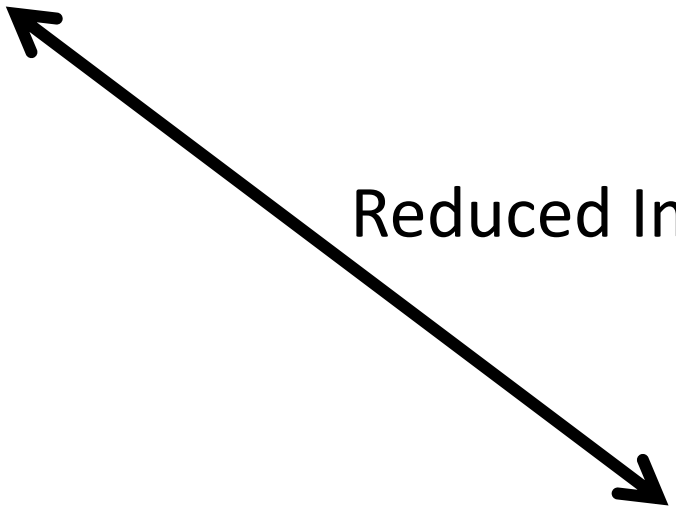
Analysis and improvement of a Pre-Harvest Inventory Design using GIS

BMU International Climate Initiative >
SPC/GIZ Project „Climate Protection through Forest Conservation in Pacific Island Countries”

Subproject: „**Development of technical parameters for the integration of SFM and REDD+ “**
> Lead to Research Project
(Supervisor: Prof. Dr. Dr.hc. Michael Mussong)

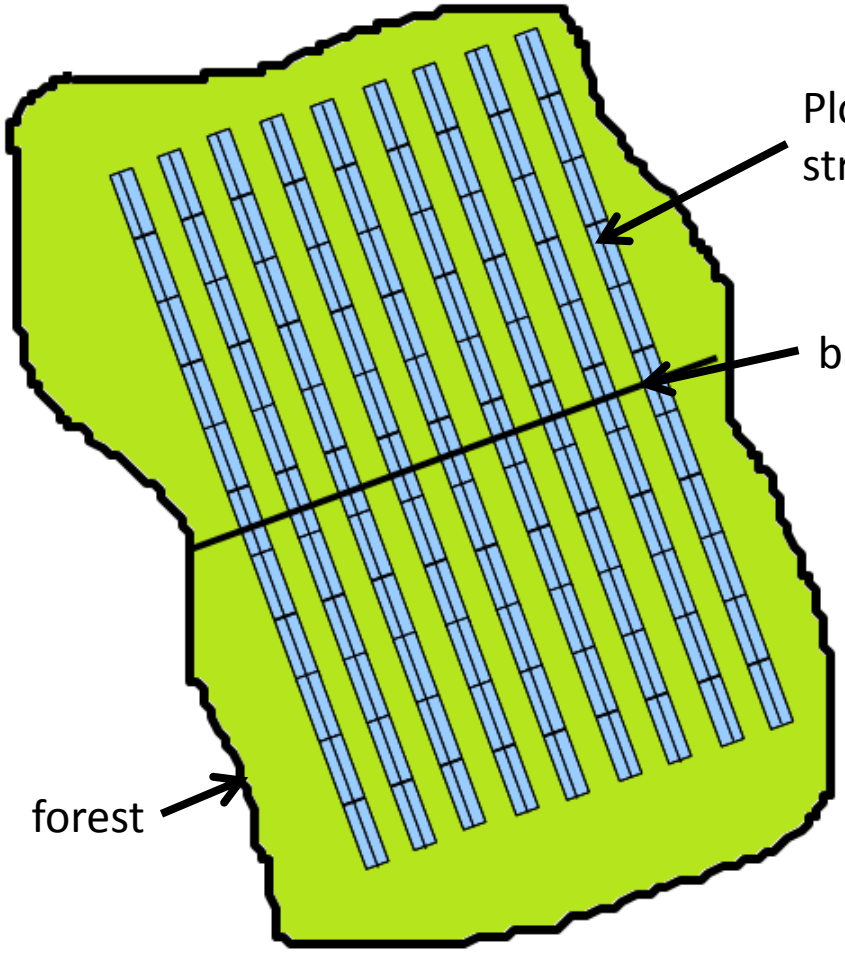
Sustainable Forest Management



Reduced Impact Logging

Pre-Harvest Inventory

Limitations of the PHI System



- Many sample plots
- Very time consuming
- High costs

Analysis of PHI systems

Full Data Set of one Forest Compartment

PHI design from 1991
Strip distances 100 m
Sample Plot Size 25 x 50 m (1250 m²)

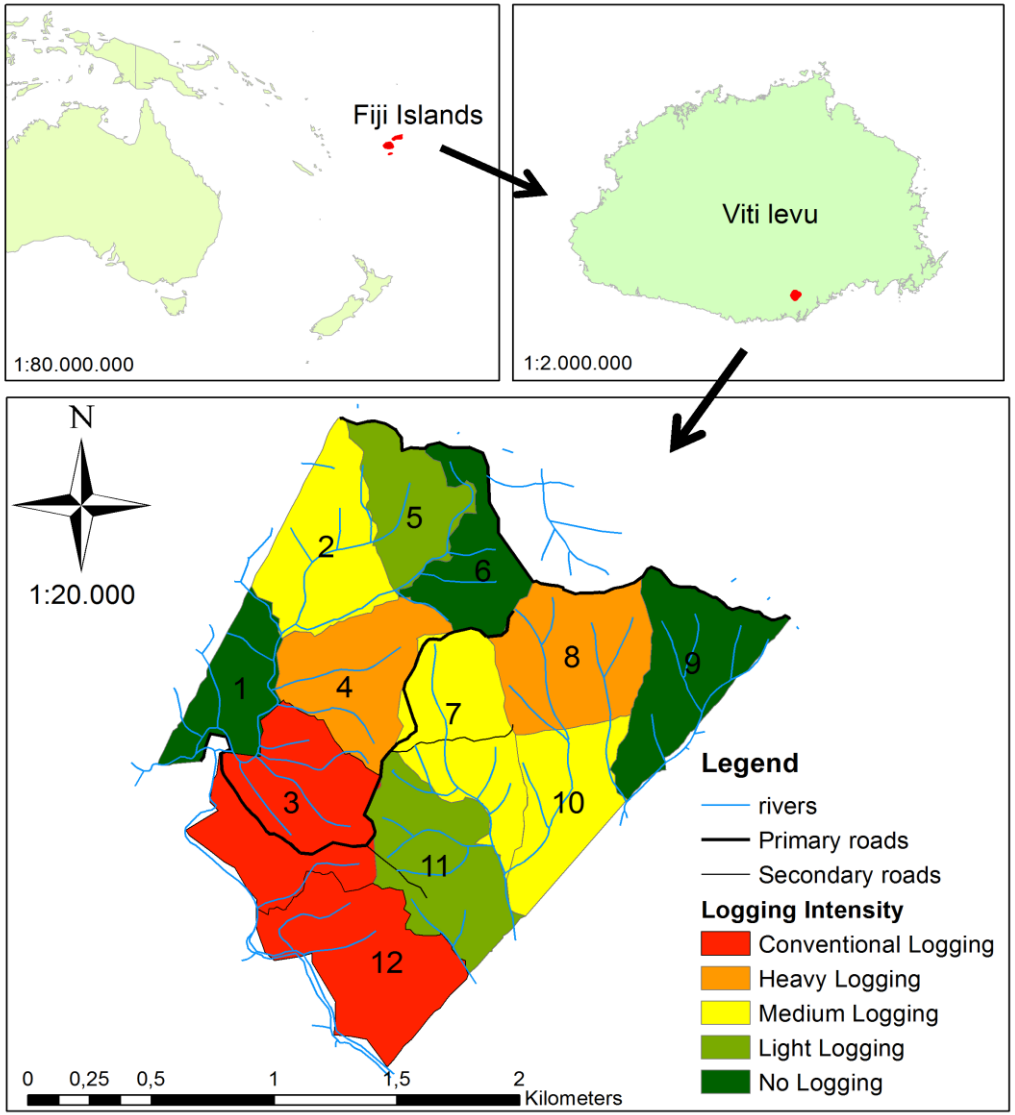
- few but big Sample Plots

PHI design from 1997
Strip distances 50 m
Sample Plot Size 10 x 20 m (200 m²)

- many but small Sample Plots

Simulation of Inventories using GIS Software

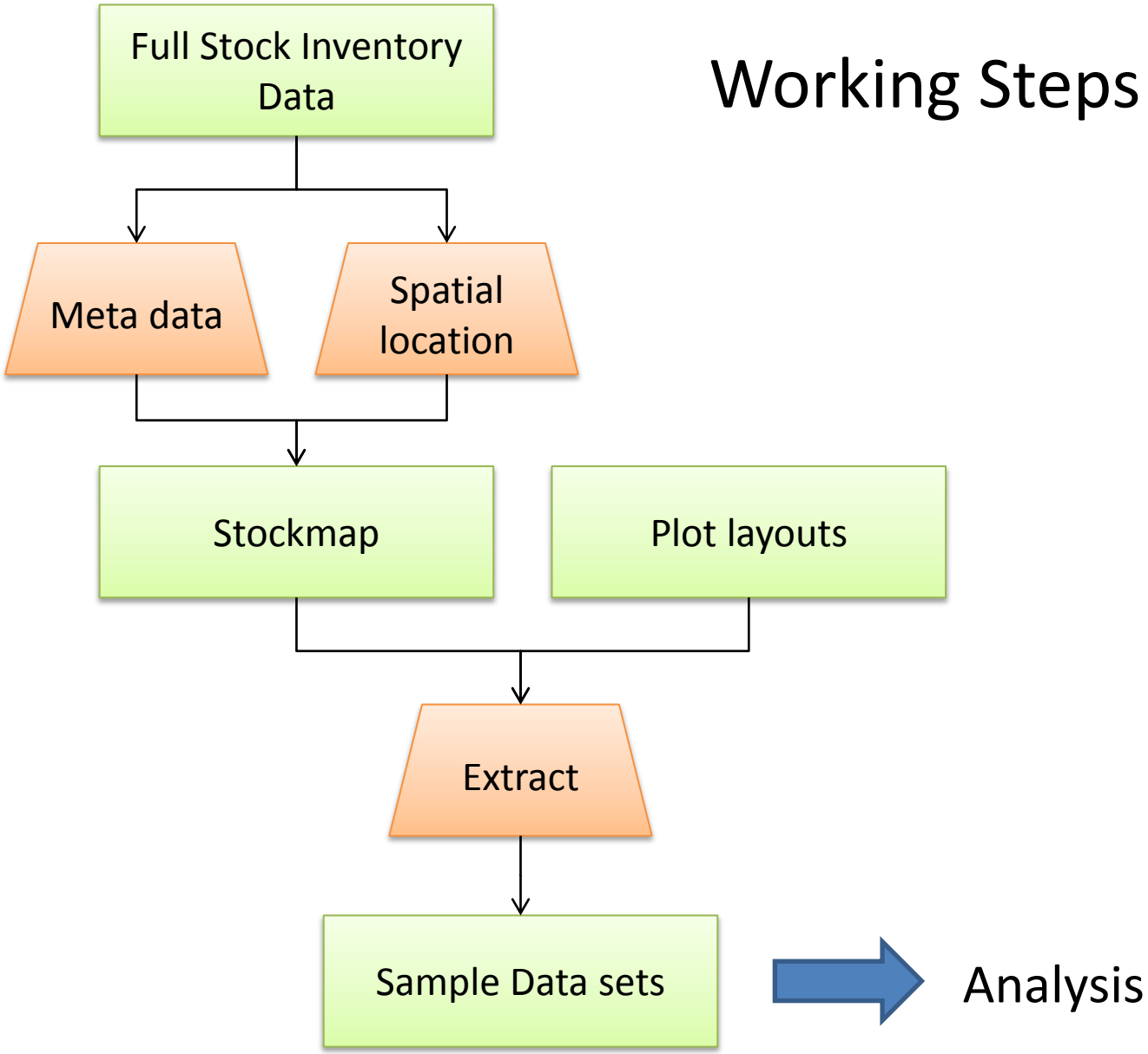
Nakavu Forest
"National Forest Management Pilot Project Area"



Author: Tom Thiele
Date: 24.04.2013

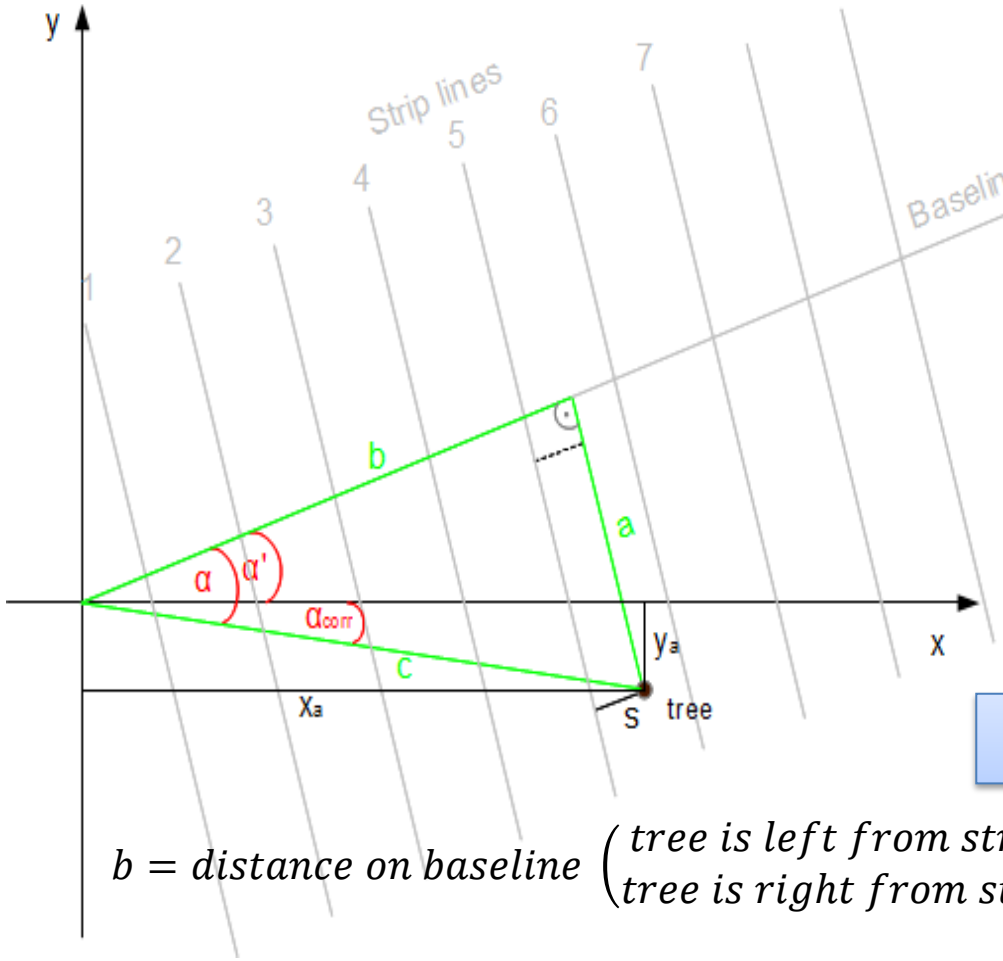
Sources: Shapes of Oceania: ESRI Data and Maps 2009
Shape of Viti Levu: Dresen, E. 2006.
Shape of Nakavu Forest: Fiji Ministry of Fisheries and Forestry (undated)

Working Steps



Mathematical derivation of Tree coordinates

1) Tree is right to baseline and α > α’



$$c = \sqrt{a^2 + b^2}$$

$$\alpha = arccos\left(\frac{b^2 + c^2 - a^2}{2bc}\right)$$

$$\propto_{corr} = 2\pi - (\propto - \propto')$$

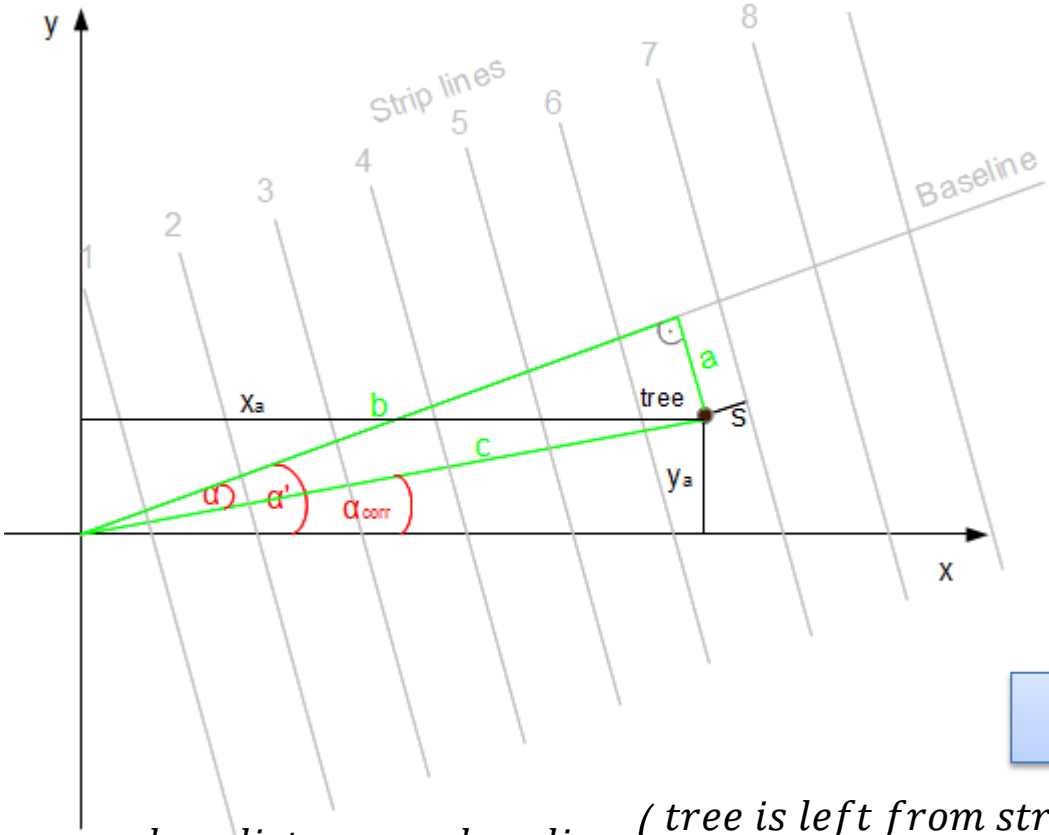
$$x_a = c * \cos \propto_{corr}$$
$$y_a = c * \sin \propto_{corr}$$

Implementation in Excel

$$b = distance\ on\ baseline \begin{pmatrix} tree\ is\ left\ from\ stripline: +s \\ tree\ is\ right\ from\ stripline: -s \end{pmatrix}$$

Mathematical derivation of Tree coordinates

2) Tree is right to baseline and α < α’



$$c = \sqrt{a^2 + b^2}$$

$$\alpha = arccos\left(\frac{b^2 + c^2 - a^2}{2bc}\right)$$

$$\propto_{corr} = \propto' - \propto$$

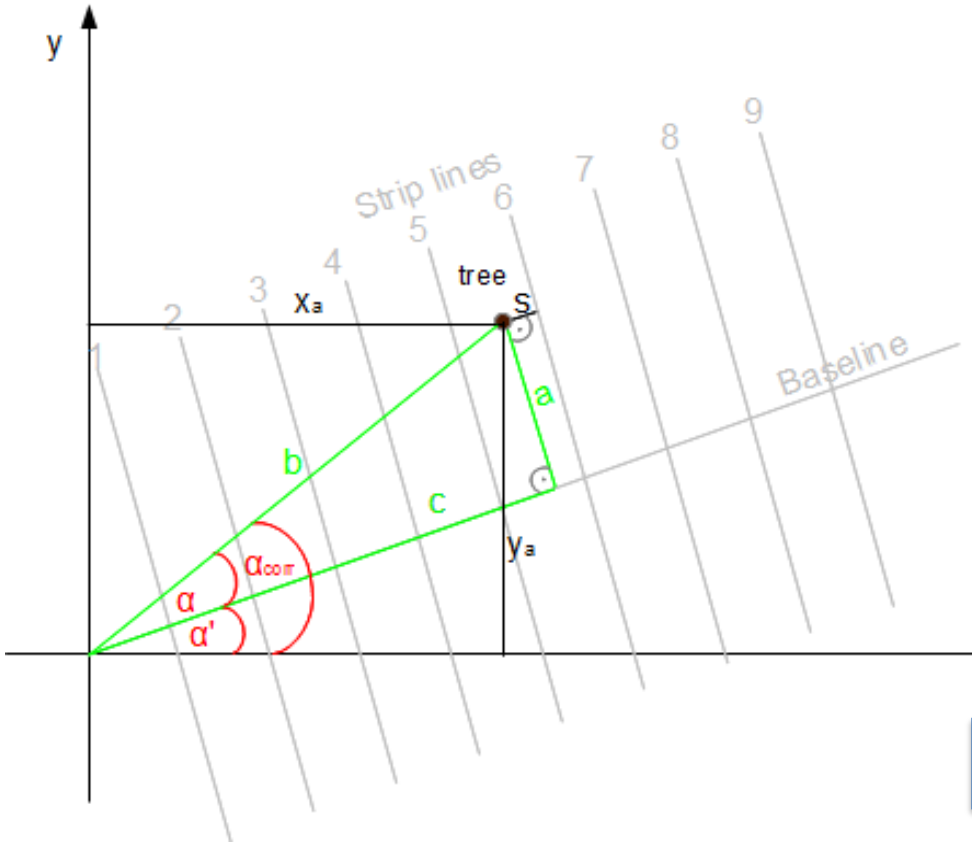
$$x_a = c * \cos \propto_{corr}$$
$$y_a = c * \sin \propto_{corr}$$

Implementation in Excel

$$b = distance\ on\ baseline \begin{pmatrix} tree\ is\ left\ from\ stripline: +s \\ tree\ is\ right\ from\ stripline: -s \end{pmatrix}$$

Mathematical derivation of Tree coordinates

3) Tree is **left** to baseline



$$b = \sqrt{c^2 + a^2}$$

$$\alpha = arccos\left(\frac{b^2 + c^2 - a^2}{2bc}\right)$$

$$\propto_{corr} = \propto' + \propto$$

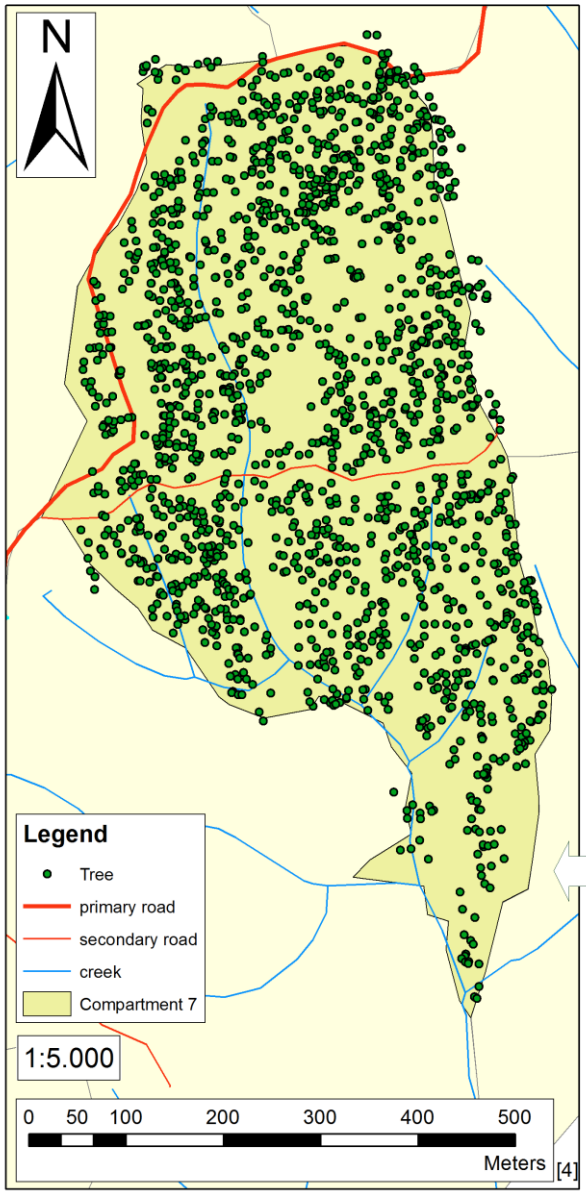
$$x_a = c * \cos \propto_{corr}$$
$$y_a = c * \sin \propto_{corr}$$

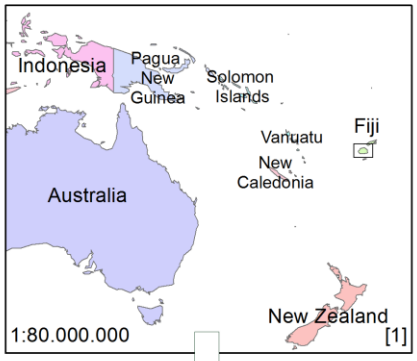
Implementation in Excel

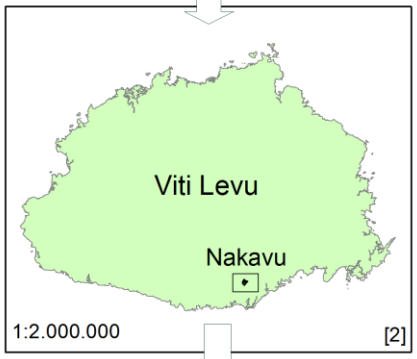
$$b = distance\ on\ baseline \begin{pmatrix} tree\ is\ left\ from\ stripline: -s \\ tree\ is\ right\ from\ stripline: +s \end{pmatrix}$$

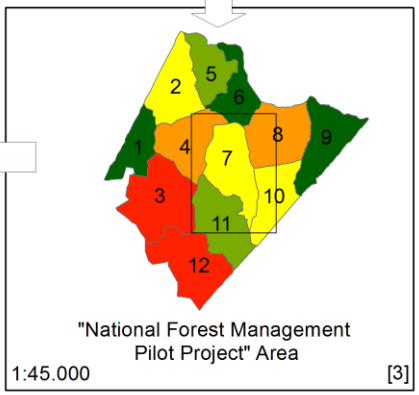
Tree distribution Map Compartment 7

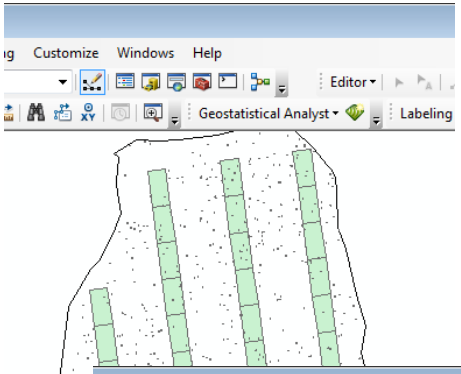
National Forest Management Pilot Project Area, Viti Levu, Fiji

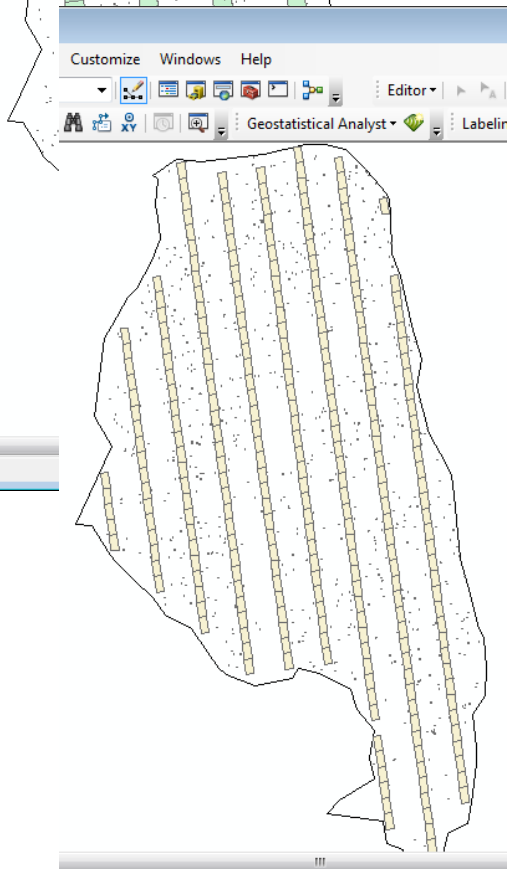












Coordinate Systems:
[1] and [2] : GCS WGS 1984
Datum: WGS 1984 Units: Degree
[3] and [4]: WGS 1984 UTM Zone 60S
Projection: Transverse Mercator
Datum: WGS 1984 Units: Meter

Date: 25.04.2013 Author: Tom Thiele

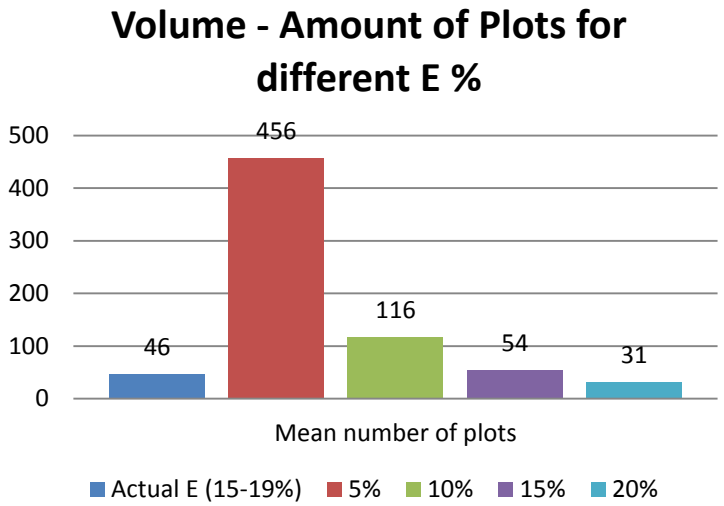
Sources:
[1] World Country Shapes, ESRI Data and Maps (2009) [2] Viti Levu Shape, Dresen, E. (2006.) [3] National Forest Management Pilot Project Area, Fiji Ministry of Fisheries and Forestry (undated) [4] Data from Regional project Climate Protection through Forest Conservation in Pacific Island Countries (2012)

Big Plots (PHI 1991)

Number of Plots needed

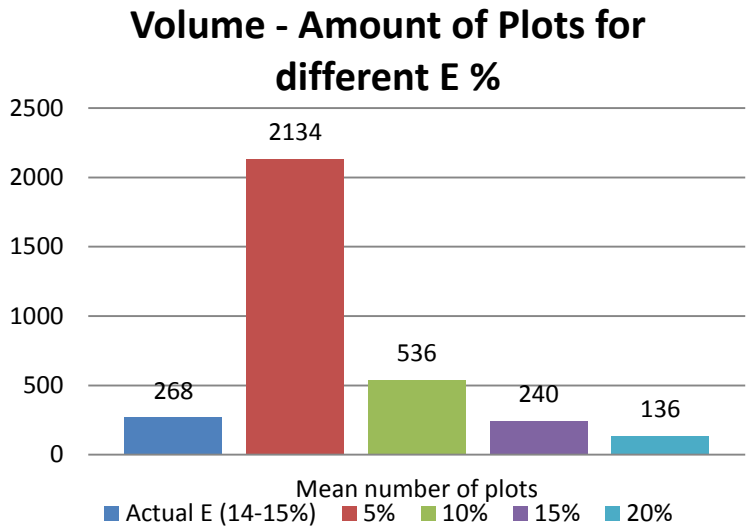
$$n = \frac{t^2 * CoVar^2}{E^2}$$

PHI 1991	Vol (per Plot)
Average	96,9 m³
Standard deviation	53,4 m³
Coefficient of variation	54 %



Small Plots (PHI 1997)

PHI 1997	Vol (per Plot)
Average	1,7 m³
Standard Deviation	2,1 m³
Coefficient of Variation	118 %



(Interim) Results

- Both systems are **not suitable for precise** forecast (5 % error level) **in such small scale**

- At 20 % error level the amount of sample plots needed can be much reduced

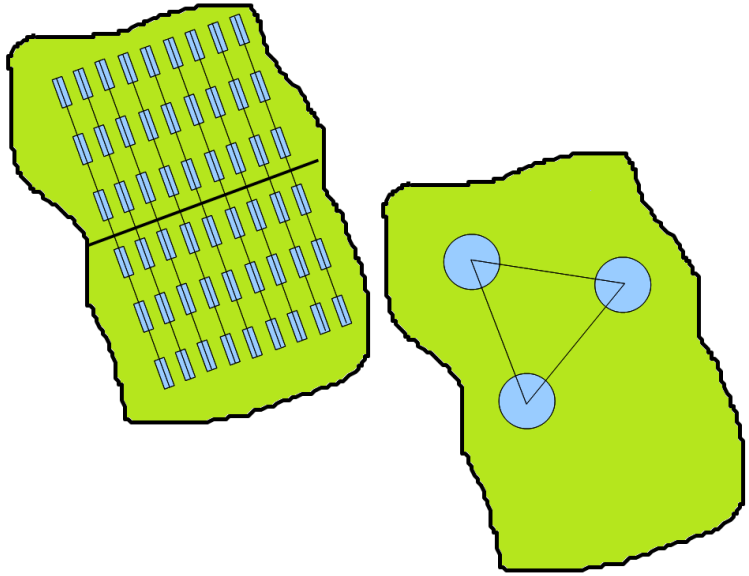
  PHI 1991 > about 30 % less plots needed

  PHI 1997 > about 50 % less plots needed

Outlook

Further investigation:

- Profound statistical analysis
- Different other sample plot arrangements
- Plotless sampling techniques as e.g. k-nearest neighbour



Until now only 1,8 GB test data was produced in 2354 files and 33 folders…

Thank you!
Questions?

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- **Lenoa, L. (2005).** Nakavu Forest: Research makes the difference. In P. Durst, C. Brown, D. Henrylito, & M. Ishikawa, *In Search of Excellence - Exemplary Forest Management in Asia and the Pacific* (pp. 271-282). Bangkok: RAP PUBLICATION 2005/02. FAO Regional Office for Asia and the Pacific.
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