Temboan and carbon sequestration

I was asked to explain more about our approach to carbon sequestration for our Temboan project supporters. This is not an easy subject to explain because the actual amount of CO_2 trees can sequester is extremely variable with growing season, which is related to altitude, temperature, climate seasons while soil type, tree species choice, forest management and many more factors also influence the amounts. Then there is the annual amount of CO_2 that young trees absorb which is lower than that of mature trees. Then towards the end of life of the trees that amount decreases again. So not easy to give a single simple number of how much carbon one tree absorbs and sequesters but let me try to explain what we are doing that makes our Temboan project in Benni's forest so special in terms of carbon sequestration. And I will have to start with explaining what exactly we are measuring as carbon sequestration and CO_2 effects, so bear with me while I try to keep this simple.

CO_2 versus C: What do we measure?

Normally people speak of carbon dioxide sequestration as a generally accepted standard comparison. We can calculate the amount of CO2 sequestered from the biomass of a tree, which comprises stem, branches, twigs, leaves and roots. About half of this weight is made up of pure carbon or C. Every molecule of carbon dioxide contains one C atom and two O or oxygen atoms. The atomic weight of a C molecule is 12 while that of O is 16. This means that compared to the number 12 of C for each CO_2 molecule we have to add two times 16 for the two O atoms which is 12 + 16 + 16 = 44. So every carbon atom represents 44/12 times CO_2 in weight. This is 3.67 times more.

So let's see when a tree weighs 100 kilograms then 50% of this weight or 50 kilograms comprises pure carbon. This amount we now multiply with 3.67 to get the number for CO_2 this tree utilized to make its biomass through photosynthesis, which in this example is 183 kilograms. Now we look at how old this 100 kg tree is and divide the 183 by the tree age which gives us a number for the amount of CO_2 sequestered by this tree each year at this particular moment in time. I guess one starts to see the complexity of doing this individual tree based calculations. Therefore we will use the actual increase in total C in the Temboan project area as a result of our activities as basis for our CO_2 sequestration number per area unit and individual tree.

Why is Temboan so special?

First of all the project area is located in the tropics where the growing season is 365 days each year and the temperature is always good for optimal growth. This is why our tree planting can result in several times higher biomass increase compared to other regions. Next we are planting a biodiverse forest which can achieve a much faster and higher biomass than a monoculture reforestation scheme. Also we have vast areas with severely degraded lands where there is no vegetation besides some short grass and virtually no organic material in the soil which as a result of that

absence easily erodes and experiences frequent landslides. This means we have an excellent baseline condition from where we can prove by a variety of techniques how much carbon has really been sequestered and how other factors like biodiversity, rainfall, etc. have improved as well.

How do we measure and monitor the results?

We are using a combination of satellite monitoring, drone images, a live video link and scientific measurements on the ground to provide our supporters with timely and accurate information. From permanent inventory field plots we can get data that we can extrapolate to the surrounding areas with the same reforestation recipes so we do not need to measure each individual tree in all of the area.

Besides the biomass measurements we will also record the effects of our biodiverse reforestation on wildlife, hydrology, recovery of the downstream corals, job opportunities for local people, local climate, costs, etc. We look at as many triple P factors as possible and use the Sustainable Development Goals as guidelines in the assessment.

But there is much more…

- In the Temboan project we build a integrated mini factory that can process the palm juice of local people. Then they do no longer need to cut trees for fuel wood to process the juice and we expect like we have seen in Tomohon that the land of the local people will grow more trees than before. This is an effect known as positive leakage.

- We will also produce biochar, which is a kind of charcoal that can last hundreds if not thousands of years in the soil. It is made from fallen branches and thinning wood of the reforestation. This biochar mixed with compost greatly increases carbon in the soil and also the microbial life in the soil. These bacteria, fungi and other soil organisms also add much biomass to the soil. At the same time the biochar makes the soil more productive thereby increasing the amount of C that can be sequestered in the new forest.

- We also will not use any fossil fuel based artificial fertilizer or pesticides and will share our organic alternatives with the local people around our area. This again reduces the emissions.

- We also will produce food from trees for people and livestock that will reduce the need for agricultural land thereby reducing the carbon footprint further.

- We are also creating a more fire resistant forest and through local climate change and job opportunities for local people expect fires to become less frequent around our area, thereby again contributing to fewer emissions and more carbon sequestration.

- By utilizing part of the biomass in wooden houses, furniture and other items, as well as a fossil fuel replacement, we also sequester carbon and reduce emissions.

- From sugar palms, nipa palms and coconuts we can produce biofuels that do not reduce the biomass of the reforestation while replacing fossil fuels

We will still look at other effects, but this short overview may make it clear that it is not easy to give a onetime number for how much carbon your dollar or euro is sequestering. So in our scheme we will invite an independent third party to do the evaluation that we will report to our supporters. Still we need something to start with. Here are some of the more generally accepted numbers from various sources:

A tree can absorb as much as 48 pounds of carbon dioxide per year and can sequester 1 ton of carbon dioxide by the time it reaches 40 years old.
https://www.google.com/url?sa=t&rct=j&q=&esrc=s&source=web&cd=2&cad=rja&uact=8&ved=2ahUKEwiLqsWDzPDiAhUDbawKHZeWD9sQFjABegQIFRAE&url=https%3A%2F%2Fprojects.ncsu.edu%2Fproject%2Ftreesofstrength%2Ftreefact.htm&usg=AOvVaw1OrmgfksaPokxOll0RWgZ

On average, one acre of new forest can sequester about 2.5 tons of carbon annually. Young trees absorb CO2 at a rate of 13 pounds per tree each year. Trees reach their most productive stage of carbon storage at about 10 years at which point they are estimated to absorb 48 pounds of CO2 per year.
https://www.google.com/url?sa=t&rct=j&q=&esrc=s&source=web&cd=10&cad=rja&uact=8&ved=2ahUKEwiLqsWDzPDiAhUDbawKHZeWD9sQFjAJegQIFhAg&url=http%3A%2F%2Furbanforestrynetwork.org%2Fbenefits%2Fair%2520quality.htm&usg=AOvVaw3WrHmpXHS8c77VDz6hfQ48

The average tropical tree sequesters a minimum of 50 lbs or 22.6 kg of carbon each year. The size and growth rate of each individual tree coupled with its specific density of biomass determines how much CO2 is pulled from the atmosphere and stored.
http://www.communitycarbontrees.org/climate-change-solutions#Tropical-Rainforest-Trees-for-CO2-Sequestration

Initially we will plant 1.100 trees per hectare at a cost of 2.2 Euro per tree which includes everything from the maintenance for three years after which the forest can be left to its own till the monitoring, management and security of the area. We will assume a period of 45 years in which the maximum biomass in a stable equilibrium will be achieved. But not all trees will survive till 45 years. The number of mature trees per hectare in the stable condition is for now assumed to be 300. With the number of 22 kilograms per tree per year on average for carbon sequestration this means a total sequestration of 300 * 45 * 22 kg = 297 tons of C per hectare which is what a “normal rainforest” should have and which is very realistic for the growing conditions in the Temboan project area. This number is however an underestimate in view of the other positive factors that contribute to the carbon issues as described above. If we now calculate back to the amount of carbon per initially planted tree we get 297 tons divided by 45 years and 1.100 trees which is 6 kg C per tree per year and a total of 270 kg C per tree over the 45 years.

With a initial cost of 2.420 Euro per hectare we achieve a minimum of 297 tons of C sequestration. This represents 297 * 3.67 tons of CO_2 equivalents or 1089 tons. This means that the cost to generate 1 ton of CO_2 compensation is 2.22 Euro per ton. The

price of CO_2 in compensation schemes has been set at 20 Euro per ton in many countries which is almost ten times more! However this value is created over a period of 45 years. We have to still decide how we can translate this biomass in carbon credits and to which party these carbon credits can be accredited. In principle these should go to Masarang to be used in a transparent way for the goals of the foundation.