

CHAPTER III

MATERIALS AND METHODS

This research was carried out in term of survey and analytical research. The data were collected from two types of land cover, tree-planting area and turf in two public parks, Lumpini park and Vachirabenjatas park, in Bangkok, in order to analyze their carbon storage.

3.1 Data collection

The following plant details were collected as the secondary data:

- Species of all plant in the parks
- Number of each plant species.
- Botanical characteristics of each plant species

3.2 Materials

3.2.1 Maps

Satellite images of Lumpini park and Vachirabenjatas park at the scale of 1:2,500 from Google Earth program were used.

3.2.2 Field Equipments:

- 1) Geographic positioning system (GPS)
- 2) Diameter tape
- 3) Clinometer
- 4) Measuring tape
- 5) Soil core

- 6) Hoe, spade and knife
- 7) Frame at the size of 1x1 m²
- 8) Plastic bags

3.2.3 Laboratory equipments and chemical substances:

- 1) Grinder
- 2) Sieve plate no. 10 (2 mm)
- 3) Glasses
- 4) Oven
- 5) pH meter
- 6) Kjeldahl distillation apparatus
- 7) Digestion system
- 8) Total organic carbon analyzer
- 9) Chemical substances

3.3 Methods

3.3.1 Selections of study area and sample plots

The studied area was selected Lumpini park and Vachirabenjatas park because of their locations in inner city and their wide green area (tree and grass planting area). They were also the most popular parks in Bangkok. The study was done by stratified random sampling in tree-planting area, both the mixed and single-species plot) and turf, calculating the area size of each plot from the coordinates of the trees using Google Earth program.

3.3.2 Samples collection

3.3.2.1 Biomass

- 1) Above-ground biomass

The diameter at breast height (DBH) of trees was measured in tree with DBH greater than 4.5 cm by diameter tape. The height of tree which are

taller than 1.30 m was measured from soil surface to the top by clinometer. The plant species and coordinates of all trees were studied.

2) Litter

Four replications of litter fall sample, which only presented in tree-planting area, were collected from the 1x1 m² sample plot on soil surface beneath the crown cover of each tree species. The duration of the litter fall trapping was 3 days. Four replications of grass litter samples were collected from the 1x1 m² of turf, which collected in each grass species. The duration of the grass litter collection was 1 month.

3.3.2.2 Soil sample

The soil samples were collected from both tree-planting area and turf. The number of samples based on the proportion of land cover type (100 samples in each park). Two types of samples were collected at the soil depth of 0-15 cm. The undisturbed samples collected from soil core were for physical properties analysis. The disturbed samples were for chemical properties and total organic carbon content analysis.

3.3.3 Samples analysis

3.3.3.1 Biomass

1) Above-ground biomass

Allometric equations were used to estimate the above-ground biomass of tree, which consisted of stems, branches and leaves. Those equations represent the relationship between the square diameter and height (D²H), and biomass of each part of tree. The equation of tropical rain forest and dry evergreen forest was used to estimate the biomass of tree because the specific equation for urban tree has not been reported yet [62].

$$W_S = 0.0509*(D^2H)^{0.919}$$

$$W_B = 0.00893*(D^2H)^{0.977}$$

$$W_L = 0.0140*(D^2H)^{0.669}$$

Where as: W_S = Biomass of stems (kg tree⁻¹)
 W_B = Biomass of branches (kg tree⁻¹)
 W_L = Biomass of leaves (kg tree⁻¹)
 H = Height of tree (m)
 D = Diameter at breast height (cm)

2) Litter

For biomass analysis, samples of litter fall and grass litter were dried at 80 °C in the oven for 48 hours or until the weight was constant. Then, the dry mass (or biomass) of the samples was weighed and recorded.

3.3.3.2 Soil

The samples of undisturbed soil were weighed. Then they were dried at 105 °C in the oven for 24 hours or until the weight was constant before weighing again for soil bulk density analysis. The disturbed soil samples were dried by open dry air for a week. After that, they were grinded and sieved through 2 mm sieve. The soil samples were then used in the following analyses:

- Physical properties analysis for soil color and texture
- Chemical properties analysis for soil reaction (pH), Organic matter (%OM), Total nitrogen (%TN), Carbon to nitrogen ratios (C:N ratios) and Total organic carbon (TOC)

Table 3.1 Method of soil properties analysis

Parameter	Method	References
1) Soil color	Munsell soil color chart	[63]
2) Soil texture	Pipette method	[63]
3) Soil bulk density	Core method	[64]
4) Soil reaction	1:1 soil:solution in H ₂ O	[63]
5) Organic matter	Walkley-Black method	[65]
6) Total nitrogen	Kjeldahl method	[66]
7) Carbon to nitrogen ratios	Calculation from %OC and %N	[66]
8) Total organic matter	Dry combustion method by total organic carbon analyzer	[67]

3.4 Estimation of carbon storage

3.4.1 Carbon storage of above-ground biomass

The carbon storage of each part in above-ground biomass was calculated by multiplying the biomass value of each part with 0.47 [18]. Then the values of all parts were summed up to estimate the carbon storage for each tree and the total carbon storage in each sample plot (t ha^{-1}), according to the following equation:

$$M_T = M_S + M_B + M_L$$

$$C_T = 0.47M_T$$

Where

- M_T = Total biomass of trees (t ha^{-1})
- M_S = Biomass of stems (t ha^{-1})
- M_B = Biomass of branches (t ha^{-1})
- M_L = Biomass of leaves (t ha^{-1})
- C_T = Total carbon storage of trees (t ha^{-1})

3.4.2 Carbon storage of litter

The carbon storage of litter fall was calculated by multiplying the biomass of litter with 0.47 [18] as described by the following equation:

$$C_{LF} = 0.47M_{LF}$$

Where

- C_{LF} = Carbon storage of litter fall (t ha^{-1})
- M_{LF} = Biomass of litter fall (t ha^{-1})

The carbon storage of grass litter was calculated by multiplying the biomass of grass litter with 0.40 [68] as described by the following equation:

$$C_{GL} = 0.40M_{GL}$$

Where

- C_{GL} = Carbon storage of grass litter (t ha^{-1})
- M_{GL} = Biomass of grass litter (t ha^{-1})

3.4.3 Carbon storage of soil

The soil organic carbon storage was calculated by multiplying the total organic carbon content with soil bulk density and the depth of soil layer (15 cm) as described by the following equation:

$$C_S = \text{TOC} \times \text{BD} \times D$$

Where C_S = Soil organic carbon storage (g m^{-2})
 TOC = Total organic carbon content (g g^{-1})
 BD = Soil bulk density (g m^{-3})
 D = Depth (m)

3.4.4 Total carbon storage

The total carbon storage in tree-planting area was calculated by summing up the carbon storage of above-ground biomass, litter fall, grass litter and soil as shown in the following equation:

$$C_T = C_{\text{ABG}} + C_{\text{LF}} + C_{\text{GL}} + C_S$$

Where C_T = Total carbon storage (t ha^{-1})
 C_{ABG} = Total carbon of above-ground biomass (t ha^{-1})
 C_{LF} = Carbon storage of litter fall (t ha^{-1})
 C_{GL} = Carbon storage of grass litter (t ha^{-1})
 C_S = Soil carbon storage (t ha^{-1})

The total carbon storage in turf was calculated by summing up the carbon storage of grass litter and soil as shown in the following equation:

$$C_T = C_{\text{GL}} + C_S$$

Where C_T = Total carbon storage (t ha^{-1})
 C_{GL} = Carbon storage of grass litter (t ha^{-1})
 C_S = Soil carbon storage (t ha^{-1})

3.5 Statistical analysis

Using Independent T-Test analysis and one-way analysis of variance (one-way ANOVA), the difference of the average values was analyzed. The multiple regression analysis of the relationship between vegetation and soil properties (independent variables) and total carbon storage (dependent variable) was further examined with IBM SPSS statistics 19 program.