Soil Organic Matter
Its Characteristics and Roles in Agricultural Environments

Kiyoshi Tsutsuki
http://timetraveler.html.xdomain.jp

Wise-being in the forest told ….

Homo ab Humo

- Human was born from a rich soil containing large amount of
- Human – Humus – Humidity

  There is a profound connection between human, humus, and humidity.

- Sleeping mind of human "Terra as the mother"

Genesis 3.19 – Old Testament

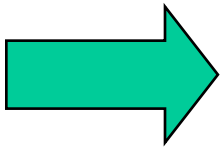
- You were made from soil, and you will become soil again.

Do you feel soil dirty?

Take a clod of soil into your hand, watch and smell it.

We will be relieved by such soils:

- Black soil
- Soft soil
- Good smelling soil
- Soil in which small worms are living

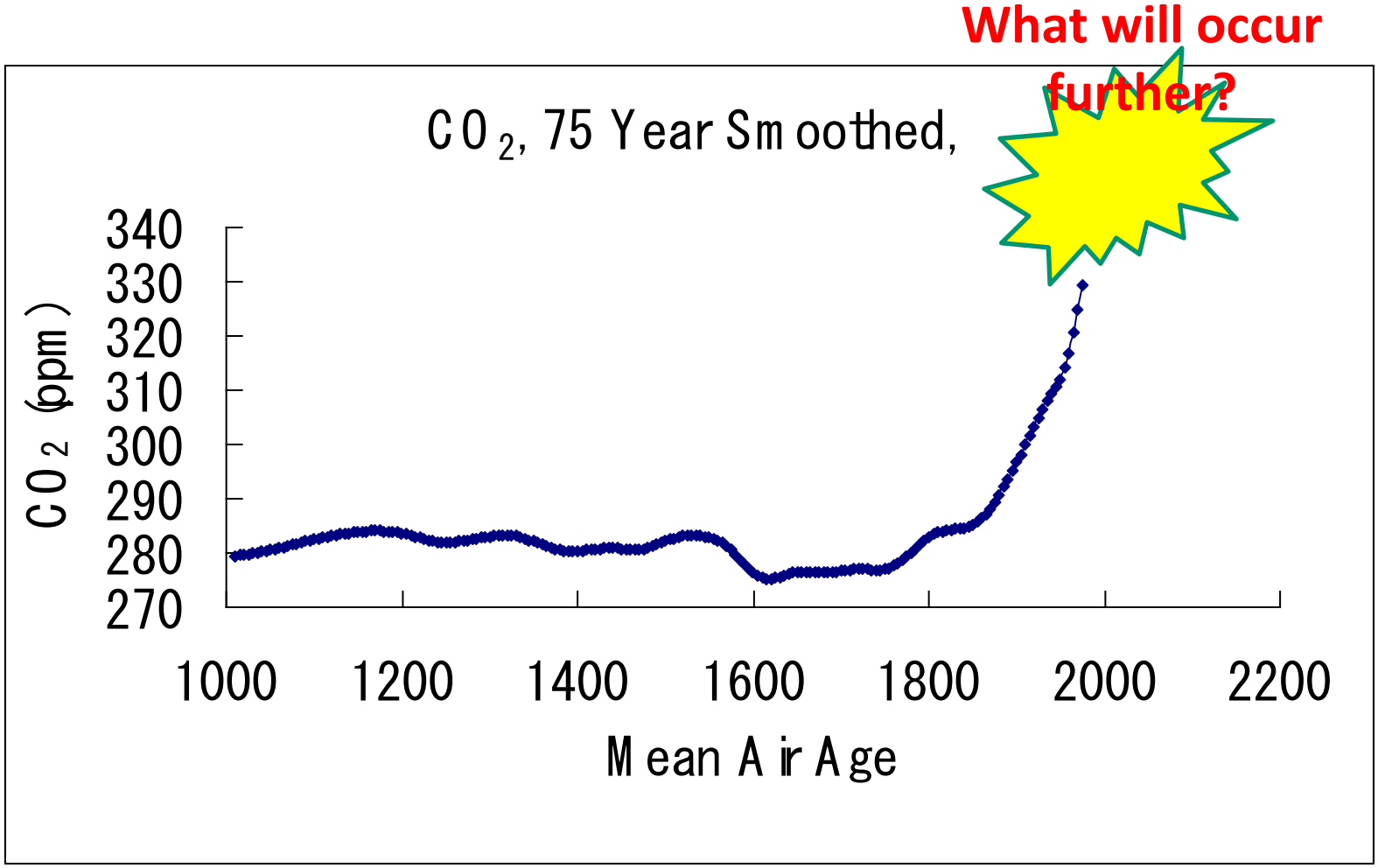


Such soils contain a suitable amount of organic matter.

Soil breeds life.

Evidence for this fact is

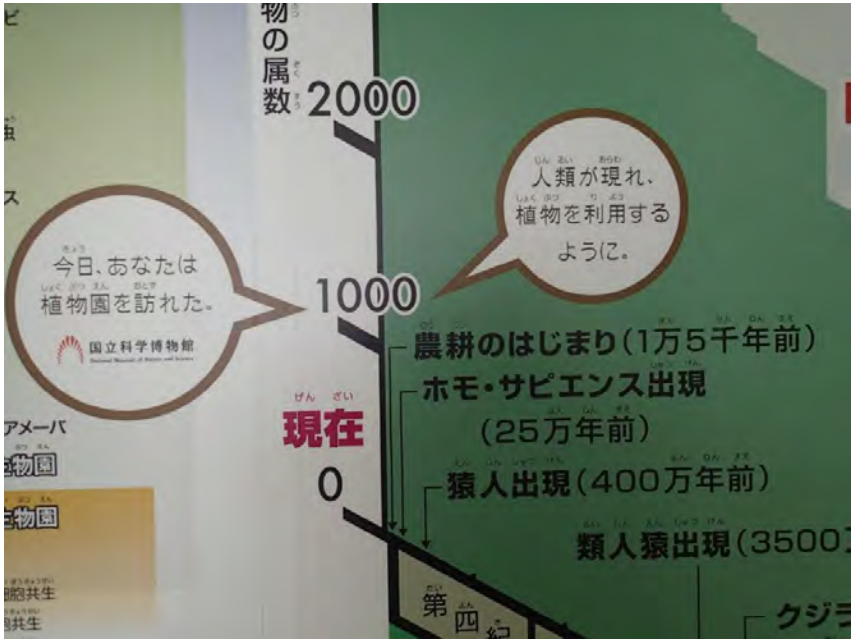
Soil Organic Matter.

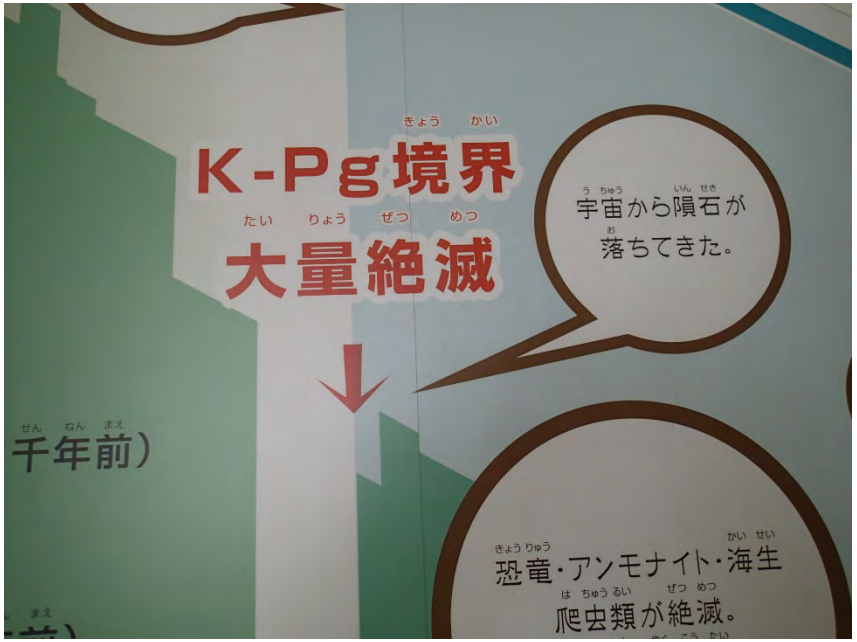


Change in ambient CO_2

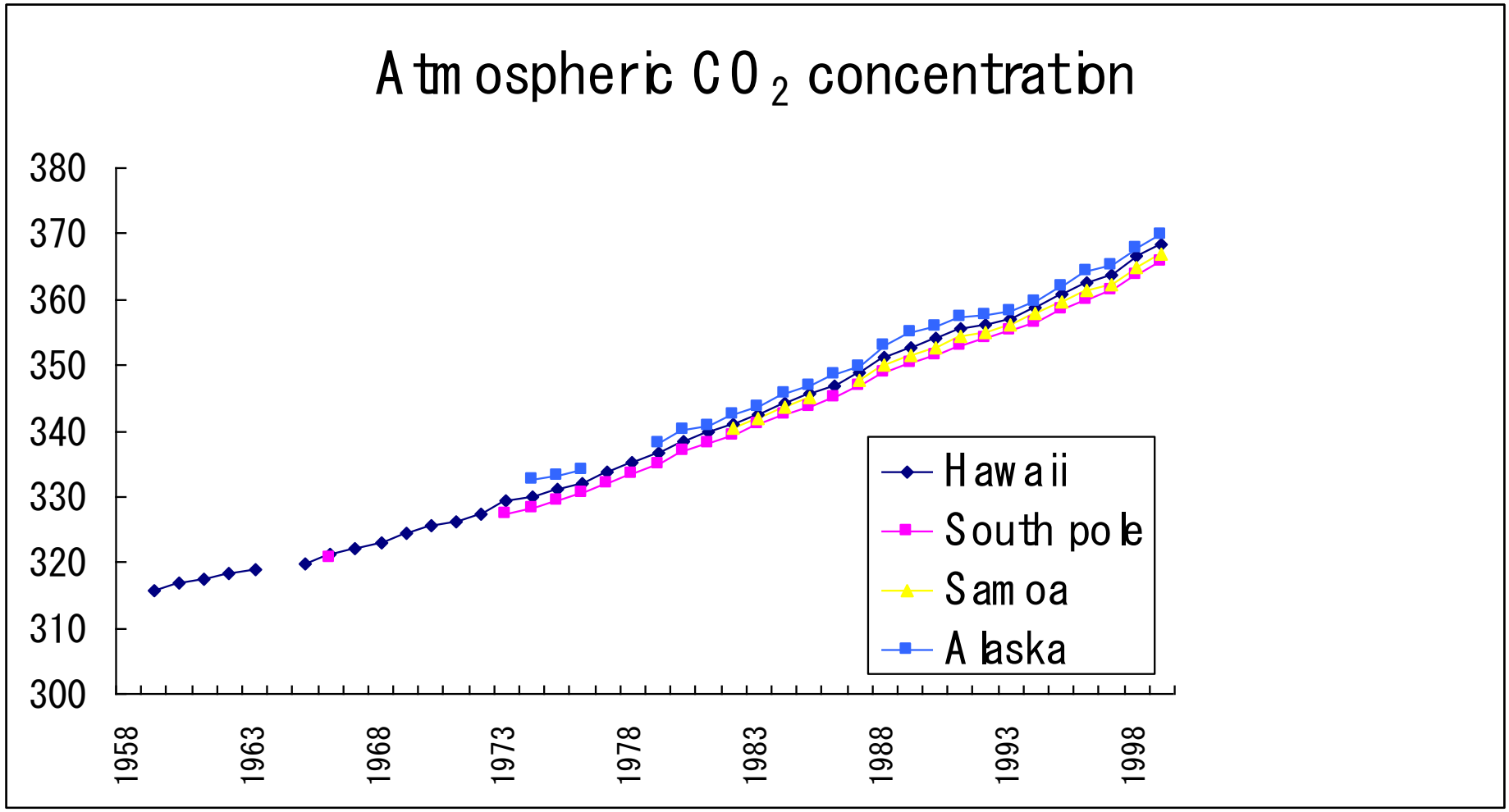
(Ice-core data of antarctics)

70% of the biologists consider that the mass extinction is occurring presently.





Increase in atmospheric CO_2 concentration

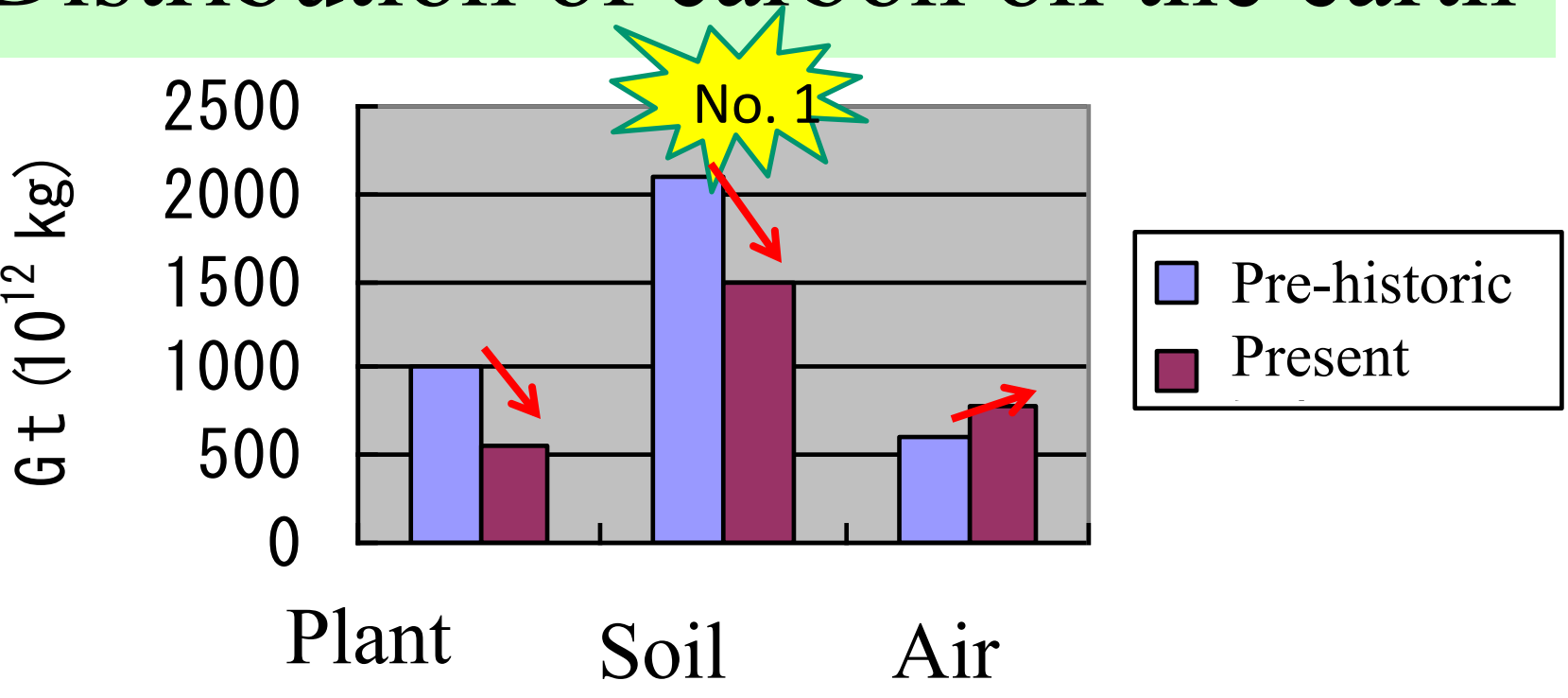


Stocks of carbon on the surface of earth

Stock pools		Stored amount 10^{12} kg
Earth		
Plant biomass		550
Soil humus		1500
Atmosphere	1850 (CO_2 260 ppm)	560
	1890 (CO_2 290 ppm)	630
	2000 (CO_2 390 ppm)	820
Ocean		38000
Carbonate salts		20×10^6
Dissolved organic matter		600
Solid suspension and sediments		3000
Earth crust (fossil fuel)		4000
Total amount		44800

Hunt(1972), Paul and Clark(1989), Eswaran et al.(1993)
CO_2 concentration was calculated from ice-core data
in Law Dome Antarctics.

Distribution of carbon on the earth



Organic matter in soil and vegetaion decreased remarkably due to civilization.

Humic substance is

- The most abundant organic matter on the earth surface. As carbon amount

  1500 Gt (10^9 t, 10^{12} kg)

- 3 times more abundant than plant biomass
- 2 times more abundant than CO_2

2100 Gt of humus carbon in pre-historic age.

Nitrogen on the earth: Location and stock size.

Location of occurrence	10^6 t
Atmosphere	3.9×10^9
Terrestrial Plants	15×10^3
Animals	0.2×10^3
Soil organic matter	150×10^3
Ocean Plants & animals	0.5×10^3
Sea water and sediments	1200×10^3
Nitrate – N in the above	570×10^3

植物栄養学第2版（文永堂）

Phosphorus on the earth: Location and stock size.

Location of occurrence	10^6 t
Terrestrial biota	2.6×10^3
Phosphor mineral	19×10^3
Soil	$96 \sim 160 \times 10^3$
Fresh water	0.090×10^3
Marine Biota	$0.05 \sim 0.12 \times 10^3$
Soluble inorganic P	80×10^3
Sediments	$840{,}000 \times 10^3$

Soil is the largest pool of stocks both for N and P.

植物栄養学第2版（文永堂）

Biomass production and respiration/ combustion on the earth (10^9 t/year)

	Biomass production	CO_2 formation
Plant	500	34.5
Animal	0.5	4.1
Human	0.1	0.7
Microbes	1.0	112
Wild fire		6.9
Volcano		0.15
Factory		15
Total	502	173.5

Emission of CO_2 due to human activity

Factors	Increase rare of CO_2 carbon
	Gt (10^9 t)/year
Fossil fuel combustion	7
Land use change	2.2

Land-use change

Forest clearing
Slush and burn
Grassland to upland field

Large amount of gas is emitted from soil surface

World energy consumption (2003)

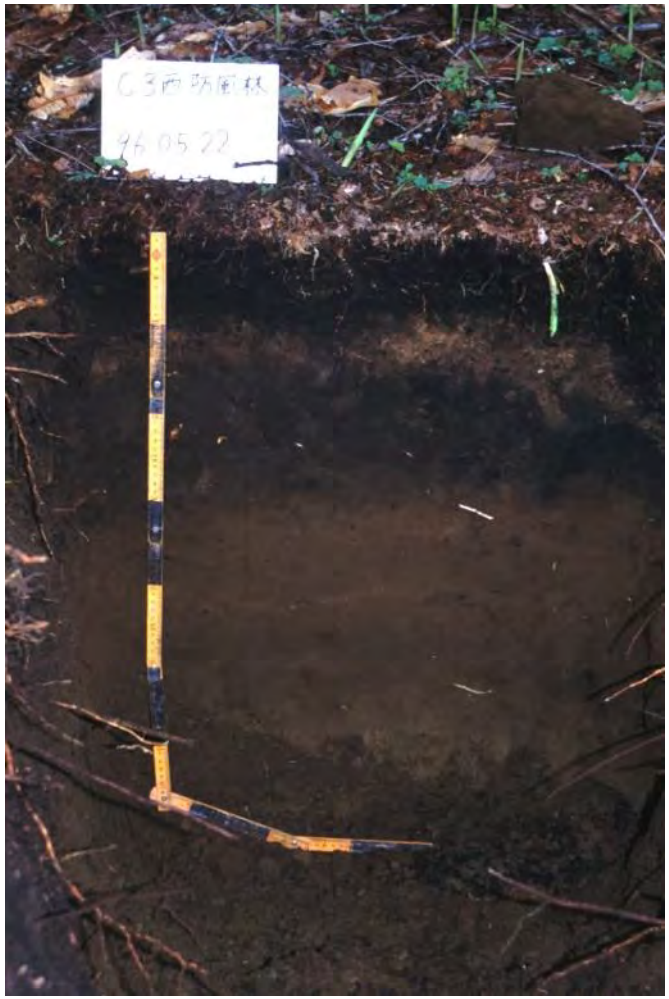
Source	Consumption (petroleum equivalent 10^8 tons)	
Petroleum	36. 4	85. 5
Natural gas	23. 3	
Coal	25. 8	
Atomic	6. 0	12. 0
Hydraulic	6. 0	

CO_2 emission

heat emission

Energy consumption per capita

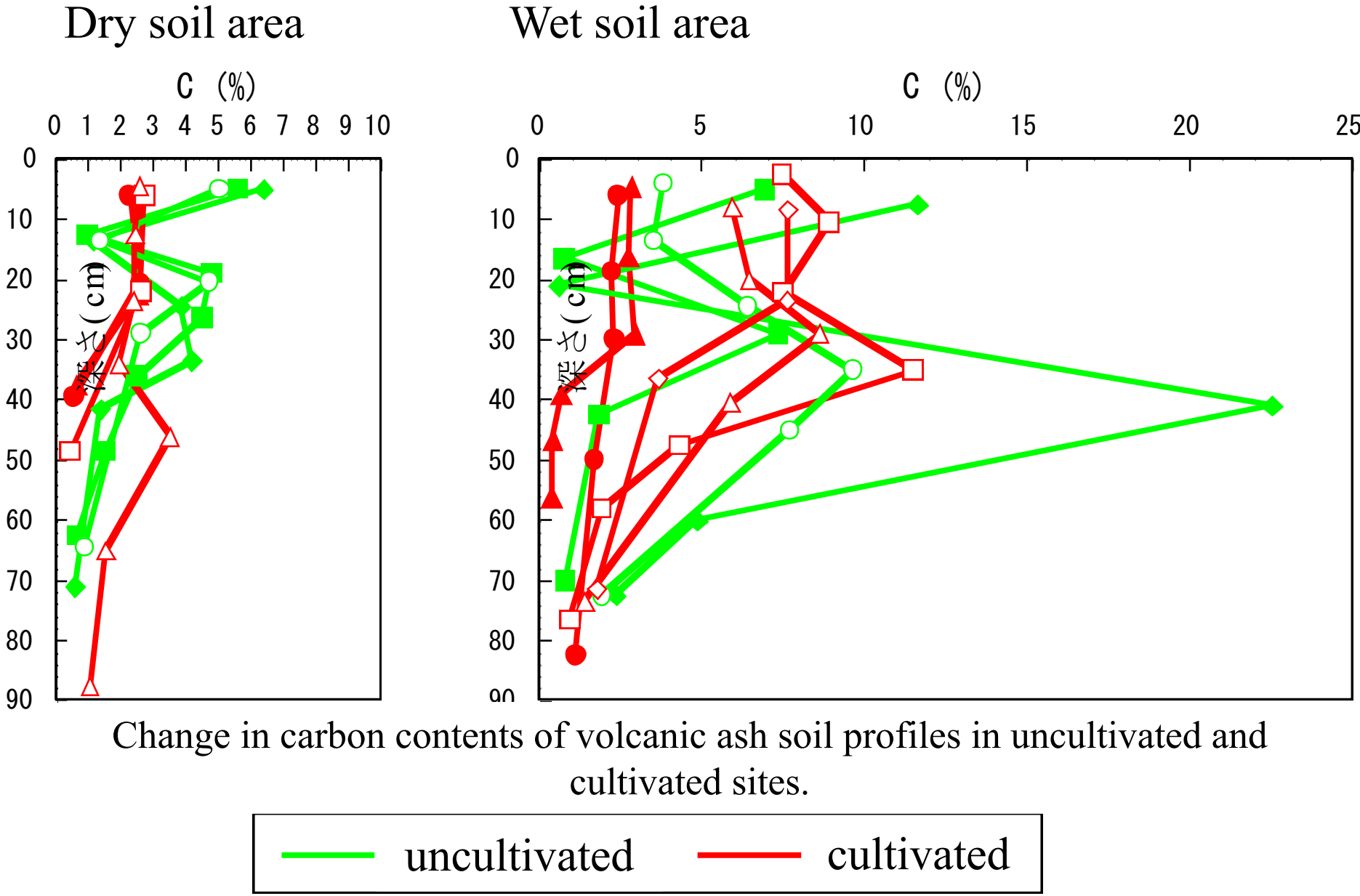
- World 1.7 ton annually
  (petroleum equivalent)
- Japan 4.1 ton annually
- USA 8.0 ton annually
- Human activity causes the increase in atmospheric CO_2 concentration.
- Plant and soil absorb CO_2.



Wind-break forest soil

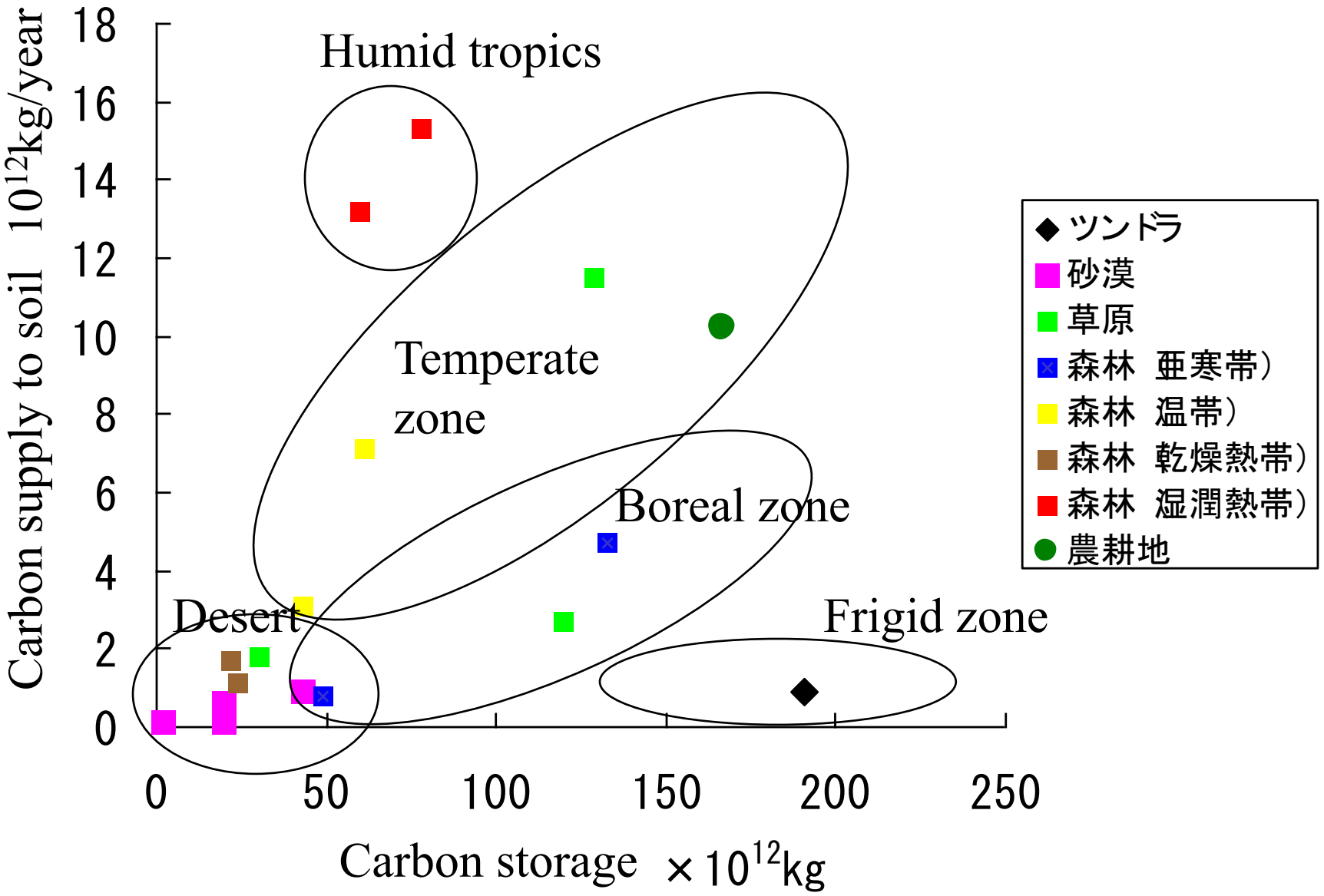
Adjacent upland field soil

Volcanic ash soil profile in the adjacent forest and upland field.

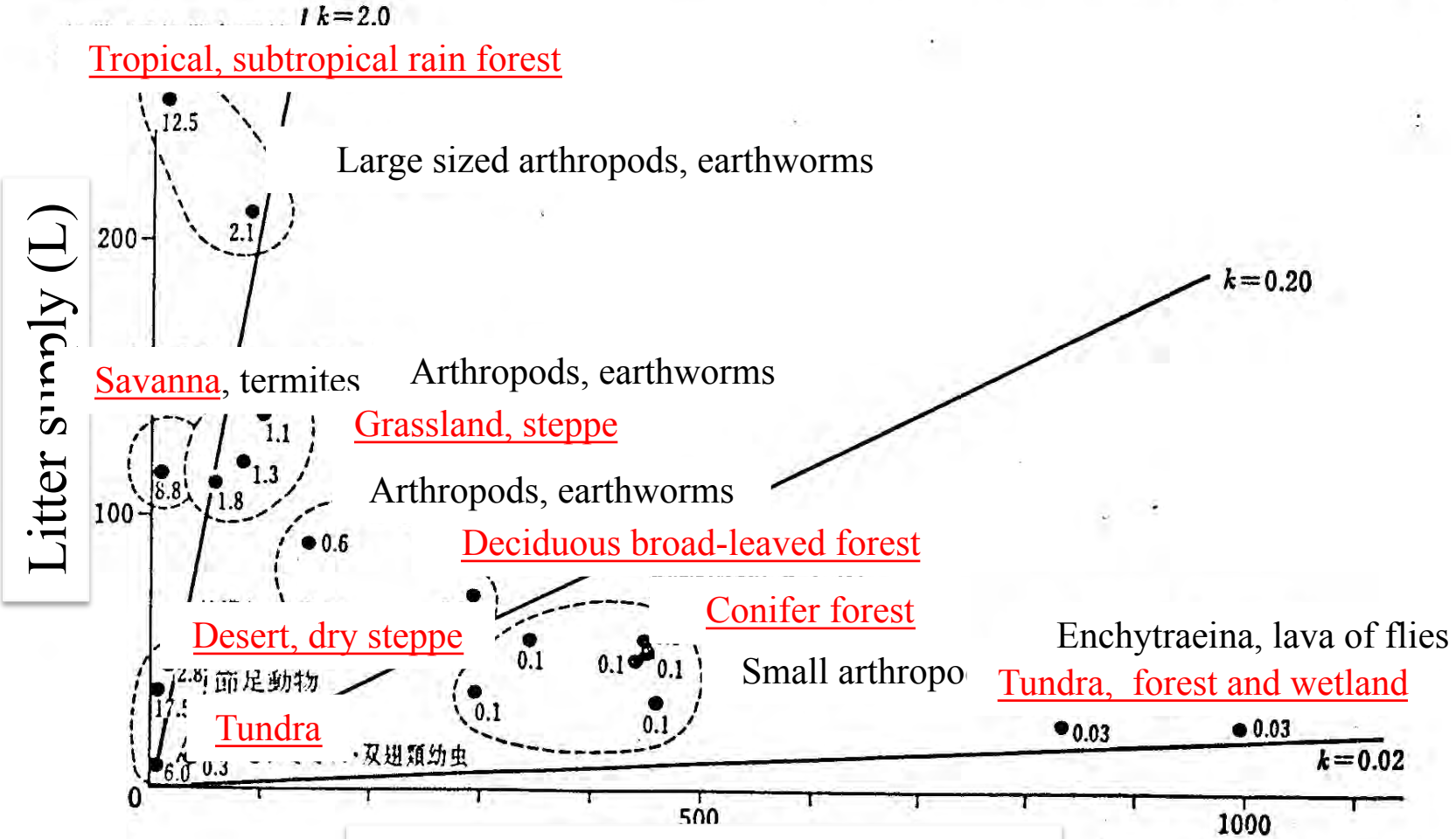


Change in carbon contents of volcanic ash soil profiles in uncultivated and cultivated sites.

Supply and storage of carbon in soil



Litter supply and SOM accumulation

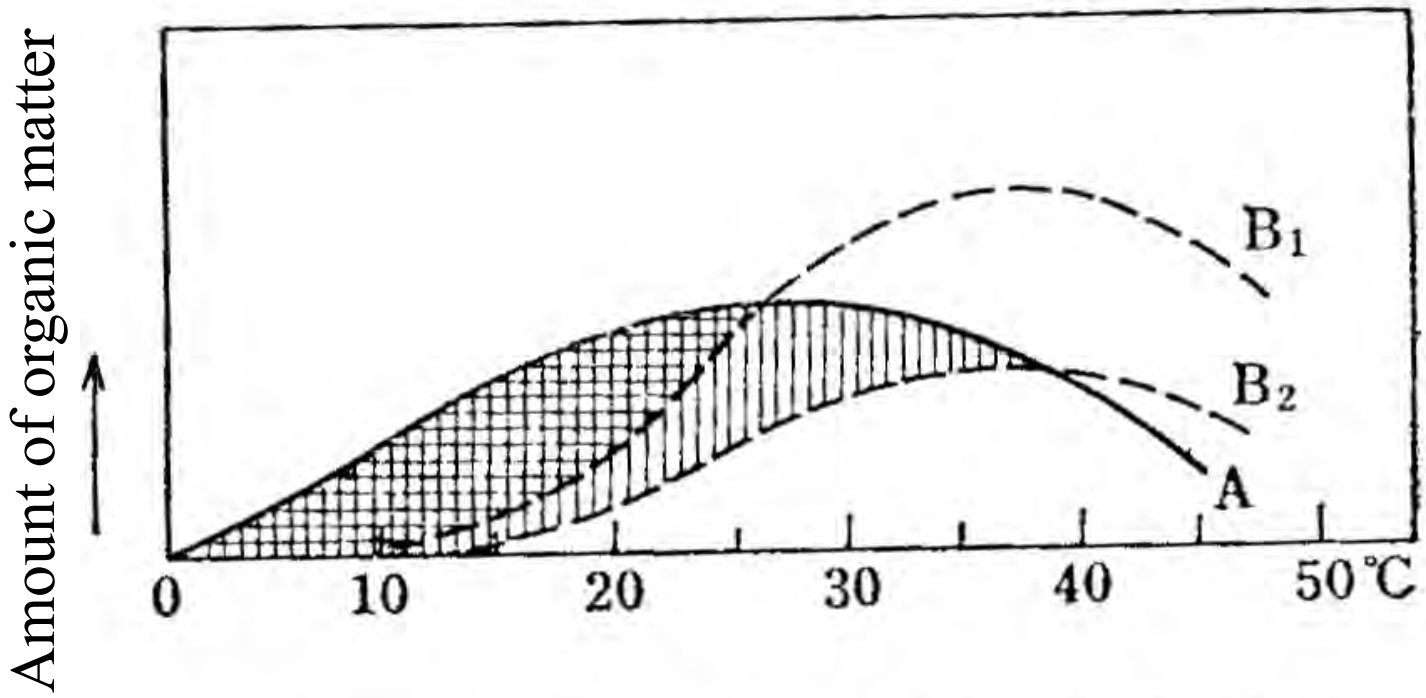


主要な生態系型の落葉供給量，(L)，土壌有機物の蓄積 (X_{ss})，分解率 $k=L/X_{ss}$ および主要な分解動物群　図中の数字はそれぞれの地点での k の値を示す。

Primary forest in Baybay, Leyte

Primary forest soil profile in Baybay, Leyte

Factors affecting SOM accumulation: temperature and moisture content of soil



Aerobic upland soil

Anaerobic flooded soil

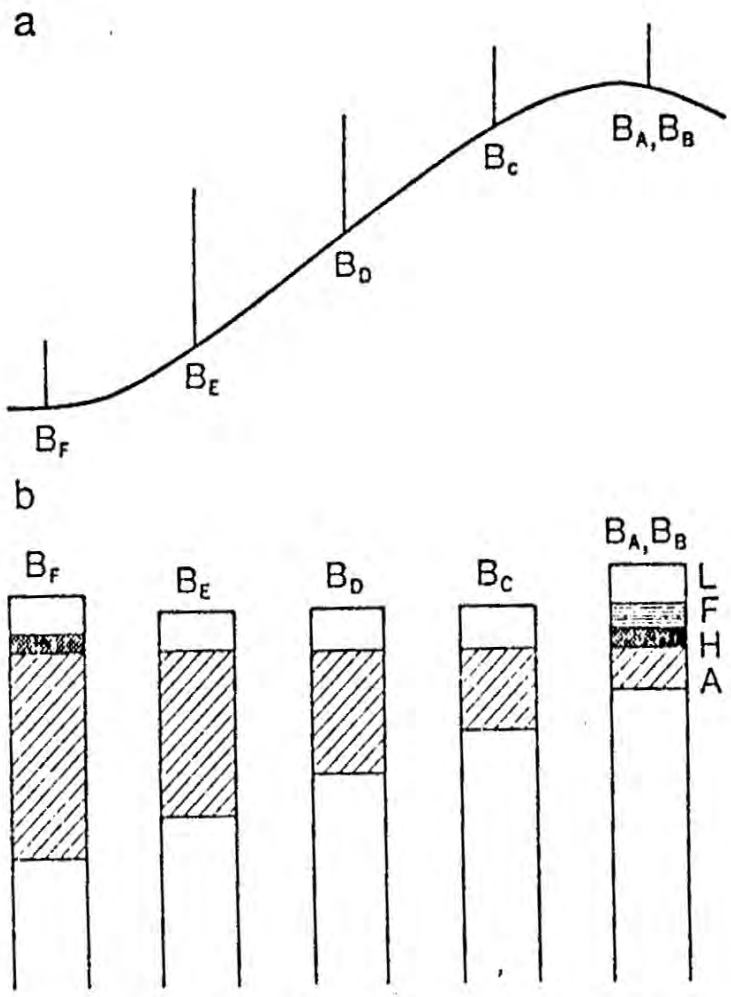
A Organic matter production by plant

B_1 Organic matter decomposition in aerobic soil

B_2 Organic matter decomposition in anaerobic soil

Amounts and Turnover Rates of C and N in the Microbial Biomass for Cultivated Soils for Three Locations

Soil and Locati	Microbial C	Microbial N	C Inputs	Nitrogen Flux through Microbial Biomass	Microbial Turnover Time
	kg/ha	kg/ha	Mg/ha/y	kg/ha/yr	yr
Temperate					
England	570	95	1.2	34	2.5
Canada	1600	300	1.6	53	6.8
Tropical					
Brazil	460	84	13	350	0.24



Schematic representation of soil types (B_A—B_F) of Brown forest soil. a: topographic location; b: A_0 and A horizons. Vertical lines indicate growth of the tree.