

# CAIRO, FIG Working Week 2005 and the 8th Conference of GSDI

Survey Department of Senegal  
*Case Studies in SDI Components (Geodetic Datum,  
Data Transformations, Cadastre, Planning etc.)*

## CONTENT

- Historical outline of Senegalese Geodetic Network
- Introducing of GPS survey in Geodetic Networks :SGD
- GPS procedures
- GPS Processing
- Coordinate Changes From Datum Changes
- Cadastral process
- Relative Specifications at the Documentation
- Summary

## Historical outline of Senegalese Geodetic Network

- Before 1933 ,just astronomical canvas
- From 1933 to 1970,Senegal ensured the mapping for west Africa
- Establishment of: 1/200000 and 1/500000
- From 1933 to 1997:5 Datums

## Introducing of GPS survey in Geodetic Networks

- Necessity to have coordinates from GPS and traditional terrestrial methods
- Today, the physical control points may have two sets of coordinates
- Connection between topocentric and geocentric

## 1) Outline of SGD

- Position will be given, with geographical longitude, latitude and height above mean sea level **or three dimensional coordinates.**
- Distance and area will be projected on the **ellipsoidal surface.**
- The Datum points will be, the Senegalese Horizontal Datum and the Senegalese Vertical Datum.
- Geographical longitude and latitude will be surveyed based on **world geodetic system.**

## 2) Results of SGD

- New Coordinates of Triangulation Points and GPS Continuous Observation Stations
  - new reference frame  
ITRF2000, GRS80 ellipsoid
- ⇒ New Topographic Maps
- New Heights of Bench Marks
  - orthometric heights (gravity correction)
- New Geoid Model

### 3) Adoption of New Geodetic Reference Frame

#### - Social Background -

- Wide Use of GPS  
⇒Problems of Coordinate Transformation in Navigation and Survey
- Development of GIS
- Recommendation by International Organizations and Senegalese Academic Organizations
- ◇ Social Requirements for Precise Geodetic Network

#### - Technical Background -

- Progress of Space Geodetic Technology  
V L B I : Connection to world geodetic system  
G P S : Establishment of precise geodetic network
- Accumulation of Results of Precise Geodetic Survey with Laser Ranging(1974~)

### 4)Merits of SGD

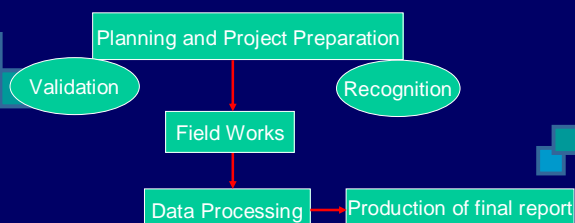
SGD will provide:

- Location Basis on "World Geodetic System"
- High Accuracy Survey Standard
- Purposes such as Survey, Navigation, Location-Based Services

### 5)Expected Effects of SGD

- Development of Location-Based Services and Utilization of GIS on World Geodetic System
- Improvement of Accuracy of Public Survey Conducted by Governmental Organizations and Local Governments

### GPS procedures



### Implementation of WGS84

- Select the GPS permanent Stations ITRF2000
- Creation of Zero order
- Creation of First order

Maps of GPS Permanent Stations



### Zero Order

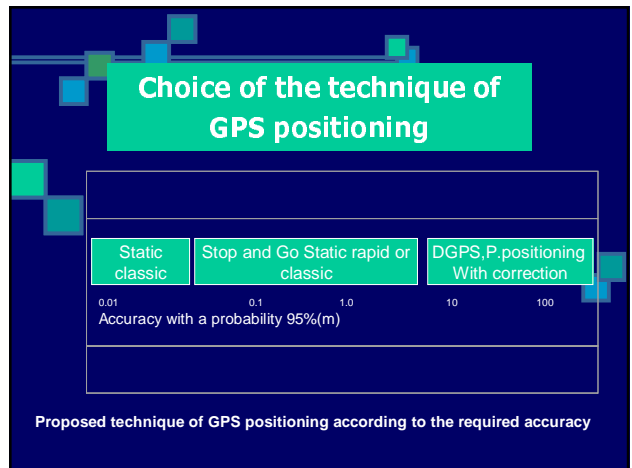
- New points for zero order

### Duration of sessions

Observations	Timing	Baselines
Zero order	3 days	More than 100 km
1 <sup>st</sup> order	1 day	50 km

### Planning and Preparation

- Wording needs of positioning
- Identify the new GCPs
- Attach the accuracy



### Choice of Receiver

Method	GPS observations
Point Positioning	Pseudoranges
Differential GPS	Pseudoranges
Stop and Go	Pseudoranges and carrier wave
Static rapid	Pseudoranges and carrier wave
Static classic	Bifrequencies Pseudoranges and carrier wave Bifrequencies for long vectors

### Validations

**Concept of Validation**  
Experience all the procedures by using Known points with upper height accuracy

**Elements of experiment**

- Method
- Type of GPS positioning
- Equipment

**Advantage**

- Detection and Resolution of problems
- Rationalization of operations
- Establishment of preview

## Recognition

Verify the new GCPs location	Absence of obstacle? Absence of interference sources?
Verify the existing geodetic points	The stations, are they located? The benchmarks, are they stable?
Formula needs of logistics	Transport mode Time to join points Procedure or special equipment
Measure to adopt	An other choice if necessary Establishment if necessary station of eccentric point Deposition of results Update the descriptions when it is necessary

## Concept of survey

Type	Requirement of control	Configuration of network
Point positioning	No	Without object
DGPS	1 point 3D or more	Radial
Static classic	3 points 3D or more	Closed geometrical figure
Static rapid, Stop and Go	Variable	variable

## Preparations

- Select a good period for the collection of GPS data
- Determine optimal number of GPS receivers
- Plan the conception of survey
- Establish a no ambiguous system of registration
- Teach the personnel how to operate
- Organize the lodgings on the field if necessary
- Prepare equipment and necessary supplies

## GPS Processing

- **Relative Positioning Using Carrier Wave**
- **Principle of interferometric survey**
- **Build the observation equation :  $Ax=b-r$**
- **Solution by the least squares : Normal equation**
- **$A^T Ax^{\wedge} = A^T b$**

## VALIDATION OF RESULTS

- the residuals are calculated as:  
 $r^{\wedge} = b - Ax^{\wedge} = b - p$
- Analysis of Ambiguities resolution
- Covariance of estimated ambiguities
- Final coordinates precision: analysis of covariances
- Ambiguities-fixed
- Study of rms

## Coordinate Changes From Datum Changes

- transformation includes rotations, translations, and a change of scale
- established between Cartesian systems
- described by seven parameters
- three translations  $t_x, t_y, t_z$ , three rotations  $\varepsilon_{x'}, \varepsilon_{y'}, \varepsilon_{z'}$  and a change of scale  $k$ .
- $X = (N+h) \cos\phi \cos\lambda$
- $Y = (N+h) \cos\phi \sin\lambda$
- $Z = ((1-f)^2 N + h) \sin\phi$

## Cadastral Process

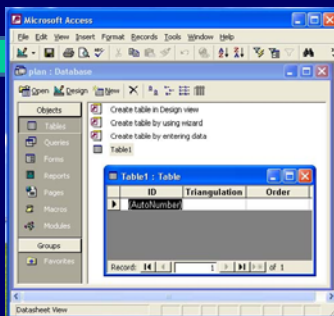
### Objective

- The objective of this paper is to approach the cadastral mapping by GIS which will be certainly benefited for planning and implementation of the rural and urban development.

## Parcel Mapping Methods

- The digital parcel maps is conversion of analog maps into digital GIS data layers.
- They are not only transferred into a digital form, but also have to be vectorized,
- There are several ways to do:
  - Manual digitizing from analog maps;
  - digitizing or automatic vectorization;
  - Coordinate Geometry conversion (COGO);
  - Positioning property corners with GPS.

## Relative Specifications at the Documentation



- These specifications manage the supply of the textual results, graphics and numerics

## Summary

- GPS survey is revolutionary for control point survey projects
- the accuracy and reliability of survey results have been highly improved

THANK YOU