


No. 1

**REPORT  
OF  
THE THIRD YEAR'S WORK  
FOR  
THE TOPOGRAPHIC MAPPING OF SOUTH KENYA  
IN  
THE REPUBLIC OF KENYA**

PLOTTING  
COMPILED  
FIELD VERIFICATION  
FIELD COMPLETION

MARCH, 1990

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JAPAN INTERNATIONAL COOPERATION AGENCY

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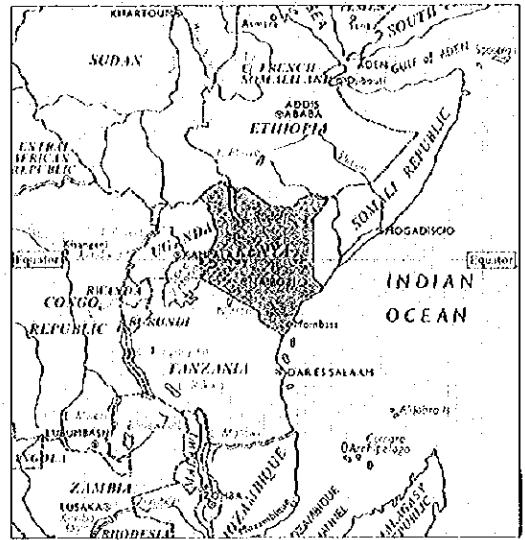
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ケニア南部地区  
国土基本図作成事業対象地域

TOPOGRAPHIC MAPPING  
OF SOUTH KENYA

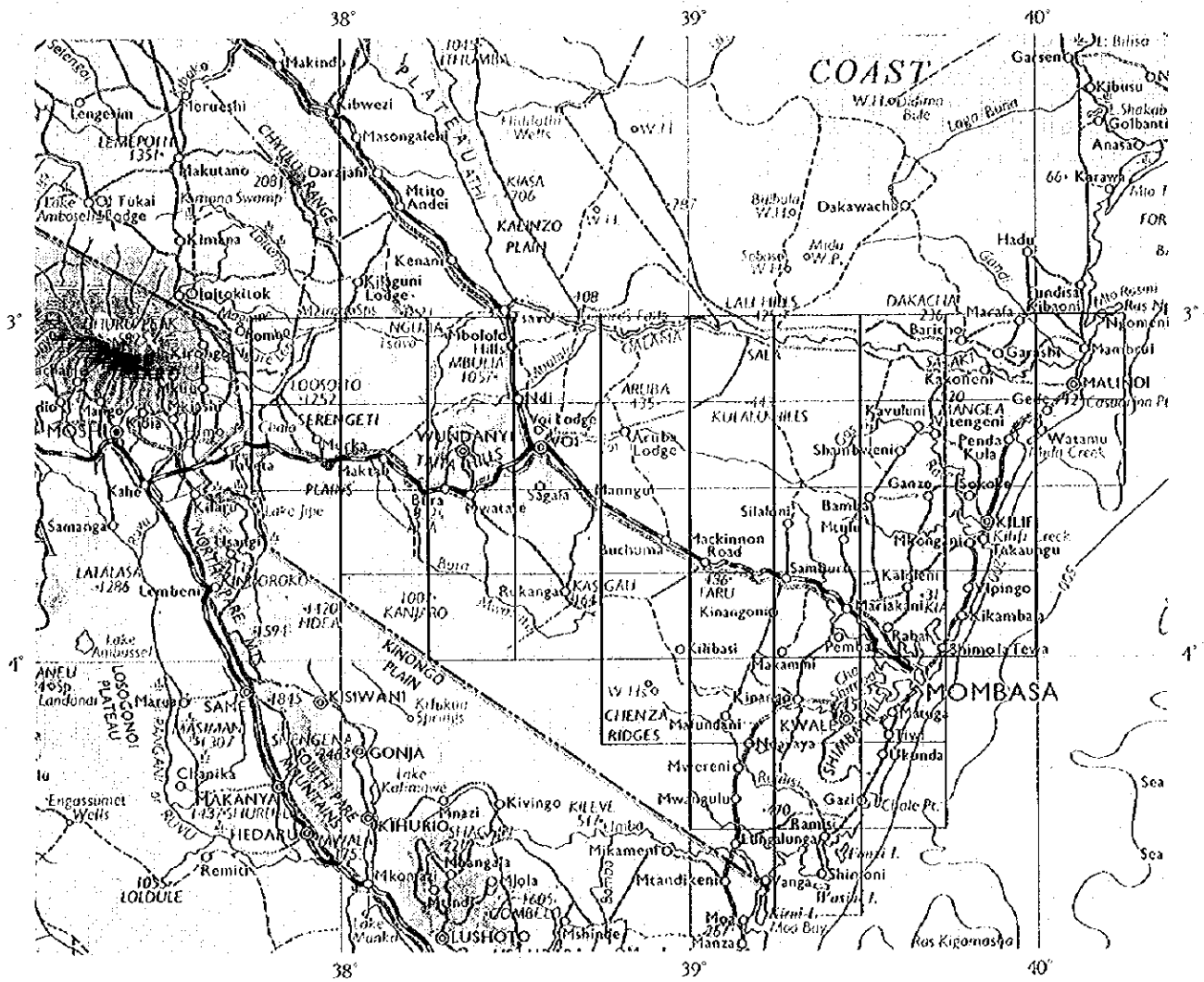


1 : 50,000国土基本図作成地域  
Mapping Area



0km 1000km

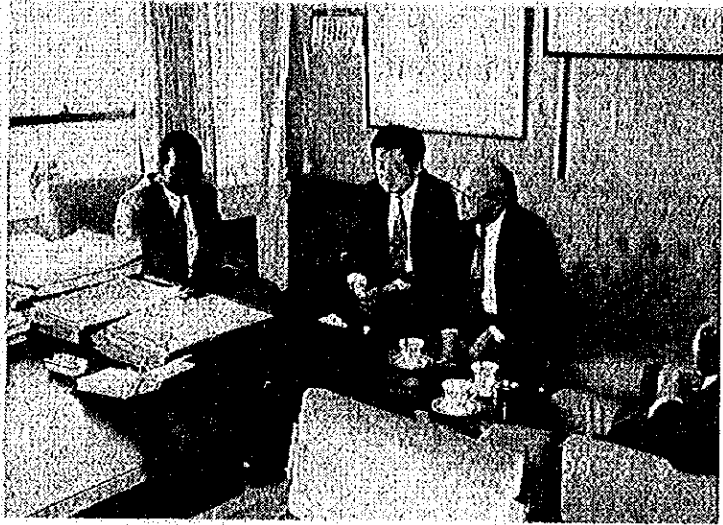
LOCATION MAP OF PROJECT AREA



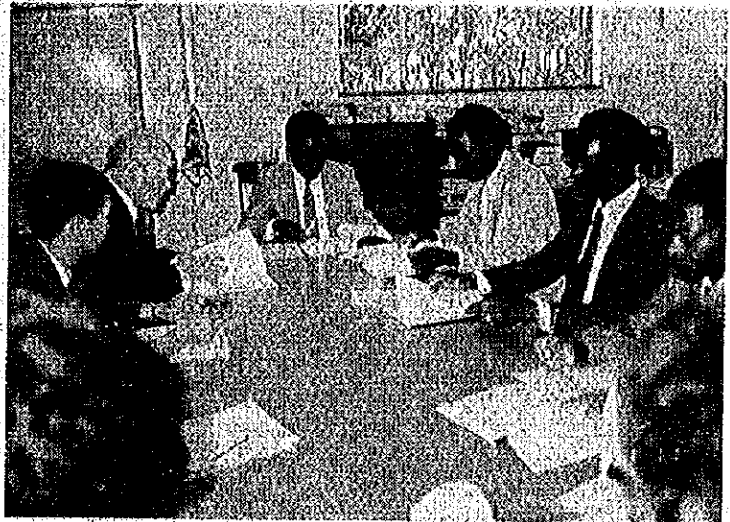
0km 20 40 60 80 100km

Photo -1 Meetings with SK

- 1) Meeting at the Ministry of Lands and Housing, Nairobi. (The left being the Director of Surveys,SK)



- 2) A Meeting on map symbols and their application etc. at the Field HQ, Ruaraka.



- 3) Signing on the Minutes of Meetings at the end of the field work at the Field HQ, Ruaraka.

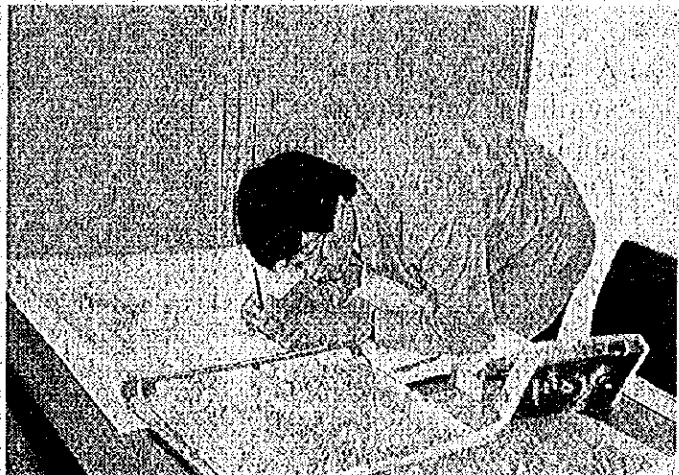


## Photo-2 Plotting and Compilation

1) Plotting Work(Auto-graph A8)



2) Compilation of  
1:50,000 topographic  
map



3) Compilation of  
annotation sheet

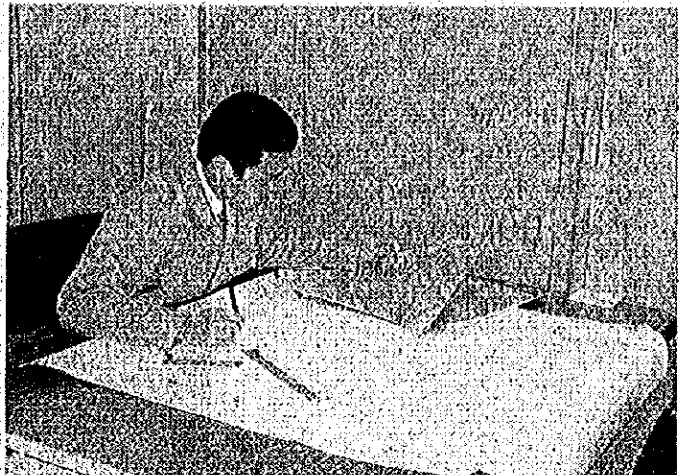


Photo - 3 Field Verification and Field Completion

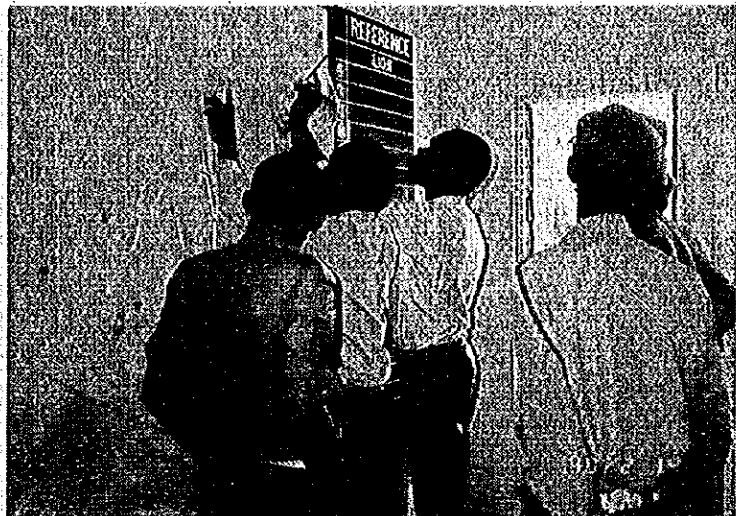
1) Confirmation of place name, etc. at a chief's Office



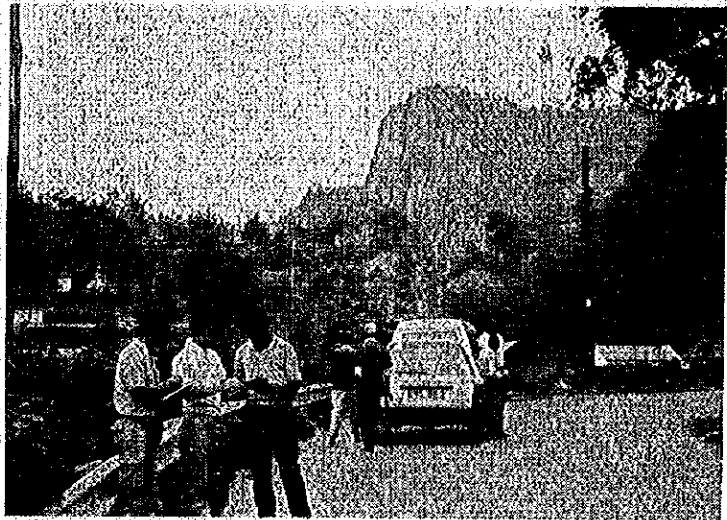
2) Hearing at a school



3) Hearing at a National Park Headquarters



4) Hearing from local residents in Taita Hills



5) Adjustment of survey results at Field Headquarters, Mombasa



6) Maintenance of survey vehicles.





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## 1. Background

The Government of the Republic of Kenya has been undertaking the development of key area under the Fifth National Development Plan, and in order to pursue their efforts most efficiently, it is essential for them to be equipped with maps of high accuracy covering the targeted areas. The need, therefore, is urgent for preparation of such maps.

The southern parts of the Republic, with such old port cities as Mombasa and Malindi located along the coast of the Indian Ocean, have high potential for development and, once developed, for growth, and therefore the region is designated as a priority area in the Fifth National Development Plan.

Basic maps were made for the region in 1950 - 1963 by Britain but nothing has been done since then to update these maps despite the substantial changes that have taken place over the years with new roads built and lands cultivated for farming. Also the elevations are shown in feet in these maps whereas the metric system is in common use in every field in the country today. Thus the situation as such calls for the up-to-date basic maps that accurately reflect the region as it actually exists.

From 1975 through 1984, Japan prepared the national base maps of Eastern Kenya under its international technical cooperation program. In addition, since 1981, Japanese surveying experts have been sent to the Survey of Kenya, Ministry of Lands and Housing, (hereinafter referred to as "SK") to help improve their technology.

Against this background, the Government of the Republic of Kenya made a request to the Japanese Government to provide technical cooperation for preparation of the national base maps. Subsequently, the feasibility study on the requested project was conducted by the Japan International Cooperation Agency (hereinafter referred to as "JICA") which sent two missions to Kenya for the purpose, the first in January 1987 and the second in February 1987. After consultations based on the findings of the feasibility study, the two governments signed the Scope of Work (hereinafter referred to as "S/W") for the captioned project (hereinafter referred to as the "Project").

According to the S/W, Project is designed to be conducted for the 4-year period from 1987 to 1990. The outline of the project is as follows.

1. Area to be mapped : Kenyan territory east of  $34^{\circ} 45'$  E. longitude and south of  $3^{\circ}$  S. latitude, not including the sheets containing the border with Tanzania (see the map on the front page.)
2. Size of Project Area: Approx. 29,800Km<sup>2</sup>
3. Number of 1:50,000 topographic map sheets to be made: 43
4. Number of prints to be made of the sheets : 1,000 each

The yearly work schedule is given in Table 1. In the following, the work that has been done is reviewed for each year.

In the first year, aerial signalization, aerial photography, and minor order leveling were conducted. Approximately 3,000Km<sup>2</sup> remained to be photographed due to unfavorable weather conditions.

In accordance with the progress of the preceding year, the second year's work included geodetic control survey and leveling to make up for the lost control points and bench marks, in addition to the aerial photography of the remaining area left over from the first year, as conducted on a modified work schedule. Other planned tasks such as field verification, aerial triangulation, plotting and compilation (15 map sheets each) were conducted as originally scheduled.

Following up on the progress of the preceding two years, the third year's work called for the continuation of the plotting and compilation work as well as the field verification of the area photographed in the second year and field completion of the entire project area. The third year's work as above was completed on schedule and the original manuscripts of the topographic maps have been produced for the entire project area thus making it possible to proceed to the fourth and last year right on time. The fourth year's work involves cartography and printing of the topographic maps.

Table 1. Yearly Work Schedule

Year	Job Classification	Work Volume	Remarks
First year 1987	Signalization Aerial photography  Minor order leveling Pricking	40 control Points scale : 1/60,000 3,000Km 21 courses  Strip photography: 1,500Km over leveling routes 731.3Km Existing routes - 700Km	5 points missing, 90% covered (out of 29,800Km <sup>2</sup> in total)  Pricking included  500Km covered
Second year 1988	Aerial photography Control point survey Minor order leveling  Field verification  Aerial triangulation Plotting Compilation	Scale : 1/60,000 760Km 13 courses 10 points, GPS observation 245.1Km (pricking included)  26,800Km <sup>2</sup>  755 models 11,475Km <sup>2</sup> (15sheets) 11,475Km <sup>2</sup> (15sheets)	Missing parts of the existing first order leveling route and connections to control points Area covered by 1st year aerial photography
Third year 1989	Plotting Compilation Field verification Field completion	18,325Km <sup>2</sup> (28sheets) 18,325Km <sup>2</sup> (28sheets) 3,000Km <sup>2</sup> 29,800Km <sup>2</sup> (43sheets)	
Fourth year 1990	Cartography (scribing) Printing	29,800Km <sup>2</sup> (43sheets)  43 sheets, 1,000 copies each	

## 2. Outline of Third year's Work

### 2 - 1. Outline

Judging from the progress of the second year's work, it was decided that the third year's work could proceed as originally scheduled covering as far as the complete production of original manuscripts of topographic maps.

The plotting and compilation were concluded by finishing the remaining sheets of 28 each as planned for the third year. Field verification of approximately 3,000Km<sup>2</sup> covered by aerial photography in the second year had to be rescheduled and conducted in parallel with field completion. The field completion was started upon completion of the compiled manuscripts in cooperation with SK and concluded as planned.

The compiled manuscripts were corrected according to the findings of the field completion and finalized as the original manuscripts of topographic maps. Transfer of map printing technology to SK was made in Kenya.

### 2 - 2 Work Periods

Work in Kenya	From	To
Headquarters	January 8, 1990	March 8, 1990
Field verification	January 14, 1990	March 6, 1990
Field completion	January 14, 1990	March 6, 1990
Work in Japan		
Plotting	September 4, 1989	November 10, 1989
Compilation	October 10, 1989	December 15, 1989

### 2 - 3. Organization of the Study Team and Periods of Dispatching

Responsibility	Name	From	To	Total
Leader	Sho Saito	Feb.22,1990	Mar.8,1990	15days
Deputy Leader	Kazuo Muraoka	Jan.8,1990	Mar.8,1990	60days
Mapping Planner	Mitsuo Yoshida		(ditto)	
Mechnician	Hironori Kobayashi		(ditto)	
Chief Engineer	Tadashi Hidaka		(ditto)	
Field verification/ field completion	Hideo Ishibashi	Jan.14,1990	Mar.6,1990	52days
	Yoshihiro Azuma		(ditto)	
	Minori Onaka		(ditto)	
	Minoru Arai		(ditto)	
	Yutaka Kokufu		(ditto)	
	Makoto Tsujimoto		(ditto)	
	Koji Yanagimachi		(ditto)	
	Norio Goto		(ditto)	

### 2 - 4. Work Volume

The work volumes for the third year were as follows:

- (1) Plotting: 1,50,000 18,325Km<sup>2</sup>. (28 sheets)
- (2) Complllation: 1,50,000 18,235Km<sup>2</sup> (28 sheets)
- (3) Field verification: 3,000Km<sup>2</sup>
- (4) Field completion: 29,800Km<sup>2</sup>

### 2 - 5. Plan and Progress

#### (1) Work Periods

The field work was conducted as originally planned starting from January 8, 1990 and ending on March 8, 1990 when the study team returned to Japan. Transfer of map printing technology was conducted "on the job" and materials necessary for the transfer were provided according to the plan.



	Original Schedules	Implementation
Leader	Feb.22,1990-Mar. 8,1990	On Schedule
Headquarters	Jan. 8,1990-Mar. 8,1990	On Schedule
Field verification	Jan.14,1990-Mar. 6,1990	On Schedule
Field completion	Jan.14,1990-Mar. 6,1990	On Schedule

## (2) Work Volumes

Work	Planned	Implementation	Remarks
Field verification	3,000Km <sup>2</sup>	3,000Km <sup>2</sup>	Out of the total 29,800Km <sup>2</sup> , an area of 3,000Km <sup>2</sup> Photographed in the 2nd year,
Field completion	29,800Km <sup>2</sup>	29,800Km <sup>2</sup>	28 sheets
Plotting	18,235Km <sup>2</sup>	18,235Km <sup>2</sup>	28 sheets
Compilation	18,235Km <sup>2</sup>	18,235Km <sup>2</sup>	28 sheets

## 2 - 6 Instruments Employed

The major instruments employed for the third year work are listed below.

### (1) Field verification/Field completion:

Transceiver (JRC-JSB20)	7 units
Plane table (Tamura type)	6 sets
Steel tape	1 set
Cloth tape	1 set
Pole	1 set
Compass	1 set

### (2) Plotting and Compilation

Coordinategraph XP1100 (Daini-Seikosha);	1 unit
2nd order plotter, Autograph 8 (Wild) and others;	10 Unit

## 2 - 7. Survey Chronicle

The Survey chronicle for the third year is annexed as Attachment 1.

## 2 - 8. Meetings with SK

Meetings with SK took place at the outset of the third year's work in early January 1990 and upon completion of the field work in late February 1990. The following is a recap of the discussions at these meetings.

### (1) Meeting at the start of field work (See Attachment 2-1-1~2-1-3).

The documents of the minutes were signed on January 23, 1990. In a meeting at the SK Field Headquarters, the JICA Study Team (hereinafter referred to as the "Team") and SK had the following discussions prior to the start of field work.

The Team reconfirmed the overall 4-year plan based on the Plan of Operations, followed by a report on the status of the second year's work and explanation on the third year's work schedule. After questions and answers, mutual understanding was reached.

Based on the above understanding, specific implementation procedures of field verification and field completion were discussed. Discussions proceeded to the selection of SK counterparts and availability of data to be provided by the Kenyan side, and mutual agreement was reached. Map symbols and cartography were separately discussed in a smaller group (See Attachment 2-2 Attachment 1).

### (2) Meeting upon completion of field work (See Attachment 2 - 2)

The document of the minutes was signed on March 2, 1990.

Upon completion of the field work, the Team briefed the SK on the status of the Project on the basis of the Progress Report, and SK agreed that the third year's field work had been completed. The map history to be printed on the topographic maps was discussed and agreed upon as proposed.

Opinions were exchanged on the method of cartography and proof checking expected to be done by SK during the fourth year. It was agreed to work out a specific method. SK was reassured of the provision of mapping paper and other material supplies to accompany the transfer of map printing technology. SK also agreed on the future handling of the survey vehicles as proposed by the JICA Kenya office.

## 2 - 9. Contribution of SK Counterparts

Cooperation was provided by SK in the form of SK counterparts who worked with JST to help collect data, guide and communicate with local residents, confirm geographical and administrative names in field verification and field completion.

The following counterparts joined the Team in the field operation in Kenya:

### Field verification/Field completion:

Mr. Z. N. GITAU	Jan. 23, 1990 - Feb. 24, 1990
Mr. S. O. OTWEYO	(ditto)
Mr. H. L. KIGAME	(ditto)
Mr. J. O. PESA	(ditto)

The following counterparts participated in individual training in Japan.

Mr. J. OGUTU	Jul. 18, 1989 - Sep. 7, 1989
Mr. P. MUIA	Jul. 18, 1989 - Sep. 13, 1989

## 2 - 10. Field Headquarters and Field Camps

The field headquarters was established in the suburbs of Mombasa City at PLOT No. 3934/1/MN MYALI MOMBASA. Field Camps were set up at Mombasa, Malindi, and Voi.

### 3: Plotting

#### 3 - 1. Outline

Based on the results of aerial triangulation and field verification, topographic features necessary for mapping were measured and delineated by a plotting machine to produce plotting manuscripts. During the second year, 15 sheets were produced covering the western block, and for this year the remaining eastern block was covered by 28 sheets. (See Figure 1 for the area covered.)

#### 3 - 2. Specifications

Plotting scale :	1:50,000
Area :	18,325Km <sup>2</sup> (See Figure 1 for the plotted area.)
Number of sheets :	28
Contour lines :	Intermediate, contour: 20m, index contour: 200m, half interval auxiliary contour: 10m (on flat land)
Projection :	UTM
Neat line :	15' east west X 15' north south
Plotting machine :	Second order or higher

#### 3 - 3. Planning and Preparation

The same operation manual as for the second year was applied. The results of aerial triangulation and field verified photos were put in order, and base sheets prepared.

#### 3 - 4. Plotting of Neat Lines and others

Base sheets were prepared as required for plotting of a planimetry sheets and contour line sheets respectively for each map sheet as well as for preparation of control point data maps, on which neat lines and other necessary items were plotted by coordinategraph. Specifically the work involved:

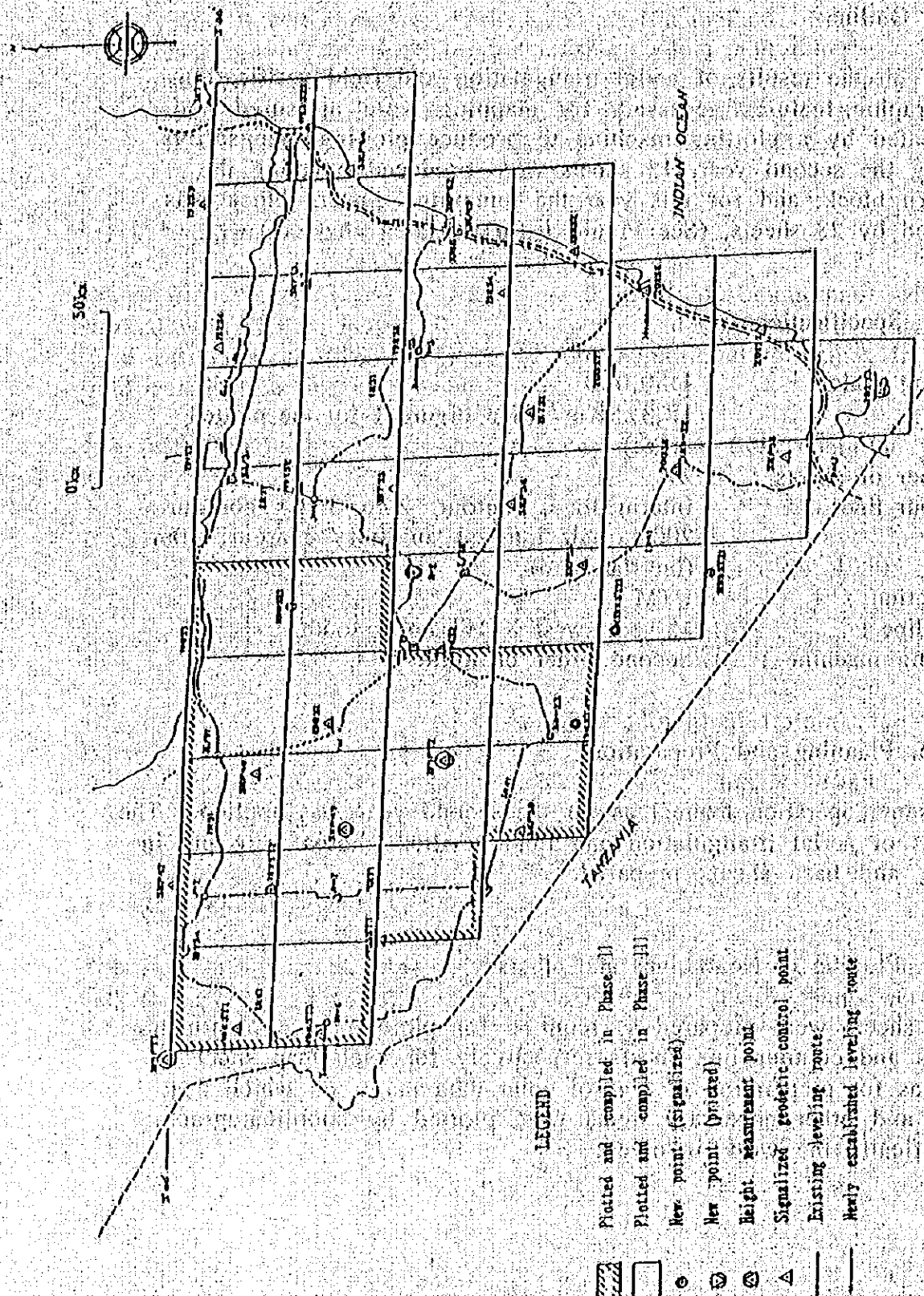










FIG. 1 AREA FOR PLOTTING AND COMPIATION

LEGEND

-  Plotted and compiled in Phase I
-  Plotted and compiled in Phase II
-  New point (signalized)
-  New point (marked)
-  Height measurement point
-  Signalized geodetic control point
-  Existing leveling route
-  Newly established leveling route

- 1) **Specifications of base sheets**  
**Material** - Planimetry sheet, contour line sheet:  
Polyester base #500  
Control point data map:  
Polyester base #300  
**Size** - 60cm X 80cm each
  - 2) **Volumes**  
**Planimetry sheet** - 28 sheets X 1 copy = 28 sheets  
**Contour line sheet** - 28 sheets X 1 copy = 28 sheets  
**Control point data map** - 28 sheets X 1 copy = 28 sheets
  - 3) **Coordinate graph**  
XP 1100 (Made by Daini-Saikosha)
  - 4) **Plotted Items**  
**Sheet** - **Plotted Items**  
**Planimetry/Contour lines** - Neat lines, grid lines (UTM)  
longitude/latitude lines, existing  
geodetic control points (provided  
by SK), photo control points,  
results of aerial triangulation  
(pass points, tie points)  
**Control point data map** - Neat lines
  - 5) **Tolerance**  
Plotting errors in neat lines, grid lines, control points, etc. are  
not to exceed 0.2mm on the map.
- 3 - 5. **Orientation**
- 1) After absolute orientation, difference in location between  
a plotted point on the base sheet and its equivalent in the  
model must not exceed 0.3mm on the map.
  - 2) For elevation, efforts were made to ensure the accuracy of  
topographic heights by using as many points such as bench  
marks contained in a model as possible.
  - 3) The record of plotting was kept for checking.

### 3 - 6. Restitution

As in the second year, operators and assistants were duly briefed on the map symbols, their application rules, specific method of detail plotting, map matching, in accordance with the specifications of detail plotting as set forth in the operation manual for restitution work so as to ensure the uniformity among operators.

With respect to the area of 3,000Km<sup>2</sup> for which field verification was expected to be done at the time of field completion during the third year, there were no field verified photos available so that photo interpretation was made of materials already collected.

Keys for photo interpretation to be applied in restitution work were developed from the existing 1:50,000 topographic maps, reference materials, survey results of surrounding areas, as well as from the experience gained during the second year. The restitution manuscripts for this portion of the study area were referred to the findings of field verification for checking and correction.

Since restitution work was conducted for three separate sheets of planimetry, contour lines and control point data map, a punch system was adopted to ensure matching between these sheets.

1) The colors used for restitution are as follows, (Ball-point pens and pencils were used as in the second year.)

- Black : Double line roads, railway, buildings, linear features, vegetation symbols.
- Red : Passes, indication symbols for specialized features, enclosures, small objects, revetments.
- Green : Vegetation boundaries, garden paths.
- Orange : Contour lines.
- Purple : Coast lines, rivers, lakes and ponds, fish nurseries, salt fields, riparian plants.

- 2) **Matching with adjoining sheets**
  - Matching of each restitution manuscript with adjoining sheets was made directly. Matching was also made with the existing 1:50,000 map covering an area north of 3° south latitude (produced by JICA and Canada) as well as with the Tanzanian side of the 1:50,000 maps of the Kenya-Tanzania border area being prepared by the Ordinance Survey. But where a discrepancy of more than 1mm on the map was found, no attempt was made for matching.
- 3) **Planimetry Sheet**
  - First linear features such as roads, rivers, railways, and then housing and vegetation, in that order, were measured and delineated according to the map symbol rule and the field verified photos.
  - Buildings were delineated truly in principle without generalization, but in concentrated areas such as urban cities they were generalized to an extent not to affect the opaqueness of lines.
- 4) **Contour Line Sheet**
  - Contour lines were delineated in such a manner as to maintain accuracy of elevation and not to affect terrain features.
  - Shore lines were delineated as they appeared at the time of aerial photography.
- 5) **Control Point Data Map**
  - Control points were shown by the relevant map symbols and their names, point numbers, and heights were indicated for each.
  - Locations of bench marks were machine-plotted and their point numbers and heights were indicated for each.
  - Spot heights were measured two times and their mean values were adopted for representation in meters.



Spot heights were measured at such places as major mountain tops, cols, major intersections of roads, knick points of major slopes, points typical of the area, bottom of depressions, other points necessary for identification of topography.

### 3 - 7. Checking and Accuracy Control

Upon completion of the restitution work, the restitution manuscripts, were compared with the field verified photos and collected data to check the conformity with the map symbols and matching with adjoining sheets. Accuracy control was performed for all map sheets.

## 4. Compilation

### 4 - 1. Outline

Compilation for the third year covered the area plotted in the same third year. Based on the restitution manuscripts, by incorporating the findings of the field verification and the research of existing data, map representations were compiled into the compiled manuscripts. At the same time, other necessary data for subsequent cartography were also prepared. The area covered by this year's compilation work is shown in Figure 1. A list of sheet names and sheet numbers of the map sheets is given in Figure 2.

### 4 - 2. Planning and Preparation

The operation manual the same as that of the second year was applied. The restitution manuscripts, field verified photos and other collected data were sorted out and assigned properly.

### 4 - 3. Plotting of Neat Lines and others

Neat lines and other necessary items were plotted on each map sheet to prepare compiled manuscripts, annotation data maps, road data maps, and boundary data maps.

### 4 - 4. Compilation

#### 1) Color Classification for Compiled Manuscripts

The same color classifications as used for the restitution manuscripts were applied for delineation of compiled manuscripts.

#### 2) Compilation Work

Compilation was done by the overlay method. Planimetry and contour lines were compiled on the same sheet. Details of compilation include the following.

- All roads were represented by symbols along with road names, and road numbers. Those within a built-up area were represented by a symbol reduced to 0.4mm in width.

TOPOGRAPHIC MAPPING IN SOUTH KENYA

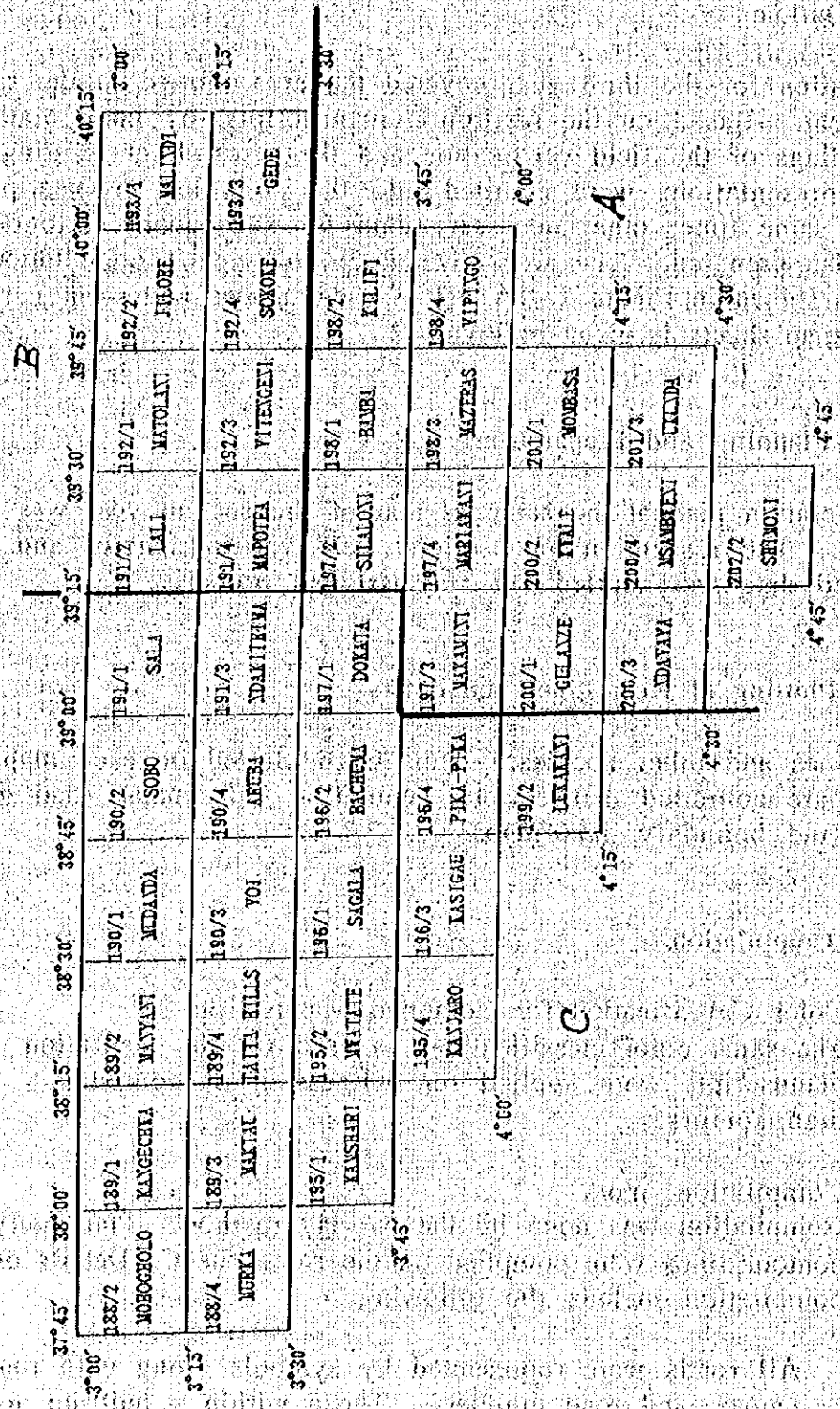


FIG. 2 MAP INDEX AND SCHEDULE OF FIELD COMPLETION

- Railway was symbolized by showing center lines of the track.
- Generalization of villages was made according to the map symbol rule.
- Buildings represented by solid black were thinned out as necessary to suit their environs.
- For where contour lines were close together in the mountains, care was taken not to have them hurt the topography.
- For where contour lines were close together in the mountains, care was taken not to have them hurt the topography.
- For those gas lines, power lines and water pipelines that were difficult to interpret on the photos, data provided by SK were referred to.
- Matching with existing map sheets was based on the reproduced maps provided by SK whereas matching of new map sheets was on the polyester based reproduced map.
- Magnetic declination was adopted as provided by SK.
- Doubtful points arisen while compilation were inscribed on overlay which was to clarify at the time of the field completion.

### 3) Annotation Sheet

- Lettering size, spacing, style, and positioning were done as specified by SK. But with respect to the letter types that are not available in Japan, swtable alternative letter type was used after discussion with SK.
- Annotation of destination was entered by SK at the time of field completion.

### 4) Data Maps

- Road data map  
The roads were classified by color as follows:

All weather road with bound surface	Red penciled solid line
All weather road with loose surface	Green penciled solid line
Dry weather road	Yellow penciled solid line

- Vegetation data map

A vegetation data map was developed for such items as forests, bamboos, thickets, plantation, etc., that require preparation of mask sheets. Vegetation data were shown on the positives copies (polyester base) of the compiled manuscripts according to the following color scheme,

Forest :	Green	Riverin trees :	Pink
Thicbet :	Blue	Mangrove swamp :	Purple
Bamboo :	Yellow	Tree swamp :	Brown
Plantation :	Orange	Papyrus swamp :	Red

- Hydrology data map

Hydrology data were shown in blue color for such items as rivers, lakes, sea, that require preparation of mask sheets similar to the preparation of vegetation data map.

#### 4 - 5. Checking and Accuracy Control

After finishing compilation work, checking was executed on the conformity with field verified photos and map application rule and the relationship between contour lines and spot heights. At the same time, questionable points were recorded to serve as matters to verify at the time of field completion. Accuracy control was executed on all sheets.

## 5. Field Verification

### 5 - 1. Outline

Field verification was conducted for the area of 3,000Km<sup>2</sup> remaining from the second year. (See Figure 3) This area was photographed in the second year although originally scheduled for the first year. It was after the field verification that the area was flown for photography due to the weather conditions. Since the photos for this particular area failed to be made available in time for the second year, field verification had to wait until the third year.

### 5 - 2. Planning and Preparation

As the field verification was preceded by plotting and compilation, restitution manuscripts and compiled manuscripts were restitution. A survey plan was developed on the basis prepared with beys for photo interpretation for surrounding areas. (See 3-6 Restitution) Therefore, doubtful points were clearly picked out. A survey plan was developed on the basis of available materials.

### 5 - 3. Implementation

Field verification was conducted along with field completion. The project area was generally flat forming peneplain. There are villages along the major roads like national roads. Further removed, there were expanses of svannas with few villages and few access roads for vehicles.

The following items were surveyed and verified as done for the rest of the project area in the second year.

- 1) Features that are difficult to interpret from photos
- 2) Roads, railways, buildings, water pipelines, special districts, rivers, vegetation, topography, etc. that are necessary for application of the map symbols.
- 3) Names that need to be identified for annotation by SK counterparts.

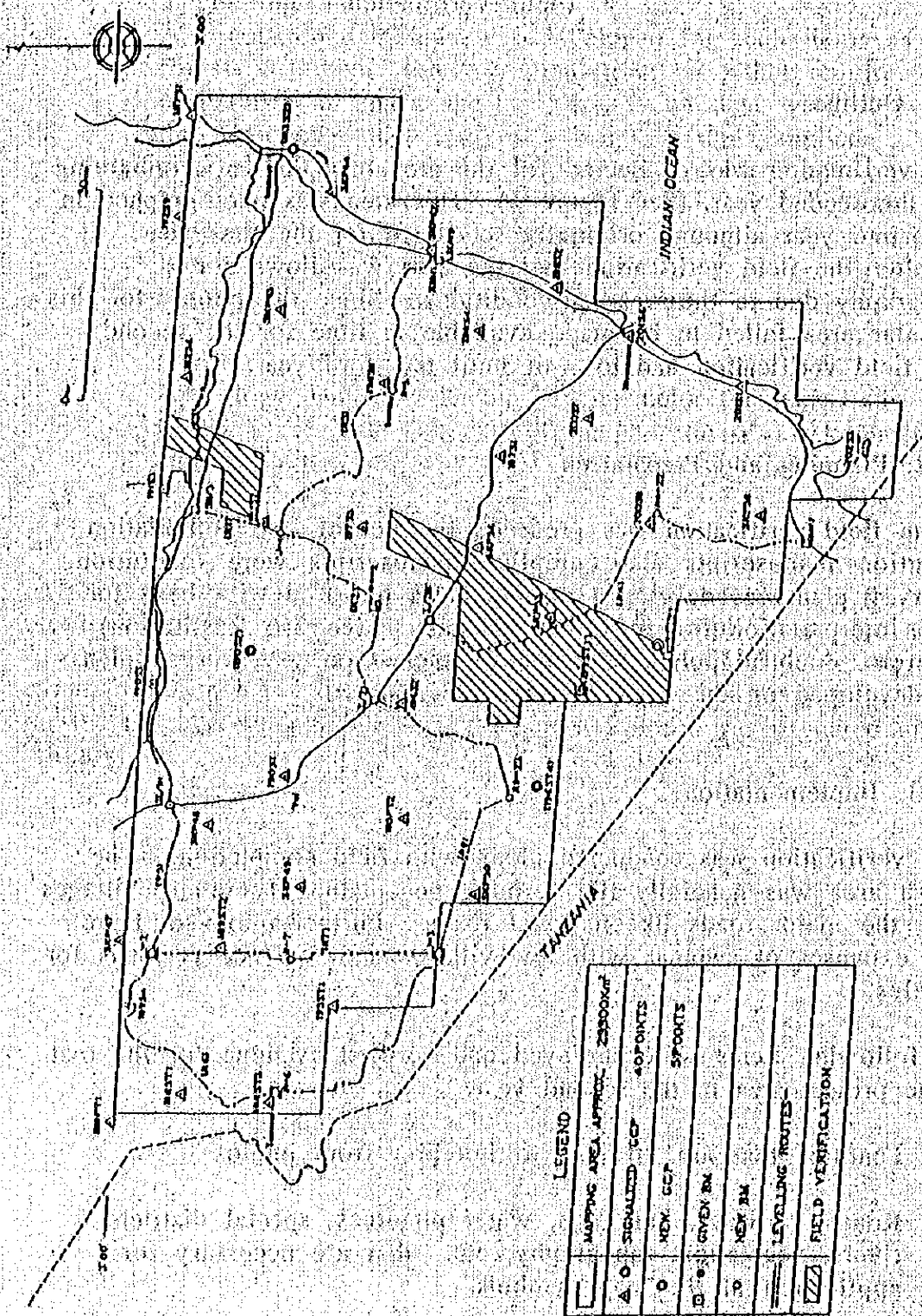


FIG-3 AREAS FOR FIELD VERIFICATION

LEGEND

[Symbol: Dashed line]	MAPPING AREA APPROX. 25000m <sup>2</sup>
[Symbol: Triangle]	SIGNALIZED CCP 40 POINTS
[Symbol: Circle]	NEW CCP 5 POINTS
[Symbol: Square]	GIVEN BM
[Symbol: Square]	NEW BM
[Symbol: Double line]	LEVELING ROUTES
[Symbol: Hatched area]	FIELD VERIFICATION

4) **Checking and sorting by SK of collected data and information on geographical names.**

**5 - 4. Adjustment**

The findings of the field work were edited on the aerial photos to be used for checking and supplementing the restitution manuscripts and compiled manuscripts.

**5 - 5. Checking and Accuracy Control**

Checking was made for missing data. Quality of adjustments and matching with the findings for other areas were examined in the field, followed by accuracy control for all aerial photos.



## 6. Field Completion

### 6 - 1. Outline

The field completion involved field survey and verification of important features such as topography, ground features, geographical names, that were shown in the compiled manuscripts and data maps, as well as clarification of the questions raised in the process of plotting and compilation. Significant changes that took place after aerial photography were also surveyed in the field at this time.

Since this was the last opportunity for the Team to meet and discuss with SK in the field, a sample map was prepared and taken to Kenya to have technical discussion on cartography and printing to follow. Also the occasion was made to serve as an opportunity for transfer of map printing technology as requested by SK.

### 6 - 2. Planning and Preparation

Field completion was planned for the entire area of 29,800Km<sup>2</sup> based on the 43 sheets of compiled manuscripts. Considering that this survey was to complete data and information necessary to make the original topographic manuscripts, planning and preparation were made as follows.

#### 1) Sharing of Field Completion Work

##### (1) Work to be done by the Team

- Technical discussions with SK.
- Survey and clarification of the questions raised in the process of plotting and compilation
- Survey of changes over years
- Receipt and confirmation of annotation data and boundary information

(2) Work to be done by SK.

- Technical discussions with the Team
- Clarification of administrative boundaries and names, other boundaries; preparation of data maps (showing administrative boundaries and names, cadastral boundaries on compiled manuscripts).
- Field verification of the annotation sheet and correction as necessary.
- Collection of supplementary information.

2) Preparation in Japan

(1) Reproduction of data

The following data were reproduced for use in the field completion.

- Compiled manuscripts (one duplicate each; three diazo copies on paper each, and two diazo copies on polyester base each)
- Composite of compiled manuscript and annotation sheet (one duplicate each and two diazo copies on paper each)
- Road data map (2 diazo copies each)
- Vegetation data map (2 diazo copies each)
- Hydrology data map (2 diazo copies each)

(2) Operation Manuals and other preparations

- Preparation of an operation manual for survey of areas to be covered by field verification.
- Preparation of operation manual for clarification of the questions raised in the process of plotting and compilation.
- Preparation of a sample map for use at the discussion with SK on cartography and map printing.
- Arrangement for shipment of equipment to be brought with the Team.

6 - 3. Implementation

1) Meeting with SK at the start of survey

Prior to the start of field completion, the Team and SK met to discuss the following.

- (1) Explanation and proposal of an implementation plan based on the Plan of Operation by the Team.

- (2) Explanation of the work done in Japan on the basis of the compiled manuscripts (reproduced) prepared by the Team and matching with existing sheets.
- (3) Discussion on details of survey procedures
  - Explanation on procedures of inscribing boundaries, administrative name, destination annotation and their confirmation to be done by SK.
  - Checking and examination of the annotation sheet to be done by SK.
  - Appointment of SK counterparts.
  - Related agencies to be informed.
  - Issuance of ID cards, permits for entry to national parks, etc.
  - Collection of data yet to be received by the Team.
  - Hiring of rangers, drivers, etc.

## 2) Implementation of Field Work

- (1) Four groups were formed, each consisting of 2 Japanese engineers and 1 Kenyan engineer, to be assisted by rangers, guardmen laborers, who were hired as necessary. The whole groups were controlled and supervised by the chief surveyor.
- (2) The base camp for field work (field headquarters) was established near Mombasa. The project area is divided into three areas A, B, and C as shown in Fig. 2. All groups worked in one of the divided areas at the same time and executed the survey on respective sheets based on the base camp Mombasa for the area A and on subcamps established at Malindi and Voi for the areas B and C respectively during the periods as shown below:

Area	Volume	Period	Sub-camp	Base camp
A	14 shts	19 Jan. - 4 Feb.		
B	8 shts	5 Feb - 11 Feb.	Malindi	Mombasa
C	21 shts	12 Feb. - 27 Feb.	Voi	

- (3) The work was divided between JST and SK engineers as described in 6 - 2; the former being responsible for verification of topography and planimetry and the latter for confirmation of annotations as entered on the annotation sheet and hearings from local residents.
- (4) Annotations were confirmed first with such local institutions as District Offices, Chiefs' Offices, schools, and when questions arose, local residents were contacted for hearing and confirmation.
- (5) The field completion was conducted most efficiently assisted by cooperation of local SK offices, local administrative offices, and local residents.
- (6) Survey and preparation of administrative boundaries, administrative names, cadastral boundaries, to be shown on the compiled manuscripts were performed by a separate group organized by SK in Nairobi.
- (7) Data maps prepared in the item (5) and annotation materials checked and confirmed in the field were submitted to responsible officials for inspection and approval and then delivered to the Team.

### 3) Technical Discussions on Cartography and Reproduction of Topographic Maps based on the Sample Map.

Technical discussions on cartography and reproduction process expected for the fourth year were held in a small group of the Team and SK members. Based on the sample map prepared by the Team for this purpose, specifications for marginal information, cartography, and printing were discussed. The discussions were noted in the Record of Discussion. (See Attachment 2 - 2).

### 4) Meeting with SK at the End of the Survey Work

- (1) Based on the Progress Report, prepared by the Team, the Team reported the meeting about the accomplishments of the field completion and its successful conclusion. Mutual understanding was obtained.

- (2) A report was made by the small review group on their discussions on the cartography and on the reproduction of topographical maps based on the Record of Discussion and understood by the meeting.
- (3) Opinions were exchanged on the method of checking and proof reading of the scribed manuscripts and final proof prints to be produced in Japan during the fourth year. The proofs are required to be read and checked by SK, and how to proceed with this phase of work was discussed.

#### 6 - 4. Adjustment

Data and information acquired from the field completion were sorted out and the compiled manuscripts were checked against them for correction before they were finalized as the original manuscripts. Data maps required for reproduction process were also checked and corrected by using the field completion data. As data maps to be used in the reproduction process, the road data maps, vegetation data map, hydrology data map were prepared.

#### 6 - 5. Checking and Accuracy Control

The original manuscripts and the data maps were checked against the relevant data and information, for error in representations, missing parts, or inadequate expressions for the base maps.

## 6-6. Technology Transfer

### 1) Field Verification and Field Completion

Four SK counterparts participated in the field work of field verification and field completion. They did checking, verification, correction of annotation data. Not only that, they provided enthusiastic cooperation for the surveying work in general and learned the surveying technology first hand through experience. At a later date, one of the counterparts said that they were impressed by our survey management method among others and learned very much in that respect. It is presumed to have had a similar impact on SK's higher ranking officials in the course of the survey work.

### 2) Map Printing Technology

This occasion of field work was made to serve also as an opportunity for transfer of map printing technology which had been strongly requested by SK. Materials for this technology transfer were shipped from Japan for use in the field. The list of materials like mapping paper, ink, printing plates, etc. prepared by the Team is given in Attachment 2 - 2 as an annex to the Minutes. Dr. Kazuo Muraoka, Deputy leader, explained to SK officials the specifications and features of these printing materials as well as how they were applied in the printing of a base map. SK engineers already had substantial knowledge about printing methodology and therefore learned quickly. And so there is every reason to believe the transfer of the technology has been successfully accomplished.

## 7. Comments on the Third Year's Work

The third year's work involved plotting, compilation, field verification (in parts) and field completion. And the original manuscripts of the 1:50,000 topographic map were completed for the entire project area. The following comments are in order on the third year's work.

- 1) Thanks to the sufficient time allowed, plotting and compilation were performed carefully enough. The area covered by this year's plotting and compilation amounting to 18,325Km<sup>2</sup> included 3,000Km<sup>2</sup> or one sixth of the area, which was not complete with field verification of aerial photographs.

In Japan where land use is highly complex, it is essential for photogrammetry to be preceded by field verification of aerial photographs and to have plotting performed based on the findings. When working on photogrammetry in other countries, it is difficult to distinguish and interpret vegetation boundaries and land use such as cities and villages, precisely from aerial photos alone due to differences in climate and culture.

Fortunately plotting and compilation as well as field verification had been performed for the other parts of the project area, providing information to develop keys for photo interpretation to assist plotting and compilation of the remaining area of incomplete field verification. Experience of the previous year helped. By assigning the team members who were familiar with the surrounding areas from plotting and compilation work, data were checked in the field for necessary correction most efficiently. In this particular instance, field verification meant much.

- 2) Assisted by the positive cooperation offered by the Kenyan side, the field verification and the field completion were accomplished in a relatively short period of time considering the size of the area to be covered. The Kenyan cooperation came not only from the SK counterparts who joined the Team in the field efforts but also from local administrative agencies which were most helpful with checking of geographical names to facilitate the survey.

Administrative boundaries and cadastral boundaries were delineated on the 1:50,000 compiled manuscripts by SK officials during the survey period. The work must have involved many SK personnel and without their cooperation it would have been impossible.