Analog Forestry as an approach to strengthen climate resilience for communities and ecosystems

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in 1920 , Fenrow the Head of US Forest Service. pointed out that;

'The first and foremost purpose of a forest growth is to supply us with wood material; it is the substance of the trees itself, not their fruit, their beauty, their shade, their shelter, that constitutes the primary object,'

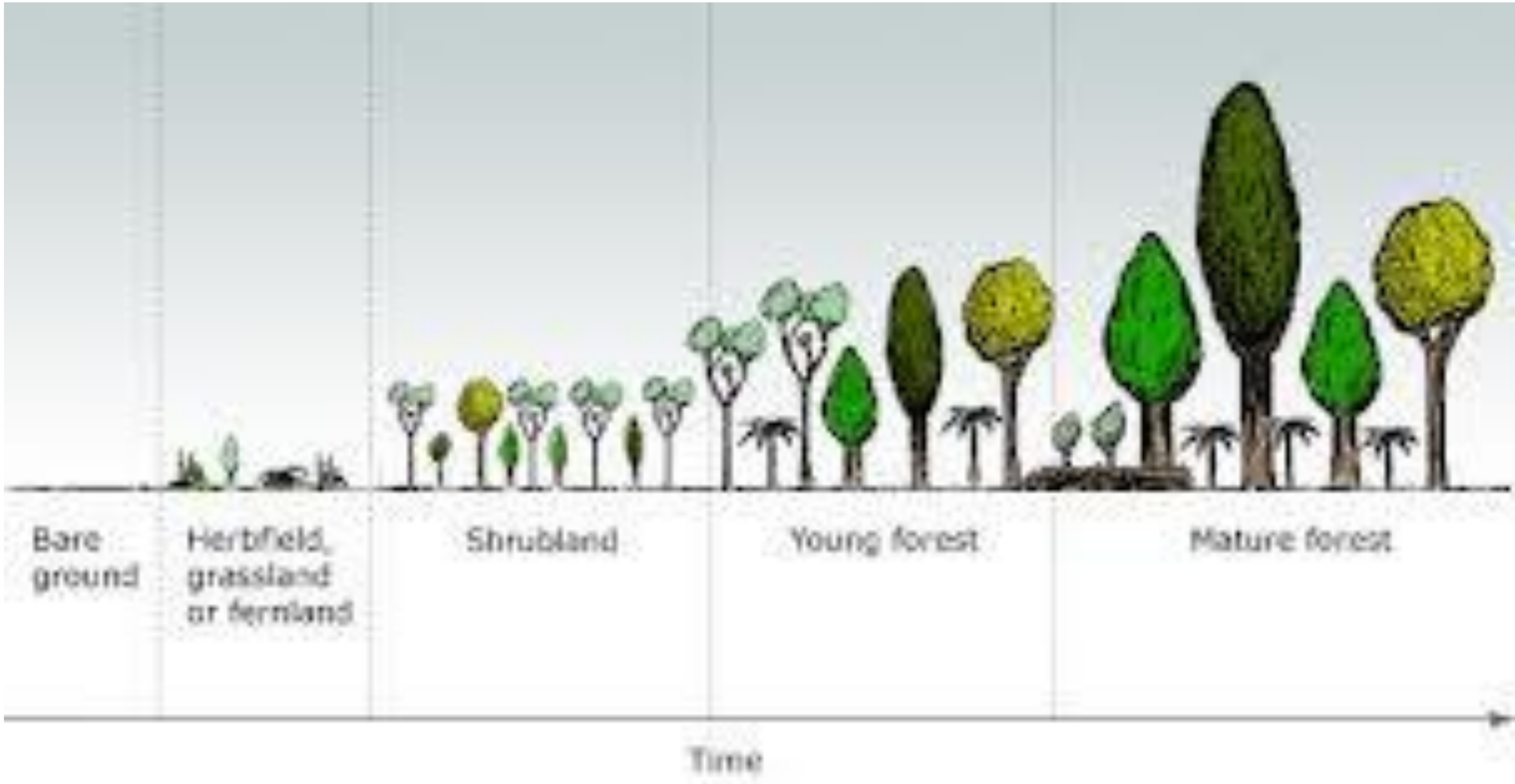
2500 years ago the Buddha said :

"The forest is a most benevolent organism, offering freely of its life processes, asking nothing in return. It even provides shade to the axeman who would fell it"

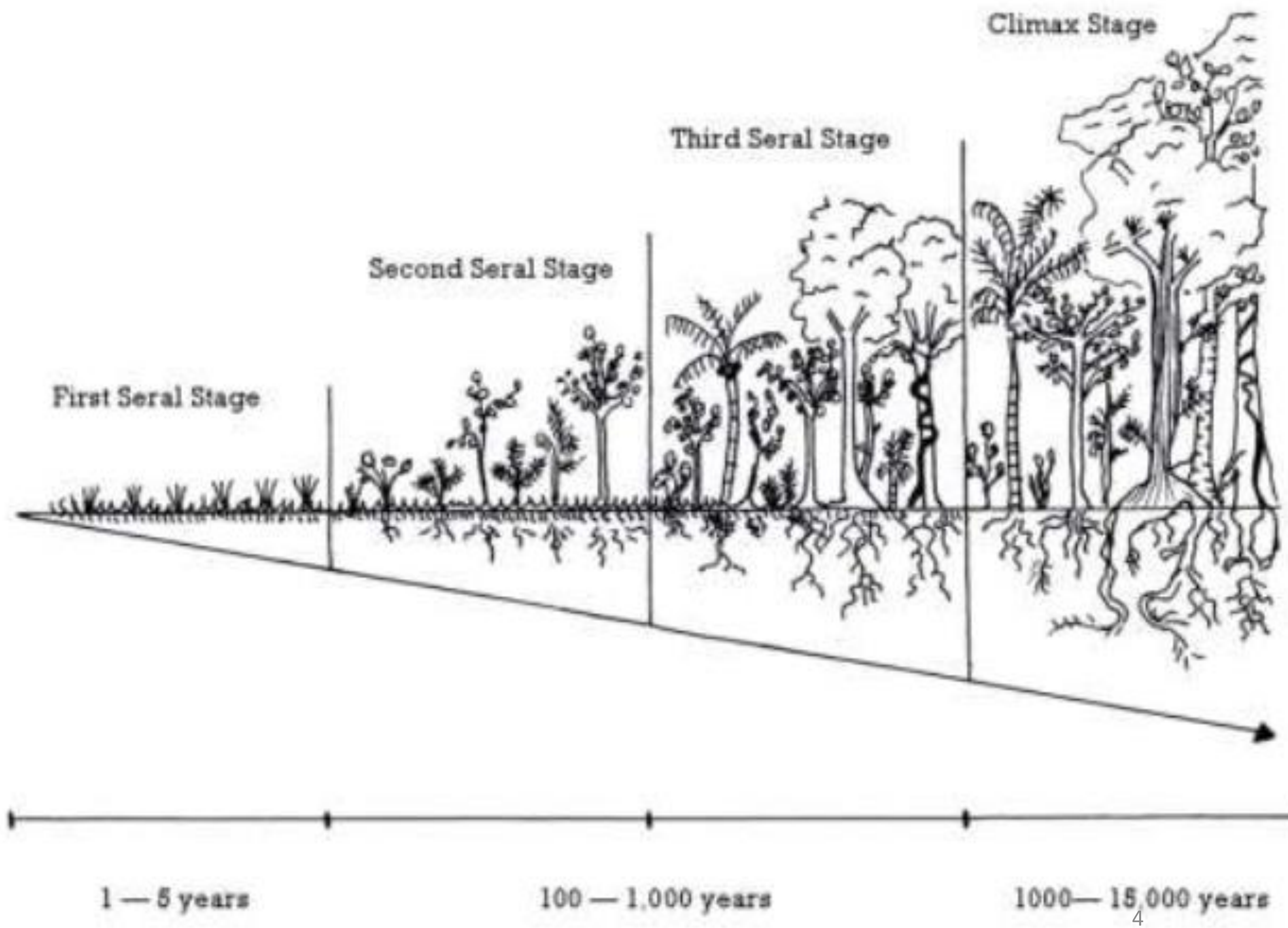
What is a Forest ?

A forest is the end of a process termed seral succession, The tree species of a forest account for less than 01 % of the biodiversity of such formations but are critical in maintaining total biodiversity.

The growth (seral succession) of a forest



A similar process drives the formation of a living soil. In Nature. Soils will evolve features that depend on the interplay of the prior listed soil-forming factors It takes decades to several thousand years for a soil to develop a profile



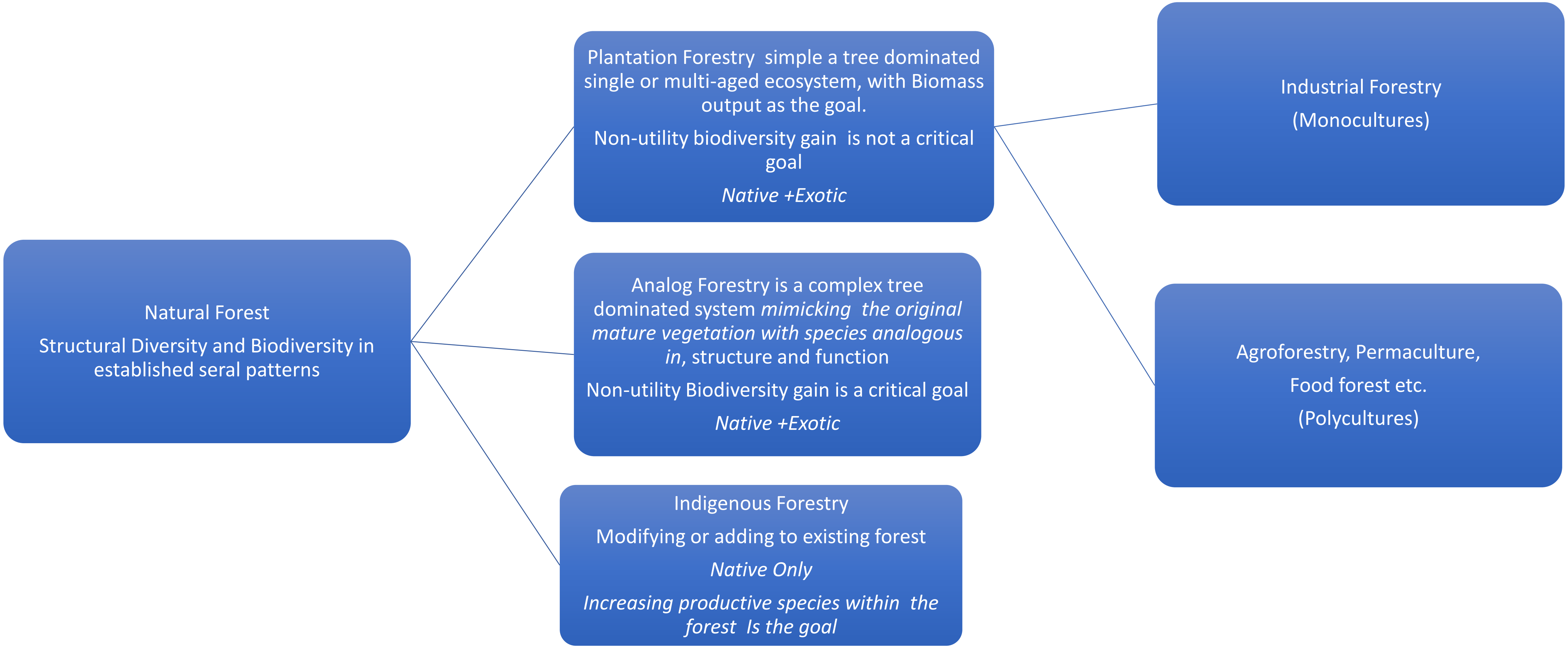
But understanding how the soil grows and working with it can shorten the time that is required to grow a soil

As a forest matures it increases the number of Microhabitats for other species that form within the complex architecture of maturity

Different Species display very different growth forms and bark chemistry.

- Branch internodes
- Leafy canopy
- Bark surface
- Dry cavities
- Phylotelomata
- Roots

How much of this knowledge is utilized in the current Approaches to Forestry



The practice of Analog Forestry is guided by twelve principles

Principle 1 Observe and record

Principle 2 Understand and Evaluate

Principle 3 know your land

Principle 4 identify levels of yield

Principle 5. Understand flow systems

Principle 6 Reduce ratio of external energy in production

Principle 7 Be guided by landscape needs.

Principle 8 Follow ecological succession

Principle 9 Utilize ecological processes

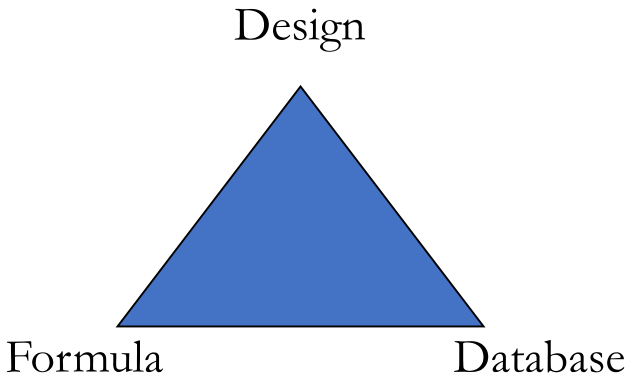
Principle 10 Value Biodiversity

Principle 11 Respect Maturity

Principle 12 Respond creatively

Analog Forestry is a silvicultural system that seeks to create a tree-dominated ecosystem that is analogous to the original mature ecosystem in architectural structure and ecological function.

www.analogforestry.org



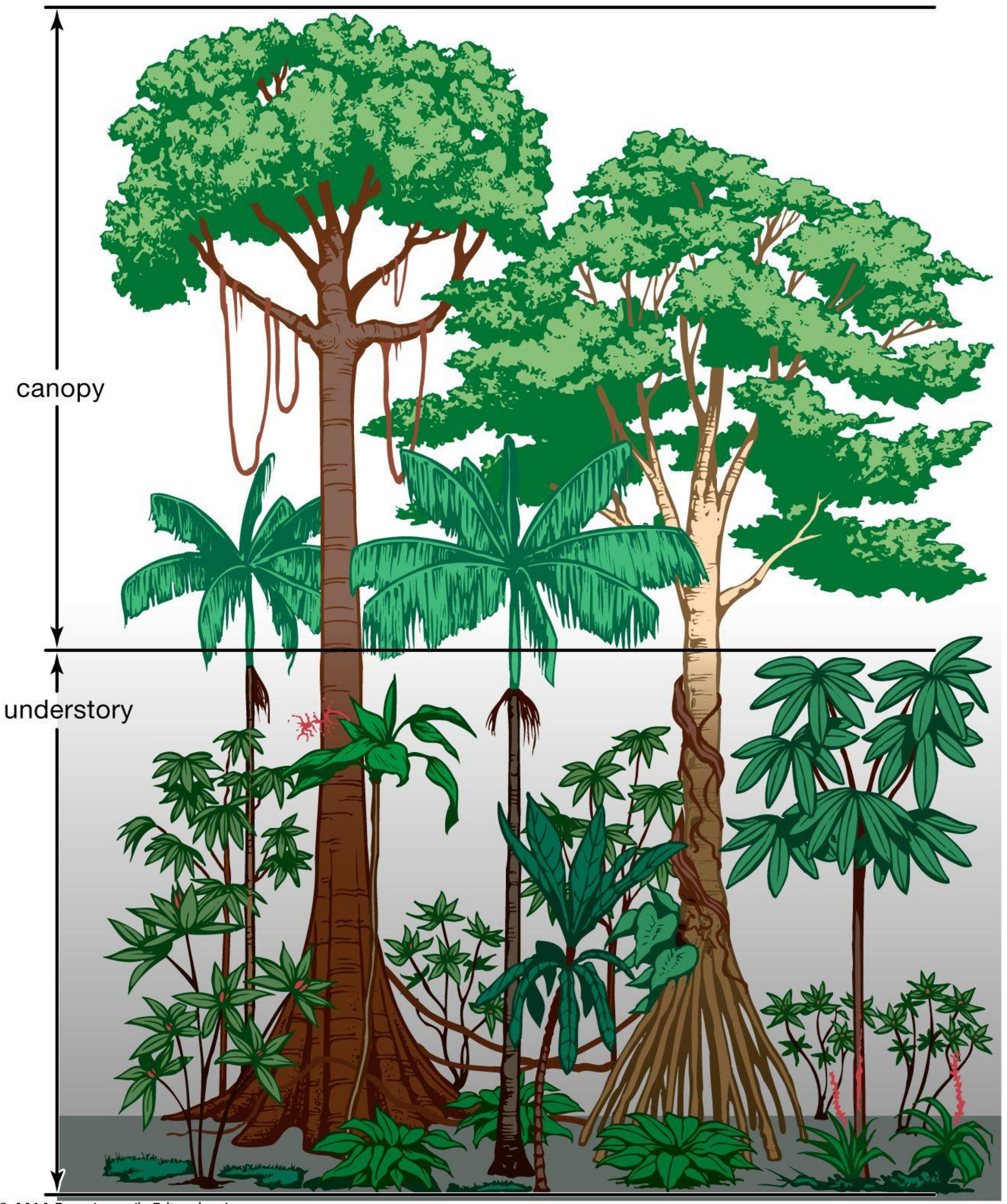
Principle 1 Observe and record

A Physiognomic formula is written to represent the architectural structure of the forest. It considers the growth forms and levels of canopies of the area considered.

It is written thus :

V7;V6,V5r,V4,V3;T5;P5,X4;R2

The mature or model forest chosen must be recorded in terms of all the visible growth forms and recorded as symbols representing them.



Principle 2

Understand the functions of the species to be used in design and propogate the species to fit the design

AVAILABLE TREE SPECIES LIST

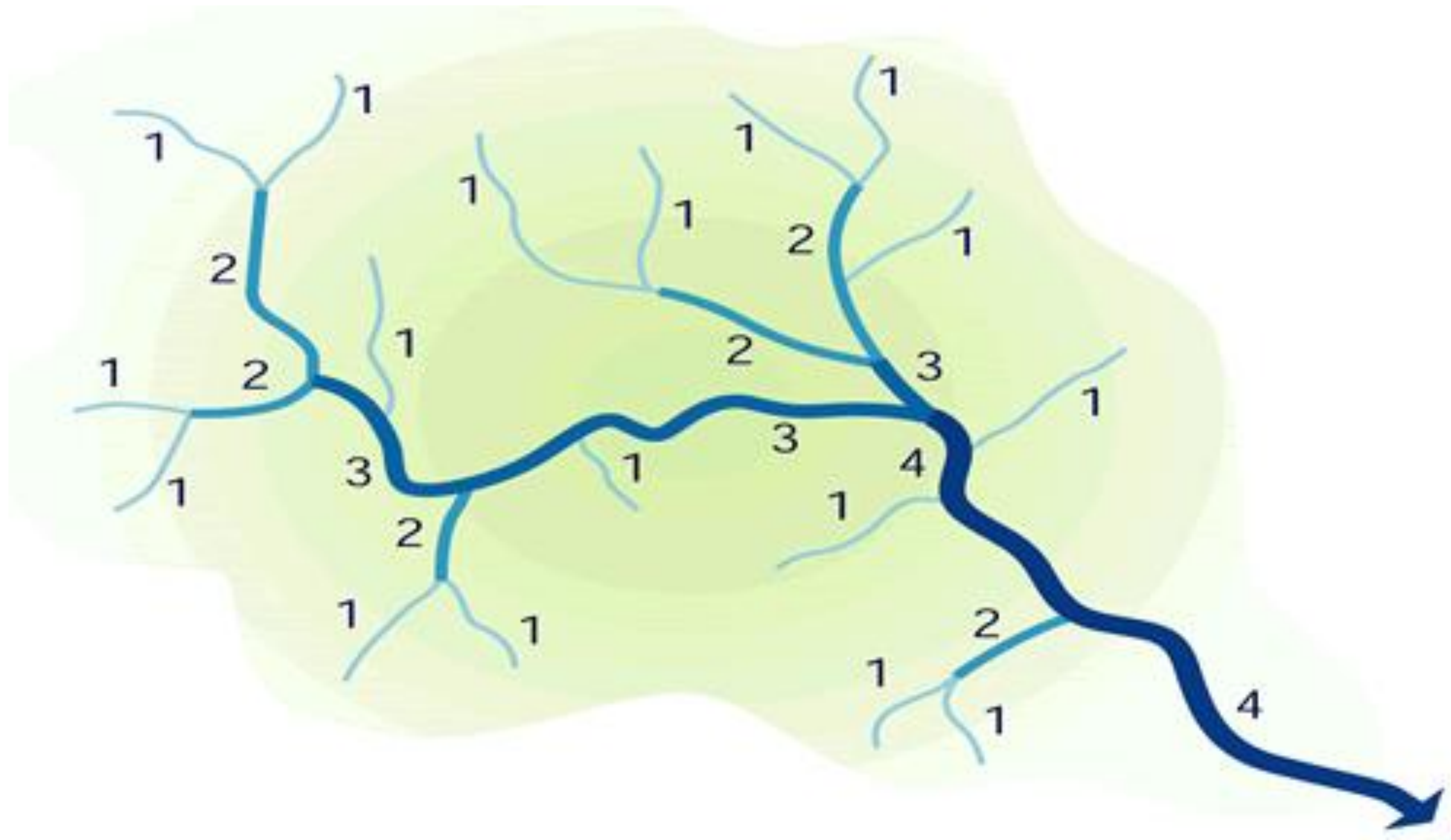
BELIPOLA ANALOG FOREST ARBORETUM

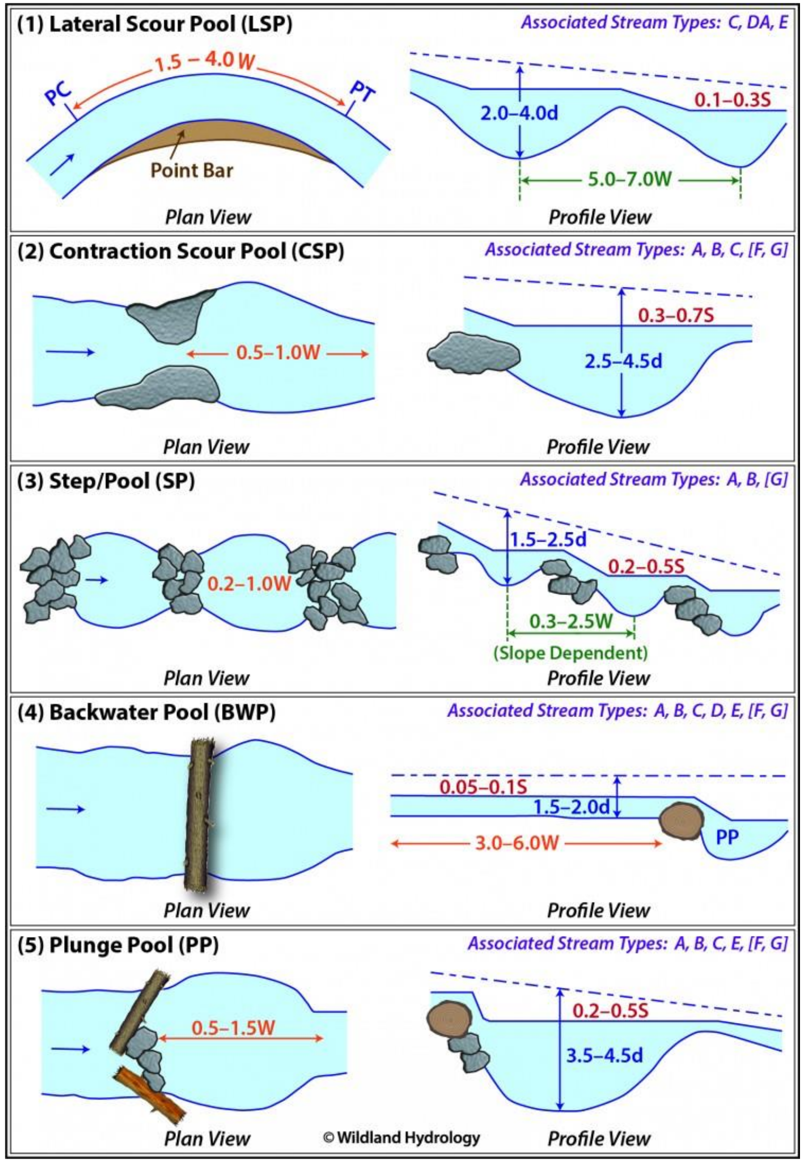
	Ref No	Familly	Botanical name	Origin of species	Sinhala name	Growth rate	Economic importance	AF note	Canopy Type	Root type	
10	6	Rutaceae	*Acronychia pedunculata*	Native	Ankenda	Moderate	Medicine, flavouring, cosmetic perfumery	V8	Round	Tap deep root	Ever
11	7	Fabaceae	*Albizia falcataria*	Exotic	Rata mara	Fast	Timber, firewood	T8	Layered, umbrella	Tap deep root	
12	8	Fabaceae	*Albizia lebbeck*	Exotic	Mara	Fast	Tanin, medicune, firewood	T8	Layered, umbrella	Tap deep root	
13	9	Euphorbiaceae	*Aleurites moluccanus*	Native	Thel kakuna	Moderate	Medicine, inedible oil, timber	V8	Dense irregula broad	Tap deep root	
14	10	Apocynaceae	*Alstonia macrophylla*	Exotic	Hawari nuga	Fast	Timber, medicine	V9	Oval	Tap deep root	
15	11	Annonaceae	*Annona cherimola*	Exotic	Sini atha	Fast	Food, medicine, insectiside	V5	Shrubby, broad	Tap moderate root	Ever
16	12	Arecaceae	*Areca catechu*	Native	Puwak	Moderate	Nut, medicine, timber	P8		Fibrus shallow root	
17	13	Moraceae	*Artocarpus heterophyllus*	Exotic	Jack fruit	Fast	Food, medicine, timber, resin	V7	Irregular round	Tap deep root	
18	14	Poaceae	*Bambusa vulgaris*	Native	Kaha una	Fast	Timber, medicine	B7		Fibrus shallow root	
19	15	Caesalpiniacea	*Bauhinia tomentosa*	Native	Patan	Fast	Dye,timber, medicine	T5	Round	Tap deep root	
20	16	Moraceae	*Ficus oppositifolia*	Native	Kota dibula	Fast	Medicine	V5	Shrubby	Tap shallow root	
21	17	Caricaceae	*Carica papaya*	Exotic	Papaya	Fast	Food, papain, medicine	T5		Tap moderate root	
22	18	Arecaceae	*Caryota urens*	Native	Kithul	Slow	Jaggary, sago, medicine, timber,toddy	P7		Fibrus moderate root	
23	19	Malvaceae	*Ceiba pentandra*	Native	Pulun	Fast	Kapok, medicine, timber	T9	Broad crown	Tap deep root	
24	20	Fabaceae	*Delonix regia*	Exotic	Mal mara	Fast	Timber, firewood	T7	Layered, umbrella	Tap deep root	
25	21	Dilleniaceae	*Dillenia indica*	Exotic	Hoda para	Moderate	Shampo, medicine, timber, polish	V8	Broad	Tap deep root	Ever
26	22	Asparagaceae	*Dracaena fragrans*	Exotic	Bothal gas	Slow	Ornamental	V5		Fibrous shallow root	Ever
27	23	Verbenaceae	*Duranta repens*	Exotic	Andara	Fast	Ornamental	V5	Shrubby irregula	Tap deep root	Ever
28	24	Fabaceae	*Erithrina edule*	Exotic	Arabadu	Fast	Firewood, medicine, timber	V6	Broad crown	Tap deep root	
29	25	Moraceae	*Ficus benghalensis*	Native	Wana nuga	Fast	Latex, tanin, firewood, medicine	V8	wide speading Broad	Tap deep root, aerial roots	
30	26	Moraceae	*Ficus benjamina*	Native	Walu nuga	Fast	Latex, tanin, firewood, medicine	V8	Dense, wide broad	Tap deep root, aerial roots	
31	27	Moraceae	*Ficus racemose*	Native	Aththikka	Fast	Latex, tanin, firewood, medicine	V8	Irregular wide broad	Tap deep root	
32	28	Sapindaceae	*Filicium decipiens*	Native	Pihibiya	Moderate	Timber	T8	Broad crown	Tap deep root	

Principle 2 Understand and Evaluate

Understand the functions of the species to be used in design and propogate the species to fit the design

Principle 5. Understand flow systems



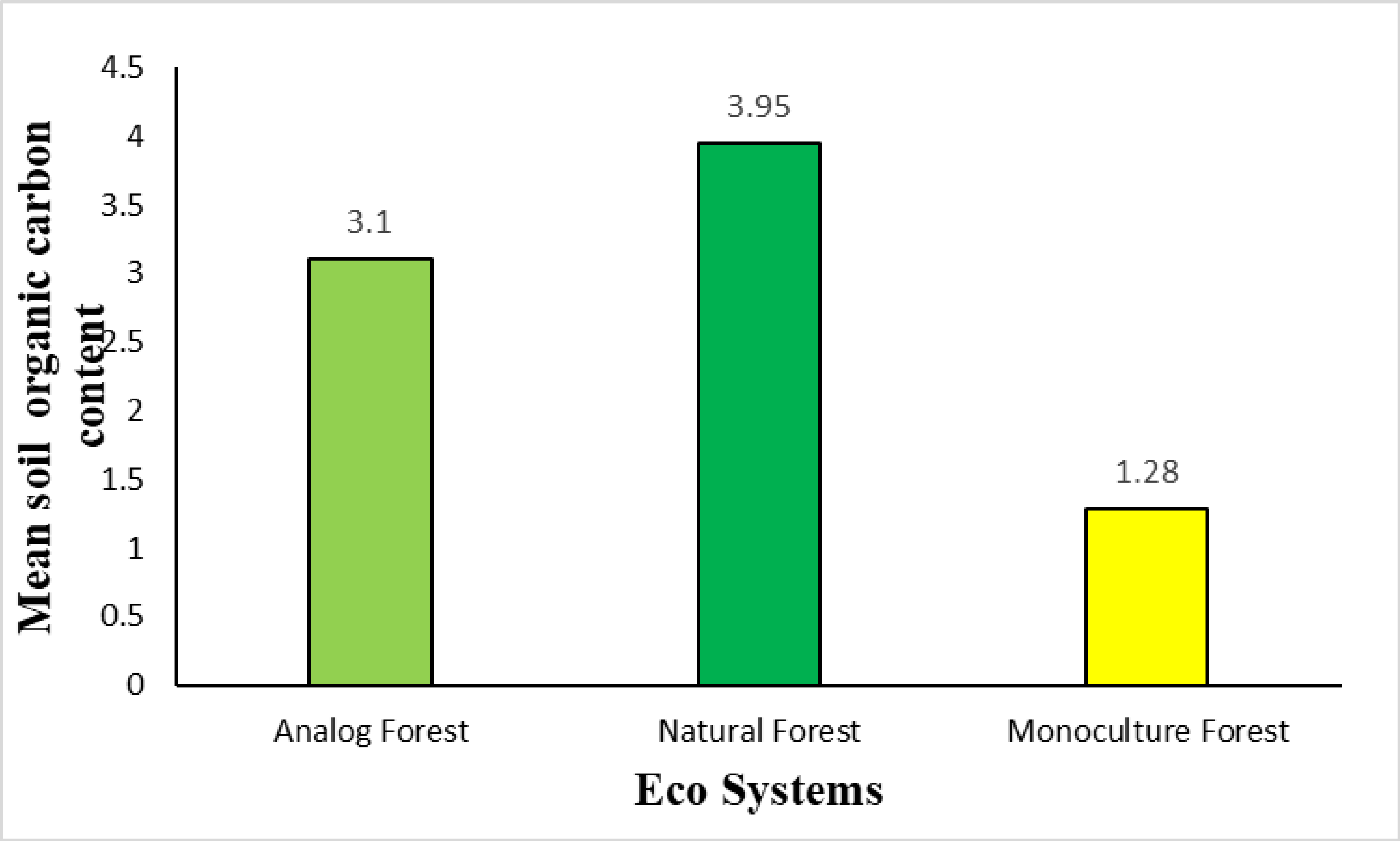


Principle 5. Understand flow systems

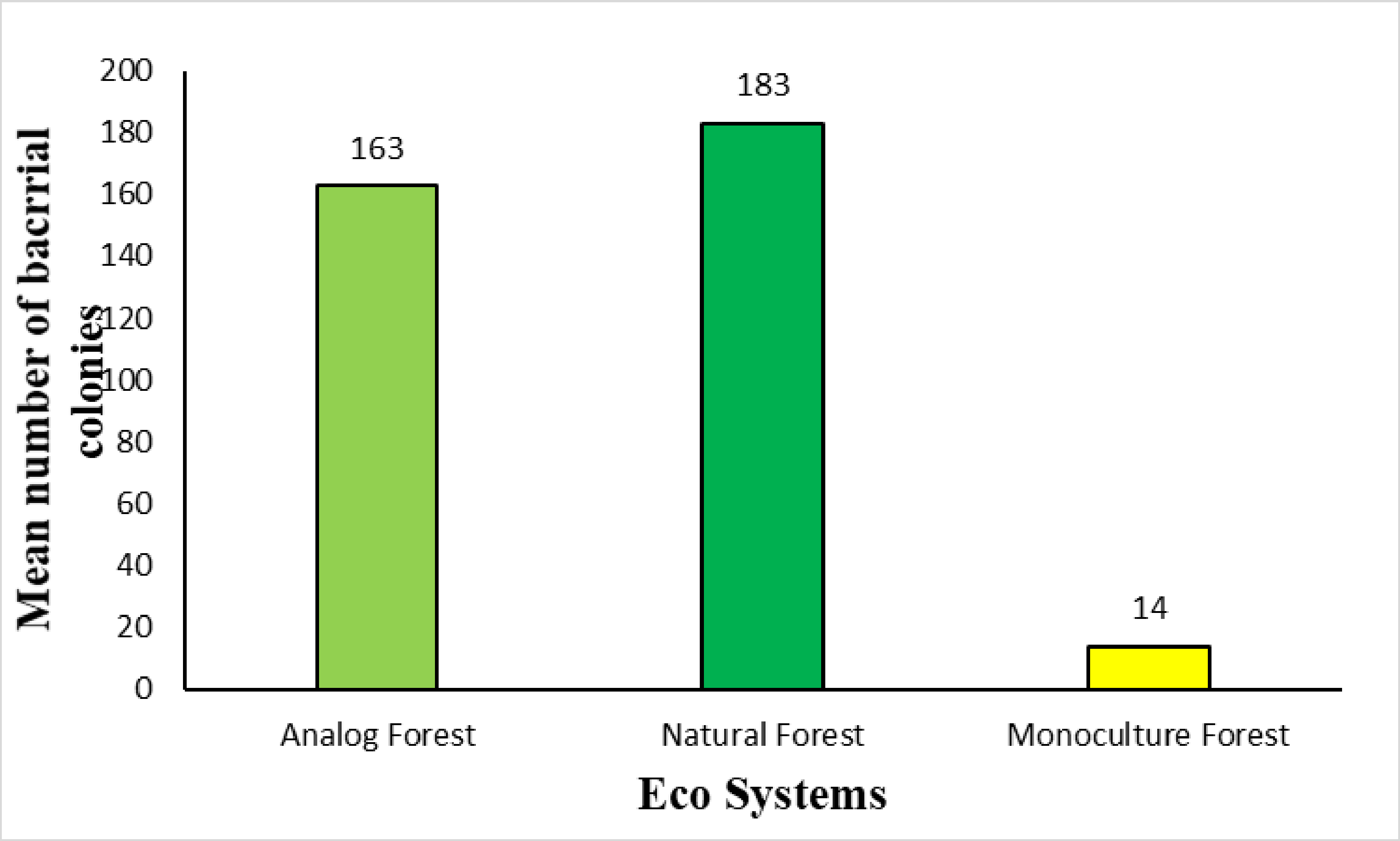
An Example of Analog Forestry Application

Analog design on the left (90% exotic species) mimics the natural forest on the right(100% native species) with added aesthetic considerations and with similar volumes of Photosynthetic Biomass.

Analysis of soil organic carbon



Analysis of soil bacterial diversity



Comparison of Soil Quality in Monoculture Forest (*Pinus carribea*), Natural Forest and Analog Forest Ecosystems (M.K.L.Chandana 2019)

Economic Development through the consumption of fossil fuels is the driver of Climate Change.

In 1979 a formal announcement was made linking development to oil "***No oil means no development, and less oil, less development. It is oil that keeps the wheels of development moving***". *Sri Lankan Government* communiqué *1979*

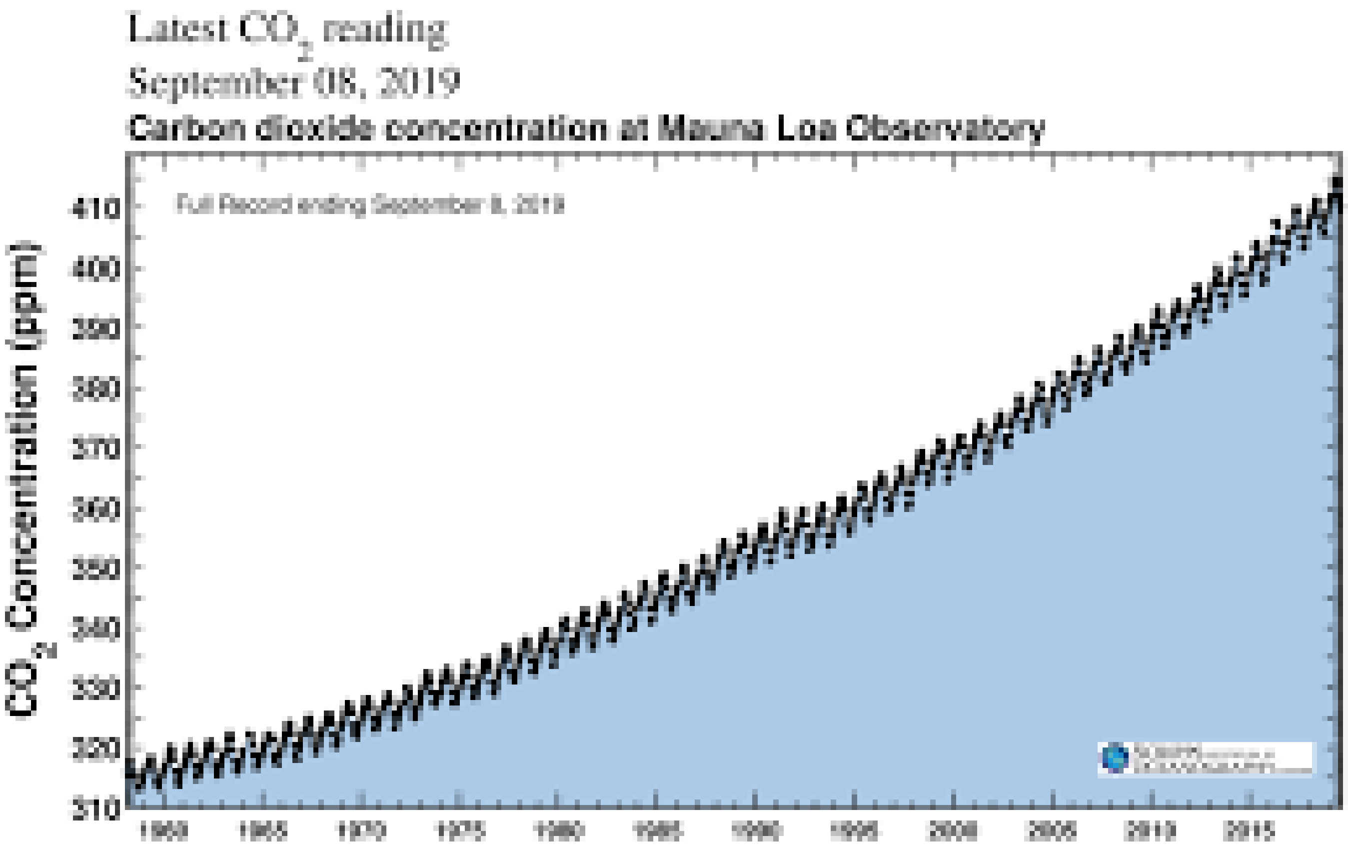
But in Ecuador, the Shuar, an Amazonian tribe under whose land lies massive deposits of oil, oppose its mining, they say :

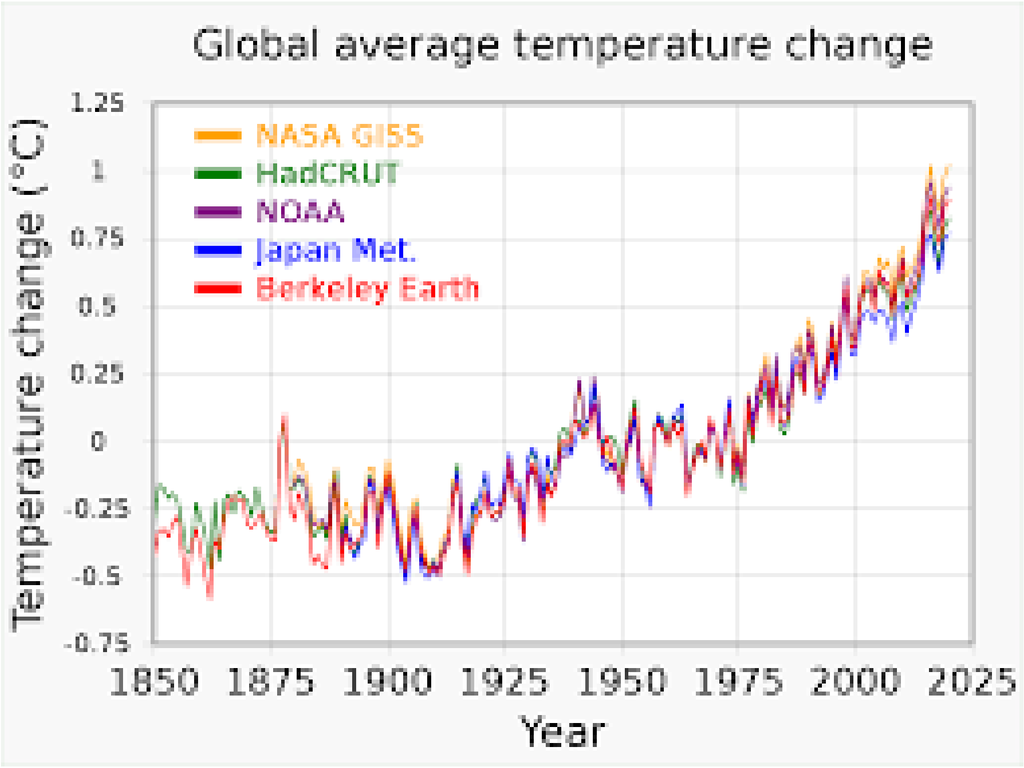
"***Oil represents the spirits of the dead to ask it for power, you scarifice your children***"(CESR, 2000)

The myth of Economic Development through consumption of fossil energy leads to oil addiction

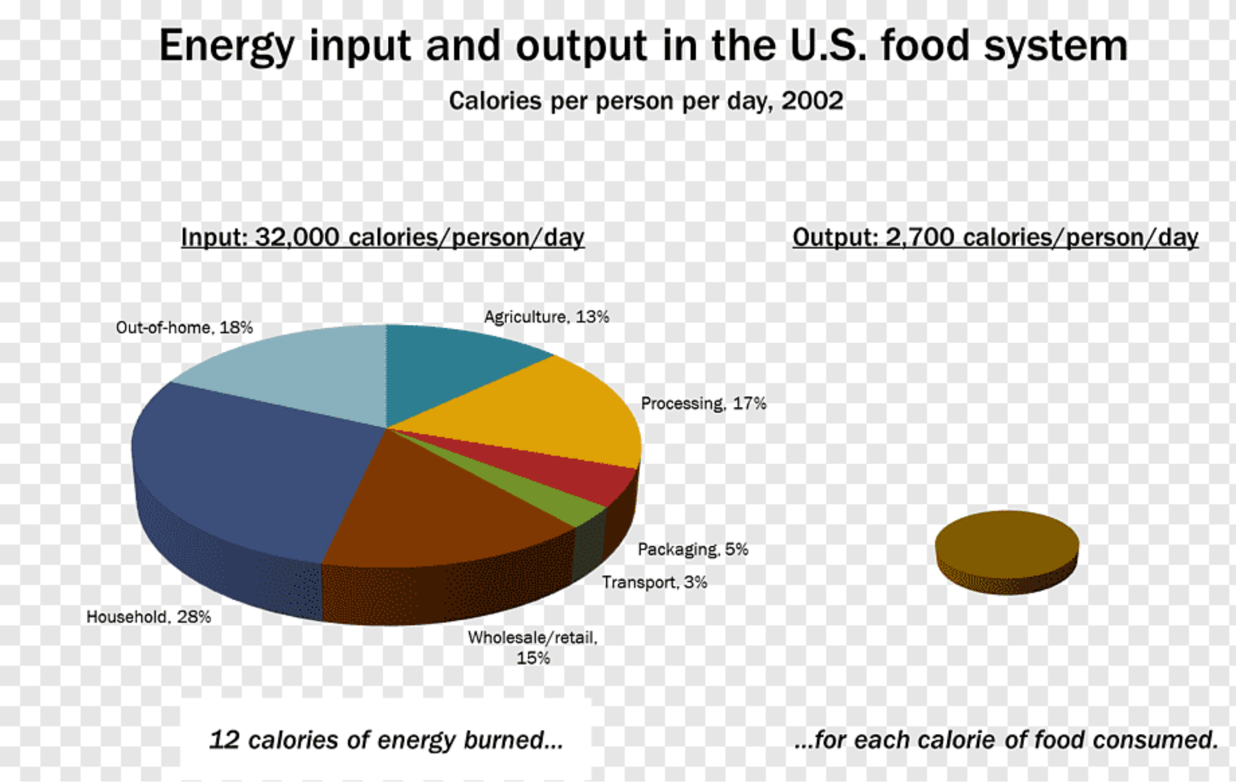
The driver of climate change is the consumption of oil

The cost of oil addiction is to have the environment absorb the negative externalities (cost) created by fossil led ‘industrial revolutions’, including the green revolution in agriculture these create the phenomenon of ‘Global Warming‘ seen now as Accelerating Climate Change

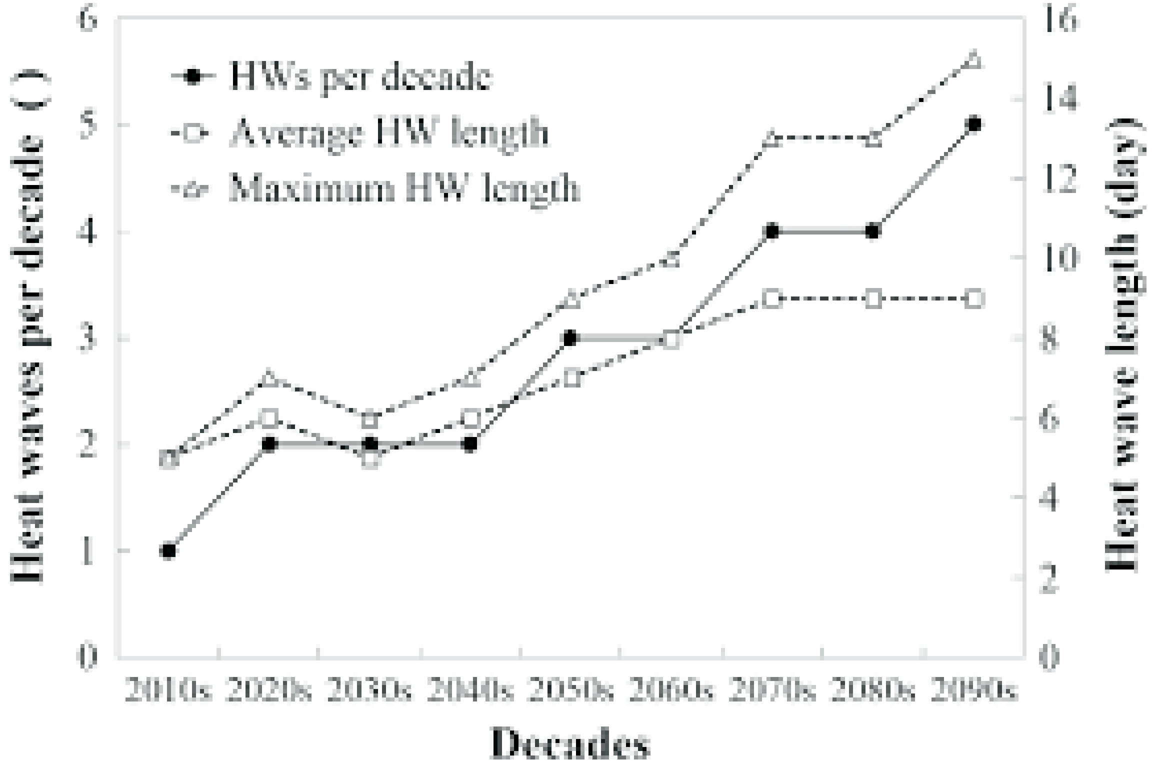


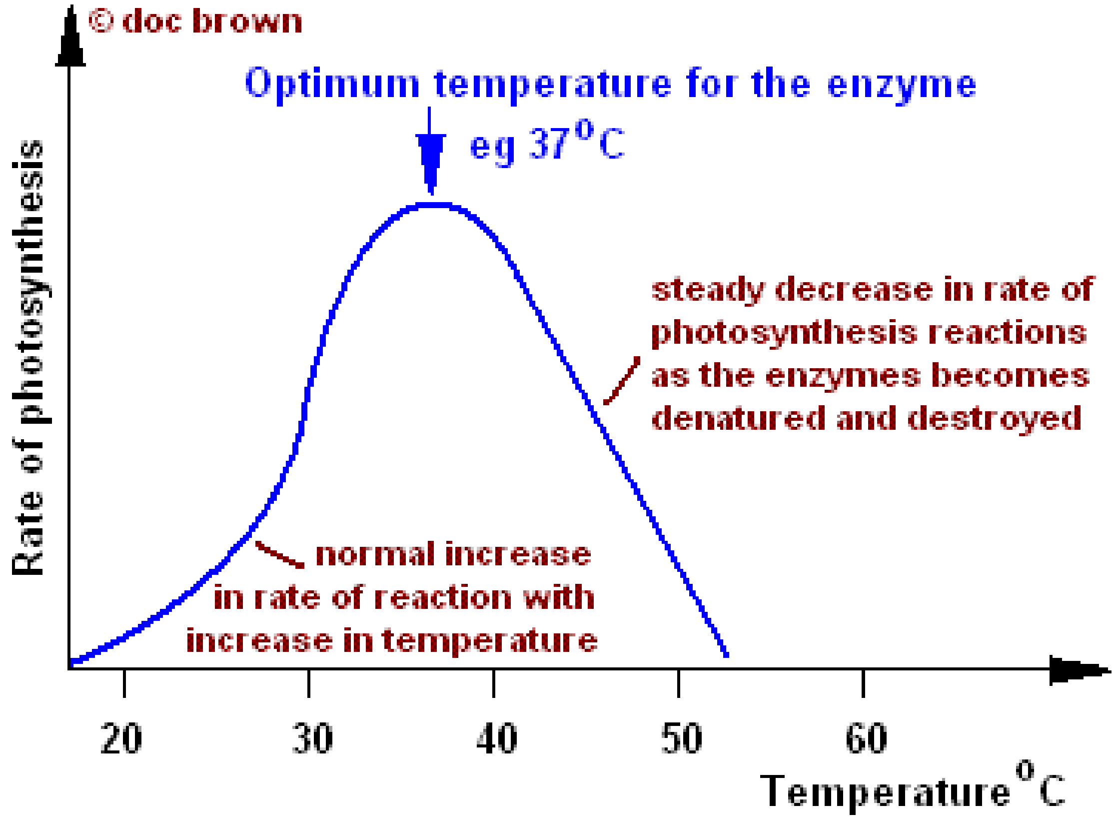


Industrial Agriculture has contributed greatly to global temperature rise through their emission of both fossil and biotic carbon dioxide



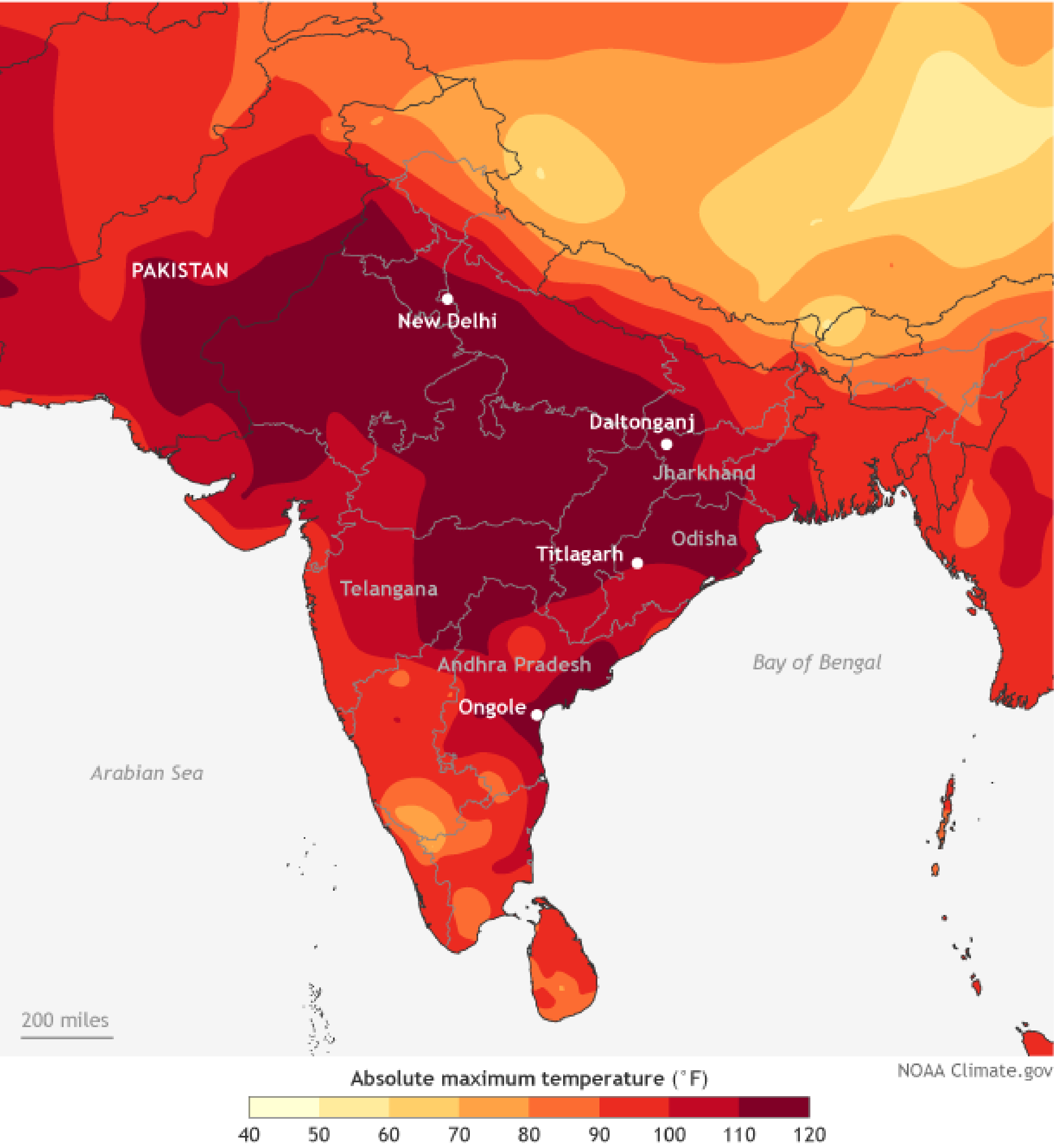
The rise in ambient temperature, is alarming because Chlorophyll has an optimum operating temperature around 37- 40 degrees beyond which there will be reduced agricultural production





As the length of the heat wave increases , there is a corresponding loss in productivity

Heat wave (May 24–30, 2015)



Heat stress
Can take the
Crop at its
most
vulnerable
time.

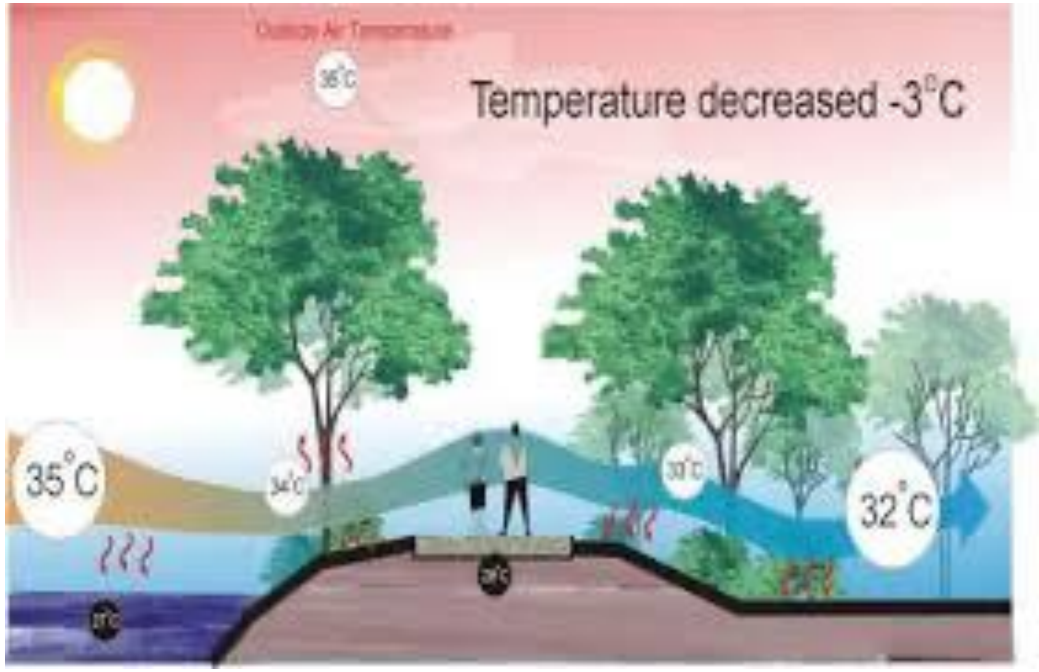
Vegetational Cooling

Transpiration produces cooling in the Ambient Environment

1 Tree = 10 AC units, 120,000 x 10 = 1,200,000 BTU /day, of ambient cooling.

450 trees /ac   = 540,000,000 BTU/day of cooling.

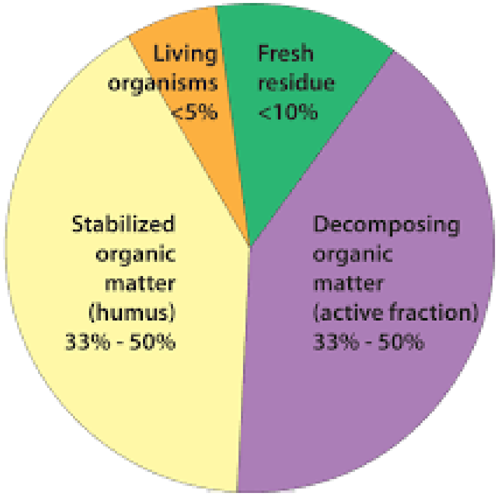
1100 trees /ha   = 594,000,000,000 BTU/day of cooling.



What are the design considerations for future of agriculture, Can industrial agriculture continue to feed the future ?

Industrial Rice production landscape

Traditional Rice production landscape



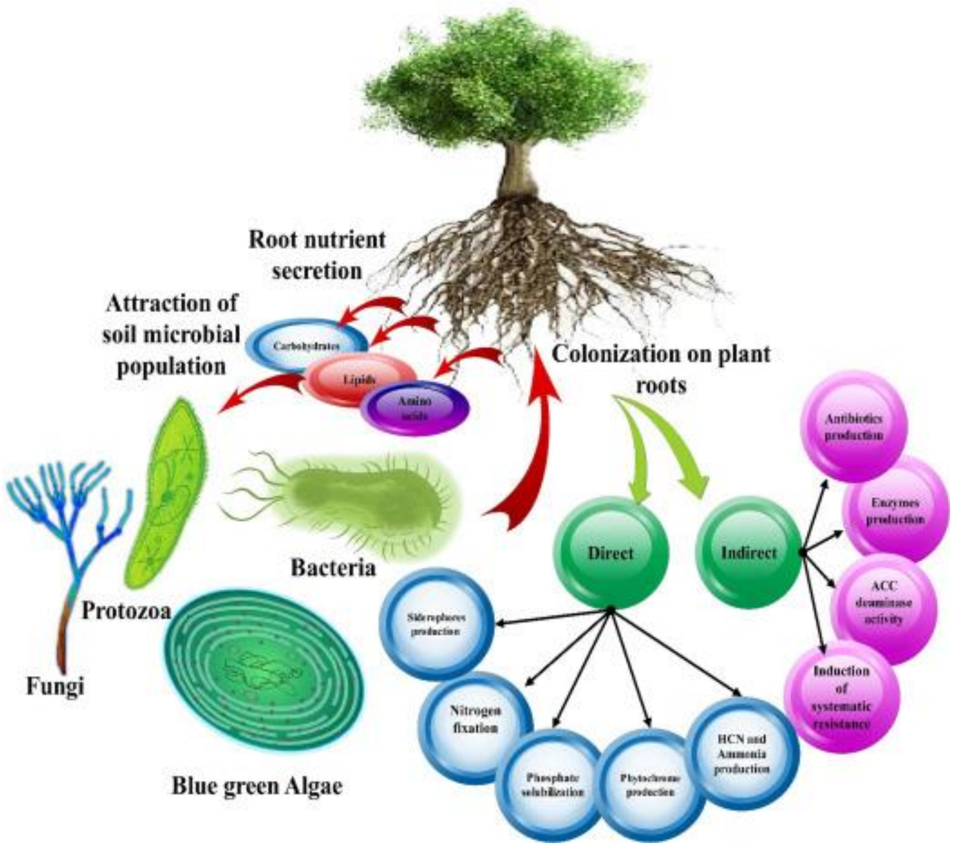
Soil is a living thing, it is also the most speciose ecosystem on Earth, the vast majority of organisms in soil are microbes, a great many of which have not yet been described

- One gram of good soil may contain 1-2 billion individual bacterial cells.
- Sharing this same gram are the actinomycetes with populations of 100-200 million individuals.
- In the same gram the fungi are present similar numbers and often have a kilometre or more of hyphae
- There are 100’s of thousands of Algal cells
- Thousands of nematodes,
- Collombolids
- Microarthropods

The mass of bacteria alone in the upper 15 cm of soil is about 500-1100 kg hectare. (Allison, 1973).

Roots and Soil

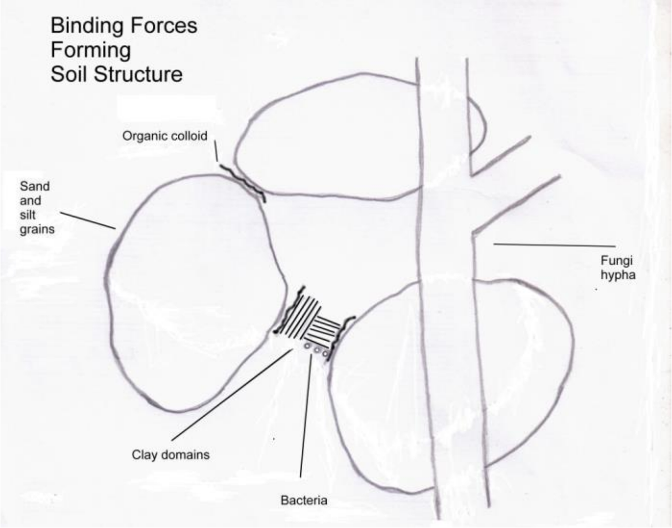
- Tree Roots provide up to 20-30 % of their total root weight as exudates into the surrounding soil.
- 1 meter of trees root = 1km fugal hyphae
- Each Species of tree provides differing chemical compounds
- Many species of trees have distinct species of associated soil organisms

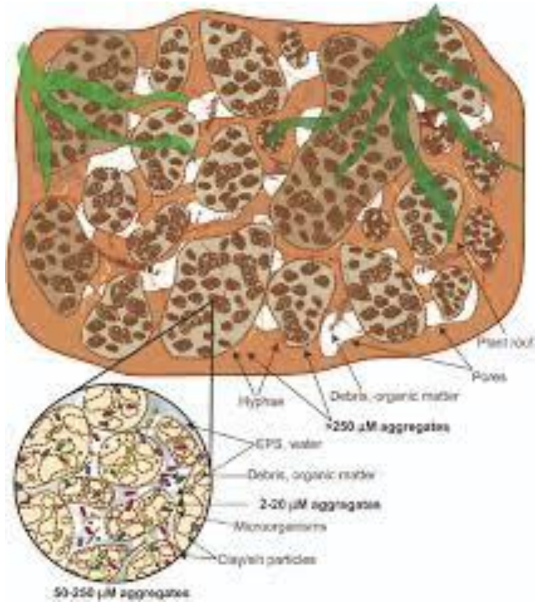


These exudates, include sugars, amino acids, flavonoids, aliphatic acids, and fatty acids—that attract and feed beneficial microbial species while repelling and killing harmful ones

Plants are critical to grow a good soil, because plant roots provide the food that the soil bacteria need to thrive.

- **Soil colloids** are the most active constituent of the soil and it determine the physical and chemical properties of the soil.
- The fertility of the soil-water solution for plants is based on the capability of the soil to hold and exchange cations; this is referred to as the cation-exchange capacity. Without soil colloids, most vital nutrients would be leached out the soil by percolating water and carried away in streams. thousandth of a millimetre (0.0001 mm; 0.0004 in) small.
- **Bacterial Gums** are some of the strongest known organic binding substances.





The depth of the tree roots deermine the depth that the soil ecosystem can extend into

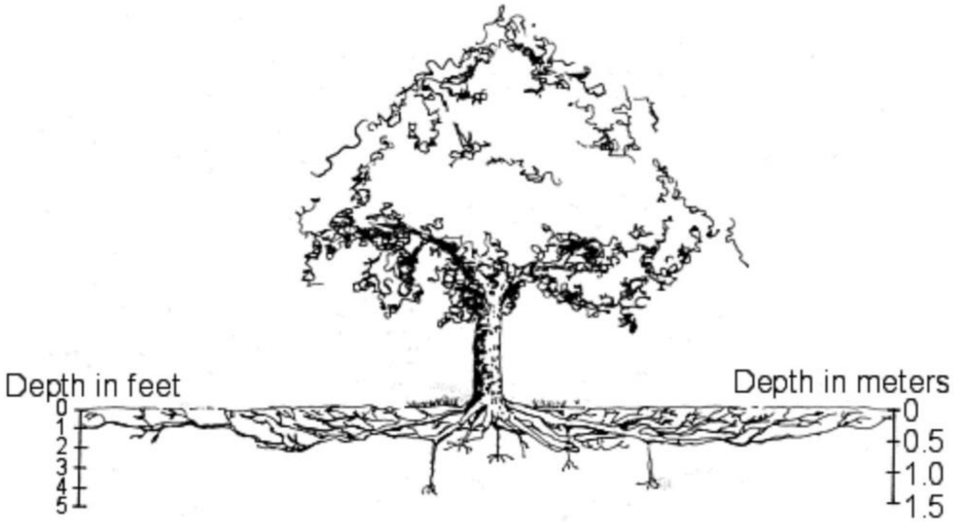
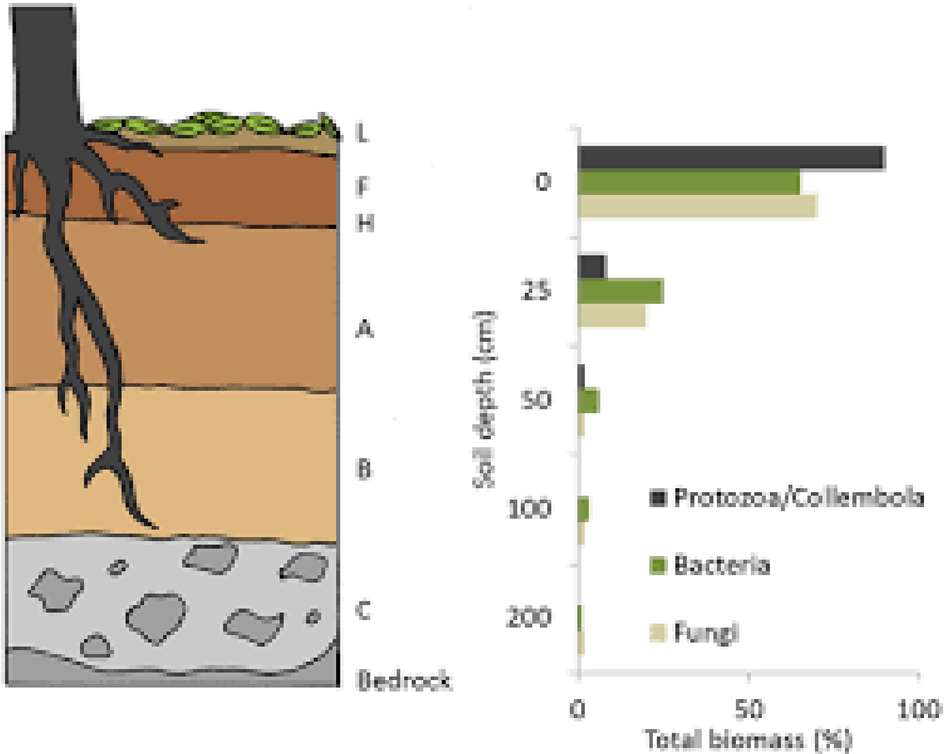
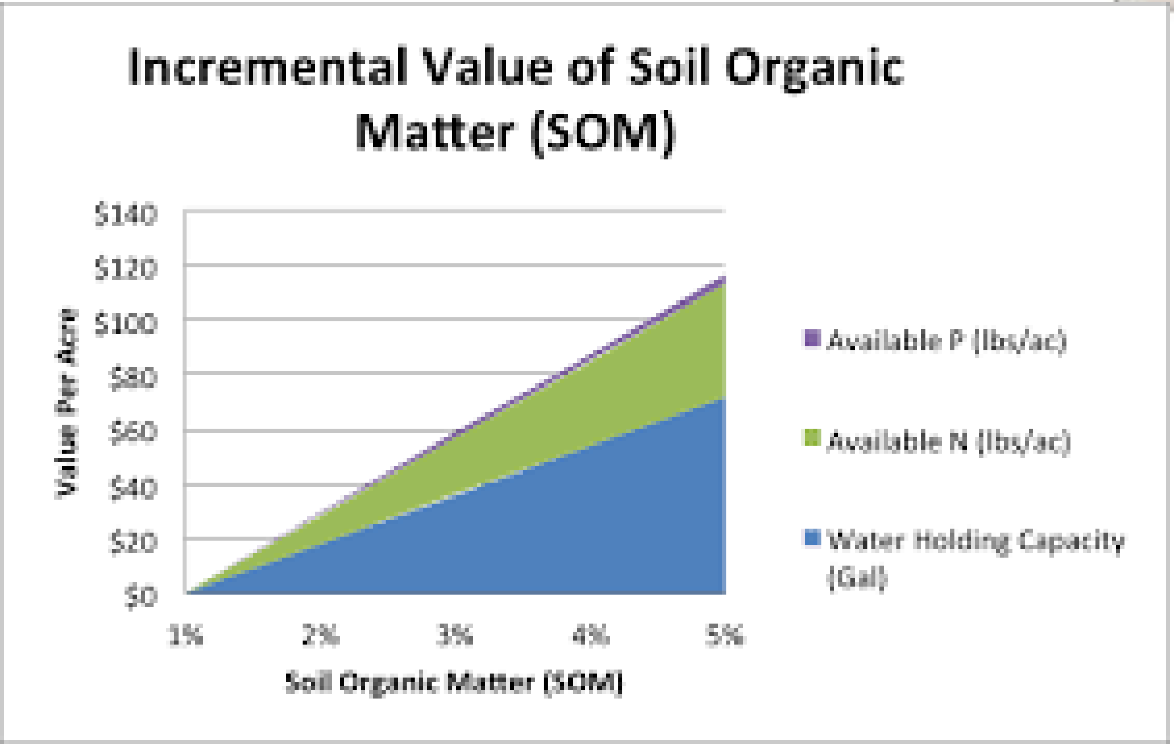


Figure 1. Diagram of a 'typical' root system



A living soil produces Soil Organic Matter (SOM)



Which acts as a means of nutrient supply, [water storage] and purification

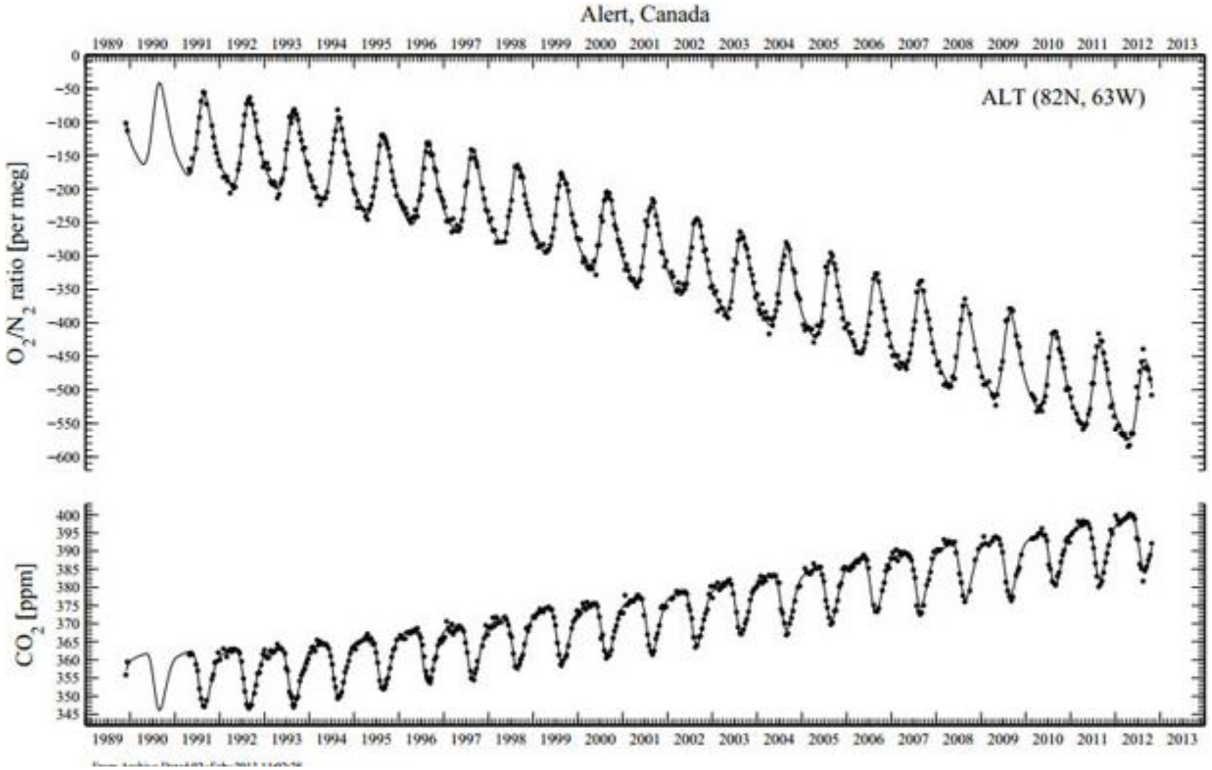
Once the Soil Organic Matter (SOM) is gone, desertification begins

Leaves are the only production system on land that supplies the Oxygen and helps create soil.

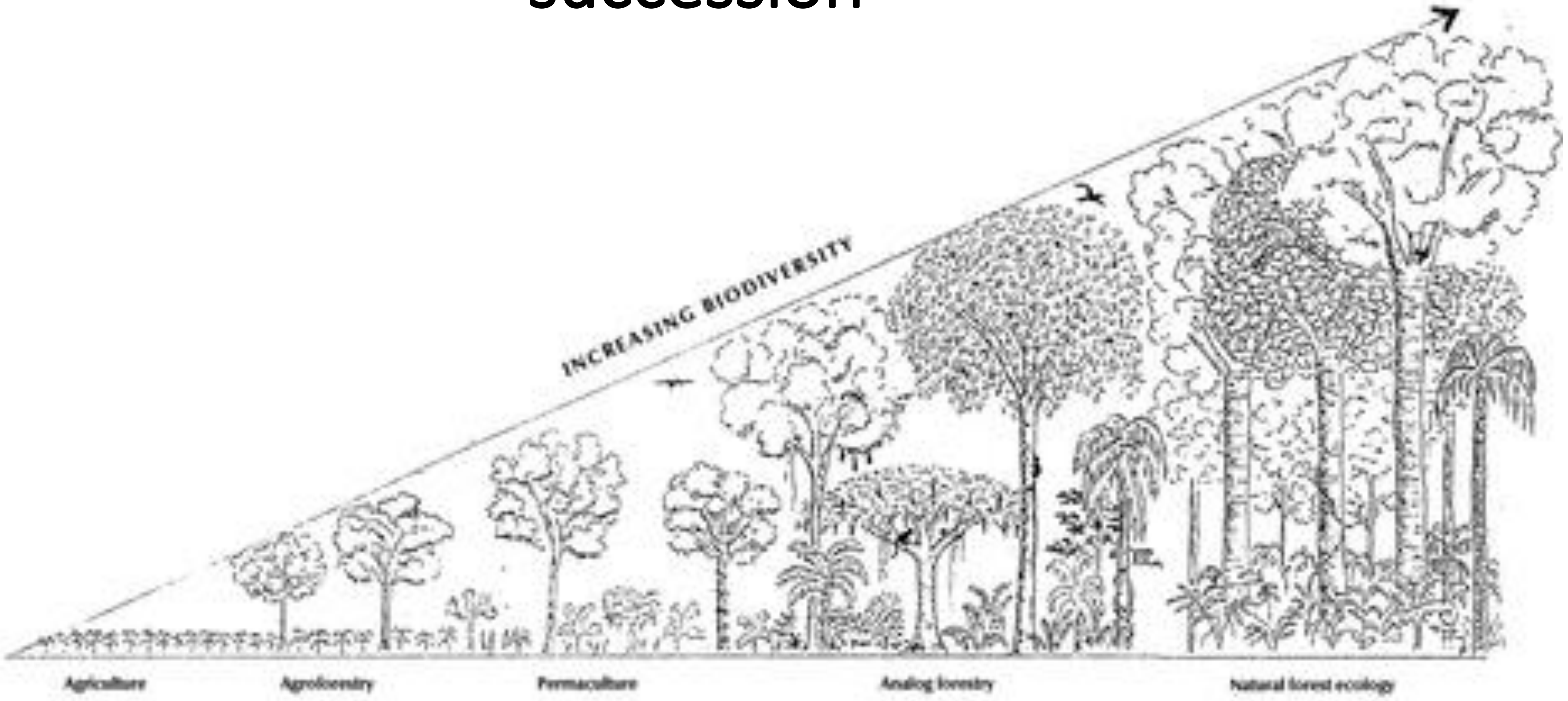
The creation and destruction of molecular Oxygen in the Global Commons are in near equilibrium, but local concentrations are now changing radically in response to increased combustion and deforestation,

Production at about 54,000 kg/ac/yr
mean value of of Oxygen $12.00 mKg

$ 648000.00



The growth and accumulation of the Photosynthetic Biomass (leafy) component in anthropogenic responses to seral succession



The opportunity cost of Ecosystem Services loss, through disruption or entombing, needs to be compensated by investing in Ecosystem Service production in rural areas

Currently only the apples have value to the city. while the PB has no value. The true value of the contributions of the rural sector remain massively discounted and therefore easily degraded.

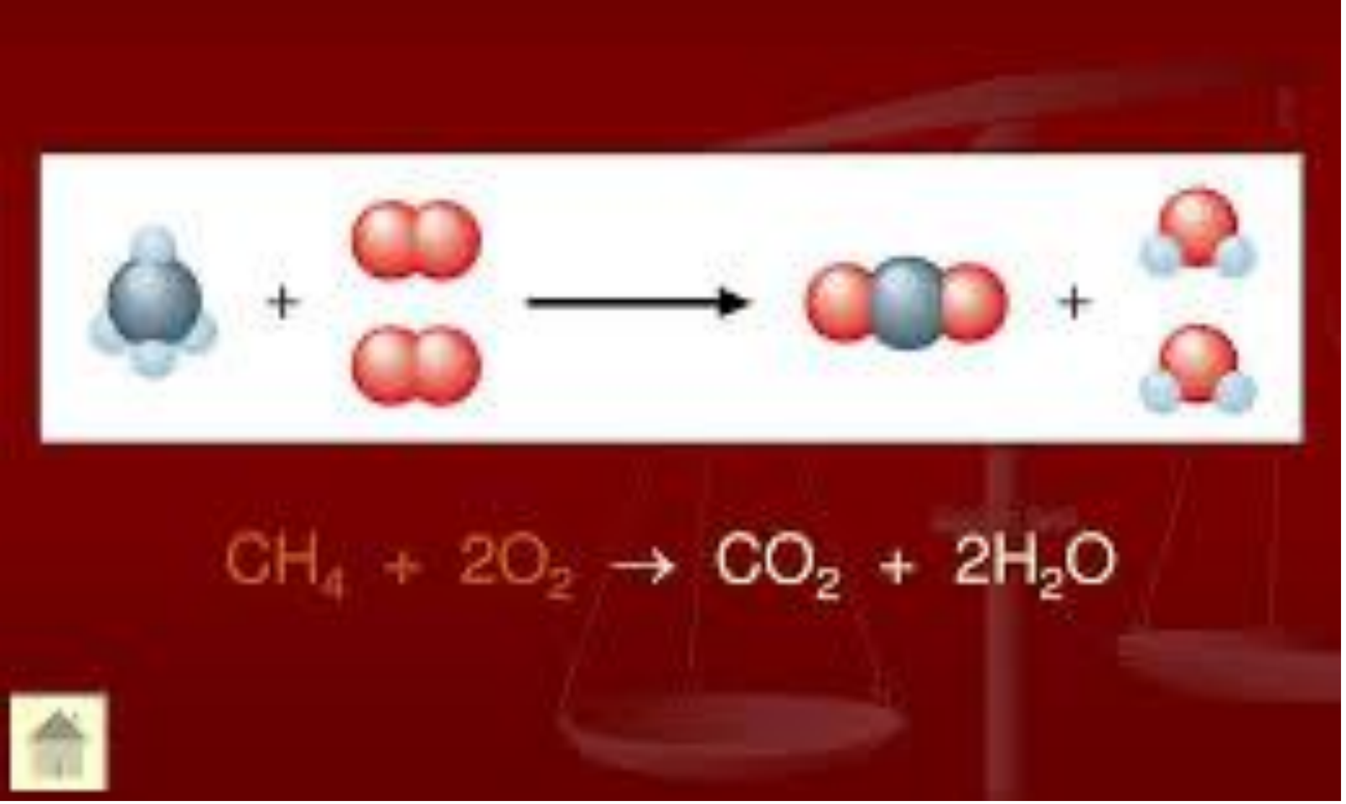
There is an urgent need to recognize the wealth of the rural sector, living Photosynthetic Biomass:

Under the current economy, only the fruit has value and only after it is plucked and sent to market

Under the proposed economy the leaves too have value but can retain value only as long as it is living.

Thus leaf on a tree, can maintain value as PB only as long as it is carrying out the activity of photosynthesis. Pluck that leaf and the activity ceases and so does the value.

A new economic paradigm that will, for the first time, begin to put a value on life.

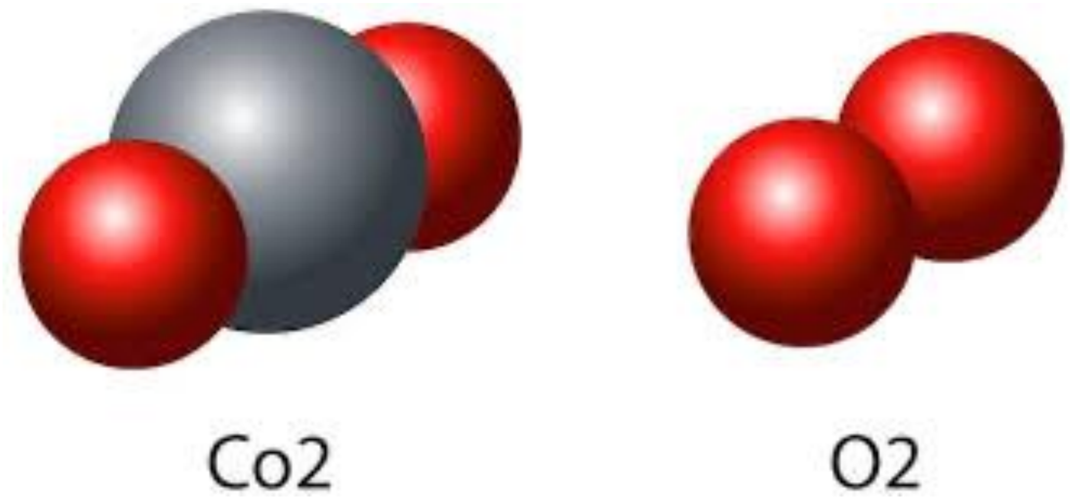


The process of laundering fossil Carbon

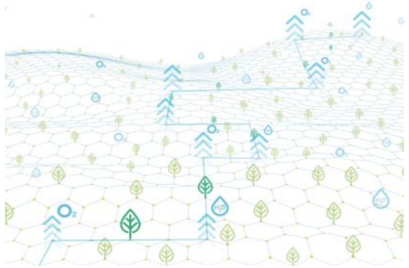
$$f\mathrm{CH_4} + b\mathrm{O_2} \rightarrow n\mathrm{CO_2} + n\mathrm{H_2O} + e$$

The fossil Carbon is over 100 million years old and cannot be put away to make a process Carbon ‘neutral’.

But the Oxygen that was used to burn it can be replaced to make the process Oxygen ‘neutral’.



Sri Lanka Position Paper
To the UN Conference for Climate Change (COP21)



We are aware that the critical Ecosystem services such as; production of Oxygen, sequestering of Carbon, water cycling and ambient cooling is carried out by the photosynthetic component of biomass. This is being lost at an exponential rate, due to the fact that these Ecosystem Services have not been valued, nor economically recognized. Paris.1-10 December 2015

Responding to the challenge :

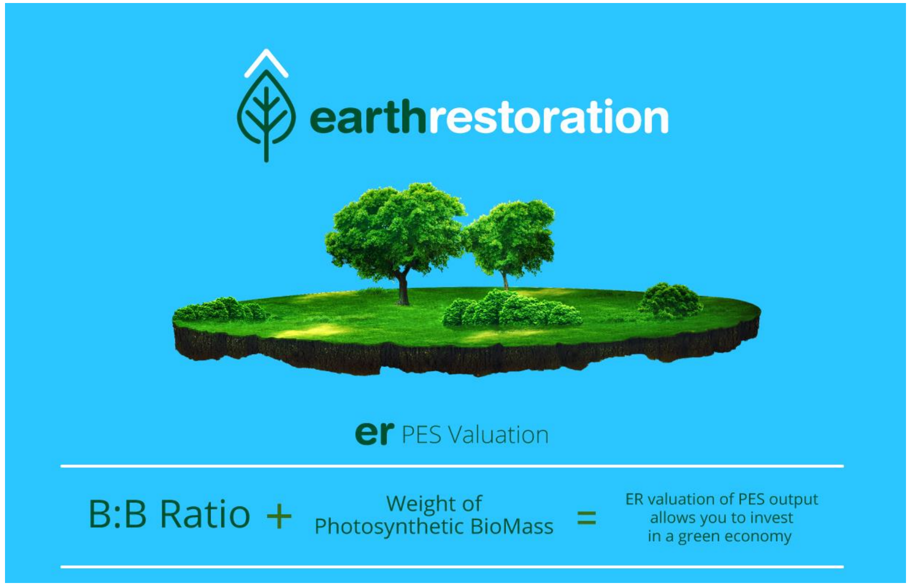
By **measuring and quantifying the activity of a leaf and is measured primary productivity**

Earthrestoration p/l

institutes

Primary Ecosystem Services (PES) production conracted as

Life Force units. By adding the B:B ratio, its value is increased



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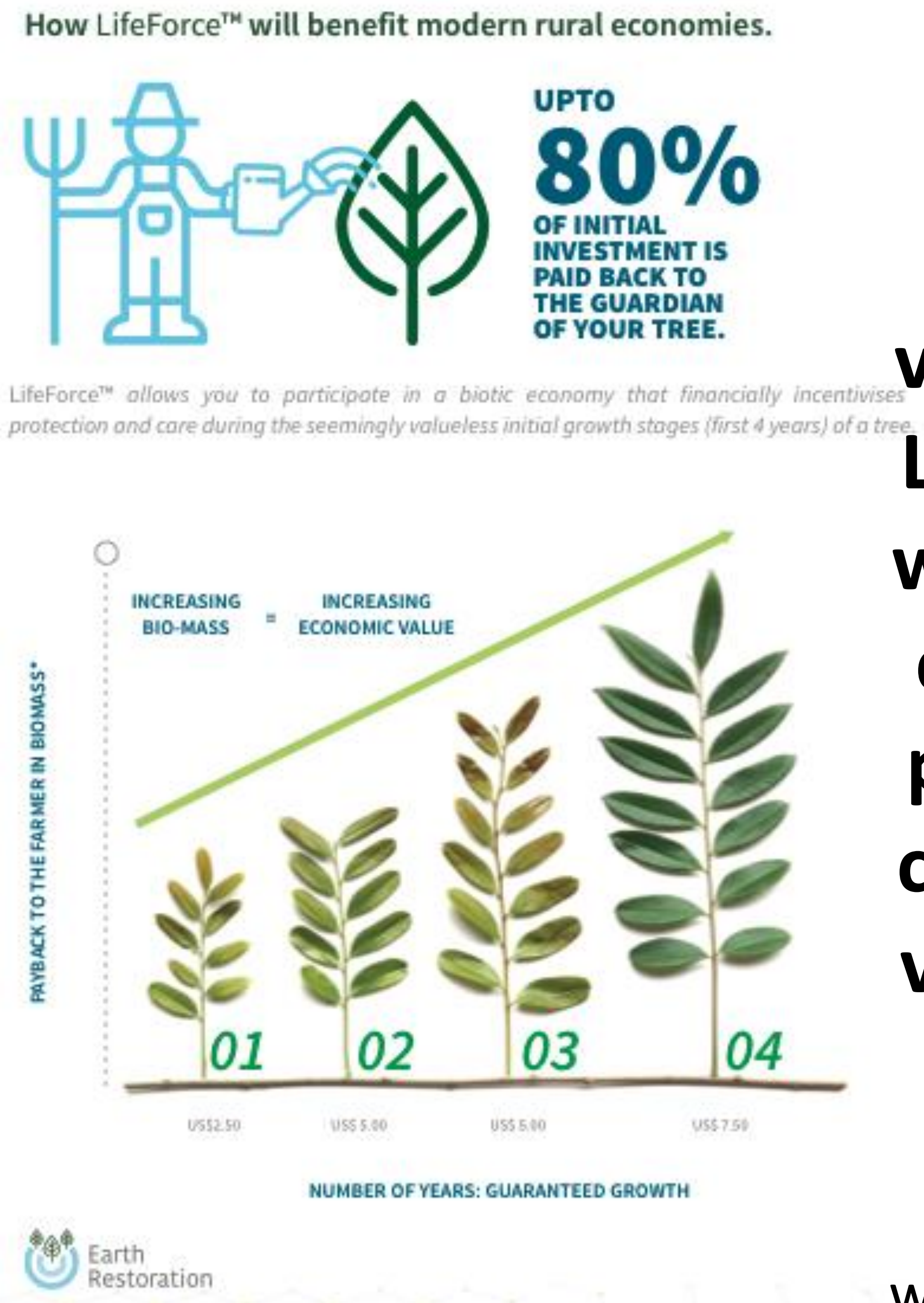
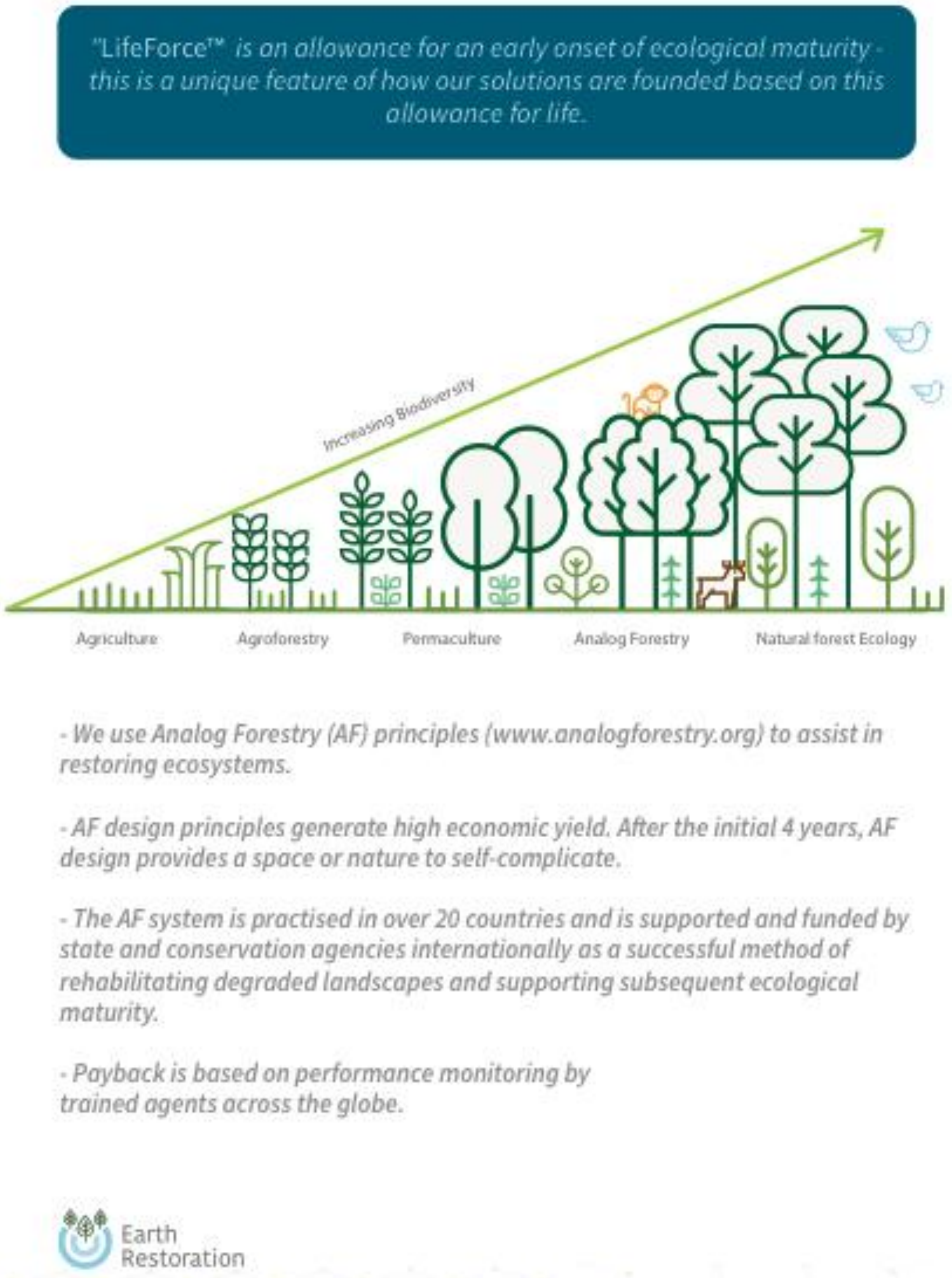


One way of capturing this value is through Life Force units, which represent contracted PES production and can increase, its value by adding a B:B ratio.



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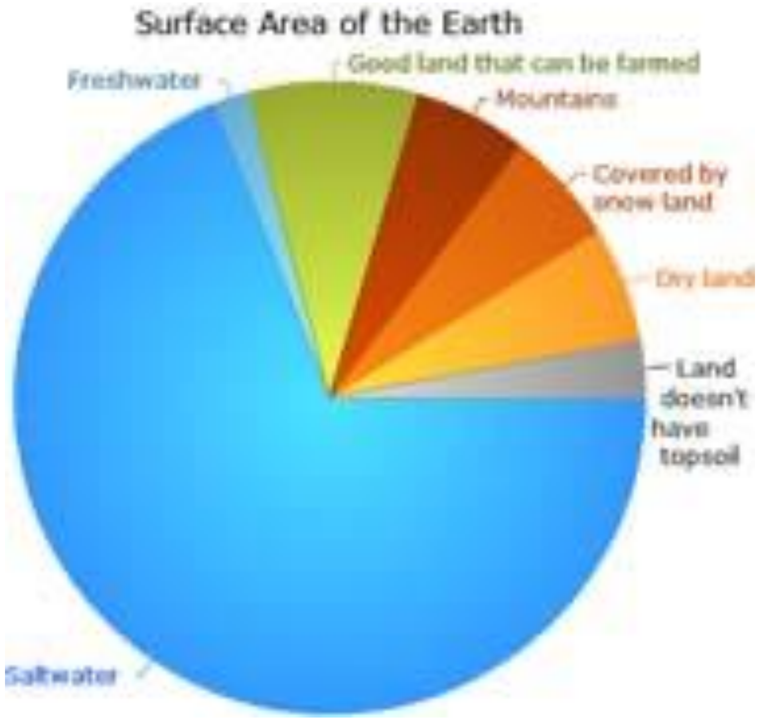
LifeForce™

QUANTIFICATION OF PES PRODUCTIONS FROM CHEDDIKULAM PROJECT
LIFE FORCE PROJECT
EARTH RESTORATION FOUNDATION

Farmers Name	ER Registered No	Species	No of ER Units	Servicing Year	PES Productions at the end of year 2021 by considering the mean PES production data values	
					O2/Liters	H2O / Liters
Pakiyaraasa Pushpawathi	ER/094/NP/001	Artocarpas hetrophylus	10	3	1,382.80	494.00
Selvarathnam Sithambaram	ER/094/NP/002	Artocarpas hetrophylus	10	3	1,382.80	494.00
Selwarthnam Vijayakumar	ER/094/NP/005	Mangifera indica	1	2	41.76	16.46
Navarathnasaami Poomani	ER/094/NP/003	Artocarpas hetrophylus	10	3	1,382.80	494.00
Somasundaram yogeshwari	ER/094/NP/020	Artocarpas hetrophylus	1	2	64.66	23.10
		Mangifera indica	2	2	83.52	32.92
Peter Nalini	ER/094/NP/004	Artocarpas hetrophylus	10	3	1,382.80	494.00
Premalingam Chandraleka	ER/094/NP/054	Artocarpas hetrophylus	1	1	10.22	3.65
Total			**45**		**5,731.36**	**2,052.13**

The leaves of plants provide a surface area about 4.3 times the total surface area of land on the planet. They are the life support system of the planet. They are being lost at an exponential rate.



But there is less than 10% of the surface area that has the living soil to support the plants with their life giving leaves

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