Addressing Climate Change (I).

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The COP on Climate Change in Paris saw Sri Lanka make pledges on the global stage, that we will be a responsible nation when it came to the issue of climate change. The president has gone on record that we will develop towards a fossil free future. The Sri Lankan position paper issued in at the Climate Change Conference stated this :

"Sri Lanka is a vulnerable island in the face of Climate Change. An increase in the intensity of rainfall, will erode our mountains and create increased flood damage. An increase in the sea level will render much of our productive agricultural lands saline. An increase of ambient temperatures will reduce our agricultural productivity. We are in agreement with the view that an increase of the Carbon Dioxide concentration in our atmosphere will contribute to this vulnerability.

We are aware of the great difference in carbon dioxide that is emitted from biological sources and carbon dioxide emitted from fossil sources. One has sequestered rates measured in thousands of years while the other in millions of years. Yet the cost is still the same. We would request the IPCC to address the relative costs of each.

We are aware that the optimum operating temperature of chlorophyll is at 37 deg C. In a warming world where temperatures will soar well above that, food production will be severely impacted. We would request the IPCC to address responses to this phenomenon.

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. We would request the Intergovernmental Panel on Climate Change (IPCC) to examine the value of photosynthetic biomass.

Sri Lanka will place her development agenda on a fossil free target and will promote an economic recognition of the ecosystem services generated by the photosynthetic biomass. In this way we offer to act in a globally responsible manner as well as to contribute in creating a cushioning effect for the climate extremes that are before us."

In addition to the pledge made by the president, there are three questions raised that question the current status quo regarding carbon trading. The first question suggests that the current system of carbon trading and claims of carbon neutrality may be a scam. To understand the great difference in carbon dioxide that is emitted from biological sources and carbon dioxide emitted from fossil sources, we must look into the history of carbon**.**

The first question : Carbon

Carbon (C), the fourth most abundant element in the Universe, after hydrogen(H), helium (He), and oxygen (O), is *the* building block of life. It's the basic element that anchors all organic substances, from fossil fuels to DNA. On Earth, carbon cycles through the land, ocean, atmosphere, and the Earth's interior in a major biogeochemical cycle (the circulation of chemical components through the biosphere from or to the lithosphere, atmosphere, and hydrosphere). The global carbon cycle can be divided into two categories: the geological/ancient, which operates over large time scales (millions of years), and the biological/modern, which operates at shorter time scales (days to thousands of years).

The fossil Carbon cycle

The operation of life has been clearly demonstrated to change the chemistry of that atmosphere to what it is today. One of the most active agents of this change were/are the oceanic plankton, photosynthetic microscopic phytoplankton that produce prodigious quantities of oxygen and biomass over time. Oxygen is released to the atmosphere and the biomass is consumed by respiring zooplankton (microscopic marine animals) within a matter of days or weeks. Only small amounts of residual carbon from these plankton settle out to the ocean bottom at any given time, but over long periods of time this process represents a significant removal of carbon from the atmosphere. This slow removal of Carbon from the primary atmosphere into the fossil reservoir, while at the same time creating an atmospheric reservoir of oxygen, had a major effect on the maintenance life on this planet.

A similar process was repeated on the land especially at Devonian times with the huge vegetation mass that covered the earth absorbing Carbon Dioxide and them being mineralized in the lithosphere into coal, effectively removing that volume of carbon from earths atmosphere. The Oxygen released by these early prodigious forests contributed greatly to the chemistry of the current atmosphere.

Life on Earth learnt how to maintain gas and material flows, optimum for the evolution of biodiversity. Carbon Dioxide, although essential to the process of life, was being introduced into the atmosphere by volcanic processes at disruptive levels, throughout geologic history. But the gas has not concentrated in the atmosphere, because it was sequestered by living things and put away out of circulation from the biosphere of living carbon. This store of carbon was fossilized and has been slowly accumulating over the last few hundred million years.

Through these processes, which are still active today, Carbon that enters the Lithosphere is removed completely from the biological cycle and becomes mineralized into pools of oil, coal and gas with ages of 100's of millions of years.

The modern (biotic) Carbon cycle

The major exchange of carbon with the atmosphere results from photosynthesis and respiration. During the daytime in the growing season, leaves absorb sunlight and take up carbon dioxide from the atmosphere. In the oceans the planktonic cycle operate a similar photosynthetic cycle. Both create biomass. In parallel, plants, animals and substrate microbes consume this carbon as organic matter, transform it in the process of respiration and finally return it as carbon dioxide to the atmosphere.

The global impact of active photosynthetic biomass can be illustrated by the volume of water released into the atmosphere as water vapour. At a water release rate of 100:1, where over 100 molecules of water are released for each molecule of carbon dioxide absorbed by the leaf. The quantity of water released annually into the atmosphere by vegetation is between 5640 - 6280 billion tons.

The carbon from biotic sources and fossil sources ate different. They hav a very different chemical signatures, in the ratio of its 13C to 12C as well as in the quantity of the rare unstable isotope 14C. All carbon that lacks 14C or has a lower 13C/12C ratio does not belong in the modern or biotic cycle. The fluxing movement of biotic carbon happens in cycles of a few days to thousands of years, but always maintain the same isotope ratio.

It is now clear that fossil Carbon and biotic Carbon have extremely different sinks and need to be valued differentially when considering the impact on the global biosphere. Biotic carbon is sequestered or 'tied up' for periods of thousands of years, while fossil carbon is sequestered or tied up for periods exceeding tens of millions of years. Using biotic activity like the planning of trees to compensate for the release of fossil Carbon must recognize the cost of burning material that was sequestered for millions of years.

A clear distinction between fossil and biotic energy and a placing of differential values on the two sources, will go a long way to expose the fossil addicted economies and assist 'developing nations ' to avoid the pitfalls. The 'fossil subsidy' including the fossil cost of cement production and use, required for the creation and operation of future 'development' projects should become cost criteria for acceptance or rejection of future 'development' projects.

Further it demonstrates the fallaciousness of the current claims of being 'Carbon Neutral' based upon the laundering of fossil carbon though planting trees to make up for it !

Addressing Climate Change (II).

The second question

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The second question raised by Sri Lanka's position at the COP on Climate Change in Paris was on the danger to agricultural productivity by the rising temperatures. This was not a simplistic knee jerk reaction like 'is is better to hold the temperature under 1 degree or 2 degrees,?' but address the alarming real danger of food insecurity that will be brought to most tropical nations by the phenomenon of ambient temperature rise.

Why is a heat wave so dangerous? Apart from the heat stress in human and animals, it could exceed the threshold for enzymatic activity. All of agriculture depends on the good growth of plants, all plants rely on their chlorophyll to grow and produce. Chlorophyll is a molecule that functions to an optimum at about 37degrees, above that their performance falls. In heat waves often exceeding 38 degrees plant productivity will be impacted and yields drop (fig1). This year much of Australia dealt with a brutal spring heat wave that reduced farmers' yields.

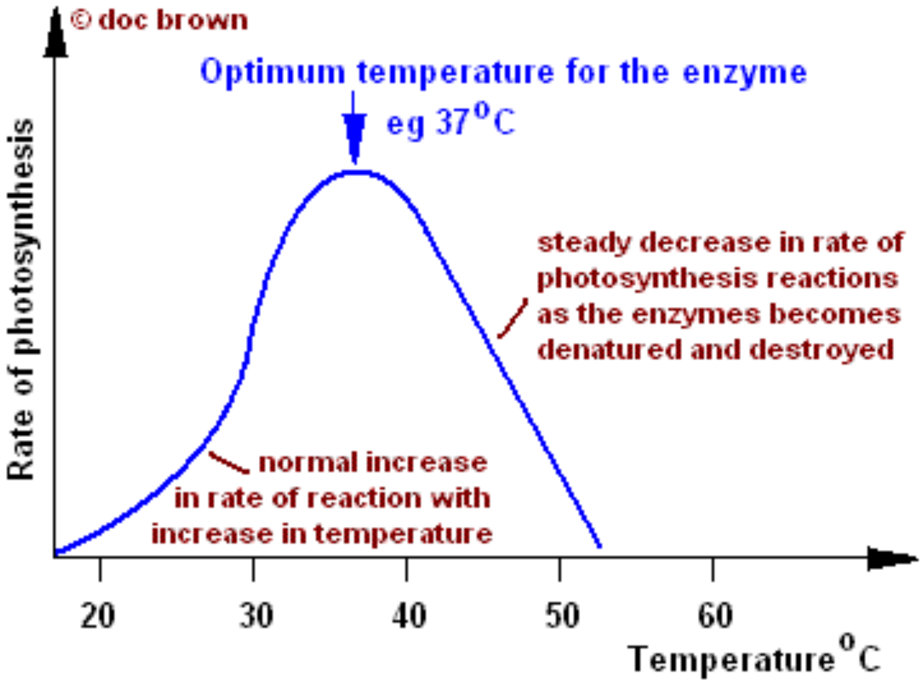

Fig 1

The danger to agricultural production is further exasperated by the reliance on chemical farming with so-called 'high yield ' crops of the so called 'Green Revolution' . These crops have been bred by reducing their maintenance biomass (leaves and roots) for crop biomass (seeds or fruit). This reduction of their natural defenses being made possible by the use of chemical fertilizers and toxins. But in a high temperature situation when chlorophyll is functioning sub-optimally such reductions may bring serious crop losses.

Chemical fertilizers are produced using large amounts of energy, usually fossil energy. The creation of this fossil energy results in the discharge of huge volumes of Carbon Dioxide into the atmosphere. This, in addition to the fossil carbon footprint of agro toxins and fossil fuel use adds greatly to global warming which in turn creates the dangerous heat waves around the planet and finally affects the farmer through increased heat stress on the crop.

What are the ways out? One would be to look for plants that have a wide heat stress tolerance; another will be to design future agroecosystems that can use the heat reducing mechanisms of ecosystems to respond to temperature raises.

However one urgent national needed to deal with climate change is to begin mapping out high risk areas in the future and warm farmers in those areas of the steps they should take to adapt to the oncoming changes. Probability maps need to be constructed for temperature, rainfall intensity, wind intensity and salt-water intrusion. Sri Lanka like many other tropical nations does not have the wherewithal to conduct research on and monitor these risks. Capacity to do so could be an outcome to our second question.

Addressing Climate Change (III).

The third question

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The third question was on the value of Photosynthetic Biomass (PB). It is basic high school knowledge that the production of Oxygen, sequestering of Carbon, water cycling and ambient cooling is carried out by the photosynthetic component of biomass. It is these very same actions that are being accepted globally as Ecosystem Services with recognized economic values. But the thing that produces these services is being lost at an exponential rate, due to the fact that these Ecosystem Services have not been valued, nor economically recognized.

Although the volume of living biomass as now been captured on most global models of carbon cycling and as the measure of living biomass is being used in the evaluation of carbon stocks with increasing frequency, there is a an urgent need to address the fundamental differences between the components of living biomass. Living biomass is present as two fundamentally different components, photosynthetic biomass and respiring biomass.

Photosynthetic biomass performs the act of primary production, the initial step in the manifestation of life. The biomass so termed has the ability to increase in mass through the absorption of solar radiation while releasing oxygen and water vapor into the atmosphere. As outlined above, it is only photosynthetic biomass that powers carbon sequestration, carbohydrate production, oxygen generation and water transformation, i.e. all actions essential for the sustainability of the life support system of the planet. Yet currently, it is only the product of photosynthetic biomass, as sequestered carbon, usually represented by wood/timber that has been recognized as having commercial value in the carbon market for mitigating climate change. The photosynthetic biomass for terrestrial ecosystems is largely composed of the leaves of terrestrial vegetation, it is the leafy component that contributes to primary production. This component varies greatly in size and temporality.

In computing value, the relative value of leaves have to be considered in terms of their representation in different ecosystems. In a forest, shade-tolerant, late-succession tree species possess significantly larger leaves compared to early-succession, shade-intolerant species. Usually, leaf sizes and leaf numbers tend to be negatively correlated, i.e. the larger the leaf-size the less in number and vice-versa.

The sheer power of operation of the terrestrial photosynthetic system is seen when the volume of water released from photosynthetic biomass is considered, at a water release rate of 100:1, where over 100 molecules of water are released for each molecule of carbon dioxide absorbed by the leaf. The quantity of water released annually by forests and grasslands are like aerial rivers cycling about 6250 billion tons of water into the atmosphere per cycle. This quantity of evaporative water not only greatly influences local cooling events, but also contributes to the distribution of heat in the atmosphere. One of the most significant consequences of evapotranspiration by terrestrial vegetation is the cleaning effect on groundwater, releasing polluted ground water freed of the chemical pollutants that it was once burdened with. This cleaning function is hardly recognized nor evaluated.

The oxygen generation function is taken for granted, but as the recent studies of the hole in the stratospheric shield of ozone show, the phenomenon is expected to last for several decades. Increasing the oxygen producing function of the biosphere, can certainly contribute to the stabilization of the ozone shield. It can also help to allay the impact of massive rates of combustion required for much of modern society. However up to date we have failed to recognize the economic value of the oxygen generation function.

It seems imperative that a real value be placed on photosynthetic biomass; initial computations can begin by considering the current values suggested for the global market for similar functions. The estimated value of the carbon market was in excess of 250 billion. Thus if we consider the current value of 125 billion dollars that has been placed on containing climate change, the value of photosynthetic biomass can now be addressed. Assuming that the market would pay at least the value of controlling climate change, the 93.1 billion tons of photosynthetic carbon currently in stock would be roughly worth about 2.20 dollars per kilogram.

This comes as a surprise when the current models of carbon sequestering to combat climate change is examined, many models discount or place a low value of leaves and twigs which are often removed or bulked before the sequestered (fixed) carbon is measured. This photosynthetic biomass, often considered being too short lived in accounting for carbon sequestering. But it is actually the most valuable component.

Slowing down the loss of global terrestrial photosynthetic biomass stock is not an option - it is a critical need! A massive investment must go towards incrementing the global photosynthetic biomass stock. The potential value of this stock can also attract the investment to develop market growth.

The current approaches to tree farming and forest management needs to accept this potential of photosynthetic biomass and work towards realizing its value. For management purposes, the photosynthetic biomass of a natural ecosystem has to be seen as a continuum of native species from the early seral or developmental stages represented by annuals and short-lived species, to shrubs and bushes, to pioneer trees, to the mature tree dominated, old growth forest. If each stage is encouraged to carry its full complement of photosynthetic biomass, it will help ensure that the management plans address the generation and maintenance of the optimal levels of photosynthetic biomass in each seral stage and gain the corresponding value.

This questions raises the possibility that most nations moving towards a responsible development paradigm could capitalize their standing photosynthetic biomass and find the resources required for their progress away from fossil addiction. As Sri Lanka has stated its goal of moving away from fossil addiction building policy around these climate realities, will assist in building new options for the future.

Concluded