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# GNSS Supported Survey and Open Source Web GIS for Forest Inventory and Its Management

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- **Component 1 :** Use of GNSS
  - To Establish Ground Control Point (GCP)

  **Component 2 :** Use of GNSS
  - Mapping Plot Location
- **Component 3 :** Web-GIS portal (Open Source)
  - PostgreSQL Server with PostGIS extensions
  - GEOSERVER
  - Apache HTTP Server

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# Component 1

## Use of GNSS to establish GCP and Mapping plots location

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# GNSS Survey to Establish GCP

### GCP Network Design

–59 GCPs (9 existing + 50 new)

- at least one GCP fall within 20km from each forest inventory sampling plots

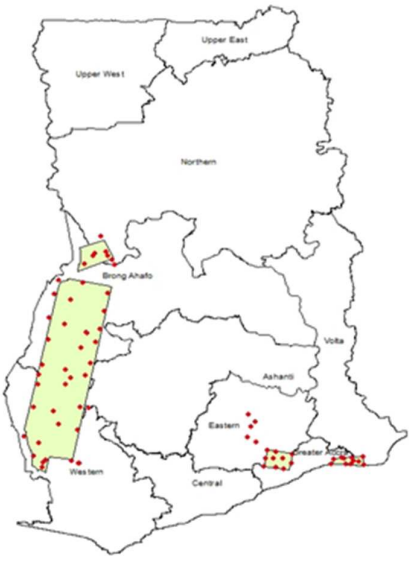
–GCP were navigated using

- 1:50,000 scale topographic map and
- handheld GPS

–GCP observation: Static method

–New GCP monumentation: concrete 24cmx24cmx54cm

–GCP numbering: Regional system




***Location of GCPs in Study Area***

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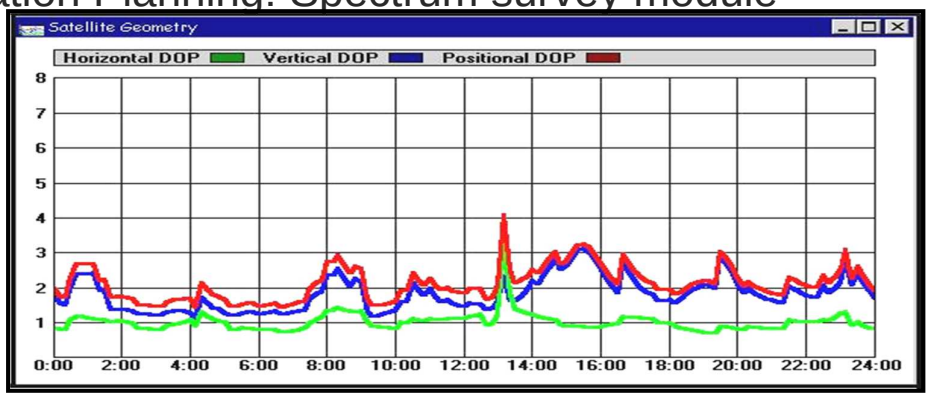
# Accuracy, HW/SW & Observation Planning

- Accuracy Requirements of Control Points
  - Third Order (FGDC, 1998) was enough, but Second Order Class II taken
- Hardware and Software used
  - South S86-S GNSS receiver (±2.5mm + 1ppm in XY & ±5mm + 1ppm in Z accuracy )
  - Spectrum Survey Version 4.20

GCPs Data Observations

- Observation Planning: Spectrum survey module

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# Observation Parameter

| | |
|---|---|
| • Geometric Dilution of Precision (GDOP) | :< 4 |
| • Observation time at a station | **:> 1.5 hr.** |
| • Elevation mask set for observation | :+15$^{o}$ |
| • Minimum log satellites for recording of epochs | : 4 |
| • Troposphere correction model | **: Hopfield** |
| • Ionosphere correction | : On |
| • Ambiguity resolution | : Search |
| • Rejection criteria | **: 3 x rms.** |
| • Epoch period | : Begin/End |

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# Data Processing

- Spectrum Survey (ver. 4.20): post-processing
- Differential processing
- Automatically generated baseline
- Known coordinates used to calculate the new GCP

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# Sample results

| Point | WGS84 UTM - ZONE 30N | | | Geographical Coordinates | | Accuracy | |
|---|---|---|---|---|---|---|---|
| Description | Northing | Easting | Height Ellipsoidal | Latitude | Longitude | RMS | SD |
| | Meter | Meter | Meter | Deg Min Sec (N) | Deg Min Sec (W) | | |
| SGB A582.11.FPP01 | 880225.521 | 538680.958 | 390.507 | 7° 57' 46.85408" | 2° 38' 56.48719" | 0.015 | 0.007 |
| SGB A582.11.FPP02 | 876261.352 | 567688.548 | 256.495 | 7° 55' 36.66988" | 2° 23' 09.17585" | 0.013 | 0.009 |
| SGB A582.11.FPP03 | 862734.597 | 599017.003 | 324.600 | 7° 48' 14.37951" | 2° 06' 06.95472" | 0.013 | 0.007 |
| SGB A582.11.FPP04 | 862257.970 | 533050.261 | 349.931 | 7° 48' 01.90788" | 2° 42' 00.83301" | 0.016 | 0.008 |
| SGB A582.11.FPP05 | 854214.368 | 553067.574 | 319.366 | 7° 43 39.37937" | 2° 31' 07.53254" | 0.015 | 0.007 |

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# Component 2

## Use of GNSS for Mapping plots location

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# Forest Inventory Sampling Plot Location Survey

- Requirement of accurate plot location measurements for
  - spatial overlay and data extraction,
  - LIDAR (Light Detection and Ranging) point cloud processing
  - modeling for deriving carbon look-up tables

- Sampling Plot Design (271 plots)
  1) Savannah and Dry semi-deciduous fire & inner zones: total 90 plots
  2) Moist semi-deciduous N-W zone: total 120 plots
  3) Moist semi-deciduous S-E, Moist & Wet evergreen: total 90 plots
  4) Upland evergreen: total 39 plots
  5) Southern Margin: total 12 plots
  6) Mangroves: total 10 plots

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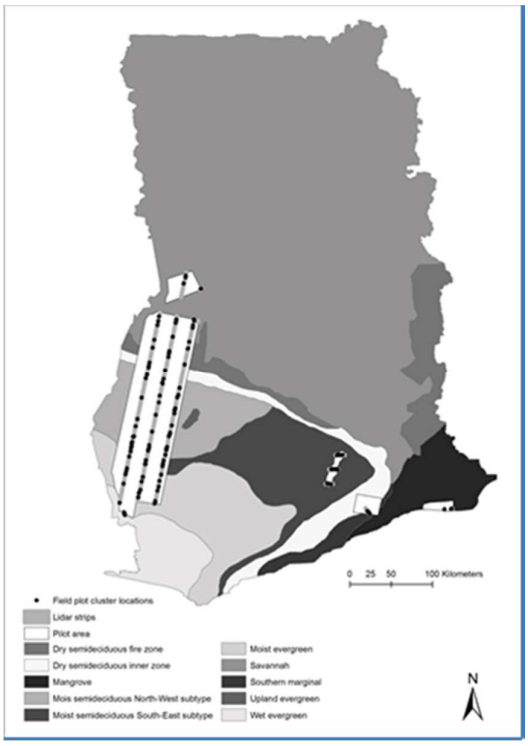
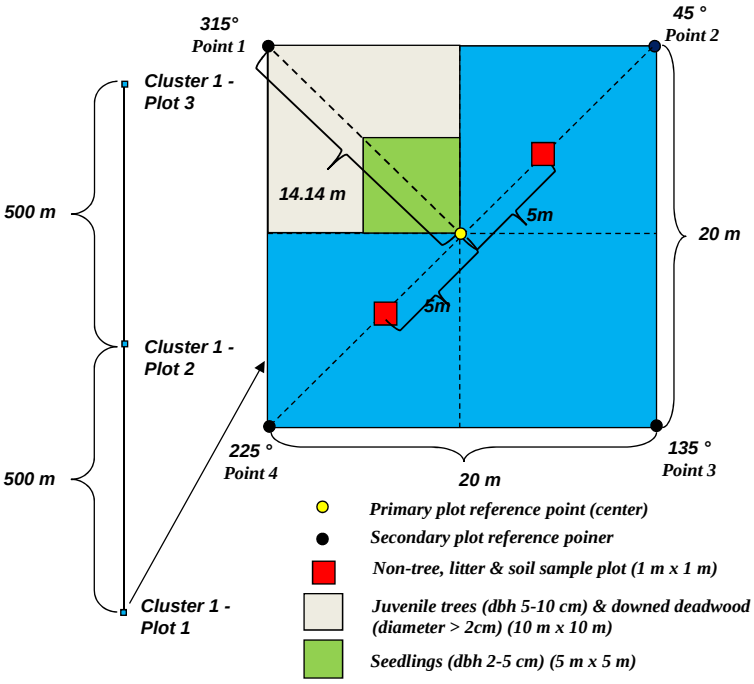
# Distribution & Design of Sample Plots




*Distribution of sample plots in Climatic Zones*




*A sample cluster with sub-plots*

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# GNSS Measurement of sample Plots

Observation specification:

- Equipment used : **Trimble GNSS**
- Observation points : **5 (center & four corners)**
- Observation time : **10 minutes**
- Observation method : **fast static**
- Software used : **Trimble TBC for post processing**

Being a forested area, 3 CASES encountered on satellite signals

- CASE 1: All five points observed
- CASE 2: At least one point observed
- CASE 3: No any point inside plot observed (traversed from nearby)

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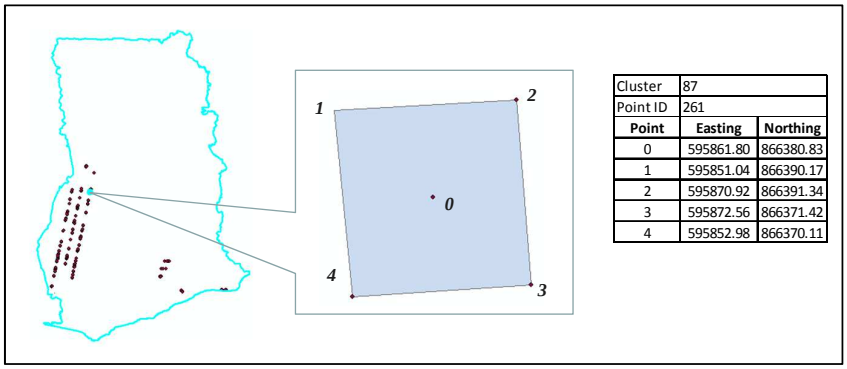
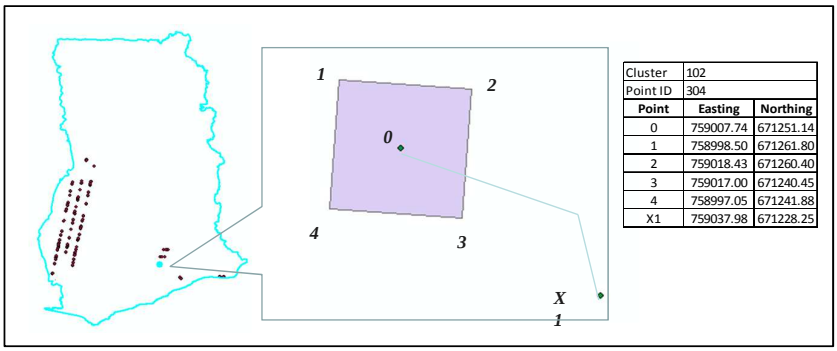
# Calculation of missing points to create plot




| Cluster | 87 | |
|---|---|---|
| Point ID | 261 | |
| **Point** | **Easting** | **Northing** |
| 0 | 595861.80 | 866380.83 |
| 1 | 595851.04 | 866390.17 |
| 2 | 595870.92 | 866391.34 |
| 3 | 595872.56 | 866371.42 |
| 4 | 595852.98 | 866370.11 |

- CASE 2: Satellite reception was difficult in one or few coordinates of a plot.




| Cluster | 102 | |
|---|---|---|
| Point ID | 304 | |
| **Point** | **Easting** | **Northing** |
| 0 | 759007.74 | 671251.14 |
| 1 | 758998.50 | 671261.80 |
| 2 | 759018.43 | 671260.40 |
| 3 | 759017.00 | 671240.45 |
| 4 | 758997.05 | 671241.88 |
| X1 | 759037.98 | 671228.25 |

- CASE 3:Satellite reception was very difficult in all coordinates of a plot

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# Component 3

**Web-GIS portal**
**for**
**Forest Inventory & Its Management**

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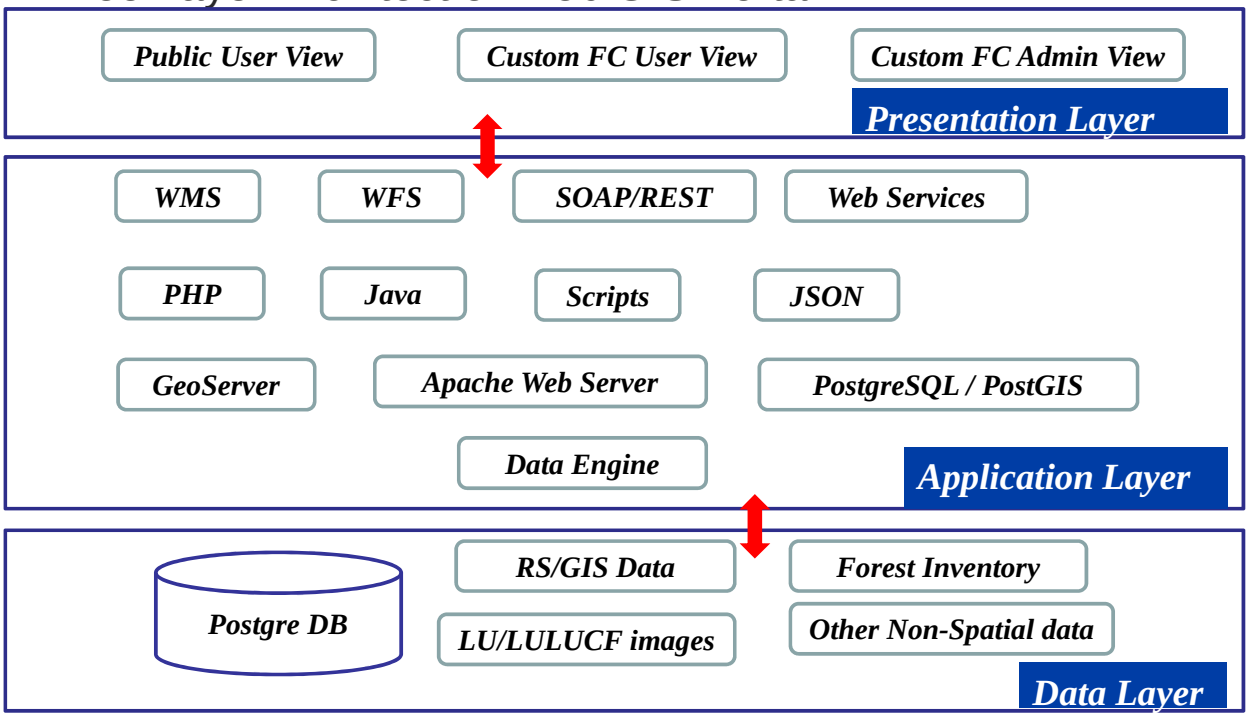
# Architect of Web-GIS Portal

- Three Layer Architect of Web GIS Portal

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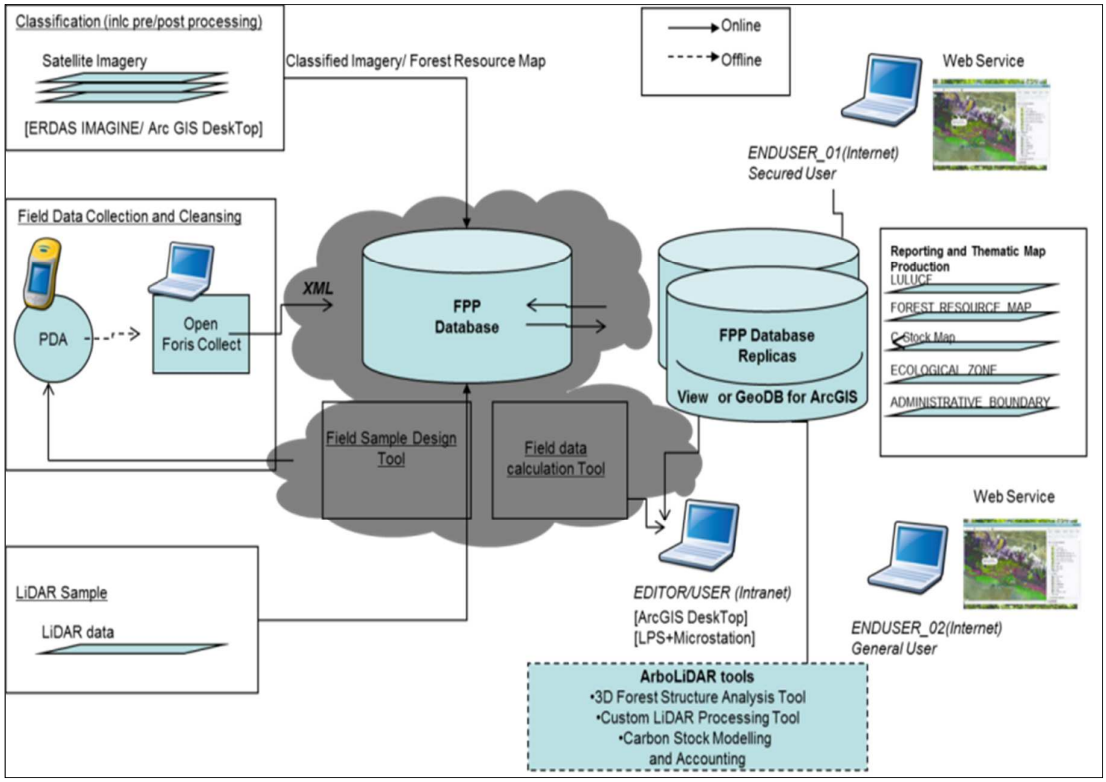
# Application of Web GIS in FC Ghana (1)

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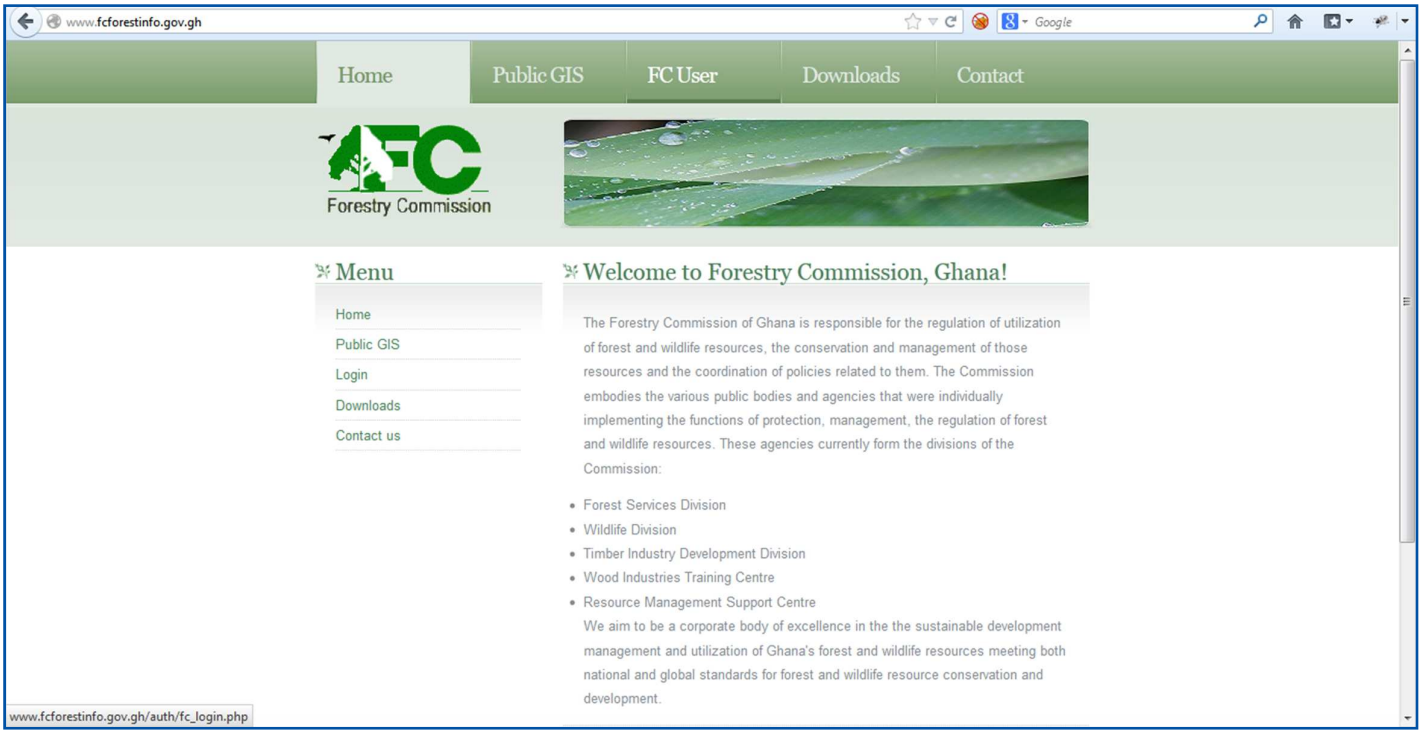
# WebGIS Portal - Homepage

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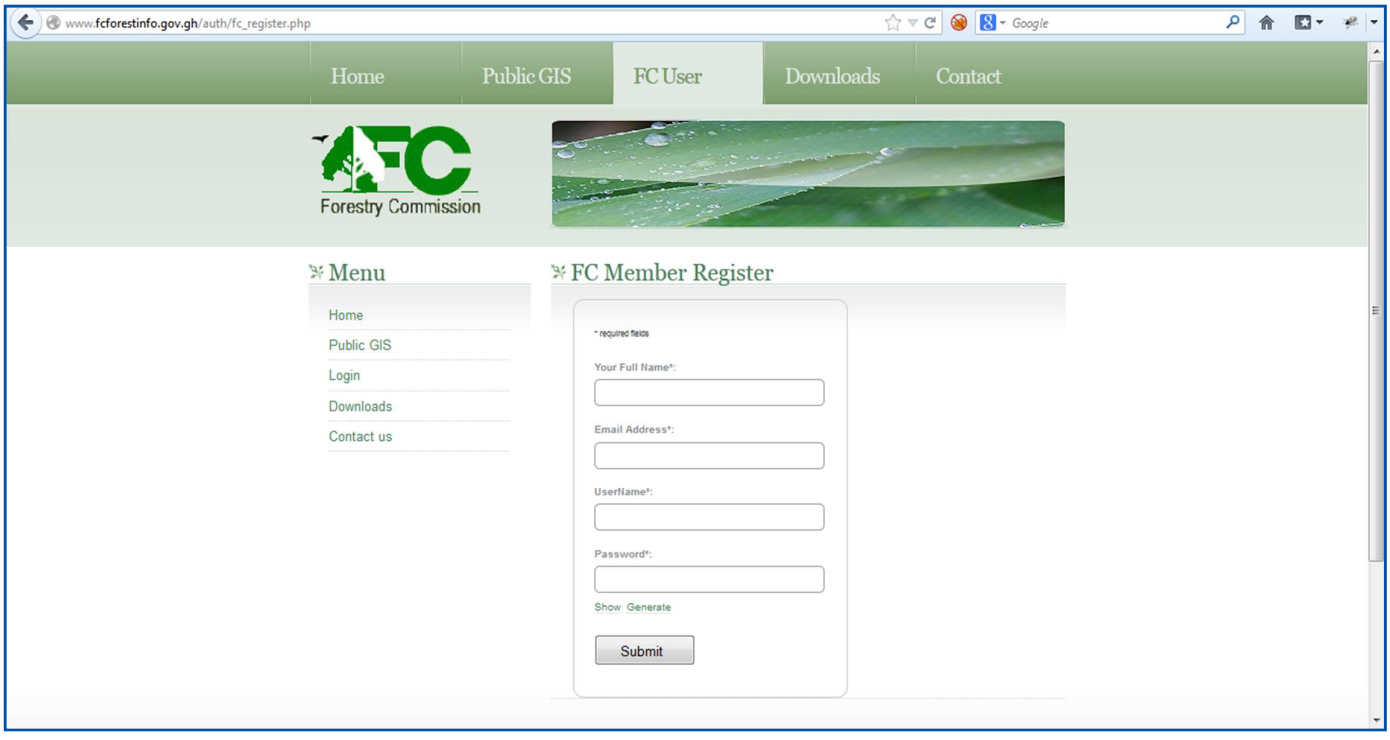
# : WebGIS Portal - Register User

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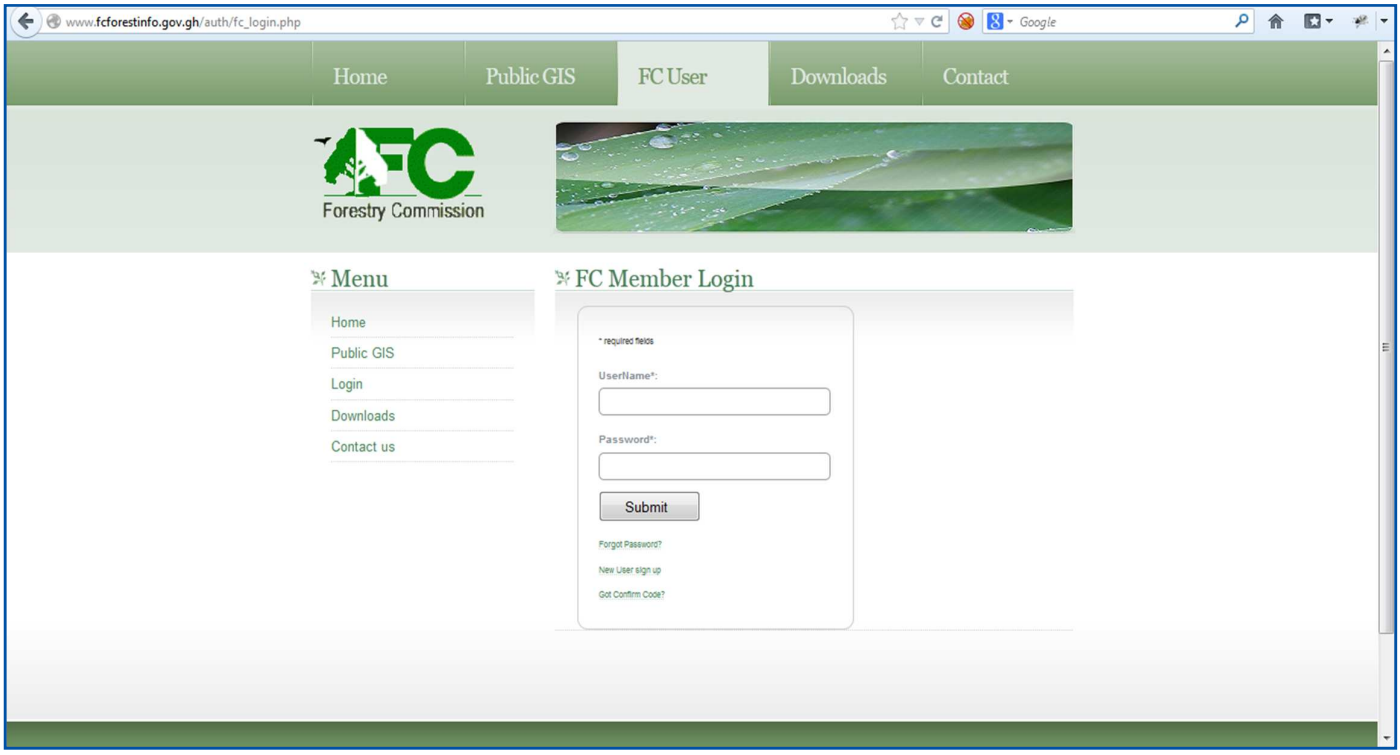
# : WebGIS Portal – Login Page

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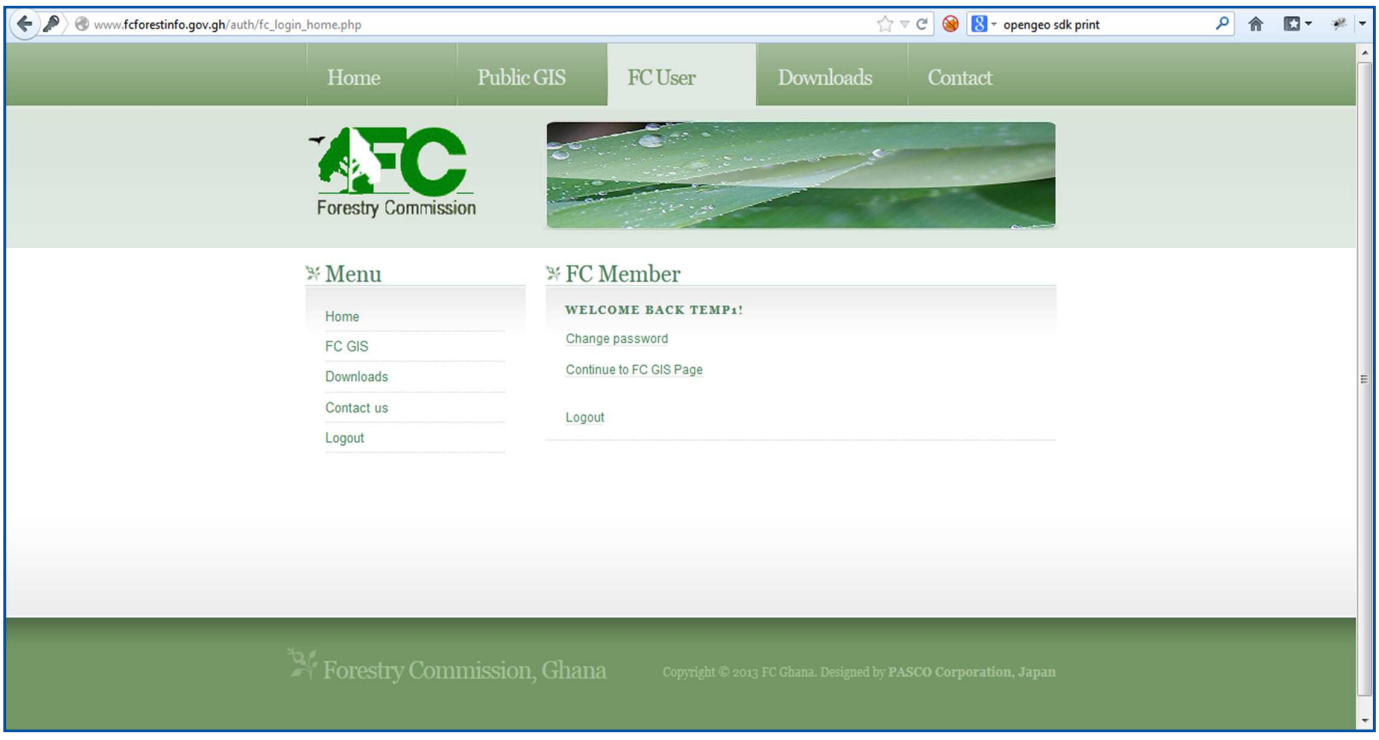
# WebGIS Portal – FC User Page

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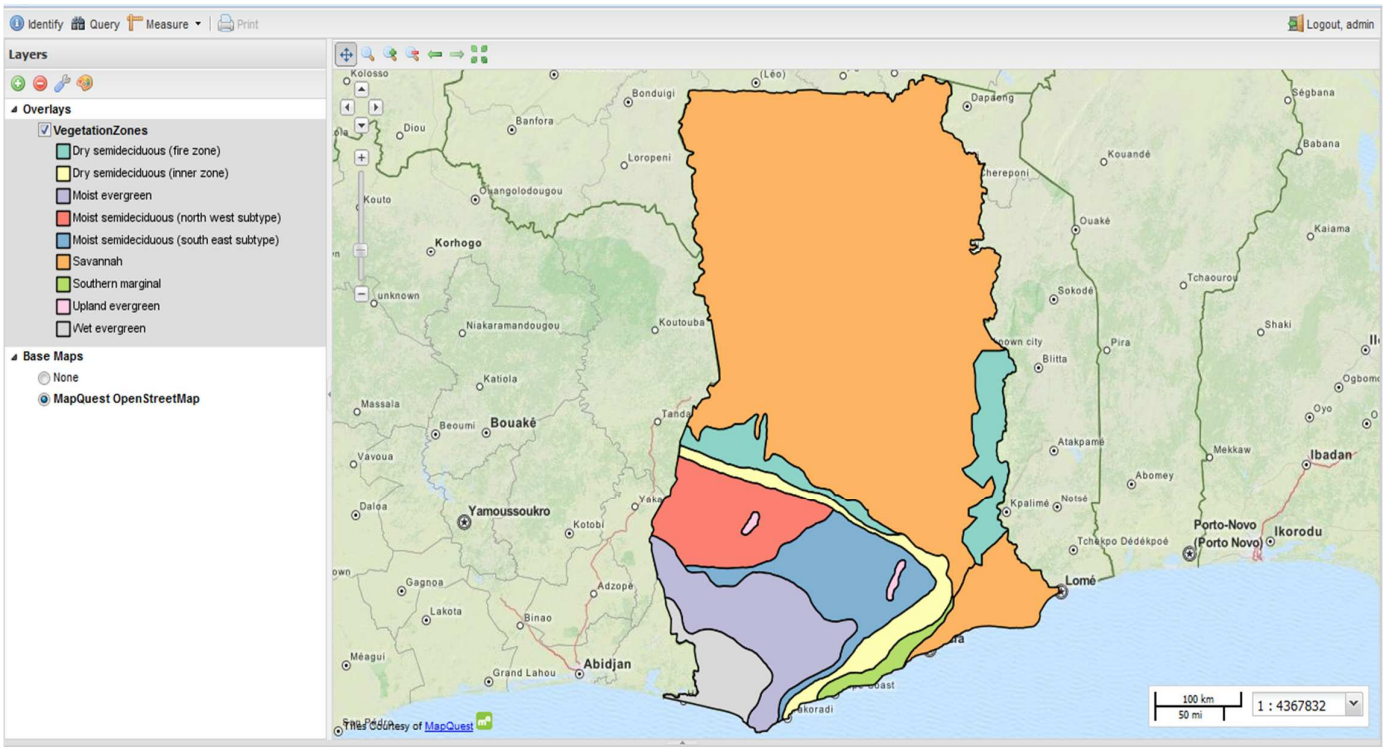
# WebGIS Portal – Map Page

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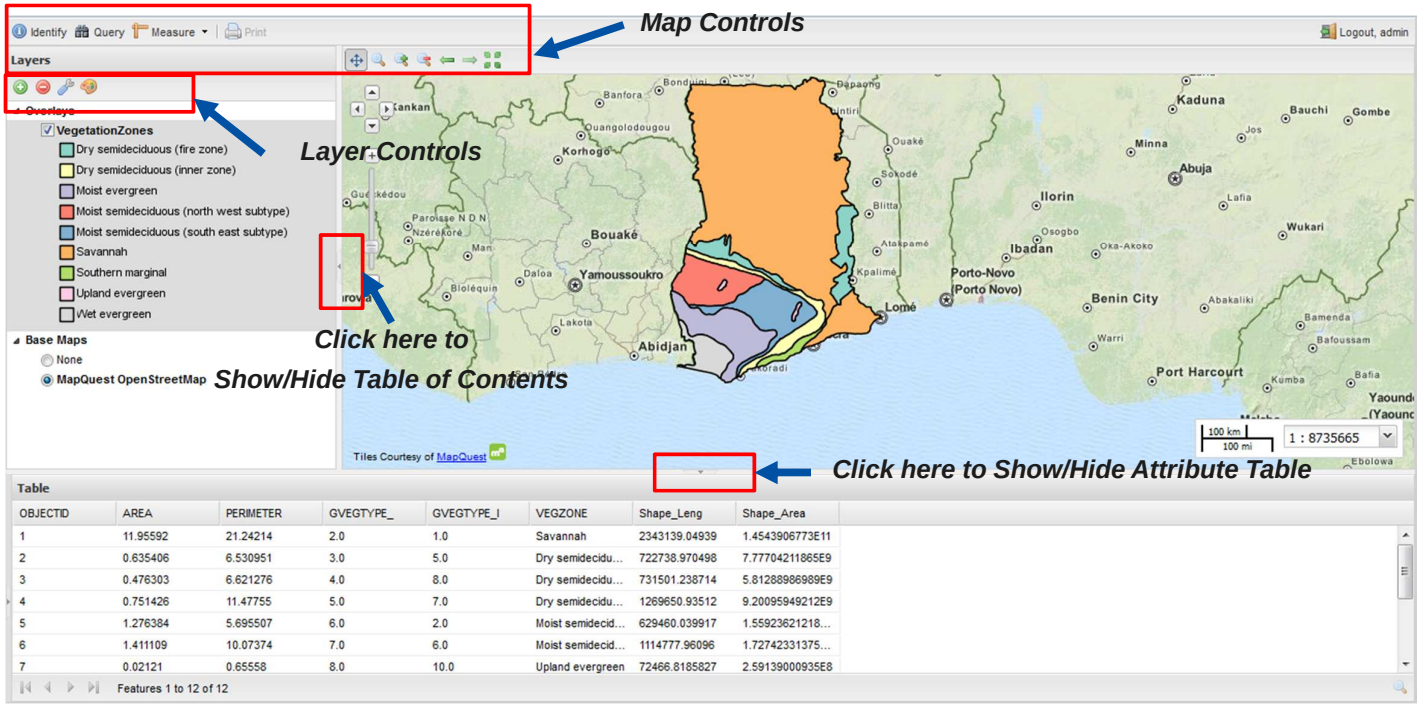
# WebGIS Portal – Map Page - Layout

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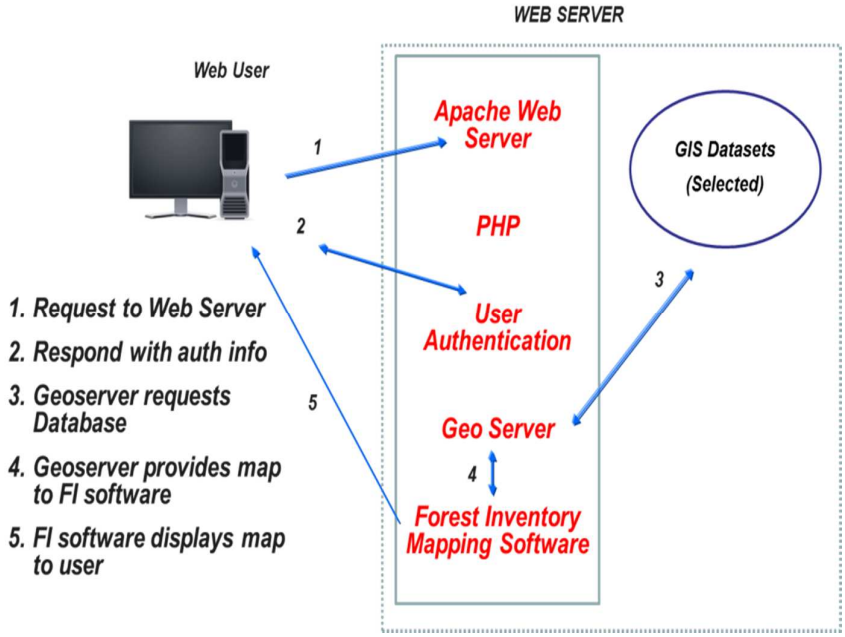
# Application of Web GIS in FC Ghana (2)

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# Conclusion

- GNSS
  - DGNSS is accurate and less time and resource consuming method of establishment of GCP
  - GNSS was successfully used for accurately locating the forest inventory sampling plots in different climatic zones with various forest canopy types
- GIS Web Portal
  - Web-GIS portal with 3 tier architecture.
  - GeoServer has been used as Web GIS Server,
  - Customised Web-GIS portal was developed using open source software
  - Well structured Web-GIS portal to server different level of users
    - General Public: viewing and query
    - FC Ghana staff (general user): download/upload data
    - FC Ghana staff (Analyst/Admin): editing, analysis/ admin control

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ありがとうございます

Arigatou-gozaimasu

TERIMA KASIH !!

Thank you very much for your attention

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