Carbon_Standars_Examples

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Generic example:

Input Data: The dataset tree_data contains Plot_ID, Tree_ID, and Biomass_kg (tree biomass in kilograms). Conversion Factor: A standard biomass-to-carbon conversion factor of 0.47 is used (the biomass to carbon conversion factor is typically around 0.5; is a good approximation of the typical carbon content in the biomass of terrestrial vegetation, and is consistent with the Good Practice Guidance in LULUCF by the IPCC (2003)). Calculations: Carbon_kg for each tree is calculated by multiplying Biomass_kg by the conversion factor. Carbon stocks are summarized for each plot. Visualization: A bar plot shows the total carbon stock per plot.

```
# Load libraries
library(dplyr)
```

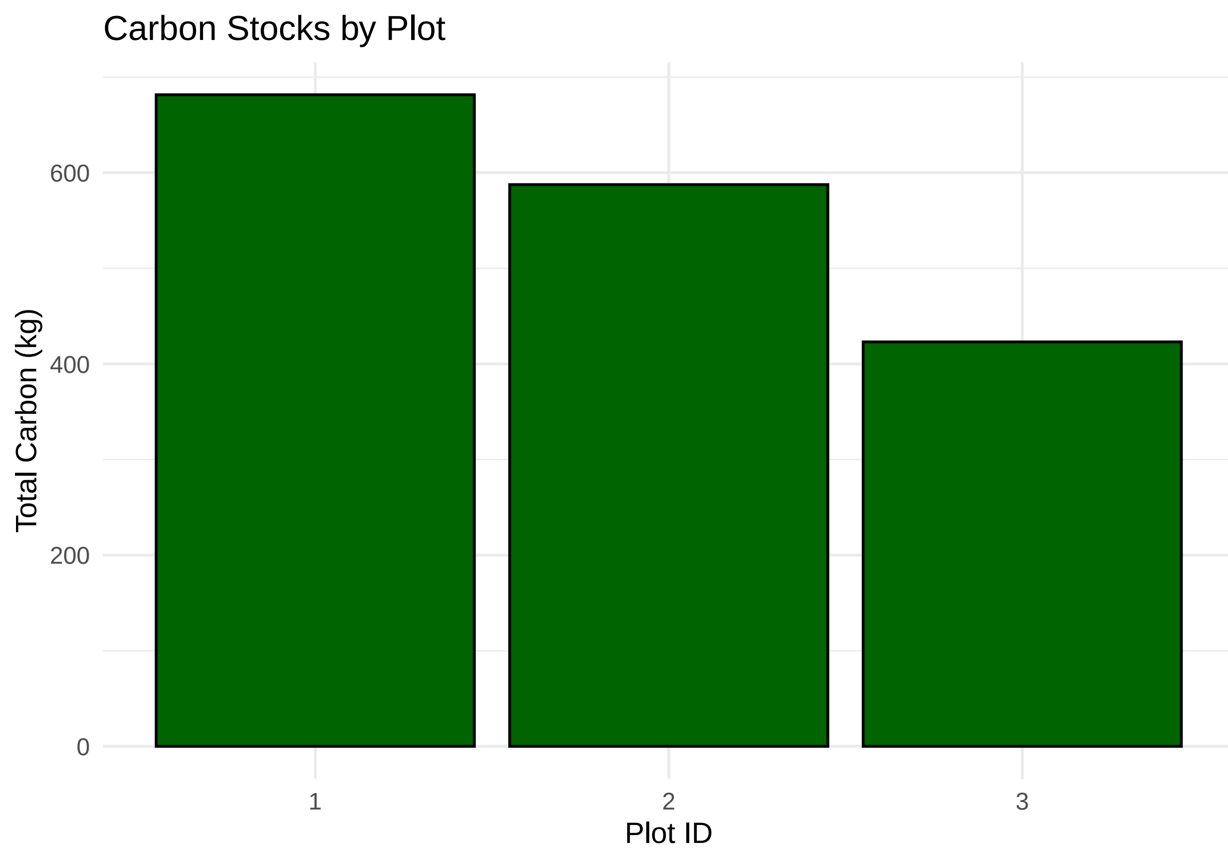
```
##
## Attaching package: 'dplyr'

## The following objects are masked from 'package:stats':
##
##     filter, lag

## The following objects are masked from 'package:base':
##
##     intersect, setdiff, setequal, union
```

```
library(ggplot2)

# Create a dataset: Tree biomass (in kg) for different plots
tree_data <- data.frame(
  Plot_ID = c(1, 1, 1, 2, 2, 3, 3, 3),
  Tree_ID = c(101, 102, 103, 201, 202, 301, 302, 303),
  Biomass_kg = c(500, 350, 600, 800, 450, 400, 300, 200)
)

# Biomass-to-carbon conversion factor (here we use 0.47)
conversion_factor <- 0.47

# Calculate carbon stock for each tree
tree_data <- tree_data %>%
  mutate(Carbon_kg = Biomass_kg * conversion_factor)
```

```r
# carbon stocks per plot
plot_carbon <- tree_data %>%
  group_by(Plot_ID) %>%
  summarise(
    Total_Biomass_kg = sum(Biomass_kg),
    Total_Carbon_kg = sum(Carbon_kg)
  )

print(plot_carbon)
```

```
## # A tibble: 3 x 3
##   Plot_ID Total_Biomass_kg Total_Carbon_kg
##     <dbl>            <dbl>           <dbl>
## 1       1             1450            682.
## 2       2             1250            588.
## 3       3              900            423
```

```r
# Visualize the results
ggplot(plot_carbon, aes(x = factor(Plot_ID), y = Total_Carbon_kg)) +
  geom_bar(stat = "identity", fill = "darkgreen", color = "black") +
  labs(
    title = "Carbon Stocks by Plot",
    x = "Plot ID",
    y = "Total Carbon (kg)"
  ) +
  theme_minimal()
```



VCS (Verified Carbon Standard)

Scenario: Estimating avoided deforestation using historical land-use data.

```r
# Create example dataset: Deforestation rates (hectares per year) over 10 years
land_use_data <- data.frame(
  Year = 2010:2019,
  Deforestation_ha = c(1000, 950, 900, 850, 800, 750, 700, 650, 600, 550)
)

# Calculate the baseline (historical average deforestation rate)
baseline_deforestation <- mean(land_use_data$Deforestation_ha)

# Assume a project intervention reduced deforestation to 400 ha/year
project_deforestation <- 400

# Calculate avoided deforestation
avoided_deforestation <- baseline_deforestation - project_deforestation

# Estimate carbon savings (assuming 50 tCO2/ha for forest carbon density)
carbon_density <- 50  # tCO2/ha
avoided_emissions <- avoided_deforestation * carbon_density

# Results
cat("Baseline deforestation rate:", baseline_deforestation, "ha/year\n")
```

```
## Baseline deforestation rate: 775 ha/year
```

```r
cat("Avoided deforestation:", avoided_deforestation, "ha/year\n")
```

```
## Avoided deforestation: 375 ha/year
```

```r
cat("Carbon savings:", avoided_emissions, "tCO2/year\n")
```

```
## Carbon savings: 18750 tCO2/year
```

GS (Gold Standard)

Scenario: Estimating emissions reductions from a renewable energy project (solar).

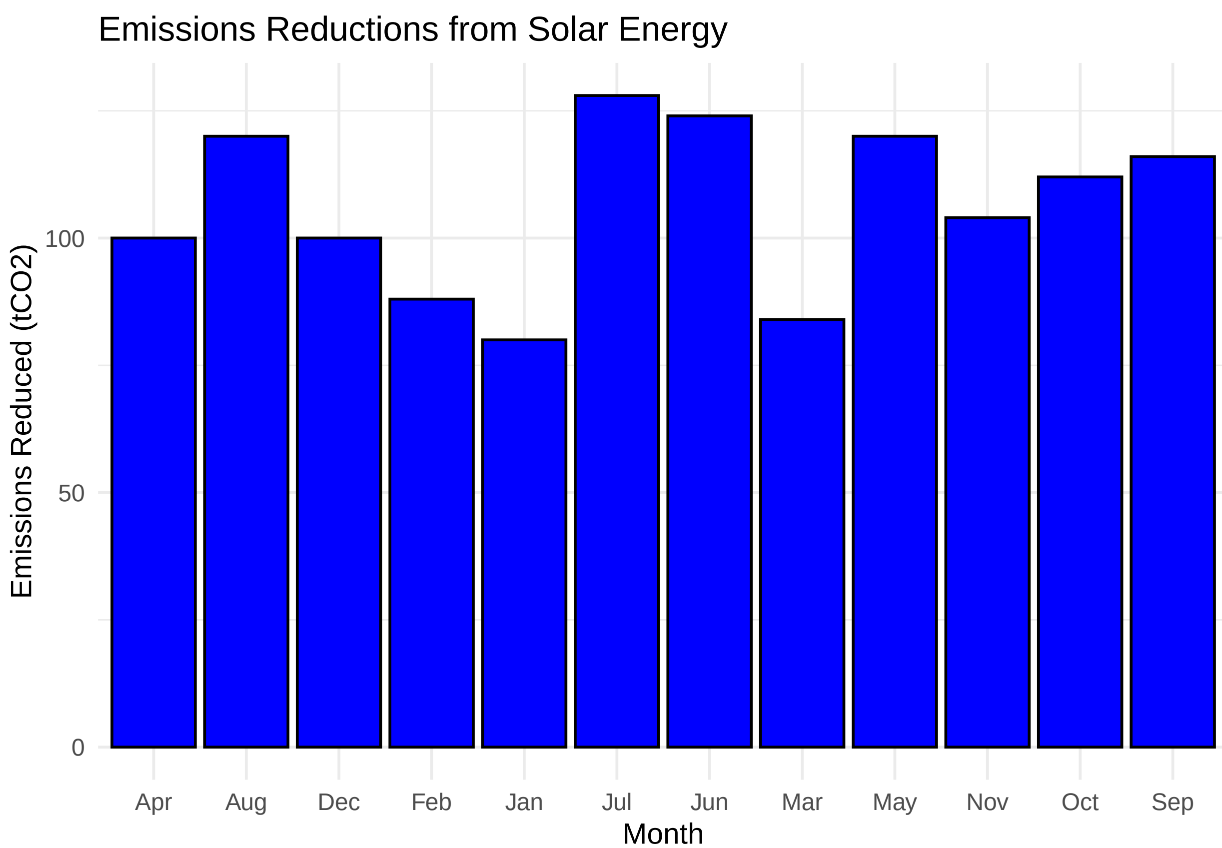
```r
# Hypothetical dataset: Energy generation (MWh) over 12 months
solar_data <- data.frame(
  Month = month.abb,
  Energy_MWh = c(200, 220, 210, 250, 300, 310, 320, 300, 290, 280, 260, 250)
)

# Calculate emissions reductions (fake grid emission factor: 0.4 tCO2/MWh)
grid_emission_factor <- 0.4  # tCO2/MWh
solar_data <- solar_data %>%
  mutate(Emissions_Reduced_tCO2 = Energy_MWh * grid_emission_factor)

# Total emissions reduced in a year
total_reductions <- sum(solar_data$Emissions_Reduced_tCO2)

# Results and visualization
print(solar_data)
```

```
##    Month Energy_MWh Emissions_Reduced_tCO2
## 1    Jan        200                     80
## 2    Feb        220                     88
## 3    Mar        210                     84
## 4    Apr        250                    100
## 5    May        300                    120
## 6    Jun        310                    124
## 7    Jul        320                    128
## 8    Aug        300                    120
## 9    Sep        290                    116
## 10   Oct        280                    112
## 11   Nov        260                    104
## 12   Dec        250                    100
```

```r
cat("Total emissions reduced:", total_reductions, "tCO2/year\n")
```

```
## Total emissions reduced: 1276 tCO2/year
```

```r
ggplot(solar_data, aes(x = Month, y = Emissions_Reduced_tCO2)) +
  geom_bar(stat = "identity", fill = "blue", color = "black") +
  labs(
    title = "Emissions Reductions from Solar Energy",
    x = "Month",
    y = "Emissions Reduced (tCO2)"
  ) +
  theme_minimal()
```



ACR (American Carbon Registry)

Scenario: Estimating soil organic carbon (SOC) sequestration in an agricultural project.

```r
# Example dataset: SOC (tC/ha) before and after project implementation
soc_data <- data.frame(
  Field_ID = 1:5,
  SOC_Before_tC_ha = c(10, 12, 15, 11, 14),
  SOC_After_tC_ha = c(15, 16, 20, 17, 19)
)

# Calculate SOC sequestration per field
soc_data <- soc_data %>%
  mutate(SOC_Sequestration_tC_ha = SOC_After_tC_ha - SOC_Before_tC_ha)
```

```r
# Total SOC sequestration across fields
total_soc_sequestration <- sum(soc_data$SOC_Sequestration_tC_ha)

# Convert to CO2 equivalent (1 tC = 3.67 tCO2)
total_soc_sequestration_CO2 <- total_soc_sequestration * 3.67

# Results
print(soc_data)
```

```
##   Field_ID SOC_Before_tC_ha SOC_After_tC_ha SOC_Sequestration_tC_ha
## 1        1               10              15                       5
## 2        2               12              16                       4
## 3        3               15              20                       5
## 4        4               11              17                       6
## 5        5               14              19                       5
```

```r
cat("Total SOC sequestration (tCO2):", total_soc_sequestration_CO2, "\n")
```

```
## Total SOC sequestration (tCO2): 91.75
```

CRCF (EU Carbon Removal Certification Framework)

Scenario: Estimating carbon removals in afforestation/reforestation. (Note from EcoMatcher: The weight of CO2 in trees is determined by the ratio of CO2 to C is 44/12 = 3.67. Therefore, to determine the weight of carbon dioxide sequestered in the tree, multiply the weight of carbon in the tree by 3.67.)

```r
# Hypothetical dataset: Tree growth and carbon sequestration over 5 years
afforestation_data <- data.frame(
  Year = 1:5,
  Biomass_kg = c(5000, 10000, 15000, 20000, 25000)  # Biomass in kg
)

# Conversion factors
biomass_to_carbon <- 0.47  # Biomass to carbon conversion
carbon_to_CO2 <- 3.67  # Carbon to CO2 conversion

# Calculate carbon removals each year
afforestation_data <- afforestation_data %>%
  mutate(
    Carbon_kg = Biomass_kg * biomass_to_carbon,
    Carbon_Removal_tCO2 = Carbon_kg * carbon_to_CO2 / 1000
  )

# Total carbon removals over 5 years
total_removals <- sum(afforestation_data$Carbon_Removal_tCO2)

# Results
print(afforestation_data)
```

```
##   Year Biomass_kg Carbon_kg Carbon_Removal_tCO2
## 1    1       5000      2350              8.6245
```

```
## 2    2      10000      4700              17.2490
## 3    3      15000      7050              25.8735
## 4    4      20000      9400              34.4980
## 5    5      25000     11750              43.1225
```

```r
cat("Total carbon removals (tCO2):", total_removals, "\n")
```

```
## Total carbon removals (tCO2): 129.3675
```