Clarification on GHG Accounting

GHG emissions and carbon removals in the baseline scenario have been calculated using the following equation as given in the VM0033 Methodology:

$$GHG_{BSL} = GHG_{BSL\text{-}biomass} + GHG_{BSL\text{-}soil} + GHG_{BSL\text{-}fuel} \quad (18)$$[1]

$$GHG_{BSL\text{-}biomass} = -\sum_{t=1}^{t*} \sum_{i=1}^{M_{BSL}} \left(\frac{44}{12} \times \Delta C_{BSL\text{-}biomass,i,t} \right) \quad (19)$$

$$GHG_{BSL\text{-}soil} = \sum_{t=1}^{t*} \sum_{i=1}^{M_{BSL}} GHG_{BSL\text{-}soil,i,t} \quad (20)$$

$$GHG_{BSL\text{-}fuel} = \sum_{t=1}^{t*} \sum_{i=1}^{M_{BSL}} GHG_{BSL\text{-}fuel,i,t} \quad (21)$$

Where:

GHG_{BSL}	Net CO_2e emissions in the baseline scenario up to year $t*$; t CO_2e
$GHG_{BSL\text{-}biomass}$	Net CO_2e emissions from biomass carbon pools in the baseline scenario up to year $t*$; t CO_2e
$GHG_{BSL\text{-}soil}$	Net CO_2e emissions from the SOC pool in the baseline scenario up to year $t*$; t CO_2e
$GHG_{BSL\text{-}fuel}$	Net CO_2e emissions from fossil fuel use in the baseline scenario up to year $t*$; t CO_2e
$\Delta C_{BSL\text{-}biomass,i,t}$	Net carbon stock changes in biomass carbon pools in the baseline scenario in stratum i in year t; t C yr^{-1}
$GHG_{BSL\text{-}soil,i,t}$	GHG emissions from the SOC pool in the baseline scenario in stratum i in year t; t CO_2e yr^{-1}
$GHG_{BSL\text{-}fuel,i,t}$	GHG emissions from fossil fuel use the baseline scenario in stratum i in year t; t CO_2e yr^{-1}
i	1, 2, 3 …M_{BSL} strata in the baseline scenario
t	1, 2, 3, … $t*$ years elapsed since the project start date

Net carbon stock change in biomass carbon pools in the baseline scenario

The baseline scenario represents degraded mangrove habitats almost void of any vegetation and without significant natural recovery. Baseline existing mangrove vegetation has been assessed and has been found to be 1.1 % of the project area. For complete analysis, please see the relevant PD **Error! Reference source not found.**.

GHG removals in this baseline vegetation is less than 5% and as per carbon accounting norms is therefore considered *de minimis*. Therefore, no deduction has to be made on account of this *de minimis* vegetation while calculating net GHG removals. However, due to oversight there was a deduction made during first monitoring report. The deduction made was 38,897 tCO2e. This deduction was unwarranted and therefore need to be recouped which has been done during the second monitoring report. The figure discrepancy that you are referring to is actually this recouping of those 38,897 tCO2e which were not supposed to be deducted but had been deducted. This rectification increases the accuracy of our carbon calculations.

Once you will recalculate the GHG emissions reduction and removals after making this needed rectification you will be able to recreate the figure of 1,939,872 tCO2e instead of the value of 1,900,975 tCO2e that you had arrived at in your calculations.

[1] Equation numbers as in VM0033.

On the same analogy and to be accurate in calculations, no deduction has been made on account of baseline vegetation in this second monitoring report. Once you do this, you will be able to determine how the ER values were reached.

Kindly note that the above carbon calculations are subject to the concurrence of the Third-Party Verifier and approval by VERRA.

Net GHG emissions from soil in the baseline scenario

Net GHG emissions from soil

Net GHG emissions from soil in the baseline scenario are estimated as:

$$GHG_{BSL\text{-}soil,i,t} = A_{i,t} \times (GHG_{BSL\text{-}soil\text{-}CO2,i,t} - Deduction_{alloch} + GHG_{BSL\text{-}soil\text{-}CH4,i,t} + GHG_{BSL\text{-}soil\text{-}N2O,i,t}) \quad (26)$$

$$GHG_{BSL\text{-}soil\text{-}CO2,i,t} = GHG_{BSL\text{-}insitu\text{-}CO2,i,t} + GHG_{BSL\text{-}eroded\text{-}CO2,i,t} + GHG_{BSL\text{-}excav\text{-}CO2,i,t} \quad (27)$$

Where:

$GHG_{BSL\text{-}soil,i,t}$ GHG emissions from the SOC pool in the baseline scenario in stratum *i* in year *t*; t CO_2e yr^{-1}

$GHG_{BSL\text{-}soil\text{-}CO2,i,t}$ CO_2 emissions from the SOC pool in the baseline scenario in stratum *i* in year *t*; t CO_2e ha^{-1} yr^{-1}

$Deduction_{alloch}$ Deduction from CO_2 emissions from the SOC pool to account for the percentage of the carbon stock that is derived from allochthonous soil organic carbon; t CO_2e ha^{-1} yr^{-1}

$GHG_{BSL\text{-}soil\text{-}CH4,i,t}$ CH_4 emissions from the SOC pool in the baseline scenario in stratum *i* in year *t*; t CO_2e ha^{-1} yr^{-1}

$GHG_{BSL\text{-}soil\text{-}N2O,i,t}$ N_2O emissions from the SOC pool in the baseline scenario in stratum *i* in year *t*; t CO_2e ha^{-1} yr^{-1}

$A_{i,t}$ Area of stratum *i* in year *t*; ha

$GHG_{BSL\text{-}insitu\text{-}CO2,i,t}$ CO_2 emissions from the tidal wetland SOC pool of *in-situ* soils in the baseline scenario in stratum *i* in year *t*; t CO_2e ha^{-1} yr^{-1}

$GHG_{BSL\text{-}eroded\text{-}CO2,i,t}$ CO_2 emissions from the eroded tidal wetland SOC pool in the baseline scenario in stratum *i* in year *t* ; t CO_2e ha^{-1} yr^{-1}

$GHG_{BSL\text{-}excav\text{-}CO2,i,t}$ CO_2 emissions from the tidal wetland SOC pool of soil exposed to an aerobic environment through excavation in the baseline scenario in stratum *i* in year *t*; t CO_2e ha^{-1} yr^{-1}

i 1, 2, 3 … M_{BSL} strata in the baseline scenario

t 1, 2, 3, … *t** years elapsed since the project start date

Excavation occurred prior to the project start date associated with the establishment of fields for red rice production since the early 19^{th} century[2]. SOC in piled-up soil has been exposed to oxidation for a long period and may have reached a steady state value. Therefore, $GHG_{BSL\text{-}excav\text{-}CO2,i}$ is not accounted for, which is always conservative for the baseline scenario.

CO_2 emissions from soil – *in situ*

The baseline scenario represents degraded mangrove habitats almost void of any vegetation and without any significant natural recovery, see Section **Error! Reference source not found.**. of PD document. The presence of ground vegetation (*Oryza coarctata* grass) is only seasonal as the grass only grows during the rainy season and is not a permanent cover. Under such circumstances, SOC levels will continue to decline and eventually reach a steady state.

As outlined in Section **Error! Reference source not found.** of the PD, DBC-1 ARR/RWE project does not claim avoided emissions (stop loss) from the soil, as a result of the restoration activities.

[2] Burnes, A. 1837. On Sindh. *Journal of the Royal Geographical Society of London* 7:11-20.

CO_2 emissions from the *in-situ* soil in the baseline scenario are conservatively not accounted for.

Deduction for allochthonous carbon

A deduction for allochthonous carbon would only apply if $GHG_{BSL\text{-}insitu\text{-}CO2,i,t}$ was negative (sequestration). Since the baseline scenario does not involve accumulation of SOC, a deduction for allochthonous carbon is not necessary.

CH_4 emissions from soil – *in situ*

CH_4 emissions from soil in the baseline scenario are not accounted for as CH_4 emissions do not increase in the project scenario compared to the baseline scenario, see Section **Error! Reference source not found.**.

N_2O emissions from soil – *in situ*

N_2O emissions from soil in the baseline scenario are not accounted for, as N_2O emissions do not increase in the project scenario compared to the baseline scenario, see Section **Error! Reference source not found.**.

CO_2 emissions from soil – *eroded*

As outlined in Section **Error! Reference source not found.** of the PD, sea level rise will over a period of 100 years cause erosion and a loss of wetland area. The predicted loss of wetland area has been calculated in 5-year time steps. For each time step, the release of carbon and emission of CO_2 to the atmosphere from the eroded wetland soil has been calculated using the following equations.

$$GHG_{BSL\text{-}eroded\text{-}CO2,i,t} = 44/12 \times C_{BSL\text{-}eroded,i,t} \times C\%_{BSL\text{-}emitted,i,t} / 100 \quad (48)$$

$$C_{BSL\text{-}eroded,i,t} = C\%_{BSL\text{-}eroded,i,t} \times BD \times Depth\_e_{BSL,i,t} \text{ x } 10 \quad (49)$$

Where:

$GHG_{BSL\text{-}eroded\text{-}CO2,i,t}$ CO_2 emissions from the eroded tidal wetland SOC pool in the baseline scenario in stratum *i* in year *t* ; t CO_2e ha^{-1} yr^{-1}

$C_{BSL\text{-}eroded,i,t}$ Soil organic carbon stock in eroded tidal wetland soil material in the baseline scenario in stratum *i* in year *t*; t C ha^{-1}

$C\%_{BSL\text{-}emitted,i,t}$ Organic carbon loss due to oxidation, as a percentage of C mass present in eroded tidal wetland soil material in the baseline scenario in stratum *i* in year *t*; %

$C\%_{BSL\text{-}eroded,i,t}$ Percentage of carbon of tidal wetland soil material eroded in the baseline scenario; %

BD Soil bulk density; kg m^{-3}

$Depth\_e_{BSL,i,t}$ Depth of the eroded area from the surface to the surface prior to erosion in the baseline scenario in stratum *i* in year *t*; m

As part of project planning, eight 1-m long soil cores were collected in degraded mangrove habitat throughout the Project Area, which visually is similar to a mudflat[3] environment with little (low-lying grass, *Oryza coarctata*) to no vegetation. The cores were collected following the methods described in Section **Error! Reference source not found.**. The average carbon stock within the top metre of soil is 163.6 t C ha^{-1} (range: 82.9 – 206.2 t C ha^{-1}; standard deviation: 43.7; standard error: 17.8 t C ha^{-1}; 95% CI: 30.3).

When coastal erosion occurs, the entire marsh plain is eroded. It is assumed that the top metre of soil is eroded ($Depth\_e_{i,t}$ = 1 m)[4]. Areas of strata *i* and years *t* of erosion are provided in **Error! Reference source not found.**. The method for calculating these areas is outlined in Section **Error! Reference source not found.**.

[3] These are degraded mangrove areas reminiscent of mudflats. Native mudflats are not part of the Project Area.

[4] This depth will be uses in both baseline and project scenario consistently

For tidal marsh and mangrove systems, a default factor for $C\%_{BSL\text{-}emitted,i,t}$ may be used in the absence of data suitable for using the published value approach, using the values provided below for the specified carbon preservation depositional environment (CPDE).

In absence of any other data relevant for the Project Area, $C\%_{BSL\text{-}emitted,i,t}$ is quantified using the default value for the relevant CPDE, using the following equation:

If CPDE is "Normal Marine" or "Deltaic fluidized muds", then $C\%_{BSL\text{-}emitted,i,t} = 80\%$

This means that 80% of the SOC eroded from the tidal wetland is emitted as CO_2.

Net GHG emissions from fossil fuel combustion

Fossil fuel combustion in the baseline scenario is not a significant emissions source in this ARR/RWE project activity, as it does not move soil material.