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THE COMPUTER ASSISTED MAPPING PROJECT (CAMP) OF SURVEY OF KENYA

Presented by the Survey of Kenya and the
Institut Géographique National (IGN)

THE
COMPUTER ASSISTED MAPPING PROJECT
OF THE
SURVEY OF KENYA

The Means
The Production

Presented by:

The Survey of Kenya and the Institut Géographique National (France)

THE MEANS

1/ BACKGROUND INFORMATION

Kenya spreads over 583000 Km². Its Cartography includes approximately 1000 maps at 1:50000, at 1:100000, and at 1:250000 depending on the regions. This country has also got a regular land register with plan scales varying from 1:200 down to 1:10000.

The Survey of Kenya is in charge of the Cartography and the Land Register. It in the Ministry of Lands and Settlement. The Ministry is also in charge of the development of the Physical Planning.

Kenya is a country of 25 million inhabitants where population doubles every 17 years. The amount of land transactions the Ministry registered last year was twenty times greater than ten years ago. The activities of services such as tourism represent now approximately 57% of the GNP. These activities have known a tremendous growth in the past ten years.

Cartography and Land Registration are part of the fundamental tools to help decision-making in a rapidly changing environment and among a large span of activities.

The idea of developing two Data Bases, one for Cartographic purpose and one for the Land Registration has been adopted in order to supply a Cartographic Base for the country's Physical Planning and to speed up the land management procedures.

In this context, the Kenyan Ministry of Lands and Settlement has trusted the Institut Géographique National since three years, and put it in charge of assisting the Survey of Kenya with this task of prime importance.

2/ SOFTWARE

The nineteen computers of the CAMP use the UNIX, SCO UNIX and SPIX operating Systems. The UNIX system V different versions are all compatible with each other. The two coordination desk computers devoted to secretarial work operate under DOS. All the machines are linked together into an ETHERNET network.

The main application software, DEMETER, allows data input and graphic display. INGRES and ORACLE take care of the data bases organization. Nowadays INGRES is internaly used by DEMETER for graphic element files input preparation and for DEMETER own management. ORACLE multi-users supports the Cartographic and Cadastral Data Bases.

The numerical acquisition of data can take three forms:

1) Data typed in from terminal keyboards:
   -Alphanumerical Data (semantic informations)
   -Numerical Data for topographic calculations.

2) Digitizing tables

3) Stereoplotter Data (A7 or A8).

The DEMETER software supplies the three acquisition interfaces mentioned above and the editing tools necessary for raw files management. This software is installed on all nineteen CAMP computers.

3/ DATA BASES

The Cadastral data base

The Cadastral data base has two components, a thematic and a graphic one.

In order to allow a friendly usage, the thematic component has been developed under two data base management systems.

- A PC/DOS version with DBASE IV

- A MINI/UNIX version with ORACLE multiusers

The structures of these two Data Bases are identical, which makes them fully compatible.

The DEMETER application software is used for graphic data storage under the INGRES format.

The link between corresponding items in the two files is given by the plot code numbers.

The Cartographic Data base

Though the data structure is very different from the Cadastral Data Base one, the software are the same and the input means are common.

The Survey of Kenya has chosen the U.T.M. Cartographic reference system for any new map or plan.

This choice, however entirely justified raises problems due to the data homogeneity in the data base in this part of the world. Kenya is located on the equator and over two U.T.M. zones. This explains the country's segmentation in four cartographic zones. For example, a problem would have appeared for regions extending across the equator line.

Therefore, it has been necessary to define a unique representation system specifically for the data base. This system exclusively designed for Kenya and named K.T.M. is entirely compatible with the U.T.M. system but allow the use of a single reference for the whole country.

Many different data base window extraction possibilities are available:

- Extraction by survey:
  For the DEMETER software the survey is a cartographic work unit. For example, it allows the user to check at once the amount of work for a given time or the impact of revision upon the maps update.

- Extraction by layer:
  The data base has nine main permanent layers attached exclusively to cartographic criteria plus three trial layers which will be removed once the methodology is set.

- Extraction by map number at 1:50000 or 1:100000.
  This option calls for a map number conversion table into K.T.M. coordinates for the four corners. Typing in a reference number from data at scale 1:50000 does not imply the final scale of the document has to be the same. For instance, it can be drafted at scale 1:25000 or 1:250000.

- Extraction by coordinates:
  The U.T.M., K.T.M. or geographic coordinates are equally good for usage.

An inventory of all conventional symbols of the 1:50000 Kenyan map has been established. This has permitted the creation of symbol tables. Thanks to DEMETER software, the symbols registered are as close possible to those of the "classic" cartography. This avoid misunderstanding among users. The advanced graphic that Survey of Kenya is in possesion of, allow short term devlopment of modern Cartography.

4/ THE EQUIPMENT

1) 19 Computers for the Data Bases:

2 DPX2000-30 BULL (mem: 20Mb, dsk: 600Mb)
+ 2 Graphic Stations BULL
+ 10 Alphanumerical Terminals
SPIX 33

2 DPX2000-20 BULL (mem: 12Mb, dsk: 300Mb)
+ 2 Graphic Stations BULL
+ 4 Alphanumerical Terminals
SPIX 33

4 BM600 386/25 BULL (mem: 4Mb, dsk: 100Mb)
+ 3 Graphic Stations PERICOM
Interactive UNIX system V

1 BM600 386/25 BULL (mem: 6Mb, dsk: 300Mb)
+ 3 Alphanumerical Terminals
Interactive UNIX system V

6 ZENITH 386/25 Graphic Stations (mem:8Mb, dsk:320Mb)
SCO UNIX

4 ZENITH 386/25 Graphic Stations (mem:12Mb, dsk:320Mb)
SCO UNIX

All the previous computers are linked through a network.

2) 16 Digitizers:

8 Digitizers OCE format A2
4 Digitizers BENSON 6301 format A0
4 Digitizers OCE format A0

3) 10 Plotters:

1 Double A0 BENSON (flat bed)

3 Plotters A0 OCE
6 Plotters A1 OCE

4) 11 Printers:

4 Laser Printers A4 BULL
7 Printers LQ COMPUPRINT BULL

5) 4 Stereplotters:

3 WILD A8
1 WILD A7

(SPIX33, interactive System V and SCO UNIX are different operating systems. They come with the computers.)

PRODUCTION TRIALS SUMMARY

Several map production trials have been carried out successfully, these include:

1- Compilation of several cadastral plans using digital methods. This has many practical uses such as in planning and land registration.

2- Overlying of digital topographic data on digital cadastral data to produce a topo cadastral map. This has been done for Ting'ang'a registration section of Kiambu district and Kisumu town.

3- A digital administrative map of Kenya has been produced.

4- A digital map of the Lake Basin Development Authority has been compiled from two existing map sheets.

5- The section has also successfully developed different programs such as conversion of Cassin_Soldner to U.T.M. coordinates, interface program for aerial triangulation software, a program to generate parcels centroid coordinates.

6- Revision of topographic maps using data captured from computer-supported stereoplotters and spot imageries.

7- The creation of Cadastral Information System (C.I.S) is in progress.

Details of these map production trials are attached here.

COMPUTER ASSISTED MAP PROJECT REPORT

1- **Development of Cadastral Information System (C.I.S)**
See Attached Document

2- **Survey Computations**
(Traverse and Triangulation Computations)

2-1 The computation of a closed traverse has successfully been carried out.

1-1.1 The data input consists of the final adjusted bearings (changed to grads) from the bearing sheet, the reduced distances and coordinates of the known points. The surveyor should therefore prepare the final traverse bearing sheet. A software is being developed to adjust the bearing sheet.

1-1.2 The output results consists of the final adjusted coordinates together with station names, angular and distance corrections, orientation and planimetric tolerances.

2-2 The computation of a triangulation network incorporating intersection and resection has also given fairly good results.

1-2.1 The data input consists of the final adjusted bearings (in grads) from the triangulation bearing sheet and the known coordinates.

1-2.2 The output data consists of name of the station being coordinated, its approximate and final adjusted coordinates. It also shows the rays that were used for intersection and/or resection as well as the angular and distance deviations at each station.

2-3 The results of the two kinds of computations (1-1 & 1-2 above) compare favourably well with the ones in the Survey of Kenya Manual.

2-4 Other kinds of computations such as trigonometric heighting are being explored.

2-5 A program is being developed to incorporate it into the system sc that the operator feeds in degrees directly instead of converting them to grads first.

merits

- The adjusted coordinates were loaded into the data base where they could easily be retrieved and the possibility of accessing the data directly from the data base for use during say digitization or triangulation data capture is being explored.

- The computations are cost-effective in terms of economy, accuracy (precision) and time.

- It is a rigorous adjustment method that produces more precise and unique solutions compared to the previous semi-graphic method but it does not take the element of weighting of observations into account.

- A possibility of using electronic note-book from say a total station exists but this has not yet been tested.

3- Digitization of Cadastral Data (Plans)

I- Nairobi Block 72 , Ngei Estate Phase II
II- Kanyakwar, Kisumu

3-1 Construction and compilation of blocks of cadastral plans using coordinates from the surveyor's field note-book. Nairobi Block 72 and Kanyakwar in Kisumu municipality are in the process of being compiled from coordinates.

3-2 Digitization of already existing authenticated cadastral plans and R.I.M.s.

3-3 Maintaining and updating the plans by either digitization or coordinates so as to incorporate boundary changes due to say subdivision or consolidation.

3-4 Editing and compilation of a flexible cadastral data base in which other information can easily be incorporated depending on the needs of users.

Merits

- Facilitates the release of survey data.

- Facilitates land allocation ; the land administrator will be able to see at a glance the allocated/non-

allocated land and/or the surveyed/un surveyed areas.

- Formation of an independent and more accurate cadastral record to minimise fraud.

- Minimisation of storage space.

- Reproduction of plans and RIMs at different scales.

- Ability to window and produce only a section of a block at a scale of our choice.

- Cost effective due to speed of production and easy retrieve and revision of cadastral data.

4- Digitization of Maps

I- Administration Map of Kenya
II- Lake Basin Development Authority.

4-1 Digitization and compilation of maps. Since the features were digitized in layers a client could be given only the data he required instead of giving him the whole map with lots of information that he did not need.

4-2 Editing and compilation of a flexible map data base in which other information could easily be incorporated depending on the needs of the users.

5- Revision of Township Maps Using Aerial Photographs

Case 5-1- Photogrammetric Data Capture

I-	Thika Town (Kiambu)	6 models used
II-	Kangemi Area (Nairobi)	2 models used

5-1.1 The features from photographs were captured stereoscopically.

5-1.2 Then using encoders, the data was stored in a digital form in the computer.

5-1.3 The map was finally edited and drawn on the plotters.

Case 5-2- Using Zoom-Transferscope and Digitization

(Naivasha Township)

5-2.1 Using the Zoom-Transferscope, similar features on the recently taken photographs (1984) were superimposed onto the old (1960) 1: 5 000 topo-cadastral map sheet.

5-2.2 The latest details on the photographs were then transferred onto the map.

5-2.3 The map sheet was finally digitized to create an easily retrievable updated digital map of the Naivasha Township and all what remained was the ground verification for say, adding street names.

Merits

Though it is important to note that the geometric accuracy of Zoom-Transferscope is inferior to direct controlled photogrammetric approach, the updated map has many uses such as;

- -Base Map for Physical Planning of Townships
- -Engineering (eg. Roads Layout) Work
- -Land Use and Land Condition
- -Municipal and County Councils
- -General Public

- The township maps can be produced at various scales of our choice.

- It is a cost effective method due to the high speed of revision (the township map was revised in one month), easy retrieval and updating of an old map once it has been stored in the computer.

- To complete the map, field completion is however necessary to get details about roads/street names, estates, factories and other man-made features, etc.

6- Map Revision Using Satellite Imageries

(1: 50 000 Menengai - Nakuru District)

6-1 Similar features on Spot Imagery were superimposed on the old map and the new features from the imagery were added through digitization process.

7- Topocadastral Maps

7-1 **Kiambu (Ting'ang'a) Registration section**
The data for this registration section was captured in two modes;
i- 3D Photogrammetrically
ii- 2D done by digitizing R.I.M.
The two set of data were effectively combined to produce a topo cadastral map.

7-2 **Kisumu Town**
By digitizing an already existing map og Kisumu and then overlying cadastral data to produce a topo cadastral map.

8- Aerial Triangulation

Migori Block
8-1 5 runs (strips) were used.
8-2 Found successfull in comparison with old triangulation data.
8-3 Interface for loading data to PAT_MR software for block adjustment, by Ackerman, has been completed.

9- Cassin Soldner - U.T.M. Conversion Program

9-1 Now complete and documented

10- Local Training

10-1 Staff
Training in CAMP have been an ongoing process and the CAMP staff have trained staff from
I- Survey Headquarters
II- Survey Field Headquarters
III- Provincial Staff
So far the trainees have received training in
I- Introduction to Computer Assisted Mapping (CAM)
II- UNIX operating system utilities
and III- Demeter software usage

10-2 Syllabus
A syllabus is now being developed to streamline the courses.

10-3 Teaching Manuals
Manuals for the different options of the demeter software viz;
TP- for Survey Computations

DG- for Digitization
and PH- for the photogrammetric data capture
are being developed.

Example:

A step-by-step self teaching "manual" on how to carry out survey computations using the TP- Option of the demeter software has been prepared (see a copy of the first version) and this has proved very effective in teaching other staff.

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