Carbon Credit Calculation and Amount of Carbon Credit at Phuket, Thailand

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Abstract

This study aims to inspect forest carbon stock using measuring lasers and GLOBE Observer application compared to the actual heights of the trees using the UAV imagery and photogrammetry method for measurement, which is the information we use to be considered and used to calculate the absorption capabilities. To portray a more precise image by our theory, we need to conduct the experiment in suitable locations that provide us with needed resources in order to get a clear result. Therefore, we have chosen Phuket City, located in Thailand. The researchers find the amount of carbon credits above the ground by using each in-area tree's height and diameter to find biomass using allometric equations, calculate the carbon credit, then record the results in our datasheets. The results show that tree measuring by measuring lasers, and GLOBE Observer application when compared to the data obtained from the drone, GLOBE Observer application has more accuracy to the drone than the measuring lasers. According to our collected data from both Koh Hey and Saphan Hin, it shows that the total amount of carbon credit from the sample space at Saphan Hin has greater amount than the sample space in Koh Hey. We can conclude that mangrove forests can consume more carbon dioxide than beach forests. Our study accomplishes to answer 2 main concerns which are "GLOBE Observer Application has more accuracy than measuring lasers" and "Mangrove forests are more capable of stocking carbon dioxide than beach forests".

Keywords: Carbon credit, Above-ground biomass, GLOBE Observer Application, Measuring laser, Drone

Introduction

Nowadays, our world is facing a severe climate problem which affects the amount of greenhouse gases and makes the average earth's temperature higher.

Global warming and climate change are the effects of the amount of greenhouse gases in the earth's atmosphere. The emission of carbon dioxide (CO_2), one of the greenhouse gases, is the main driver of global climate change (Ritchie et al., 2020). CO_2 emission has been growing every year since the mid-18th century. Nowadays, the world emits over 37 billion tons in 2021(Ritchie et al., 2020).

Carbon credits, also known as carbon offsets, are permits that allow the owner to emit a certain amount of carbon dioxide or other greenhouse gases. One credit permits the emission of one ton of carbon dioxide or the equivalent in other greenhouse gases. Forest is considered as the main carbon sink because of its availability to absorb CO2 through photosynthesis and becomes forest biomass (Government of Canada, 2013).

The study of the ability to absorb CO2 in forests or plantations could possibly benefit environmental management and carbon trading which can easily relieve the problem. So, this research is determined to find the most effective area to absorb carbon dioxide for environmental management and carbon trading appliances.

The reason why we chose Phuket to be the area of observation is that Phuket is one of the most touristy and famous provinces in Thailand, producing a lot of carbon dioxide, which is the main reason for exacerbating global warming, and Phuket also has different types of observation areas which allow us to compare the amount of carbon credits conveniently.

Using the drone to find tree heights is expensive and requires a lot of expertise in using tools. To reduce costs and find the best way to measure height, researchers also aim to find a better measuring tool, considered by the capability of tree height measuring accurately, between measuring lasers and GLOBE Observer application by using the drone as the measuring standard which has reliable accuracy.

Research Questions

1. What is the best method to measure the height of a tree between using measuring sensors and using the GLOBE Observer application?
2. What is the best area to consume carbon dioxide between Koh Hey and Saphan Hin ?
3. Which affects the amount of carbon stock more between tree height and tree diameter?

The Objectives

1. To find the best method to measure the height of a tree between GLOBE Observer application and measuring lasers, compared to the data from the drone.
2. To find the area that is most likely to consume carbon dioxide the most.
3. To find whether tree height or tree diameter affects the amount of carbon stock more.

Materials and Methods

1. Study sites

The study was conducted from 25 February - 2 March 2023 at Koh hey and Saphan Hin, Phuket (at N 7.74555, E 98.37550) from 25 February - 2 March 2023.

(a)

(b)

(c)

(d)

Map of Thailand and study site at Phuket, Thailand.
(a) Thailand map, (b) Phuket map, (c) Koh Hey, (d) Saphan Hin

2. **Data Collecting Method**

Due to the objectives of the study, three methods were used for tree height measurement including (1) GLOBE Observer Application, (2) Measuring Lasers (3) Drone

(1) GLOBE Observer Application

The Trees tool allows citizen scientists to measure tree height (and optionally tree circumference) to track the growth of trees over time. Tree height is the most widely used indicator of an environment's ability to grow trees. Observing tree height allows NASA scientists to understand the gain or loss of biomass which can inform calculations of the carbon that trees and forests either take in from or release into the atmosphere.

1. Set up sampling plots
2. Measure trees' heights and the coordination plant located using GLOBE Observer application; tree height
3. Measure the GBH at 1.3 m in the field and convert it into DBH, Record the measurement in data sheets.

(2) Measuring Lasers

Measuring lasers emit a pulse of laser at a target, the pulse reflects the laser off the target and back to the sending device. This "time of flight" principle is based on the fact that laser light travels at a fairly constant speed through the Earth's atmosphere. Inside the meter, a simple computer quickly calculates the distance between the target and the sending point. This method of distance calculation is capable of measuring the distance from the Earth to the moon within a few centimeters. Measuring lasers may also be referred to as "range finders" or "laser range finders".

1. Press button no. 4 and switch to direct Pythagoras measurement.
2. According to the flashing edge, point the laser at the first point of the target, and press button number 2 to measure the hypotenuse.
3. Rotate to the perpendicular direction to the target with the set reference as the center, then press button no. 2 to measure one right-angle side.
4. The calculation result of the other right-angle side is displayed at the bottom of the screen.

(3) Drone

DJI Mavic 2 Enterprise was used to do the aerial images of our study site. Aerial images were processed with Pix4Dmapper to create a digital surface model (DSM), a digital terrain model (DTM), and an orthomosaic image. These models and the orthomosaic images were analyzed with a photogrammetry process to find the tree heights in QGIS. The canopy height model (CHM) was subtracted from DTM and DSM to represent tree heights (H) within the canopy cover. The highest CHM within the canopy cover represents each tree's height. The zonal statistic algorithm was employed to reveal the highest CHM.

1. Place a ground-control point
2. Use PIX4D to create a digital surface model (DSM), a digital terrain model (DTM), and an orthomosaic image.
3. Analyze The models and the orthomosaic images with a photogrammetry process on QGIS in order to find tree heights.
4. Subtract the canopy height model (CHM) from DTM and DSM to represent tree height (H) within the canopy cover.
5. Lastly, use the zonal statistics algorithm to obtain the highest CHM.

Observational Results

After investigating the areas, the data was recorded in the following datasheets.

Observation Site	Tree Number	Latitude	Longitude	Circumference	Diameter	Height (GLOBE)
Koh Hey	1	7.74538	98.375162	22	7.01	5.4
Koh Hey	2	7.745382	98.376982	15	4.78	2.4
Koh Hey	3	7.745381	98.375162	34.5	10.99	6.7
Koh Hey	4	7.745381	98.376069	18	5.73	3.4
Koh Hey	5	7.745382	98.376976	15.5	4.94	1.8
Koh Hey	6	7.745382	98.376976	23.3	7.42	2.7
Koh Hey	7	7.745382	98.375162	18.4	5.86	1.8
Koh Hey	8	7.745382	98.376976	19.5	6.21	2
Koh Hey	9	7.745382	98.376976	17.5	5.57	1.6
Koh Hey	10	7.745383	98.376975	18.5	5.89	3.02
Koh Hey	11	7.745383	98.376975	8.7	2.77	2.54
Koh Hey	12	7.745383	98.376975	17.5	5.57	3.34
Koh Hey	13	7.745383	98.376975	17.7	5.64	2.68
Koh Hey	14	7.745383	98.376975	9	2.87	2.88
Koh Hey	15	7.745383	98.376975	29	9.24	3.15
Koh Hey	16	7.745383	98.376975	27	8.6	3.13
Koh Hey	17	7.745383	98.376975	15	4.78	3.1
Koh Hey	18	7.745384	98.376979	23	7.32	2.82
Koh Hey	19	7.745384	98.376979	24	7.64	3.96
Koh Hey	20	7.745384	98.376979	27.5	8.76	3
Koh Hey	21	7.745384	98.376979	24.5	7.8	3.55
Koh Hey	22	7.745384	98.376979	27	8.6	2.51
Koh Hey	23	7.745381	98.376977	13	4.14	3.26
Koh Hey	24	7.745381	98.376977	12	3.82	3.13

Table 1: Observational Result from Trees on Koh Hey (used to calculate carbon credits)

Observation Site	Tree Number	Latitude	Longitude	GBH	DBH	Height		
						GLOBE	Sensor	Drone
Sapan hin	1	7.867523	98.398565	9	2.87	5.03	4.5	7
Sapan hin	2	7.867523	98.398565	11.2	3.57	5.19	6.3	9
Sapan hin	3	7.867523	98.398565	18.4	5.86	11.69	5.3	11
Sapan hin	4	7.867523	98.398565	12.6	4.01	4.29	4	6
Sapan hin	5	7.867523	98.398565	16.3	5.19	13.66	6	7
Sapan hin	6	7.867523	98.398565	12	3.82	11.19	5	9
Sapan hin	7	7.866619	98.398567	19	6.05	8.36	6.2	9
Sapan hin	8	7.867523	98.398565	28	8.92	14.18	7.4	10
Sapan hin	9	7.867523	98.398565	14.5	4.62	8.31	6.5	8
Sapan hin	10	7.867523	98.398565	17.2	5.48	10.94	5.3	8
Sapan hin	11	7.867523	98.398565	14	4.46	10.28	7.5	11
Sapan hin	12	7.867523	98.398565	11.8	3.76	7.27	4.8	7
Sapan hin	13	7.867523	98.398565	6.3	2.01	6.06	2.6	6
Sapan hin	14	7.867523	98.398565	12.3	3.92	7.46	4.5	8
Sapan hin	15	7.867523	98.398565	9	2.87	9.67	4.4	10
Sapan hin	16	7.867523	98.398565	9.5	3.03	10.82	3.7	8
Sapan hin	17	7.867523	98.398565	6.3	2.01	10.36	3.3	10
Sapan hin	18	7.867523	98.398565	8.4	2.68	12.96	3.3	11
Sapan hin	19	7.867523	98.398565	18	5.73	9.42	6.2	9
Sapan hin	20	7.867523	98.398565	5.8	1.85	10.42	2.9	11
Sapan hin	21	7.867523	98.398565	14.8	4.71	10.08	3.4	9
Sapan hin	22	7.867523	98.398565	11	3.5	7.71	3.4	7
Sapan hin	23	7.867523	98.398565	17	5.41	10.24	6.8	9
Sapan hin	24	7.866619	98.398567	7.3	2.32	9.82	9	10

Sapan hin	25	7.866619	98.398567	8.2	2.61	10.23	5.4	9
Sapan hin	26	7.864811	98.399476	12	3.82	7.11	7.3	6
Sapan hin	27	7.867523	98.398565	11.5	3.66	15.09	7.3	9
Sapan hin	28	7.867523	98.398565	9.1	2.9	9.16	6.9	8
Sapan hin	29	7.867523	98.398565	10.5	3.34	8.71	6.6	9
Sapan hin	30	7.867523	98.398565	6.7	2.13	7.89	6	9
Sapan hin	31	7.867523	98.398565	6	1.91	7.41	5.8	7
Sapan hin	32	7.86662	98.399474	6.5	2.07	11.5	4.9	11
Sapan hin	33	7.867523	98.398565	5.8	1.85	10.33	6.7	9
Sapan hin	34	7.867523	98.398565	15.3	4.87	9.45	6.7	9
Sapan hin	35	7.867523	98.398565	17	5.41	11	6.6	12
Sapan hin	36	7.867523	98.398565	10.3	3.28	9.06	5.7	9
Sapan hin	37	7.867523	98.398565	7.4	2.36	11.51	4.7	10
Sapan hin	38	7.867524	98.399473	15.5	4.94	4.34	7.6	5
Sapan hin	39	7.866619	98.398567	16	5.1	10.92	6.7	9
Sapan hin	40	7.867523	98.398565	17.9	5.7	5.19	2.8	5
Sapan hin	41	7.867523	98.398565	16.8	5.35	10.81	7.5	10
Sapan hin	42	7.867523	98.398565	27	8.6	10.67	6.9	9
Sapan hin	43	7.867523	98.398565	14	4.46	9.99	4.4	9
Sapan hin	44	7.866619	98.398567	19.7	6.27	8.72	6.1	8
Sapan hin	45	7.867523	98.398565	15.2	4.84	6.41	6.2	7
Sapan hin	46	7.867523	98.398565	17.3	5.51	10.82	6.3	11
Sapan hin	47	7.867523	98.398565	12.4	3.95	8.37	4.3	9
Sapan hin	48	7.867523	98.398565	6.3	2.01	11.76	5	7
Sapan hin	49	7.863906	98.399478	10	3.18	2.49	4.9	3
Sapan hin	50	7.866619	98.398567	22	7.01	6.57	5.5	9

Sapan hin	51	7.867523	98.398565	12.4	3.95	6.28	3.8	8
Sapan hin	52	7.884654	98.432737	29.3	9.33	8.35	6.3	8
Sapan hin	53	7.885561	98.43455	23	7.32	6.41	6	7
Sapan hin	54	7.883749	98.432738	26	8.28	17.04	7.2	15
Sapan hin	55	7.88556	98.433643	33	10.51	8.7	6.1	8
Sapan hin	56	7.886465	98.434549	18	5.73	5.09	7.5	5
Sapan hin	57	7.886465	98.434549	45	14.33	13.87	6.3	11
Sapan hin	58	7.884654	98.432737	25	7.96	15.35	8.3	13
Sapan hin	59	7.884676	98.432737	19	6.05	28.01	25	27
Sapan hin	60	7.886465	98.434549	17.4	5.54	9.84	7.6	9
Sapan hin	61	7.886465	98.434549	10.6	3.38	6.37	8.2	7
Sapan hin	62	7.886465	98.434549	30	9.55	9.47	6	10
Sapan hin	63	7.886465	98.434549	14	4.46	16.07	13.2	15
Sapan hin	64	7.886465	98.434549	44	14.01	11.9	5.9	10
Sapan hin	65	7.886465	98.434549	54	17.2	1.5	7	3
Sapan hin	66	7.886465	98.434549	23	7.32	7.01	8.2	7
Sapan hin	67	7.886465	98.434549	15	4.78	6.16	9.2	7
Sapan hin	68	7.886465	98.434549	37	11.78	8.01	4.3	9
Sapan hin	69	7.886465	98.434549	30	9.55	9.75	5	10
Sapan hin	70	7.886465	98.434549	13	4.14	10.77	5.8	11
Sapan hin	71	7.886465	98.434549	25	7.96	14.06	12.9	15
Sapan hin	72	7.886465	98.434549	29	9.24	9.38	7.8	10
Sapan hin	73	7.886465	98.434549	39	12.42	8.76	10.2	9
Sapan hin	74	7.886465	98.434549	16	5.1	6.86	4.1	5
Sapan hin	75	7.886465	98.434549	12	3.82	7.54	10.9	8

Table 2: Observational Result from Trees on Sapan hin (used to calculate carbon credits)

Data Analysis

How to Calculate Carbon Credits

Step 1: Convert the circumference into diameter

Convert the tree circumference recorded into diameter to use in the allometric equations and to find the biomass of each tree.

H2 =DIVIDE(F2,3.14)

	A	B	C	D	E	F	G	H	I	J
1	Observation Site	Tree Number	Latitude	Longitude	Types of Plants	GBH	DBH	7.006369427 ×	GLOBE app.	Sensor
2	Koh Hey	25	7.74538	98.375162	ต้นมะขาม	22	7.01	=DIVIDE(F2,3.14)	5.4	
3	Koh Hey	26	7.745382	98.376982	ต้นสน	15	4.78	4.777070064	2.4	
4	Koh Hey	27	7.74538	98.375162	ต้นมะขาม	34.5	10.99	10.98726115	6.7	
5	Koh Hey	28	7.745381	98.376069	ต้นมสน	18	5.73	5.732484076	3.4	
6	Koh Hey	29	7.745382	98.376976	ต้นสะเดาเทียม	15.5	4.94	4.936305732	1.8	
7	Koh Hey	30	7.745382	98.376976	ต้นสะเดาเทียม	23.3	7.42	7.420382166	2.7	
8	Koh Hey	31	7.74538	98.375162	ต้นสะเดาเทียม	18.4	5.86	5.859872611	1.8	
9	Koh Hey	32	7.745382	98.376976	ต้นสะเดาเทียม	19.5	6.21	6.210191083	2	
10	Koh Hey	33	7.745382	98.376976	ต้นสะเดาเทียม	17.5	5.57	5.573248408	1.6	

Step 2: Find the biomass of each tree

Use the diameter and the height of the trees obtained to calculate the biomass.

Label	Equations	Reference
Koh Hey (Typical Plants)	$W_s = 0.396(D^2H)^{0.933}$ $W_B = 0.00349(D^2H)^{1.030}$ $W_L = (28/(W_s + W_B + 0.025))^{-1}$ $W_r = W_s + W_B + W_L$	Ogawa et al. (1965)
Saphan Hin (Mangrove Forests)	$W_s = 0.05466(D^2H)^{0.945}$ $W_B = 0.01579(D^2H)^{0.9124}$ $W_L = 0.0678(D^2H)^{0.5806}$ $W_T = W_s + W_B + W_L$	Komiyama et al. (1987)

Table 3: Allometric equations for the estimation of Above-ground biomass in Phuket.

Step 3: Determine the total green weight of the tree

The green weight is the weight of the tree when it is alive. First, you have to calculate the green weight of the above-ground weight. The root system weight is about 20% of the above-ground weight. Therefore, to determine the total green weight of the tree, multiply the above-ground weight by 1.2.

$$W_{\text{total green weight}} = 1.2 * W_{\text{above-ground}}$$

Step 4: Determine the dry weight of the tree

The average tree is 72.5% dry matter and 27.5% moisture. Therefore, to determine the dry weight of the tree, multiply the total green weight of the tree by 72.5%.

$$W_{\text{dry-weight}} = 0.725 * W_{\text{total-green-weight}}$$

Step 5: Determine the weight of carbon in the tree

The average carbon content is generally 50% of the tree's dry weight total volume. Therefore, in determining the weight of carbon in the tree, multiply the dry weight by 50%.

$$W_{\text{carbon}} = 0.5 * W_{\text{dry-weight}}$$

Step 6: Determine the weight of carbon dioxide sequestered in the tree

CO_2 has one molecule of Carbon and 2 molecules of Oxygen. The atomic weight of Carbon is 12 (u) and the atomic weight of Oxygen is 16 (u). The weight of CO_2 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.

$$W_{\text{carbon-dioxide}} = 3.67 * W_{\text{carbon}}$$

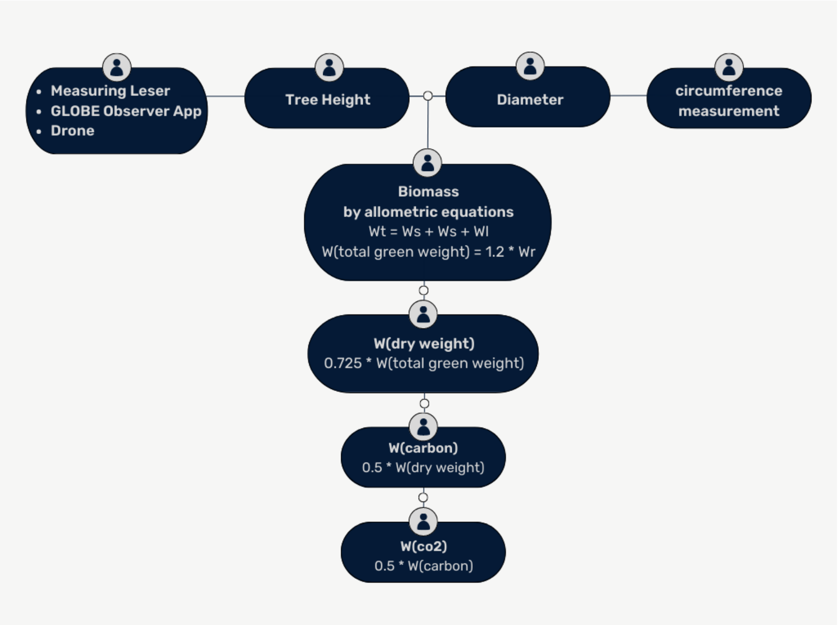


Figure 1: Implementation of the study, representing the analysis and output

Koh Hey

Order the data in ascending order according to diameter.

In [589]:
```
vfk = f_koh_hey.sort_values(by ="DBH", ascending=True)
vfk
```

Sample 20 data sets.

In [591]:
```
svfk = vfk.sample(20)
svfk
```

Calculate the total carbon credits from 20 sampled data sets.

In [593]:
```
scacrkh = 0
for i in range (len(svfk)):
    wco = vfk.loc[i,'WCO']
    scacrkh = wco + scacrkh
print(f'Carbon Credit (ABG) Koh Hey = {round(scacrkh,2)}')
```

Saphan Hin

Order the data in descending order according to diameter.

In [590]:
```
vfs = f_Sapan_hin.sort_values(by ="DBH", ascending=False)
vfs
```

Sample 20 data sets.

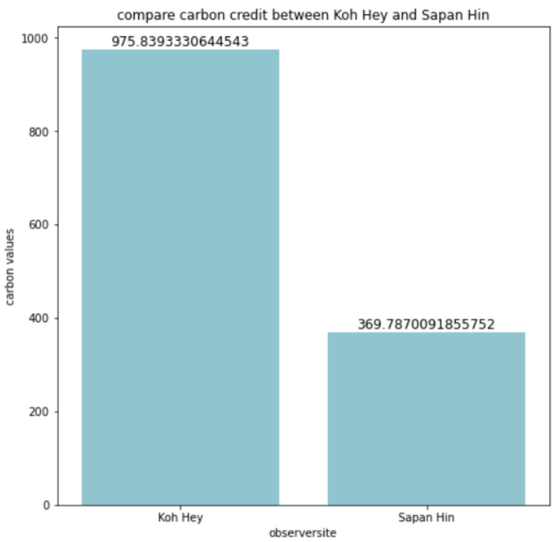
In [592]:
```
svfs = vfs.sample(20)
svfs
```

Calculate the total carbon credits from 20 sampled data sets.

- GLOBE Observer Application

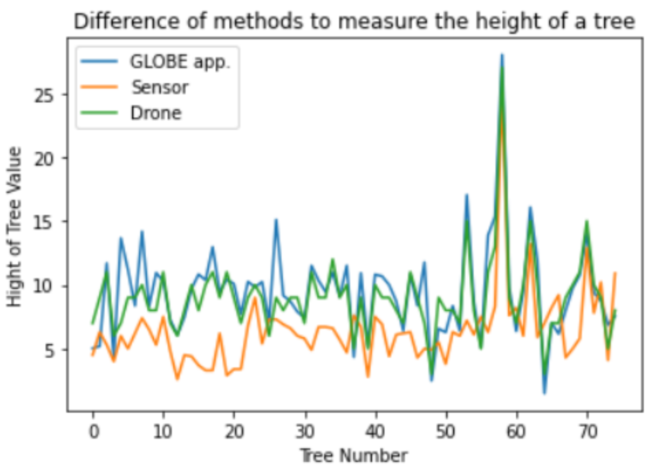
In [594]:
```
scacrshg = 0
for i in range (len(svfs)):
    wco = vfs.loc[i,'WCO GLOBE']
    scacrshg = wco + scacrshg
print(f'Carbon Credit (ABG) Sapan Hin (GLOBE) = {round(scacrshg,2)}')
```

Total-Carbon-Credit Comparison Graph of Koh Hey and Saphan Hin Using GLOBE (from 20 Sampled Trees)



Code to generate carbon-credit-amount comparing graph of each tree using 3 different measuring instruments to measure tree height.

```
from pylab import figure, show, legend, ylabel
fsdf = f_Sapan_hin[['WCO SENSER','WCO GLOBE','WCO DRONE']]
fsdf.plot()
plt.legend(loc='upper left')
plt.xlabel("Tree Number")
plt.ylabel("Carbon Credit Value")
# plt.title
plt.show()
```



Statistical Analysis

The following data is analyzed and reported using SPSS program to answer research question 1 and 3. To answer research question 1, we use Mean ± S.D. between the height from the GLOBE Observer application and the measuring sensor to calculate and find out which one is the closest in number to Mean ± S.D. from the drone. For research question 3, the analysis is statistically considered significant at P-Value < 0.05 and multiple regression analysis (MRA) is used to analyze the correlation between a single variable and several independent variables. By doing this, we can conclude which affects the amount of carbon stock more between tree height and tree diameter.

For Research Question 1

1. Import the recorded data.
2. Click Analyze > Descriptive Statistics > Descriptives.
3. Drag the variable of interest from the left into the variable box on the right side.
4. Click Options, and select Mean and Standard Deviation.
5. Press Continue, and then press OK.
6. The result will appear in the SPSS output viewer.

Descriptive Statistics

	N	Minimum	Maximum	Mean	Std. Deviation
sensor	75	2.6	25.0	6.399	2.9761
drone	75	3	27	9.53	3.500
globe	75	1.50	26.01	9.4729	3.56081
Valid N (listwise)	75				

Figure 2: Descriptive Statistics Table from SPSS program

For Research Question 3

1. The data is entered in a multivariate fashion.
2. Click Analyze.
3. Drag the cursor over the Regression drop-down menu.
4. Click Linear.
5. Click on the continuous outcome variable to highlight it.
6. Click on the arrow to move the variable into the Dependent: box.
7. Click on the first predictor variable to highlight it.
8. Click on the arrow to move the variable into the Independent(s): box.
9. Repeat step 7 and 8 until all of the predictor variables are in the Independent box.
10. Click on the Statistics button.
11. Click on the R squared change, Collinearity diagnostics, Durbin-Watson, and Casewise diagnostics boxes to select them.
12. Click on the Plots button.
13. Click on the dependent variable to highlight it.
14. Click on the arrow to move the variable into the X: box.
15. Click on the *ZRESID variable to highlight it.

16. Click on the arrow to move the variable into the Y: box.

17. In the Standardized Residual Plots table, click on the Histogram and Normal probability plot boxes to select them.

18. Click Continue.

19. Click OK.

And the results will be shown in the following pictures.

ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	83174.644	2	41587.322	169.226	<.001[b]
	Residual	17693.990	72	245.750		
	Total	100868.634	74			

a. Dependent Variable: carbon

b. Predictors: (Constant), Height, DBH

Figure 4: ANOVA Table from SPSS program

Coefficients[a]

Model		Unstandardized Coefficients B	Unstandardized Coefficients Std. Error	Standardized Coefficients Beta	t	Sig.
1	(Constant)	-56.643	5.941		-9.534	<.001
	DBH	9.537	.579	.814	16.471	<.001
	Height	3.771	.512	.364	7.359	<.001

a. Dependent Variable: carbon

Figure 5: Coefficients Table from SPSS program

Analytic Results

Part 1: Finding the best measuring instrument to measure a tree.

	GLOBE Observer Application	Measuring Laser	Drone
Height	9.47 ± 3.56	6.40 ± 2.98	9.53 ± 3.50

Table 1: Comparing using Mean ± S.D. of tree height at Saphan Hin between GLOBE Observer Application, the Measuring Laser, and the Drone

Part 2: Finding the area capable of carbon absorption the most

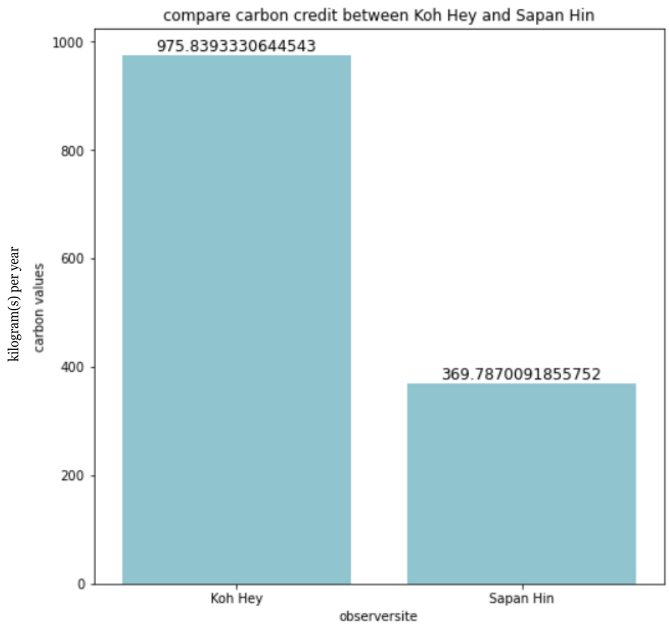


Figure 3: Bar chart showing the amounts of carbon absorption from sampled trees comparing between Koh Hey and Saphan Hin

Part 3: Finding whether tree height or diameter is more effective to carbon-dioxide absorption

ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	83174.644	2	41587.322	169.226	<.001[b]
	Residual	17693.990	72	245.750		
	Total	100868.634	74			

a. Dependent Variable: carbon

b. Predictors: (Constant), Height, DBH

Figure 4: ANOVA Table from SPSS program

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	-56.643	5.941		-9.534	<.001
	DBH	9.537	.579	.814	16.471	<.001
	Height	3.771	.512	.364	7.359	<.001

a. Dependent Variable: carbon

Figure 5: Coefficients Table from SPSS program

Discussion

In this study, according to table 1, comparing Mean ± S.D. of tree height, it shows that Mean ± S.D. from GLOBE Observer application is 9.47 ± 3.56, the measuring laser is 6.40 ± 2.98, and the drone is 9.53 ± 3.50.

The carbon-credit calculation from 20 sampled trees shows that the amount of carbon credit from Koh Hey is 975.84 kilograms per year, and the amount from Saphan Hin is 369.79 kilograms per year.

As shown in figure 5, it was found that P-Values from both variables are less than 0.001, considering the unstandardized beta (B) of variable 1 (DBH) equals 9.537 which is greater than the unstandardized beta (B) of variable 2 (Height) which equals 3.771. And the standardized beta (β) of variable 1 (DBH) equals 0.841 which is closer in number to 1 than the standardized beta (β) of variable 2 (Height) which is 0.364.

Conclusion

The data which represents the height of the trees in the observation area obtained from GLOBE Observer application is closer in numbers to the data obtained from the drone, which is used to be the measuring benchmark for the experiment, than the one that was obtained from measuring the laser. Thus, the better measuring instrument that costs less and is more compatible with this experiment is the GLOBE Observer application. For this reason, it was used to find and collect the data that required an accurate measuring instrument.

To answer research question number 2, the data from GLOBE Observer application was used to analyze and answer, we can conclude that the sampled trees on Koh Hey have more ability to absorb carbon dioxide than the sampled trees at Saphan Hin (as shown in figure 3).

According to figure 5, when P-Value is less than 0.001, we can interpret that both independent variables (diameter, and height) significantly affect the dependent variable (carbon absorption). The unstandardized beta (B) is to represent the slope of the line between the predictor variable and the dependent variable when an independent variable is increased by one unit. The figure shows that for every unit increased to variable 1 (DBH), the dependent variable will be increased by 9.537 units, and for every unit increased to variable 2 (height), the dependent variable will be increased by 3.771 units too. And for the standardized beta (β), its value range is between 0 to 1 or 0 to -1, depending on the variation of the relationship. The closer the value is to 1 or -1, the more effective the value is to the dependent variable. Comparing the standardized beta (β) between both variables, we can conclude that variable 1 (DBH) has the strongest correlation.

In conclusion, the diameter of a tree affects and has more significance on the amount of carbon absorption than the height of a tree.

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Optional Badges

1. *I am a Data Scientist.*

After investigating the areas to collect the observational data, we had to deal with a large amount of data to calculate and find the variables we needed, furthermore, the following variables are also used to make statistical comparisons. Doing was impossible without using the datasheets cooperated with python codes entirely written by ourselves to manage, organize, and analyze the data.

2. *I am a Student Researcher.*

Researchers are people who accomplish to answer their main concerns by following the steps strictly, and that is what made us able to answer our main concerns of the research. As student researchers we were always ready to learn new things, and we also were to accomplish this research by proceeding stictly to the steps from the advice given by specialized people to help us get the information we needed to present and publish with this research, such as our group counselors, teachers, and professors.

3. *I make an Impact.*

Nowadays, greenhouse effects have always been concerned and attentive to most countries, which make the earth's temperature continuously rise and more effective against living things on the earth. One of the main reasons to cause this is CO_2 emission because of its major among greenhouse gases. So that, this research was made to study about carbon-dioxide absorption of the tress and can be used in reference to show how to solve the following problems.