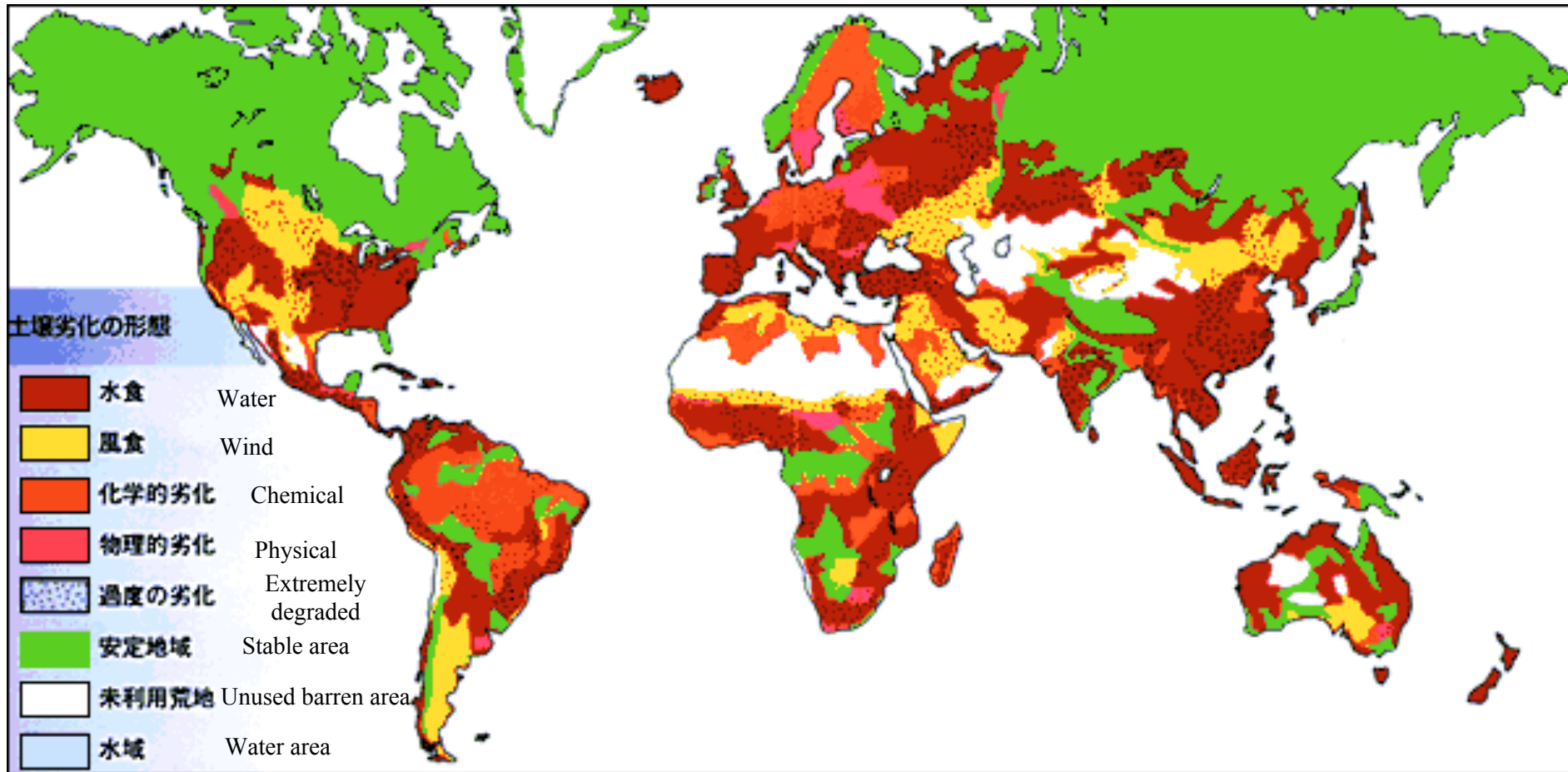
Soil degradation (Microbical processes)

- Exhaustion of soil organic matter
- Decrease in soil microbial biomass
- Simplification in microbial composition
- Decrease in soil biological activity
- Emission of green house gasses (CO_2 , CH_4 , N_2O)
- Decrease in bio-diversity
- Occurrence of soil born crop disease

World-Wide Soil Degradation Mechanisms for all Land-Use Types



Human caused soil degradation



FAO

How to prevent soil degradation

- Prevent wind and water erosion
 - Refrain from the agricultural land unplanted
 - Leveling of agricultural land
 - Plant wind break trees, Contour culture
 - Crop rotation
 - No-till farming, less tillage farming
 - Suppression of soil organic matter decomposition
 - Application of compost, cultivation of green manure and incorporation
- Activation of soil biota.

Merits of agriculture on environment

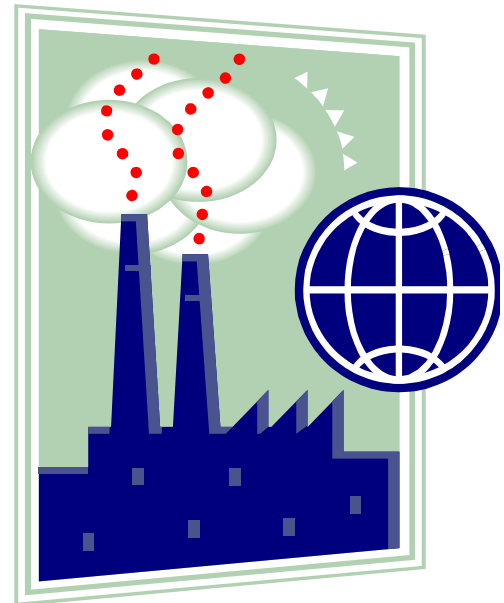
- Water holding and storage, prevent flooding (especially paddy land)
- Organic matter decomposition (Important function for nutrient cycling)
- Photosynthesis (Absorption of CO₂ and formation of Oxygen)
- Cover the soil surface (Prevent erosion)
- Supply beautiful landscape
- Background of human society

Negative effects of agriculture on the environment

- Flowing out of soils, turbid river water
- Soil dust in air (wind erosion)
- Leaching of nutrients (N, P, K) → Eutrophication of river and lake water
- Pollution by excess pesticides
- Bad smell (during the application of slurry and manure)
- Emission of greenhouse gasses (CO_2 , CH_4 , N_2O)
- Decrease in habitats for wild animals
- Decrease in natural environments (Forest, wetland)

Environmental Capacity

- Maximum load of pollutants by the environment (soil, water, and air) without causing negative effects to human and other lives.



Environmental capacity of soils

Organic matter: ca. 50 tons/ha

Nitrogen: ca. 200 kg/ha

**Standard for maximum application rate
of nitrogen fertilizers**

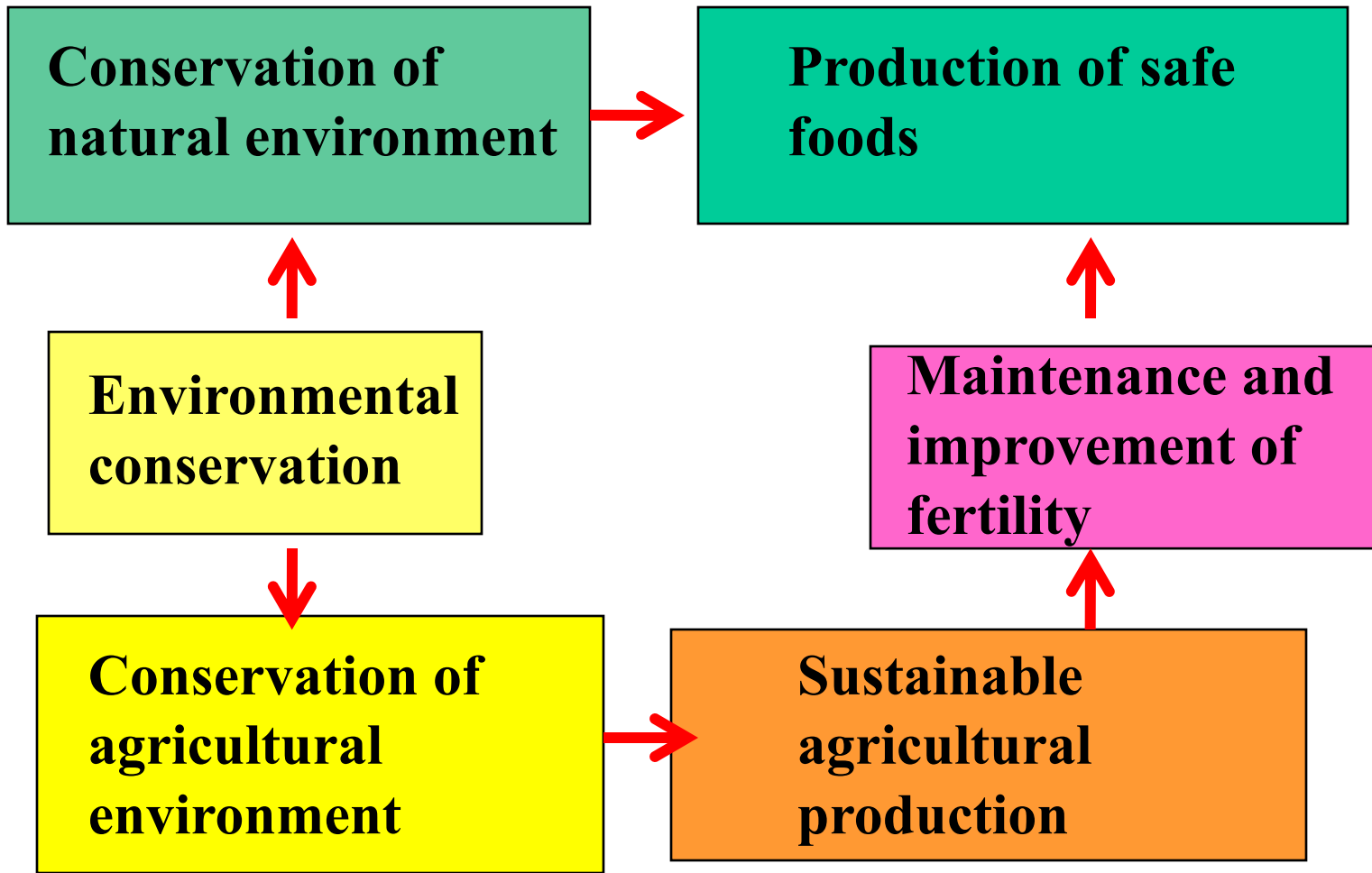
(In Europe, 140 kg N/ha is adopted.)

Carriers of environmental capacity

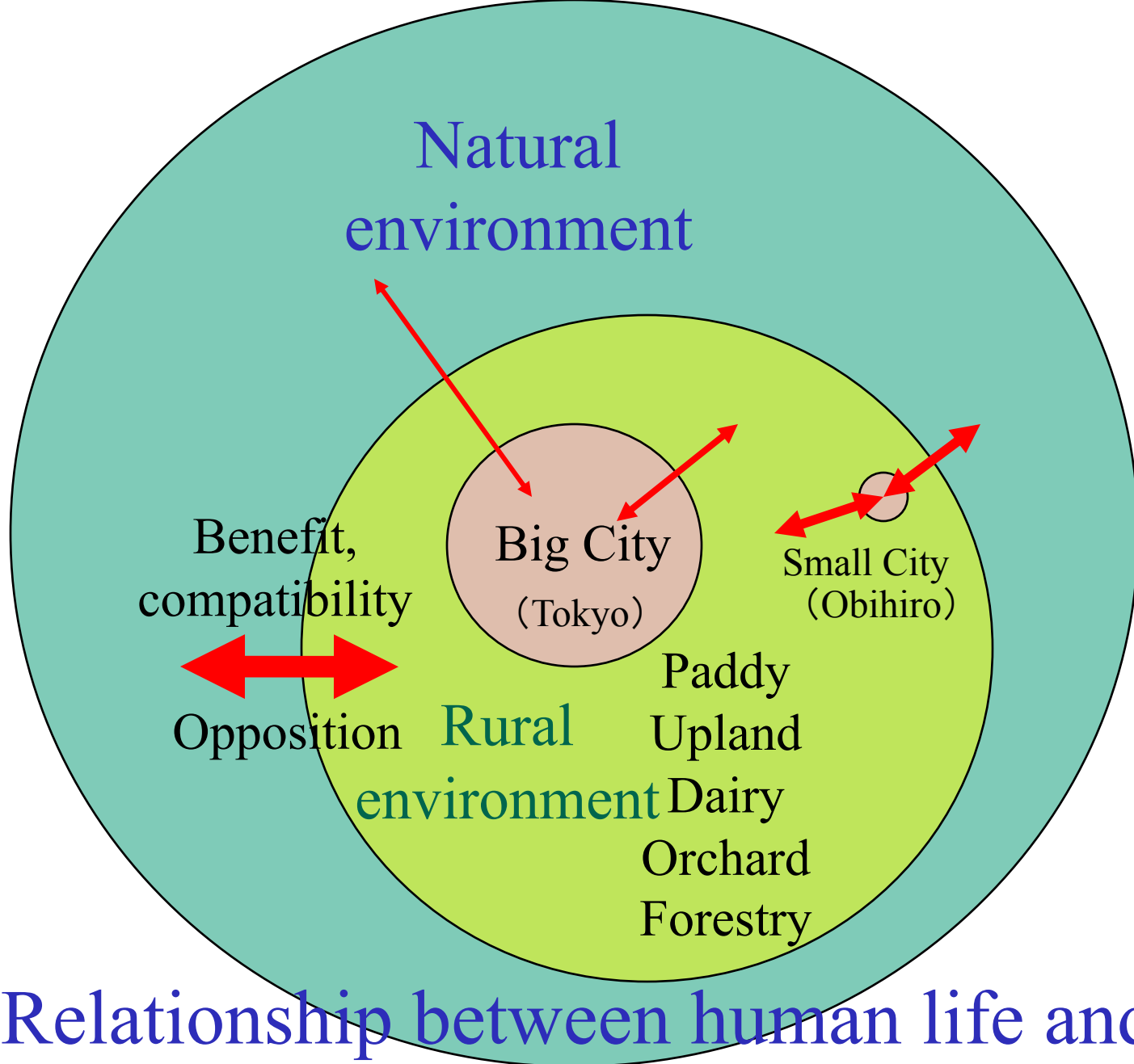
- **Clay minerals (Adsorption, ion exchange)**
(Crystalline clay minerals, allophane, gels of alumina and iron)
- **Soil organic matter (Adsorption, ion exchange)**
(Humic substances, applied organic matter)
- **Soil animals (Decomposition)**
(Fallen leaves, harvest rests, animal remains, feces and urine, organic wastes, residual pesticides)
- **Plants (Absorption)**
(Green manure, phyto-remediation)

Soils and soil lives are

- Contributing to the purification of environments.
- If the lives in soils are lost, circulation of materials will stop, and the background for all the creature will be lost.
- Human should treat the soil and the lives in soils carefully.



Purpose of Agricultural technology in harmony with environment



Relationship between human life and natural/rural environment

Soil is living

- Soil, like living things, is born, grows, and die.
- Human is benefitted from the soil only during the limited period of its process from the birth to its death.
- Misuse of soils by human may hasten the death of soils.

Creature lives by soil, while soil lives also by creatures.

- Soil exists on the very delicate balance of ecosystem.
- Therefore, soil is a very fragile (vulnerable) material.
- Conservation of soil is performed by the conservation of whole ecosystem.

Human can not but use the soil.

When using soils, human should follow the mechanism of natural ecosystem, and treat it tenderly.

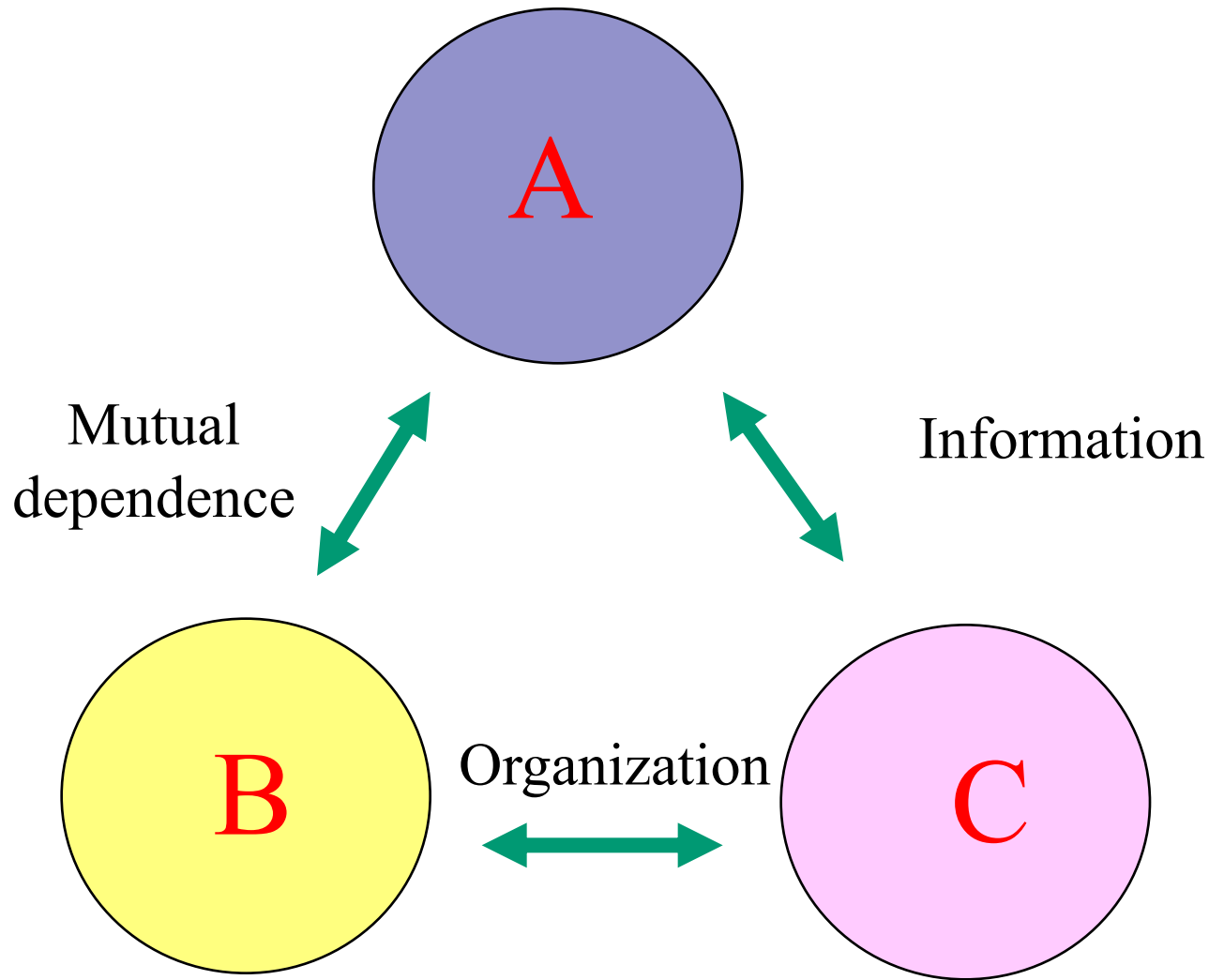
⇒ Recycle organic matter into the farm land.

⇒ Harmony between forest and farmland.

⇒ Harmony between cultivation and animal husbandry.

⇒ Adopt the principle of plant succession by crop rotation and green manure cultivation.

⇒ Use and preserve various genes.



Factors A, B, C acquire new functions by establishing mutual relationships.

By establishing mutual relationships between
the factors,

- **The decrease in entropy and**
- **The creation of a new system** are brought about.
- Activities of living things, establishment of ecosystem, production activities, civilizations, and cultures all accompany the decrease in entropy.

It seems to be inconformity with the principle
of the increasing entropy.

Agricultural Ecosystem

- The relationships between the factors selected by human (the decrease in entropy).
- The denial and destruction between the other factors (the increase in entropy)
- While increasing the entropy in the surrounding environment, only the entropy in the agricultural ecosystem is decreased.

(Common tendency in the production activity by human)

Natural Ecosystem

- The relationships between infinite factors.
- By making the total relationship diverse and complex, the total system will be stabilized.
- The system will evolve for the decrease of entropy as a whole.

This is the keyword for
sustainability.

Both agriculture and soils ...

Can be led to their sustainability, wholesomeness, and stability, by making use of their complexity and diversity.

The rationalization and simplification only in their appearance are brought by sacrificing the sustainability, wholesomeness, and stability in the long run.

Thank you for your attention.

You can find the pdf file of this lecture on my homepage as follows.

<http://timetraveler.html.xdomain.jp/>