



### This paper serves to give examples on

- how to convert 'Stem volume' to 'tons of CO<sub>2</sub>'
- how to convert 'Fresh non-woody biomass' to 'tons of CO<sub>2</sub>'
- how to determine the parameter 'Baseline'
- how to determine the parameter 'Leakage'

## Conversion Procedure

In the following two example calculations, some default values (see CarbonFix Standard) of the chapter 'Conservative Approach' are used.

### 1 m<sup>3</sup> of 'Stem volume' converts to 0.7 tons of CO<sub>2</sub>

Stem volume	* BEF	* Wood density	* Carbon fraction	* C-to-CO <sub>2</sub>	* (1+ Root-to-Shoot ratio)
= 1	* 1.1	* 0.3	* 0.5	* 3.666	* (1+ 0.1)
= 0.7 tCO <sub>2</sub>					

Calculated with default values for the parameter CO<sub>2</sub>-fixation.

### 1 ton of 'Fresh non-woody biomass' converts to 3.6 tons of CO<sub>2</sub>

Fresh biomass	* Dry-to-Wet	* Carbon fraction	* C-to-CO <sub>2</sub>	* (1+ Root-to-Shoot ratio)
= 1	* 0.5	* 0.4	* 3.666	* (1+ 4.0)
= 3.6 tCO <sub>2</sub>				

Calculated with default values for the parameter baseline.



## CFS Methodology

### Example Calculations

#### Baseline

Formula to be applied

$$\text{Baseline [tCO}_2\text{/ha]} = (\text{Baseline woody biomass [tCO}_2\text{]} + \text{Baseline non-woody biomass [tCO}_2\text{]}) / \text{Eligible planting area [ha]}$$

Result of the example calculation. The determination of the variables is described below.

$$\begin{aligned} \text{Baseline} &= (\text{Baseline woody biomass} + \text{Baseline non-woody biomass}) / \text{Eligible planting area} \\ &= (4\,000 + 3\,000) / (200 + 300) \\ &= \mathbf{14\ tCO_2/ha} \end{aligned}$$

*Note that the results are always rounded off to full tons.*

#### Baseline woody biomass

The total eligible planting area of a project has the size of 500 ha and consists of two strata. The 1<sup>st</sup> stratum is 200 ha bushland and has according to a national default value 10 m<sup>3</sup> of standing wood (Stem volume) per hectare. The 2<sup>nd</sup> stratum is 300 ha of grassland and therefore counts as non-woody baseline (see next example).

The entire stratum of 200ha is eligible and will be planted.

International default values are used for the Biomass Expansion Factor (1.3) and the Root-to-Shoot ratio (0.2).

For the factor 'Wood density' no scientific rigorous figure was found, therefore the value of the 'Conservative Approach' is used = 0.7.

$$\begin{aligned} 0.5 &= \text{Carbon fraction of biomass} \\ 3.666 &= \text{Factor to convert from C to CO}_2 \end{aligned}$$

Formula to be applied

$$\text{Baseline woody biomass [tCO}_2\text{]} = (\text{Baseline aboveground woody biomass [tCO}_2\text{]} + \text{Baseline belowground woody biomass [tCO}_2\text{]}) * \text{Eligible planting area [ha]}$$

#### Selected carbon pools

$$\begin{aligned} \text{Aboveground woody b.} &= \text{Stem volume} * \text{Biomass Expansion Factor} * \text{Wood density} * \text{Carbon fraction} * \text{C to CO}_2 \text{ factor} \\ \text{Belowground woody b.} &= \text{Aboveground woody biomass} * \text{Root-to-Shoot ratio} \end{aligned}$$

$$\begin{aligned} \text{Aboveground woody b.} &= \text{Stem volume} * \text{BEF} * \text{Wood density} * \text{Carbon fraction} * \text{C-to-CO}_2 \\ &= 10 * 1.3 * 0.7 * 0.5 * 3.666 \\ &= 16.7 \text{ tCO}_2\text{/ha} \end{aligned}$$

$$\begin{aligned} \text{Belowground woody b.} &= \text{Aboveground woody b.} * \text{Root-to-Shoot ratio} \\ &= 16.7 * 0.2 \\ &= 3.3 \text{ tCO}_2\text{/ha} \end{aligned}$$

$$\begin{aligned} \text{Baseline woody biomass} &= (\text{Aboveground woody b.} + \text{Belowground woody b.}) * \text{Area} \\ &= (16.7 + 3.3) * 200 \text{ ha} \\ &= 20 \text{ tCO}_2\text{/ha} * 200 \text{ ha} \\ &= \mathbf{4\,000\ tCO}_2 \end{aligned}$$

## CFS Methodology

### Example Calculations



#### Baseline non-woody biomass

As mentioned above, the 2<sup>nd</sup> stratum of this project consists of grassland. Here, measurements determined a value of 3.4 tons of dry biomass (grass, herbs and scattered leaves) per hectare.

The entire stratum of 300ha is eligible and will be planted.

For the Root-to-Shoot ratio an international default value of 0.61 is used.

0.5 = Carbon fraction of biomass  
3.666 = Factor to convert from C to CO<sub>2</sub>

#### Formula to be applied

##### Baseline non-woody biomass [tCO<sub>2</sub>]

= (Baseline aboveground non-woody b. [tCO<sub>2</sub>] + Baseline belowground non-woody b. [tCO<sub>2</sub>]) \* Eligible planting area [ha]

##### Selected carbon pools

Aboveground non-woody b. = Fresh biomass \* Dry-to-Wet ratio \* Carbon fraction \* C to CO<sub>2</sub> factor

Belowground non-woody b. = Aboveground non-woody biomass \* Root-to-Shoot ratio

Dry biomass = Fresh biomass \* Dry-to-Wet ratio

Aboveground non-woody b. = Dry biomass \* Carbon fraction \* C-to-CO<sub>2</sub>  
= 3.4 \* 0.5 \* 3.666  
= 6.2 tCO<sub>2</sub>/ha

Belowground non-woody b. = Aboveground non-woody b. \* Root-to-Shoot ratio  
= 6.2 \* 0.61  
= 3.1 t dm/ha

Baseline non-woody biomass = (Aboveground non-woody b. + Belowground non-woody b.) \* Area  
= (6.2 + 3.8) \* 300 ha  
= 10.0 tCO<sub>2</sub>/ha \* 300 ha  
= **3 000 tCO<sub>2</sub>**



## Leakage

### Note !

All leakage examples do not include the 'belowground woody biomass'. This is due to an adaptation of the methodology in v3.2. Therefore the examples still require to be multiplied by a root-to-shoot factor.

### Formula to be applied

$$\begin{aligned} \text{Leakage [tCO}_2\text{/ha]} \\ &= \text{Leakage aboveground woody biomass [tCO}_2\text{]} / \text{Eligible planting area [ha]} \end{aligned}$$

Result of the example calculation (only considering category e. and f.). The determination of these variables and the ones of other leakage categories is described below.

$$\begin{aligned} \text{Leakage} &= \text{Leakage aboveground woody biomass} / \text{Eligible planting area} \\ &= 4\,172 \text{ tCO}_2 / 450\text{ha} \\ &= \mathbf{9 \text{ tCO}_2\text{/ha}} \end{aligned}$$

*Note that the result is always rounded off to a full ton.*

### Description of the example

A project has a total project area of 750 ha. 450 ha of these will be planted (planting area) and 300 ha will be preserved for conservation purposes (conservation area). The planting area consists of grass- and bushland. On the conservation area existing forest is standing.

To determine the 'Leakage', the following activities shifts are examined:

- |                      |                         |
|----------------------|-------------------------|
| a. fuelwood use      | d. agricultural farming |
| b. charcoal burning  | e. resettlement         |
| c. timber harvesting | f. livestock grazing    |



### a. Leakage Use of fuelwood

People neighbouring the project used to collect fuelwood on the planting area of the project 450 ha (Area).

The project developer expects that all people (% of displacement) have to find other places to collect their fuelwood from, because the planting area will be planted and the nature conservation area will be protected.

According to the project developer it is not known where exactly the activities will be shifted to. Therefore, as CO<sub>2</sub>-stock, the area where the activities *took* place can be used.

In our example the CO<sub>2</sub>-stock of the carbon pool 'aboveground woody biomass' on the planting area is in average 35 tCO<sub>2</sub>/ha (CO<sub>2</sub>-stock).

Formula to be applied

Leakage aboveground woody biomass [tCO<sub>2</sub>] = % of displacement [%] \* CO<sub>2</sub>-stock [tCO<sub>2</sub>/ha] \* Area [ha]

#### Selected carbon pools

Aboveground woody b. = Stem volume \* Biomass Expansion Factor \* Wood density \* Carbon fraction \* C to CO<sub>2</sub> factor

<b>Leakage a.</b>	= % of displacement	* CO <sub>2</sub> -stock	* Area
	= 100%	* 35	* 450
	<b>= 15 750 tCO<sub>2</sub></b>		

### b. Leakage Production of charcoal

Villagers of surrounding settlements also used to burn charcoal on the 450 ha planting area (Area). Due to the project activities the villagers will have to find other bushland to collect their biomass.

A representative survey determined that 25% (% of displacement) of the people will continue their work outside the project area as soon as the project starts. Others will look for alternative jobs.

As it is most likely that the people who will continue their charcoal activities will stay within the region, the CO<sub>2</sub>-stock is determined by the amount of biomass on bushland within the province.

Calculated with a conservative approach this is 45 tCO<sub>2</sub>/ha (CO<sub>2</sub>-stock).

Formula to be applied

Leakage aboveground woody biomass [tCO<sub>2</sub>] = % of displacement [%] \* CO<sub>2</sub>-stock [tCO<sub>2</sub>/ha] \* Area [ha]

#### Selected carbon pools

Aboveground woody b. = Stem volume \* Biomass Expansion Factor \* Wood density \* Carbon fraction \* C to CO<sub>2</sub> factor

<b>Leakage b.</b>	= % of displacement	* CO <sub>2</sub> -stock	* Area
	= 25%	* 45	* 450
	<b>= 5 063 tCO<sub>2</sub></b>		



### c. Leakage Production of timber

Villagers of surrounding settlements used to cut timber within the conservation area of 300ha (Area).

Due to the project activities the villagers will have to find other places to cut their timber. The estimation of the local mayor is that most of the timber cutters will find different employment, since other land for cutting timber is not available in the vicinity and most of the men have family and land which does not allow them to move. According to the default values outlines in the 'Criteria & Methodology' document, the percentage of displacement can therefore be estimated to 75% (% of displacement).

According to scientific literature, a forest of the projects host country has on average a 'Stem volume' of the 100 m<sup>3</sup>/ha. As a Biomass Expansion Factor the national mean value of 2.0 is taken. For the factor 'Wood density' the default value of the 'Conservative Approach' is taken = 0.7.

0.5 = Carbon fraction of biomass  
3.666 = factor to convert from C to CO<sub>2</sub>

Formula to be applied

Leakage aboveground woody biomass [tCO<sub>2</sub>] = % of displacement [%] \* CO<sub>2</sub>-stock [tCO<sub>2</sub>/ha] \* Area [ha]

#### Selected carbon pools

Aboveground woody b. = Stem volume \* Biomass Expansion Factor \* Wood density \* Carbon fraction \* C to CO<sub>2</sub> factor

CO<sub>2</sub>-stock = Stem volume \* BEF \* Wood density \* Carbon fraction \* C-to-CO<sub>2</sub>  
= 100 \* 2.0 \* 0.7 \* 0.5 \* 3.666  
= 257 tCO<sub>2</sub>/ha

**Leakage c.** = % of displacement \* CO<sub>2</sub>-stock \* Area  
= 75% \* 257 \* 300  
= **57 825 tCO<sub>2</sub>**

### d. Leakage Agricultural activities

Before the land was sold to become a climate project, the former landowner was cultivating 50ha of his land with maize (Area).

With the sale of the land the farmer confirmed, that he will be able to cultivate the same area on his new property (100% of displacement).

As it is not known where exactly the family was moving, the national default value of a natural forest must be taken to determine the CO<sub>2</sub>-stock. As calculated above, this is 257 tCO<sub>2</sub>/ha (CO<sub>2</sub>-stock).

Formula to be applied

Leakage aboveground woody biomass [tCO<sub>2</sub>] = % of displacement [%] \* CO<sub>2</sub>-stock [tCO<sub>2</sub>/ha] \* Area [ha]

#### Selected carbon pools

Aboveground woody b. = Stem volume \* Biomass Expansion Factor \* Wood density \* Carbon fraction \* C to CO<sub>2</sub> factor

**Leakage d.** = % of displacement \* CO<sub>2</sub>-stock \* Area  
= 100% \* 257 \* 50  
= **12 850 tCO<sub>2</sub>**



### e. Leakage Resettlements

Due to forestation activities, 10 people illegally living within the project area must be resettled. The mayor of the nearest village expects that the size of land where the people will be resettled to will stay the same as it was before. This was 3 hectares (Area).

A survey determined that 9 of the people (90% of displacement) will buy land close to the project area, since they are used to the vicinity. As the type of vegetation inside and outside the project area is very similar, the CO<sub>2</sub>-stock is the same as determined by the 'Baseline' assessment. This was 35 tCO<sub>2</sub>/ha (CO<sub>2</sub>-stock).

1 man wants to move elsewhere. Here, the national default value for forest must be considered as CO<sub>2</sub>-stock. As calculated above, this is 257 tCO<sub>2</sub>/ha (CO<sub>2</sub>-stock).

Formula to be applied

Leakage aboveground woody biomass [tCO<sub>2</sub>] = % of displacement [%] \* CO<sub>2</sub>-stock [tCO<sub>2</sub>/ha] \* Area [ha]

#### Selected carbon pools

Aboveground woody b. = Stem volume \* Biomass Expansion Factor \* Wood density \* Carbon fraction \* C to CO<sub>2</sub> factor

Leakage <sub>e.1</sub>	= % of displacement	* CO <sub>2</sub> -stock	* Area
	= 90%	* 35	* 3
	= 95 tCO <sub>2</sub>		

Leakage <sub>e.2</sub>	= % of displacement	* CO <sub>2</sub> -stock	* Area
	= 10%	* 257	* 3
	= 77 tCO <sub>2</sub>		

<b>Leakage <sub>e.</sub></b>	= 95 + 77 tCO <sub>2</sub>
	= <b>172 tCO<sub>2</sub></b>



### f. Leakage Livestock grazing

A survey has determined that 500 cows (Head) were grazing within the project area before the project started. The project is situated in a tropical dry climate. Therefore, according to an international default value, the sustainable grazing capacity is 0.5 cows per hectare. This equals 2 hectares per cow (Capacity).

A survey with the cattle keepers resulted that 20% of them will move to other land which will have impacts on the carbon pool 'aboveground woody biomass' (displacement). The remaining 80% said that they will find other jobs or move to grazing-land without trees - the carbon pool 'aboveground woody biomass' is not impacted.

The CO<sub>2</sub>-stock where the displacement will take place is expected to be a combination of bush- and grassland with an average 'aboveground woody' carbon stock of 20 tCO<sub>2</sub> per hectare (CO<sub>2</sub>-stock).

Formula to be applied

$$\text{Leakage aboveground woody b. [tCO}_2\text{]} = \text{CO}_2\text{-stock [tCO}_2\text{/ha]} * \text{Displaced heads [head]} * \text{Capacity [ha/head]}$$

#### Selected carbon pools

Aboveground woody b. = Stem volume \* Biomass Expansion Factor \* Wood density \* Carbon fraction \* C to CO<sub>2</sub> factor

<b>Leakage<sub>f</sub></b>	= CO <sub>2</sub> -stock	* Head	* Capacity
	= 20	* 20% * 500	* 2
	<b>= 4 000 tCO<sub>2</sub></b>		