# National Forest Inventory Workshop

## Hodava Hotel- Port Moresby
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# FOREST SOIL SURVEY IN PAPUA NEW GUINEA

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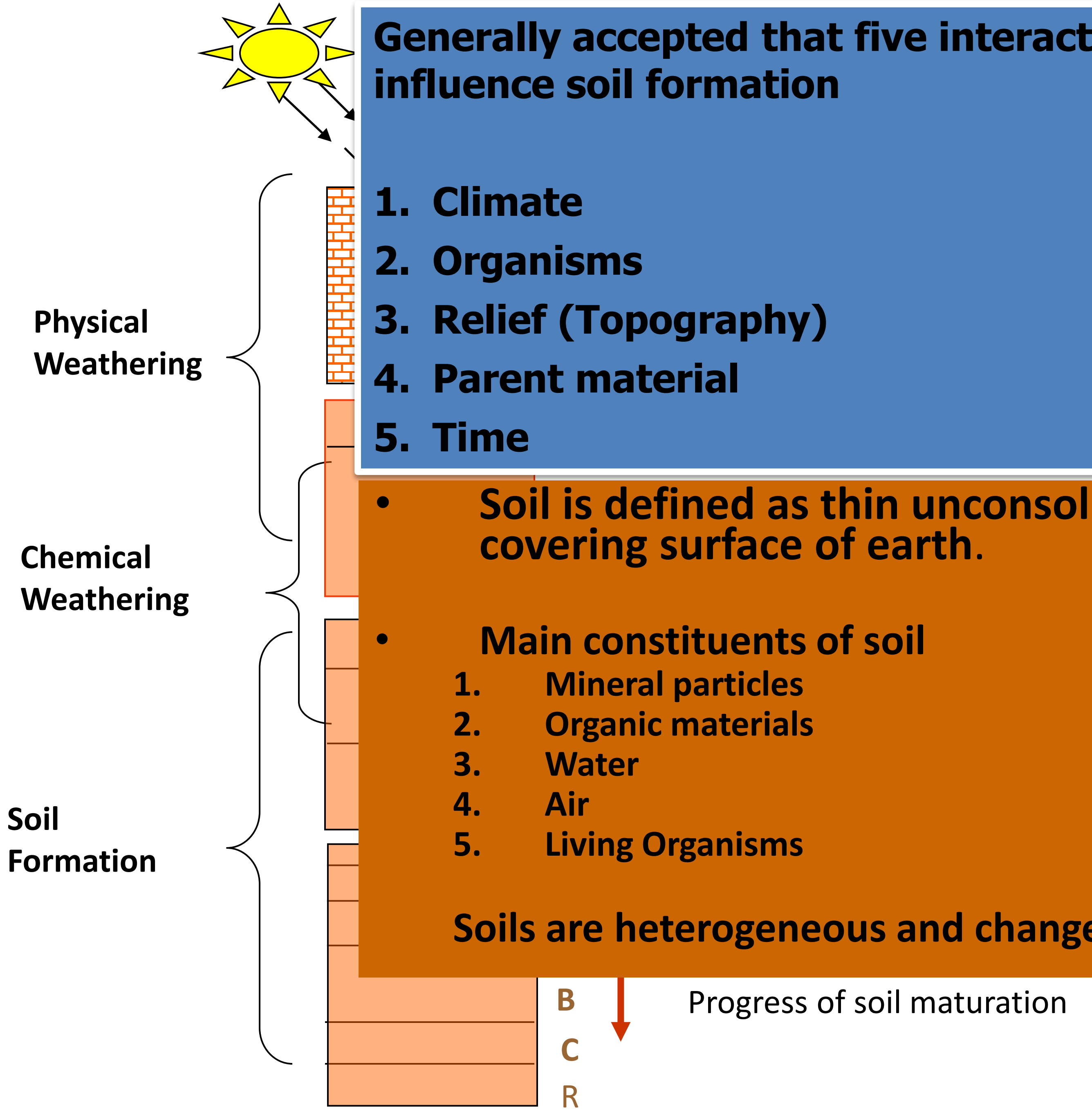
# PRESENTATION CONTENT

1. Why soil survey
2. What to survey and measure
3. Where  to sample soil
4. Timing of sample
5. Sampling techniques
6. Depth of soil  sapling
7. Number of soil samples
8. Handling of samples
9. Laboratory work
10. Interpretation of results
11. Discussion Points

- INTRODUCTION /BACKGROUND
- AVAILABLE DATA/ KNOWLEDGE
- STRATIFICATION
- SUMARRY
- DISCUSSION

## PROCESS OF SOIL FORMATION




**Generally accepted that five interacting factors influence soil formation**

1. **Climate**
2. **Organisms**
3. **Relief (Topography)**
4. **Parent material**
5. **Time**

- **Soil is defined as thin unconsolidated material covering surface of earth.**

- **Main constituents of soil**
  1. **Mineral particles**
  2. **Organic materials**
  3. **Water**
  4. **Air**
  5. **Living Organisms**

**Soils are heterogeneous and changes in space and time**

# Soil horizons

- Soil layers are called horizons, and are defined by differences in color and/or texture and/or structure

- O, A, B, C system used to name horizons;

| | |
|---|---|
| **O horizons** | organic-rich, surface layers |
| **A horizons** | surface/near-surface layers |
| **B horizons** | subsurface layers |
| **C horizons** | parent material layers |

# Soil profiles

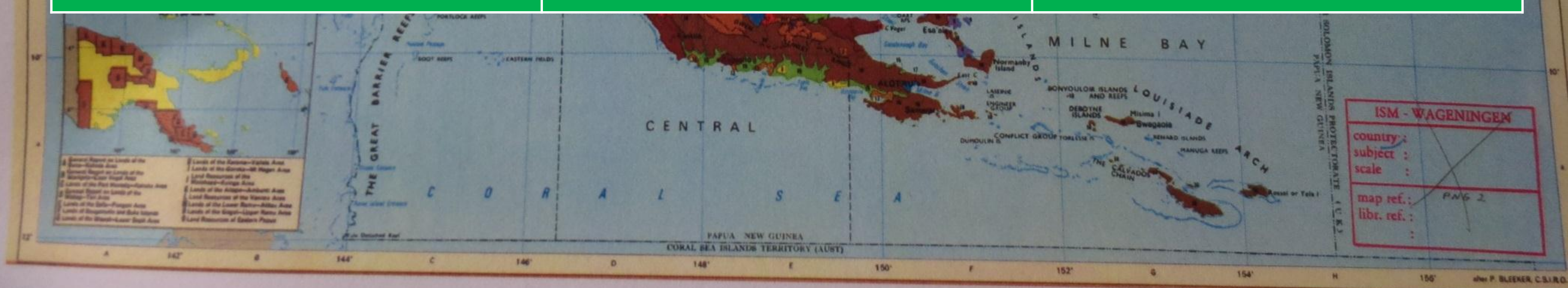
- Soil profiles consists of different combinations of O, A and B horizons

- The A horizons represent the greatest store of organic carbon in the soil profile, even though the B horizons are generally much deeper and more clayey

- Thick O horizons are most common in cool, moist environments

# Broad Soil Groups (Orders by FAO Classification)

| High Mountains (All Montane Forests) | Low Mountains and Hills (Low Altitude Forests- Uplands) | Plains and Valleys (Low Altitude Forests – Plains and Fans) |
|---|---|---|
| Histosols | Cambisols | Histosols |
| Lithosols | Luvisols | Gleysols |
| Cambisols | Lithosols | Fluvisols |
| Acrisols | Andosols | Acrisols |
| Luvisols | Regosols | Luvisols |
| Andosols | Gleysols | Cambisols |
| | Acrisols | |



# Soil survey for assessing carbon and other nutrients

## Soils of PNG stores a lot of organic carbon

1. **Methodology – How soil carbon is assessed**
   - **Cheaper measurement**
   - **Outputs useful in models**
   - **Makes sense to the end-user**
2. **Preliminary results-comparable results**
   - Contributes to
     - Usefulness for policy
     - Agriculture
     - SFM
     - Climate change

## Stratifying for soil types, soil organic carbon (SOC) management types

- SOC of mineral forest soils (0-1 m) varies between 20 and 300 t ha-1, depending on forest type and climatic condition.
- 50% SOC within upper 30 cm of the soil profiles.
  - In forest soils the highest input from above-ground litter, soil organic matter tends to concentrate in the upper soil horizons.
  - Carbon held in the upper profile is often the most chemically decomposable, and the most directly exposed to natural and anthropogenic disturbances.

➢ Soil is a sink for carbon

  ➢ Different origins (vegetative sources)

  ➢ Transformations (pyrolysis, decomposition, symbionts)

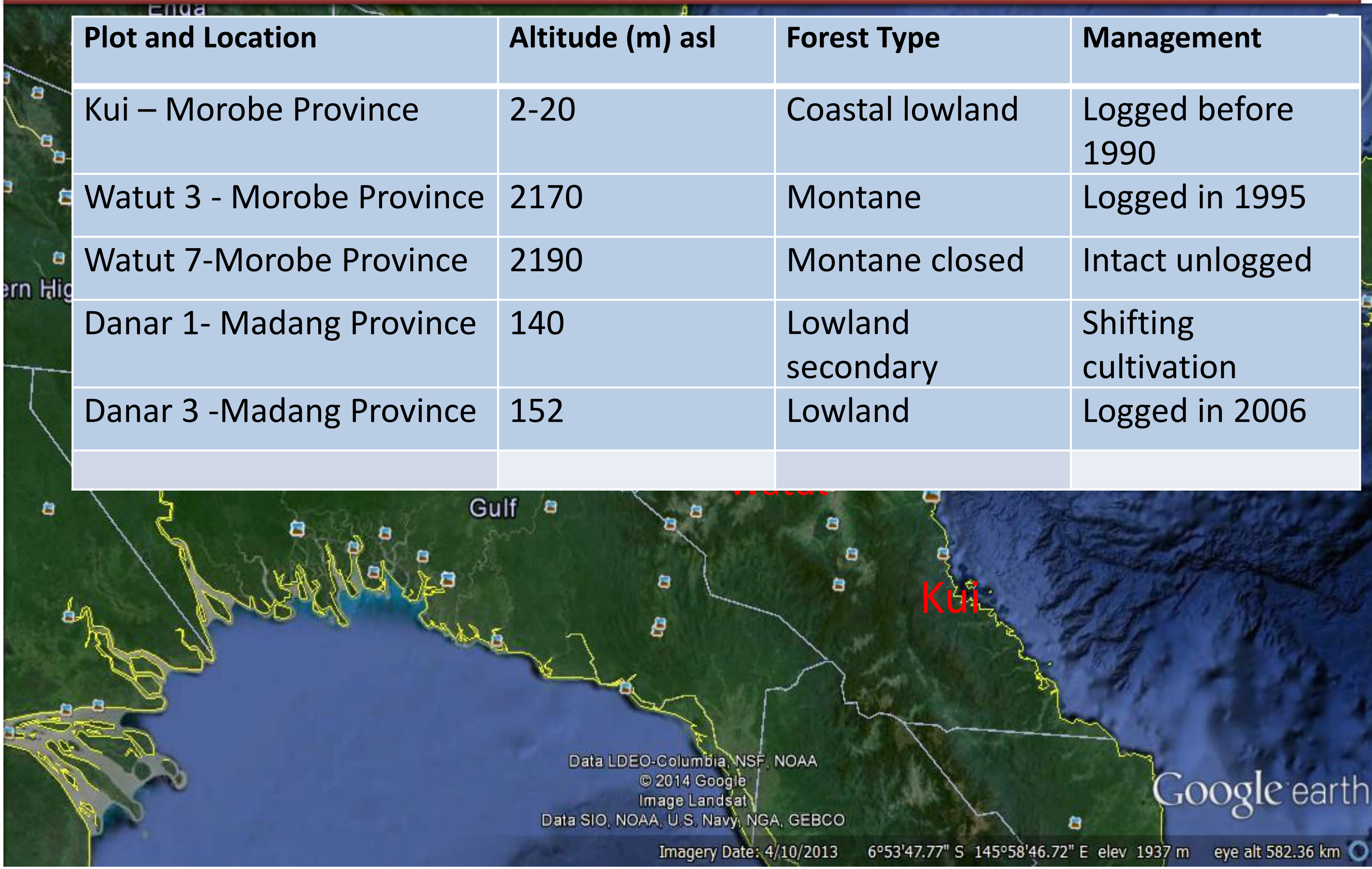
  ➢ Different forms (chemical, physical, protected

# SOIL CARBON – OTHER PNG SITES

| Site | Characteristics | Soil carbon (t/ha to 1 m) | Reference |
|---|---|---|---|
| **Oomsis-1** | Lowland, schist, upper slope | **86** | Matsuura 1997 |
| **Oomsis-2** | Lowland, schist, lower slope | **132** | Matsuura 1997 |
| **Buang** | 1400 m, schist upper slope, | **97** | Matsuura 1997 |
| **Madang-Kumil** | Lowland, sedimentary, upper slope | **123** | Matsuura 1997 |
| **Madang-Kumil** | Lowland, sedimentary, lower slope | **95** | Matsuura 1997 |
| **Mongi-Busiga 9720** | Lowland primary forest, limestone, $34^{o}$ slope, slight erosion | **157** | Abe 2007 |
| **Mongi-Busiga 9721** | Lowland primary forest, limestone, $17^{o}$ slope, no erosion | **101** | Abe 2007 |
| **Mongi-Busiga 9722** | Lowland primary forest, limestone, $17^{o}$ slope, slight erosion | **112** | Abe 2007 |
| **Mongi-Busiga 9720** | Lowland primary forest, limestone, $13^{o}$ slope, slight erosion | **134** | Abe 2007 |

# Detail soil carbon sampling sites by FRI

| Plot and Location | Altitude (m) asl | Forest Type | Management |
|---|---|---|---|
| Kui – Morobe Province | 2-20 | Coastal lowland | Logged before 1990 |
| Watut 3 - Morobe Province | 2170 | Montane | Logged in 1995 |
| Watut 7-Morobe Province | 2190 | Montane closed | Intact unlogged |
| Danar 1- Madang Province | 140 | Lowland secondary | Shifting cultivation |
| Danar 3 -Madang Province | 152 | Lowland | Logged in 2006 |
| | | | |



# Indicative figures of C from selected FRI PSPs

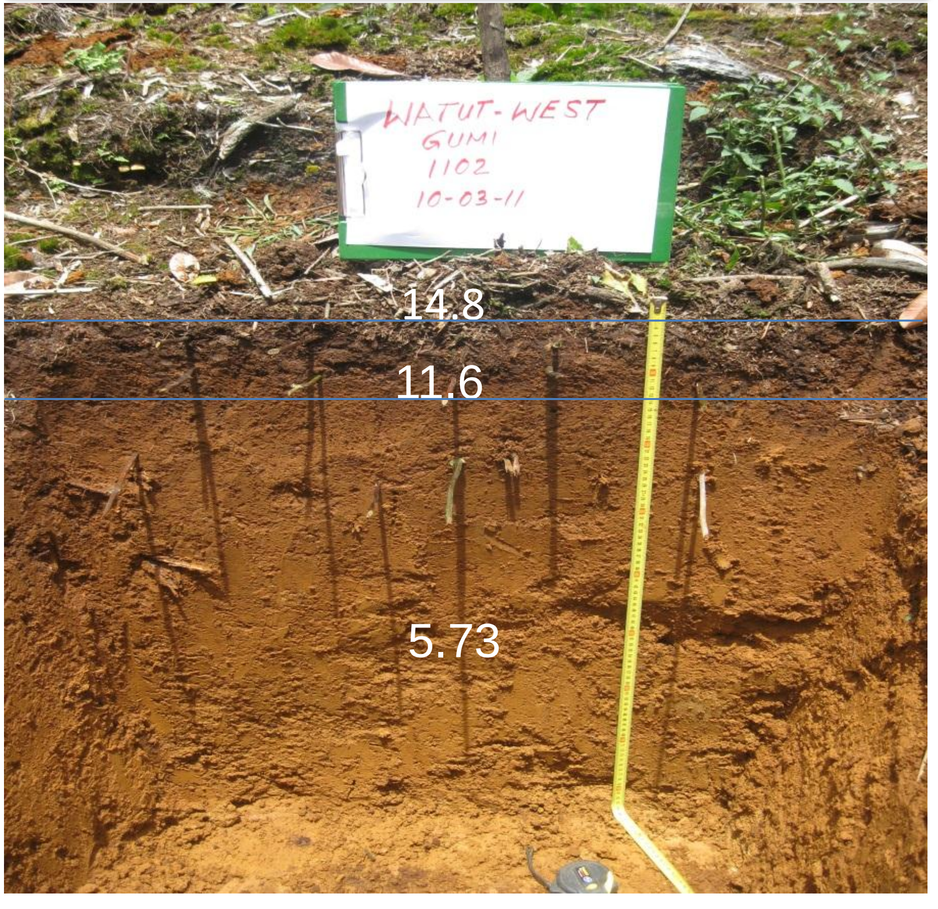
**Mean total soil carbon stock with standard deviations in the parenthesis**

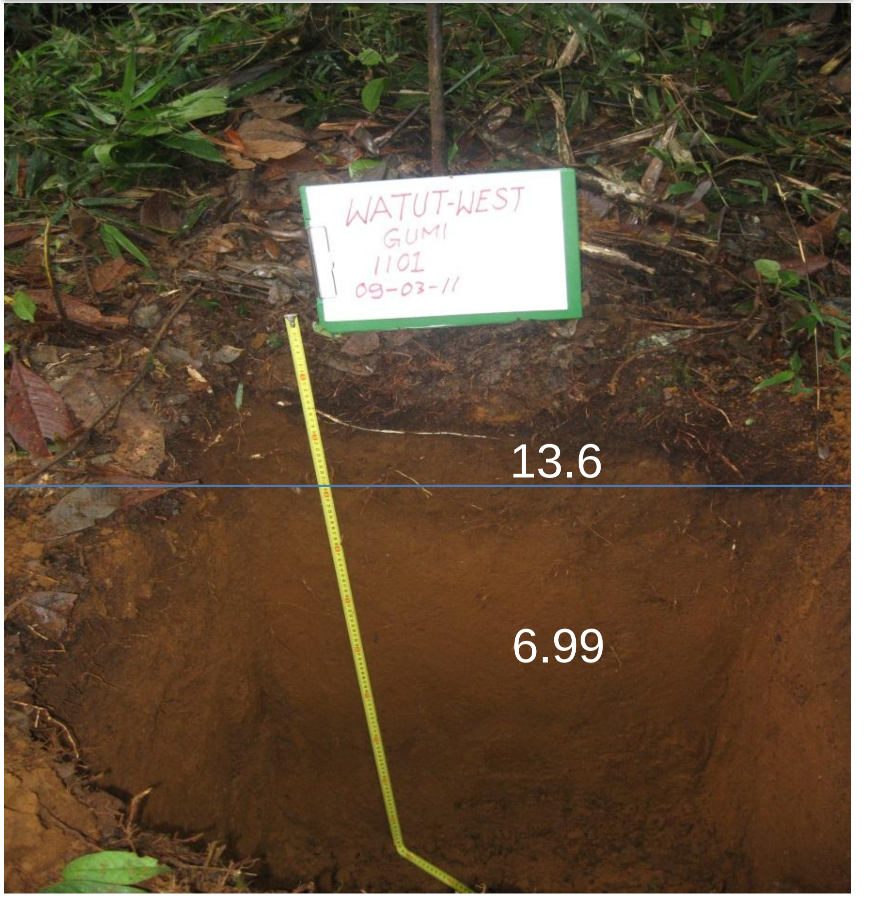
| Site | Altitude (m) asl | Management Type | Sample No | Carbon stock (t/ha) by soil layer | | | | Total |
|---|---|---|---|---|---|---|---|---|
| | | | | 5 cm | 10cm | 20cm | 30cm | |
| Kui | 2-20 | Logged before 1990 | 11 | 11.29 (5.60) | 8.70 (3.21) | 13.12 (3.50) | 12.12 (8.10) | 45.22 (11.28) |
| Danar 1 | 2170 | Logged in 1995 | 12 | 12.79 (2.85) | 10.02 (2.05) | 18.46 (4.56) | 14.65 (3.91) | 55.92 (5.56) |
| Danar 3 | 2190 | Intact unlogged | 12 | 12.76 (3.77) | 7.19 (2.77) | 6.67 (3.69) | 4.65 (1.16) | 31.27 (8.55) |
| Watut 3 | 140 | Shifting cultivation | 12 | 22.14 (4.17) | 19.13 (3.95) | 38.21 (11.20) | 33.46 (7.50) | 112.95 (21.38) |
| Watut 7 | 152 | Logged in 2006 | 9 | 22.88 (6.12) | 20.44 (6.88) | 30.85 (7.82) | 28.60 (9.36) | 102.78 (22.78) |

# Some examples of carbon content from profile surveys in high altitude

| Soil Profile Code | Horizon | Depth (cm) | Total C (%) |
|---|---|---|---|
| Watut West 1102 | A | 0-4 | 14.8 |
| | $B_1$ | 4-12 | 11.6 |
| | $B_2$ | 12-60 | 5.73 |

| Soil Profile Code | Horizon | Depth (cm) | Total C (%) |
|---|---|---|---|
| Watut West 1101 | AB | 0-21 | 13.6 |
| | $B_1$ | 21-56 | 6.99 |



# Some examples of carbon content from profile surveys in low altitude plains fans

| Soil Profile Code | Horizon | Depth (cm) | Total C (%) |
|---|---|---|---|
| **Wasapea 0702** | A1 | 0-5 | 3.15 |
| | AB | 5-20 | 2.57 |
| | B1 | 20-38 | 2.41 |
| | B2 | 38-63 | 1.90 |


| Soil Profile Code | Horizon | Depth (cm) | Total C (%) |
|---|---|---|---|
| **Gogoroba 0704** | A0 | 0-4 | 10.7 |
| | A1 | 4-11 | 3.18 |
| | AB | 11-29 | 2.13 |
| | B1 | 29-62 | 1.78 |
| | B2 | 62-85 | 1.90 |

# General methodology

1. **Overall Plan –Objective-providing acceptable estimates of soil nutrients or carbon stock changes . Design takes into consideration- sampling intensity, sampling intervals, layers to sample.**

2. **Survey of Soil Profile**

   **Site Conditions - Location, Climatic features, topography, Land Form, Vegetation, Geology**

   **Master Horizons**

   **Features of Soil Profile** Soil description classification

3. **Soil Analyses**

   **Physical and Chemical Analyses**

4. **Reports**

   **Maps**

# Stratification-Site Selection

1. Selection of the site is based on the objective of the survey and variability in nature of soil

2. A broad area is stratified into homogenous units based on similar soil groupings, climate, vegetation, topography, slope, aspect and elevation, age (if possible), and land use.

3. Stratification is done using soil maps, satellite images, and photographs and local knowledge of soil type boundaries.

4. Prior to surveys landowners must be informed especially in PNG and where land is privately owned.

5. For the purpose of monitoring soil carbon stock changes the selected sampling sites must be accessible and secured for as long term.

# Soil carbon survey methodology
# - Compliance with UNFCCC-IPCC Guidelines-

Need to know number of samples for estimating statistical significant changes

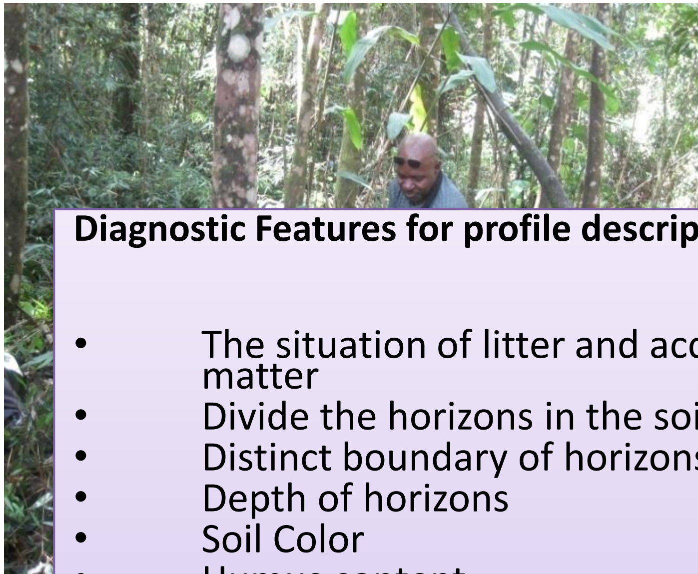
Appropriate sampling intensity and sampling interval can be designed after collecting information on between-site and within site variation and estimation of change.

Selection of layers guided by sensitivity human induced disturbance

Efficiency of survey can be improved and costs reduced by stratified sampling

Stratification by land use category, soil type,  where similar rates of changes on best estimates.

# Accepted Methodology-Soil profile survey



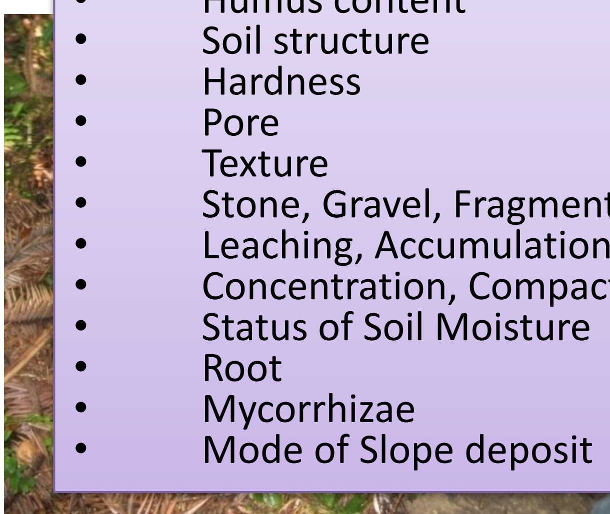
Selecting Site

Digging a profile

Describing a profile

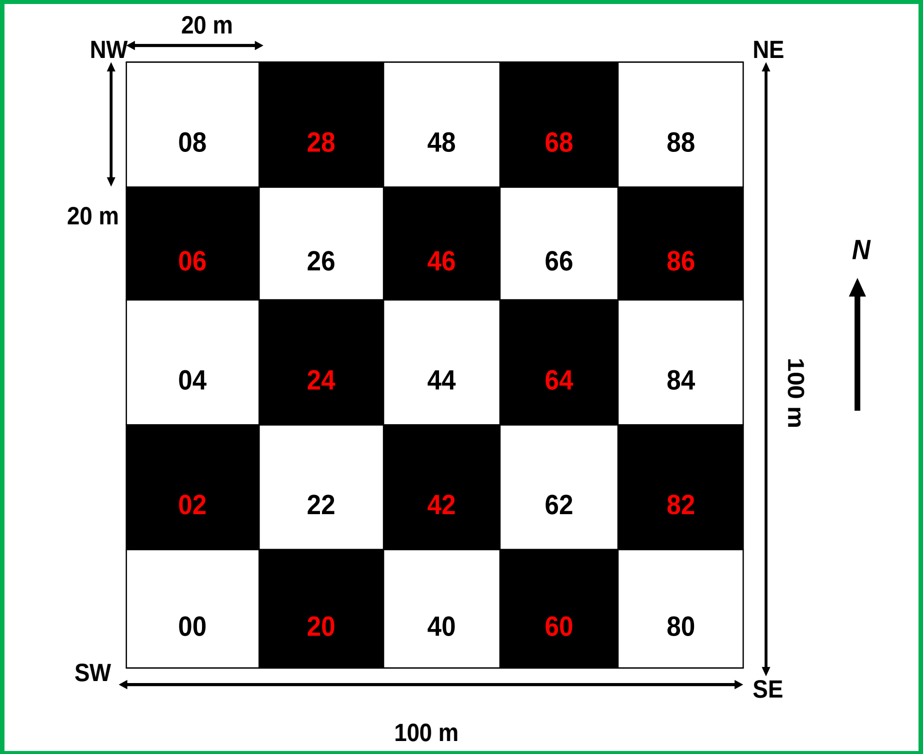

**Diagnostic Features for profile description**

- The situation of litter and accumulated organic matter
- Divide the horizons in the soil profile
- Distinct boundary of horizons
- Depth of horizons
- Soil Color
- Humus content
- Soil structure
- Hardness
- Pore
- Texture
- Stone, Gravel, Fragment
- Leaching, Accumulation
- Concentration, Compaction Mineral Nodules
- Status of Soil Moisture
- Root
- Mycorrhizae
- Mode of Slope deposit

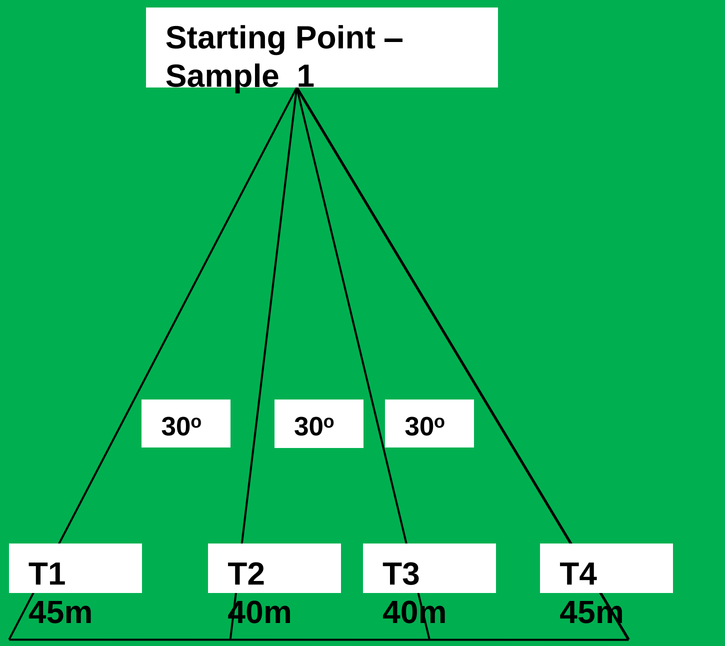


# Sampling Patterns in PSP and outside PSP for soil carbon

***Gathering already available reference data on:***
- ***forest (vegetation) type, structure, spp composition***
- ***land use history***
- ***Management type***




**PSP plot design and location of soil sampling in shaded quadrates**

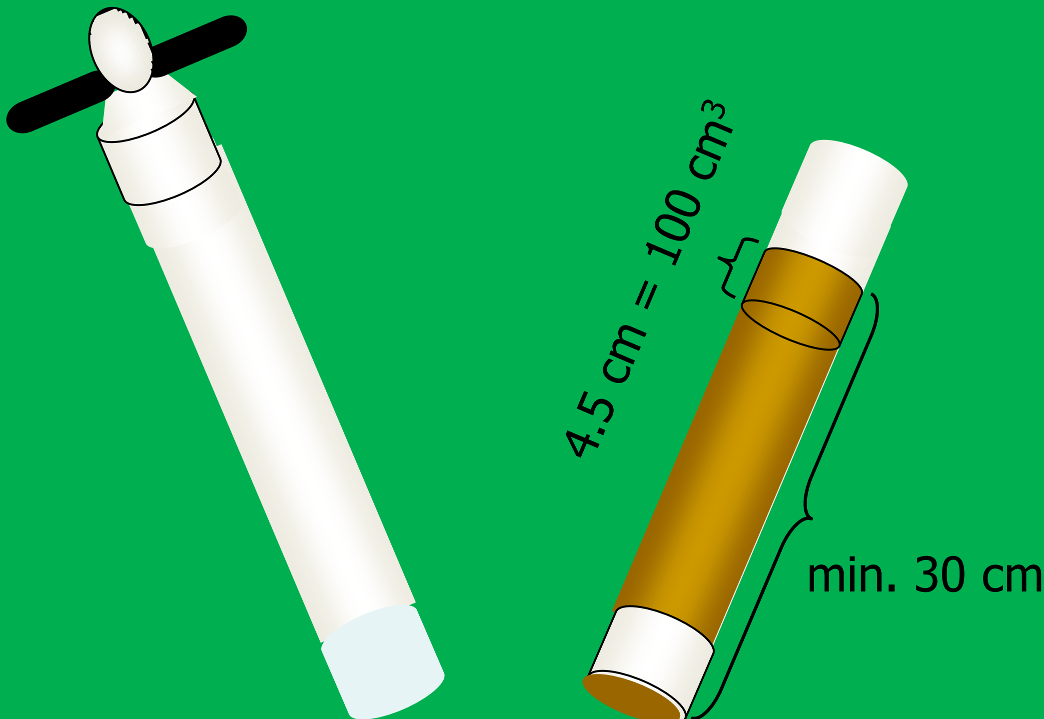



- T1 and T4 Samples taken at 15 m distance
- T2 and T3 Samples taken at 20 m distance
- Total of 11 Samples

# Locating the site and sampling in forest



# Using Split - tube to collect soil samples




**Increments (cm):**

**0-5,**
**5-10,**
**10-20**
**20-30**

# Preparation for Lab Analysis -Drying, Weighing and Homogenizing soils & litter




# Laboratory measurement of soil carbon and other nutrients

1


2


3

4


# SUMMARY

- Soil survey is essential to provide the basic information needed for efficient and effective land use planning or sustainable land use.
- Although there is increasing knowledge about soil, today's technology is still unable to fully delimit soil units on a specific landscape.
- Among the various land uses, forestry activities are one of the most important factors that produce changes in the environment.
- Understanding soil characteristics in their physical; chemical, mineralogical and biological aspects are essential to predict their behavior under changing environmental conditions from different uses.

# Discussion Points

## Considerations → For → Planning an inventory

### Considerations

1. Do we know about the status soil carbon and other plant nutrients in PNG forest soils?
2. Does current knowledge guide sampling strategy for assessing soil nutrients of PNG?
3. What replication is required to cover expected soil carbon variation?
   - Within sites
   - Between Sites
4. Should we asses other nutrients apart from carbon?
5. Are surveyors, methods and equipment available?
6. Should we get outside support- collaboration?
7. Costs and logistics

### Planning an inventory

1. Survey Site and Objective
2. Information
3. Maps
4. Staff- team
5. Equipment
6. Laboratory
7. Logistics
8. Reports
9. Budget


The End
Thank you