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the framework of the 2000 round of population and  
housing censuses

15-19 November 1999  
Addis Ababa, Ethiopia

## **A. CENSUS PREPARATORY ACTIVITIES**

### **b. Census mapping**

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**PRE-ENUMERATION MAPPING**

**Preparatory Activities:  
Planning, Administration and Training**

**Paper prepared for:**

**Training Workshop for  
National Census Personnel  
within the framework of  
the 2000 round  
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## **Summary:**

i. This paper examines pre-enumeration mapping from the perspectives of planning, administration and training - which are the first steps before production of Enumeration Area (EA) maps begins.

ii. The first section of the paper looks at the initial planning activities, for example, setting up a cartographic sub-committee and determining the sizes of EAs. This is followed by some cartographic administrative issues: eg, preparing work programmes and the mapping budget. The third part offers buying advice on cartographic equipment, and the fourth considers the recruitment and training of cartographic personnel. The paper concludes that pre-enumeration mapping takes about three years to accomplish properly, so an early start is required. It is essential to have an on-going mapping programme and a viable and permanent census cartographic department.

## **Introduction:**

1) Pre-enumeration cartographic activities vary from country to country, but in general they can be divided into two major overlapping phases: the first consists of the planning of the operations, the administrative actions to get them underway, and the training of the personnel involved. The second is the actual cartographic work in the office and field - including the demarcation of EAs - quality control, printing and distribution of the maps, and GIS preparations.

2) This paper examines the first phase, the planning, administration and training, and is divided into four sections, namely: I, the Initial Planning of Cartographic Activities; II, Cartographic Administration; III, the Procurement of Cartographic Equipment; and, IV, the Recruitment and Training of Cartographic Personnel. This is followed by a conclusion, and Annex I lists basic cartographic equipment and materials.

## **I. Initial Planning of Cartographic Activities:**

### **1. Examination of Previous Census Records:**

3) The first step in preparing to take a census is to **read the reports and files of the previous census**, in order to gain background information, and to learn about some of the requirements and problems that may arise. It is necessary to build on the experiences of the last census by searching for its successes and avoiding its mistakes.

4) This applies to the cartographic work as well as other census operations, and the **administrative report** or procedural history of the previous census will usually contain a chapter on the **cartographic work**. Because of the decennial cycles of censuses, it is inevitable that there will be key staff changes from one census to the next - through retirement, job promotion, transfers, etc, - and sometimes these

factors can result in staff turnover at awkward moments. So the systematic recording of census experience should in a small way compensate for this, by starting at the beginning of the preparatory work and continuing through all the subsequent phases.

## 2. The Census Planning Group:

5) The census operations, from the preliminary activities to the final publications, need to be tightly controlled and monitored to ensure that all the activities are in step. So it is essential to set up the central planning and coordination group, the **Census Office** as soon as possible.

6) This central Census Office should be headed by a very senior government officer (eg, Permanent Secretary or above) who will be the Census Director or **Census Commissioner**. He may be brought in from outside the statistical system, or he may already be the national head of statistics, and additionally takes on the role of Census Commissioner for the duration of the census programme, but either way, it is essential that this person is in place at least three years before the due census date.

7) The Census Commissioner's leadership is vital in getting the census operations underway and keeping them on track. Apart from leading and coordinating the exercise, the Commissioner's most important functions are to ensure that the census is adequately funded, and that the financial requirements are received when required.

8) There should also be a system of **census committees**, from a high-level ministerial committee, through to the Census Office's **technical committee**. The cartographic work, particularly in the beginning, will benefit from drawing on expertise and ideas outside the Census Office.

9) This can be done through a **cartographic sub-committee**, chaired by the head of the Census Cartographic Office (hereinafter the Census Cartographer), and consisting of persons, say, from the Geography Department of the University, and from government departments such as Lands and Surveys, Town Planning, Geological Surveys, the Roads Department, Forestry, and Agriculture. Apart from the courtesy of keeping them informed of progress, they can assist with such issues as knowing the availability and location of base maps and air-photos, and loaning drawing equipment and camping gear. In addition, because of their field contacts, they will have knowledge of field conditions in different parts of the country.

## 3. Early Opportunities to Test Base Maps:

10) The **census test** should take place about two years before the due census date. The Census Cartographer should use this opportunity to observe the exercise on the spot and to test the existing base maps in the field. However, the emphasis of the census test may not be to test the draft questionnaires in sample EAs, but in specific problem areas with different settlement patterns. For example: in a densely

populated rural area ; a coastal fishing area; a remote mountainous area; a semi-nomadic area with water points; or, a high density urban area, and so on.

11) But nevertheless, even if the basis of the test is not EAs, the Census Cartographer should go out with the enumerators and see if the test areas can be readily identified on the existing base maps - and if not, why not?

12) Let's take some examples: perhaps the scale of the map is too small for the densely populated rural area; or the coastal fishing camps are seasonal and not shown; perhaps the positions of the mountain villages are shown with 'hut symbols' but are not named on the maps - and there are no footpaths showing how they can be reached; or, the high density squatter area is not shown at all on the old base maps. These problems have to be solved, and the sooner the Census Cartographer knows about them the better.

13) Similarly, during the **pilot census**, the Census Cartographer should go out with the enumerators and study the actual pilot enumeration, for example, in the villages, in the mining camps, in the blocks of flats, on the islands - and see if the maps are good enough. Is the scale still too small? Are the sub-village names shown? Does the mining area have restricted access? Can its EA boundaries be easily followed? Does the map have a map-legend and a scale bar? Can the enumerators follow the maps? What would the enumerators like on the maps that is not there? - Ask them! After all, the enumerators are the people who use the maps!

14) The answer from enumerators - and from map users in general - will always be, "Larger scales and more details, please!".....Suggestions from rural enumerators may include, for example: show more paths between villages to help decide the enumeration route; show all the churches and mosques as landmarks, and indicate other social facilities; show more hills and stream names as identification points. Or, in the urban areas: show power lines and other features that mark location boundaries; show swampy areas where there are no houses - (don't leave anything blank!); show more street names (even local ones that don't have signs); show corner shops, rows of kiosks, the police station, etc. It is no good the Census Cartographer leaving this self-evaluation until the census enumeration. By then it will be too late, so use the early opportunities available.

#### **4. The Sizes of Urban and Rural EAs:**

15) One of the early basic decisions to be made by the Census Office must be the determination of the sizes of urban and rural EAs - in terms of the number of households or population. An **optimum EA size**, neither too large or too small, must be determined. The decision on the sizes of the EAs ultimately depends on the amount of funds available - and the duration of the enumeration. Another factor which may be considered are the sizes of the long and short questionnaires and the length of time it is expected it will take enumerators to complete them, and the sample size. In general terms, small EAs make the enumeration go faster but the costs are higher because more enumerators and supervisors must be employed. Printing and training costs also increase.

16) **It also increases the amount of mapping required:** if the EAs are small but the rural population density is quite high (eg, over 100 per sq.km) and the base maps are at relatively small scales (eg, 1:50,000), then often there is hardly any space to write the EA numbers and the names of the villages in the EAs, let alone any other details such as boundary features. So in this case the base maps would have to be enlarged to 1:25,000 to accomodate the extra details required - and that is a lengthy job. So unless the maps are very good, having small EAs increases the risk of confusion in 'congested areas' of the maps.

17) On the other hand, if the EAs are too large, the enumeration will take too long to complete - and even though there is a census reference point, this can be critical, particularly in the urban areas where there are a lot of short-term movements and 'census fatigue' occurs. Large EAs also increase the workloads of the enumerators, which can lead to unsatisfactory coverage and a lack of supervision. And with regards to the questionnaires, if a long questionnaire is being used in both rural and urban areas on a sample basis, this is where a higher level of supervision is required to ensure that enumeration is as rapid as possible, whilst retaining quality in completion.

18) An Enumeration Area may be defined as :

*"An area to be covered by one enumerator. It comprises part of a village, a whole village or several villages / hamlets, an estate, or all or part of an urban area. It should have identifiable boundaries where possible and must lie wholly within or consist of a lowest order administrative unit".*

19) The basis of an EA is a pre-determined range of households or population. For many censuses it is 50-100 households in the urban areas and 100-150 in rural areas. This is to provide equable work-loads for the enumerators and ensure that the enumeration is completed within an allotted period, eg, 7-10 days.

20) On average, an enumerator can complete about 20 questionnaires / households per day in the rural areas, so an area of 140 households would take about 7 days to enumerate. A few extra days can be added onto the enumeration period to cover difficult or remote areas. In urban areas, with problems of access and call-backs, perhaps only 15 questionnaires can be completed per day, so an EA of 90 households may take 6 days, which is long enough when, particularly in the capital city, the census is subject to critical scrutiny.

21) In marginal areas of sparse population, EAs may be larger in area and smaller in terms of the numbers of households they contain. These EAs therefore, should be kept at the lower end of the range by the cartographic field teams. Conversely, in densely populated areas the EAs can be smaller in area size but larger in terms of the households to be covered, so the upper end of the range should be the target.

22) However, for the sake of homogeneity and subsequent sample surveys, great efforts should be made to **keep EA sizes within the specified ranges**, except in exceptional circumstances, such as special areas, remote areas of very low population density, nomadic areas, etc. Where EAs are not within the specified



ranges, then an approved note can be photocopied onto the enumerator's and supervisor's EA maps, and the special arrangements necessary for enumeration can be brought to the attention of the district census officers, training officers, etc.

24) In a census, an enumerator is responsible for the entire area of his EA, so if a village has been built in his EA but is not shown on his map, he must enumerate it. **And it is very important that the boundaries of all EAs, rural and urban, should interlock like a jig-saw puzzle, covering the entire country.** It is then known as the 'EA frame', and assists with census planning and coverage.

25) The long-term aim should be to create **standard EAs**, whereby except for sub-division or amalgamation of complete EAs where required by population changes over time, no adjustments are made. This permits comparisons of data from survey to survey and from census to census.

26) Because EAs consist of a pre-determined range of households, they are more homogeneous than villages which are of no fixed size. So EAs are used as the basis for sample surveys based on the household. It is clear that if all the sample surveys to be carried out during an inter-censal period of ten years can have this same basis, then the data becomes more standardised and the quality of the data is improved.

27) Before any statistical surveys can be carried out however, it is necessary to have a master sampling frame (EA maps and lists) from which the survey samples can be selected. The sampling frame must show the exact number of EAs in each administrative unit, and the EAs must be consecutively numbered and coded. Segments of the selected EAs are then mapped at even larger scales and households within the segments are numbered and sampled during the surveys.

## **5. Defining Urban Areas:**

28) Another basic decision for the planners is the criteria to be applied in defining urban areas (cities, municipalities, town planning areas, population growth centres, trading centres, etc). The criteria varies from country to country but is usually based on either population size, social amenities or administrative status.

29) With regards to **population size**, if we define any place, for example, that has over 2,000 people as being urban, this may omit very large villages which have distinctively rural ways of life. In semi-arid regions with limited surface water resources, very large clusters of rural population can occur where there are artesian wells or other groundwater sources. In this case, **additional criteria** may be required such as the percentage of the population employed in the non-agricultural sector, or the availability of public amenities which we associate with urban life such as electricity, telephones, piped water, etc.

30) Other criteria may cover the **administrative status** of a locality, eg, as a district headquarters. That is to say, it is not the population size that determines its urban status, but only the fact that it is an administrative centre. There have been numerous cases where an isolated village in the mountains, having no more than 20

households, is designated as urban because it has a tiny office and a local official employed as a government administrator.

## 6. The Geocoding Scheme:

31) In order to process and tabulate census results by administrative areas - or by EAs, by villages, by wards, by special areas and by urban / rural - a geocoding scheme is required. Development of the codes is not always done by the cartographic office, sometimes the responsibility is with the data processing department or the demographic section, but it needs inputs from the Census Cartographer, who must have a complete knowledge of the various administrative areas and the ability to develop the system as changes occur.

32) But even if the Census Cartographer does not devise the scheme himself, he must check it with his own administrative lists to ensure that the number of digits for each level is correct, that there are no gaps, and that everything is uniquely identified. In turn, when quality control has been completed, he must inform those responsible for maintaining the 'master geocode', how many EAs have been demarcated in each of the lowest administrative divisions.

33) There may also be changes after the census where, for example, some urban EAs have been sub-divided to speed up enumeration, and the numbering system may have changed. These changes must also be incorporated into the master geocode, on the maps and in the data processing programme.

34) The **sequence** of the areas within each level must also be devised. There are three main methods:

Alphabetic: this is the simplest method: each administrative area within each level is listed alphabetically and numbered accordingly;

Traditional: here, for example, the capital city and its environs are listed first, then the remainder of the regions;

Geographic: here, the administrative areas, EAs, etc, are listed 'by neighbours', whereby the lists are devised 'serpentine fashion' from north to south at each level.

## II. Cartographic Administration:

### 1. Preparation of Work Programmes:

35) One of the first essential steps for the Census Cartographer is to make a **cartographic activities work programme**. This should list all the activities in each phase: - who is responsible for their completion; whether the tasks are to be done in the office or the field; their starting dates and duration; and the output, ie, the end result.

36) The success of the mapping - and ultimately the success of the census - will depend on how well, and efficiently, these work activities have been integrated into the overall census plan of operations. This is because the activities are closely linked and interdependent. For example, training of the field mapping teams cannot begin without the training manual being ready, which is itself dependent on the basic decisions of EA sizes, definition of urban areas, and the geocodes.

37) The next step is a **cartographic staff work programme** indicating the time and personnel required to complete each activity, and the grades and salary levels of those personnel. This must be done for office and field staff and will give the total estimated local personnel costs.

38) A detailed **calendar of mapping activities** (and an overall census calendar) should be produced after the first drafts of the work programmes are ready. A graphic calendar will show how the activities are interdependent. This used to be a tedious job when done by hand on drafting film, but now that project management software is available, changes are easier to make, so it is easier to keep the calendar up to date. The cartographic work programmes and the calendars should be incorporated into the census Master Plan (plan of action) and the project document.

39) A **production schedule** should also be produced. This shows how much of each activity is expected to be completed within specific time periods. For the cartography, for example, it can be estimated how much of each operation must be completed each month to meet the dates set out in the workplan.

40) The total population expected to be enumerated during the census can be projected and estimated when census planning begins, and, for example, once the population / household ranges of rural and urban EAs have been determined, estimates of the number of EAs can be made for each district. Production schedules can then be produced to show how many EAs must be completed in each month in order to meet the dates set out in the workplan.

41) Most operations are achieved by gradually increasing the number of people to do the work, so production is gradually increased to a maximum level. Production schedules will assist in the preparation of monthly budget requests and allocations, and can be used when writing progress reports.

42) Making periodic **progress reports** recording the progress of the various aspects of the mapping programme is essential for good census management. Progress can then be evaluated with reference to the production schedule, ie, recording the percentage of the work completed in relation to the time that is available.

43) It is also important that accurate records and files are made, so a **map register** book or card system must be maintained by the Census Cartographer. This lists each map produced, for example, by district, by title of map, rural or urban, map scale, date registered, drawing number, and perhaps the number of the filing cabinet the map is kept in.

44) **Communication and meetings** are also vitally important. Every person in the Cartographic Office should have the opportunity to make suggestions for improving work procedures and the quality of the work. And regular Census Office staff meetings and technical committee meetings - which must be attended by the Census Cartographer - are necessary to review progress, discuss problems and announce decisions.

45) In order that future census or survey activities may benefit from the successes and failures of the mapping programme, it is essential that a **procedural history** is produced. This is usually a chapter on **cartography** for the **preliminary report** and a more detailed one for the **administrative report**. The Census Cartographer should know from the beginning that such reports will be required, and that they will cover all stages of the programme, from preparing the inventory to producing the final report maps and graphs. It should contain dates when policy decisions were made, preparatory activities, copies of field forms and problems encountered. To be effective, the Census Cartographer should collect and file items for the reports as the programme progresses.

46) Because dates are an important input, it is strongly recommended that a **daily work diary** be kept by the Census Cartographer. For example, an A5 'week-to-view' diary is sufficient to briefly list the following: the work the Census Cartographer does each day; the work his staff are producing; the committee meetings held and decisions made; the persons the Census Cartographer meets, either in the office or on visits, and the outcome of the meetings. This should take not more than five minutes to complete each day and will serve to jog the memory when reports have to be written.

## **2. Cartographic Space Requirements:**

47) More office space per person is needed for the cartographic office than for most other census activities. This is because many maps are large in size and large tables are needed to spread them out. Everyone needs a large table or desk, and large drawers or upright cabinets are needed to keep the maps in. Additional space is required for map printing machines, photocopiers, computers, printers, stationery cupboards, filing cabinets, the two-way radio equipment, etc.

48) To illustrate the above points, typical cartographic office room requirements and a list of metric paper sizes most often used in a drawing office are shown below, as follows:

### Typical Cartographic Office Space Requirements - by room:

Census Cartographer's admin office: with computer and printer, etc;

Census Cartographer's working office: with light-table, map table, map-files and photocopier;

General drawing office: with map tables and files for about 6 core drawing staff, and extra during preparatory activities;

Administrative Assistant's office: with steel safe and radio communications equipment;

Map printing room: with two map printing machines and map tables;

Store room: for cartographic equipment, map printing paper, field camping equipment, tyres, etc.

<u>Metric Paper Sizes</u>	<u>Dimensions</u>	<u>Typical Scales / Maps</u>
A4	21 x 29.7cm	Enumerators maps/Report maps Index maps.
A3	29.7 x 42cm	Enumerators maps/Trading centre sketch maps/Census Atlas maps
A1	59.4 x 84cm	Maps of lowest administrative divisions (with EAs) - 1:50,000
A0	84 x 118.8cm	Maps of lowest administrative divisions (with EAs) - 1:25,000

### 3. The Cartographic Budget::

49) If the census is to be successfully conducted, there has to be an **assurance of regular and adequate funding for each of the three years**, from start to finish, of the pre-enumeration activities - including the cartography. Inadequate or delayed release of funds for any particular component will throw the entire sequence of activities out of gear and seriously jeopardise the completion of operations.

50) Preparing the **cartographic budget** for a mapping programme is complicated and must be done in consultation with others. The Census Cartographer must consult with his commissioner, with the demographers, with administrators and finance officers, with his own staff, and with equipment suppliers to ensure that things are not left out, undervalued or exaggerated. The availability of budget records and costs from the previous census can help in developing the budget.

51) The various elements that make up the cartographic budget, in terms of total size and as a percentage of the total census budget, varies widely between countries. Salary levels and the costs of fuel, vehicles, vehicle maintenance, travel, equipment and materials and renting buildings vary so considerably it is impossible to put figures on it.

52) **Mapping considerations** include, for example: the size and population of the country; the scope of the cartographic field work; whether there is complete coverage of 1:50,000 or 1:100,000 scale topographic base maps; whether they are less than 10 years old - or more than 30 years old; whether there are vast areas that have only 1:250,000 scale or less; whether air-photos or satellite images will have to be purchased in large numbers; whether the towns and cities have been mapped at 1:2,500 and / or 1:10,000; whether drawing equipment and map printing paper can be bought locally; whether the local agent for the map printing machine keeps spare parts, etc, etc.

53) All these things and many more make a great deal of difference to the costs, the personnel required and preparation times. Previous census base maps, for example, may have been well prepared and kept in good order, and these can

provide the starting point for the new work. But if they have been lost and new ones are required, then this can add months to the schedule - and to the costs.

#### 4. How Many Field Teams to Budget for?

54) Cartographic field work is the most extensive, time consuming and expensive of all pre-enumeration activities, so estimating how many field teams are required, and the number of field mapping assistants that are needed for each team, is an important budgetary requirement. The number of team days required can be estimated and projected from the previous census. Other factors which may affect the speed of the work are the quality of the available base maps, the settlement patterns and physical conditions in the field. If estimates are not made and too few teams are deployed, a lot of time can be wasted in trying to catch up.

55) Some points to consider when making the estimates are as follows:

- **Normally, the cartographic field work should not be scheduled to last for more than two years**, though there are exceptions, eg, if the population is very large, or if the mapping is being done in the inter-censal period with meagre resources. The necessity to finish the mapping as quickly as possible - whilst still maintaining standards - is due to changes which take place after field updating has been done, and the longer the time that has elapsed between map updating and the census, the more changes are likely, particularly in the urban areas;
- For the above reason, **the main urban areas should be scheduled towards the end of the field mapping, and the capital city should be done last of all;**
- **Field tests**, using one field team equipped with a Global Positioning System satellite receiver (GPS) and a vehicle and driver, should be conducted for about two weeks to see how fast the work goes using various methods. The Census Cartographer should lead the team of about four office cartographic assistants. The tests can be held in rural and urban areas near the office, and should be done before the field manual is finalised and before the field mapping assistants are recruited, so there is no delay in training them when they do arrive;
- The field tests should examine the following: **the daily rates of demarcating EAs per team by each of the following methods: household listing; household counts; population quick-counts; and structure counts;**
- Although not required for budgetary purposes, the Census Cartographer should also use the opportunity of being in the field to look at other working practices: eg, whether the GPS coordinates should be plotted on the maps in the field or in the office; whether the GPS 'waypoints' (coordinates used for plotting roads and tracks not

shown on the base maps) should be plotted in the field, downloaded into a handheld computer, written in notebooks or on field forms; whether the mapping assistants should work singly or in pairs; whether petrol supplies should be pre-paid or delivered in drums to the teams; etc;

- The methods should not be pre-determined in the office; trial and error in the field will determine the most suitable methods. Factors which will affect the speed of the work include: the percentage of villages correctly shown on the base maps; and, whether the boundaries of the lowest level rural divisions and the urban ward boundaries are shown on the base maps;

- Every area of the country will have different factors, but the daily rates of demarcating EAs by the preferred method can be used to estimate the number of teams required. Additionally, the amount of field updating to be done will assist in deciding the size of the teams, the methods of working, the urban and rural rates of honorarium required to ensure the cooperation of guides and other local officials, and the scales of the maps, etc;

- **Once a method of obtaining population / household estimates has been decided, and a daily rate of EA demarcation by that method has been estimated (eg, 4 EAs per day), the next step is to make the estimates for the number of teams required;**

- For this, the Census Cartographer will also need: the total estimated population to be enumerated in the census; the estimated rural and urban population in % terms; the estimated urban and rural household sizes; and, the average rural and urban EA sizes.

- For example, if:
  - the total estimated population is 30,000,000, of which 80% is rural and 20% is urban;
  - the average rural and urban h/h sizes are 4.5 and 4.3 respectively;
  - the average rural and urban EA sizes are estimated at 120 h/h and 80 h/h respectively;
  - the work is to be completed in two years using household counts at an average of four EAs per day, and;
  - constant petrol supplies and funds are assumed, then:

**Example: Estimating the No.of Field Mapping Teams Required:**

- $30,000,000 \times 80\% = 24,000,000$  rural pop
- $30,000,000 \times 20\% = 6,000,000$  urban pop
- $24,000,000 \div 4.5 = 5,333,333$  rural h/h
- $6,000,000 \div 4.3 = 1,395,349$  urban h/h
- $5,333,333 \div 120 = 44,444$  rural EAs
- $1,395,349 \div 80 = 17,442$  urban EAs
- $44,444 + 17,442 = 62,000$  total EAs (rounded)
- $62,000 \div 4$  EAs per day = 15,500 days
- $15,500 \div 300$  working days per year = 52 'work years' (rounded)

- 52 work years ÷ 26 field teams / vehicles = 2 years.
- Therefore, 26 field teams, each with a vehicle, would be required to complete the field mapping in two years. In addition, two overall field supervisors, each with a vehicle, are needed. A truck, for delivering fuel, food, camping equipment, etc, to the teams (and later, questionnaires for the enumeration) is also required, and the Census Cartographer will need a vehicle - total 30 vehicles.
- So if a field team is to consist of five mapping assistants (one of whom becomes the team leader), plus a driver and a vehicle, then (26 x 5) 125 mapping assistants would need to be employed. However, a few more than this (eg, 135) should be selected and trained, and these extra staff should be kept on a waiting list for possible future deployment to replace those dropping out or being dismissed, etc.

## **5. Inventory of Existing Maps:**

56) If there is a permanent and functional cartographic office with an on-going programme and long-term staff, then the inventory is less important, because the Census Cartographer already knows what he has and doesn't have. But if mapping is being started from scratch, then an evaluation of existing materials - the 'looking for a starting point' - is important. As the inventory is being done, an evaluation should be made on the usefulness of each sheet. The inventory should be systematic and written out in table format in a notebook. It can be done by scale: eg, 1:50,000 sheets - the number of copies available; the sheet name or number; the air-photography date; remarks (eg, map condition, boundary information), etc.

57) For each series and scale, an index map of the entire country (a sheet index) should also be drawn up, or photocopied from the Lands and Surveys catalogue and enlarged. **The sheet indexes** of the main base map series for both the rural and urban areas (eg, 1:50,000 and 1:2,500) are very important, and each should clearly indicate: the sheet name or number, the number of copies available and the publication date for each map sheet. The sheet indexes should be kept up to date if the local Lands and Surveys department are producing new editions.

## **6. The Search for New Base Maps:**

58) Depending on what the inventory came up with, the Census Cartographer must then look for new maps. The search for new maps can also be valuable because it brings him, and the members of the cartographic sub-committee, into contact with other cartographers and geographers in the country, and informs them about the census preparations.

59) All departments visited in the quest for new maps will be interested to hear about the census mapping, but many may not be able to help much, and some have maps only of their areas of interest. But valuable information can be gained into these departments' present programmes.



60) The following departments should be visited:

- Lands and Surveys: - to find out what topo sheets exist, at what scales, what is out of print, whether file copies or repro-materials may be printed '**for census purposes only**', ie, a project of national importance, and what their future plans are. Also to see air-photo indexes, and to enquire about the cost and availability of air-photo films and prints, developer and fixer, and to discuss the feasibility of obtaining some satellite images from a regional centre. They may also have done some computer-assisted mapping (CAD) or have established a Geographical Information System (GIS), and may be able to demonstrate their capabilities;
- A '**free exchange of maps**' may be agreed, eg, Lands and Surveys supply two free copies of each of their maps, and in return the Census Office supplies two free copies of each updated census map after the enumeration. This assists with long-term cooperation and is well worth pursuing;
- Town Planning Department: - for boundaries and large scale maps of designated 'town planning areas', ie, trading centres and small towns scheduled as population growth centres - but check whether the plans show proposed or actual development. Again, a free map exchange may be worked out ;
- Geological Survey: - they may have some enlargements of topo sheets on film;
- Water and Sewerage Authority: - for large scale maps of water supply project towns - with or without pipe lines marked on;
- Ministry of Agriculture: - their drawing office may have enlarged air-photos or photo-mosaics of rural project areas;
- Geography Department of the University: - their map library may have maps that are out-of-print elsewhere, and which may be copied for census use;
- Military Survey: - they may have maps that were previously for military use only, but which may now be used for census purposes only. If they know it is for a government project of national importance they can be very helpful. Anyway, it is advisable that they are informed about the census mapping programme, and, for example, that only standard GPS equipment will be used in the field;
- International Agencies: - such as UNFPA, UNDP, UNICEF, FAO, USAID, DFID (British Aid), GTZ, Norwegian Aid, etc, may have projects with a mapping element. They may only cover project areas, but may include some up-to-date field work. Occasionally, they may have some

maps or air-photos they have commissioned themselves and are not generally available in the country.

## **7. Administrative Lists and Village Lists:**

61) Lists of all administrative areas and their sub-divisions, right down to village level, must be obtained before the field mapping teams are trained, so that the lists can be discussed during the training. The teams must be taught to use them as **check-lists**, eg, ticking the villages off as they quick-count them so that nothing is missed out.

62) The administrative lists should also be used when numbering the EAs within the lowest administrative level to help ensure that the numbers are consecutive and no area is missed. Also, during the checking process (quality control) after the field work, the team leaders must 'account' for any village that is on the original list but not on the field returns.

63) A country's **administrative divisions** are known as 1st Order, 2nd Order, 3rd Order, etc, ie, the hierarchy from the top to the bottom. Therefore:

- the first set of lists will be of the 1st order administrative divisions such as regions, provinces and governorates;
- the second set of lists will be of all the sub-regions within the first order, such as districts or mudiriyah;
- the third set of lists will be of all the sub-divisions of the districts, such as sub-counties or traditional authorities (chiefs);
- the fourth set of lists will be of all the parishes within the sub-counties, or of all the uzlahs (markaz) within the mudiriyahs; and,
- the fifth set of lists will be of all the villages within the parishes or traditional authority areas.

64) The starting point for geographic lists (and geocode lists) of administrative areas can be those prepared during the previous census, and they are updated by changes made in the inter-censal period. These changes should have been set out in the government gazette or any other official notification that creates new administrative areas or towns, or makes changes to existing ones. Occasionally, in remote areas far from central government control, eg, in semi-nomadic areas, local traditional leaders may have made their own administrative arrangements which are not gazetted, but these boundaries may not be recognised nationally.

65) **Village lists** may be obtained from previous census data processing records, but new ones should be obtained during the early preparation stages from the various district headquarters or other competent local authorities.

*- A village may be defined as 'a distinct population cluster (or locality or settlement), in which the inhabitants live in neighbouring living quarters, and which has a name or locally recognised status, eg, a village headman, a village council, or its own land'.*

66) The names on the village lists may have been obtained by district authorities from local tax lists or local councils lists. That is, for example, the villages on the lists have a headman recognised by the local authorities, eg, the district council, and who is authorized to collect a local tax under the village name, or perhaps they have a recognised chairman and their own local council.

67) A sub-village or hamlet on the other hand, may be a distinct population cluster or locality, but it does not have a headman recognised by the district council, and so comes under the authority of the main village headman. The status of a sub-village however, can change to a village if it grows in population size and the local people want their locality to be of village status with a headman.

68) **It is this change of status** that makes it very important for field mapping teams to check their village lists carefully and not to just accept what has been given them by the District Council or the Census Cartographer. So when the teams are introducing themselves to the village headmen or village council, they should check the current status of the villages on the lists, and get lists of the sub-villages under the main ones.

69) In accordance with the country's definition of 'urban', separate lists will also have to be made of all the **urban places** (cities, municipalities, towns, town planning areas, trading centres, etc) and of all urban wards within those places. These will have to be obtained from the municipality or the town planning department, who may have special requests, for example, that the census codes everything within specified town planning area boundaries as urban, even though some may be distinctly rural in appearance at the time.

70) The Census Cartographer must also obtain lists of **educational institutions** such as teacher training colleges, secondary and primary schools from the Ministry of Education; and **health facilities** lists of hospitals, health centres and dispensaries from the Ministry of Health. He will also need **protected areas** lists of the national parks and game reserves from the Ministry of Tourism, and lists of the forest reserves from the Forestry Department.

71) The field mapping teams should also note other **social amenities** such as: churches, mosques, markets, traditional courts, postal agencies, police posts, etc, and these should be added to the maps, and to the EA listing forms if people actually live in them. At the same time they should check the names of **other inhabited places** in the surrounding area, such as farms, ranches, road camps, railway camps, mining camps, fishing camps, agricultural stations, boarding secondary schools, etc, to ensure that nothing is missed off the maps and field control forms.

72) The Census Cartographer must also prepare **Special Areas** lists of anything that will require a special geocode - national parks, game reserves, forest reserves,

etc, and areas that will require special enumerators and enumeration procedures such as army camps and restricted port areas.

### **III. Procurement of Cartographic Equipment:**

#### **1. Drawing Equipment and Supplies:**

73) After the initial planning of cartographic activities has been undertaken, and the work plans and staff required for their implementation have been prepared, the next step is to assess the amounts and kinds of cartographic equipment and materials needed to carry out the pre-enumeration mapping. Experience from the previous census will also provide useful guidelines.

74) The types of equipment and materials required will depend on the methods to be used in the office and the field, the amount of work to be done, and the number of staff to be deployed. It is not possible to be precise on the quantities of the many things needed, particularly the expendable items, but some estimates can be made by taking into account the types, numbers and sizes of the maps to be prepared and printed before the enumeration.

75) An important point is that it is necessary to make budgetary provision for the **basic equipment and materials** needed to carry out the various tasks listed in the work plan. Sophisticated and precision equipment may be obtained if funds are available and trained personnel are there to use them. But the primary thoughts in the mind of the Census Cartographer must always be, firstly and most importantly - **what do I need to get to the enumeration?**, and secondly, what is needed for the report mapping and GIS development?

76) As stated previously, three years preparation time is needed for pre-enumeration mapping, so purchases should be planned and budgeted for by year. For example, the GPSs must be ordered in the first year so that they are available for field work, but the scanner and plotter may not be needed until after the enumeration, ready for the report mapping.

77) It is necessary to divide the requirements lists up into non-expendable (capital) equipment and expendable items (consumables). A common definition for capital equipment is 'anything that lasts for five or more years'.

78) But it is also necessary to list the requirements into those things that can be purchased locally, and those that need to be ordered from outside the country and purchased with foreign exchange - or to be obtained through external funding from either bilateral or multilateral donors. And if equipment is to be obtained through a donor then strong justification is required as to why it is needed.

79) Some important points to consider when **ordering equipment from overseas** are:

- The Census Cartographer must know **exactly what he wants**: in terms of quantities, full specifications, catalogue numbers, suppliers

and approximate costs. These must be known before the order is placed, otherwise administrators processing the order may supply the wrong things, which can be an extreme waste of time and money ;

- It is therefore, wise to obtain some catalogues before placing the order, and to write to manufacturers if more information is required. Items bought locally can be taken back if they are wrong, but it is very difficult to send back things ordered from outside the country;

- With regards to the time and weight factors, some cartographic equipment is extremely heavy (eg, map filing cabinets, printing machines), and so the articles may be sent by sea to avoid excessive air-freight costs. But sea-freight can take six months from ordering to receipt, particularly if the local port is congested. These possible delays have to be taken into account when ordering;

- Again, with regards to weight, if the shipment is extremely heavy it may need a fork-lift truck to unload it from the delivery lorry, rather than local labourers, who perhaps cannot support the weight. If it falls, long-term damage can easily occur;

- With regards to airfreight costs, if map cabinets, for example, are sent by air-freight from the USA, the cost of the airfreight can exceed the value of the goods, which is wasteful of project resources;

- Even if the equipment is not particularly heavy, administrators may still send the things by sea unless it is specifically requested that they must be sent by air-freight;

- With regards to imported goods made of wood, it is not necessary, for example, to pay US\$1,000 for an imported light table if the local carpentry workshop at the Ministry of Works can make one in half the time for the equivalent of \$200. The same can apply to drawing tables and office desks. With furniture, see what is available locally first.

80) It is not practical, for the purposes of this paper, to prepare a comprehensive list of equipment, with specifications and funds needed for a census cartographic office, because the quantites will vary according to the needs of individual countries. However, a basic list of non-expendable equipment and expendable items suitable for pre- and post-enumeration mapping is shown as Annex I.

## **2. Map Printing Machines and Photocopiers:**

81) The end product of the pre-enumeration mapping is **printed copies of the EA maps** for the enumerators and other census field staff. So clearly, ordering and maintaining the map reproduction equipment is extremely important. It is also absolutely essential that the **cartographic office has its own map printing machines and photocopiers**, and does not have to borrow them, or print in another

department or hire commercially. Getting this priority right early on will save a lot of time and money in the long-term.

82) Wherever possible, and if funds allow, the cartographic office should have **two map printing machines and two photocopiers**, in case of breakdowns and lack of spare parts. These need not be purchased at the same time, nor be of the same make or model, but when printing of maps for the census field staff does get underway, the workload is so heavy that breakdowns and delays are extremely likely, and the local agent may not carry a full range of spares. A delay in the reproduction of EA maps just before a census can be disastrous, and the cartographic office will bear the responsibility if, through lack of planning and foresight, they have not made adequate provision for printing the maps!

83) So when the Census Cartographer has decided on his methods, he must visit the local agents of map printing machines and photocopiers, etc, and find out the specifications and prices of the machines, what spare parts and consumables are stocked locally, and delivery times. When he is choosing a make and model of map printing machine and photocopier, **it is vital that installation and servicing of the reproduction equipment is available locally**, otherwise serious delays can occur.

84) The agents must **guarantee** that the models ordered can be installed and serviced by local technicians, and that the main spare parts are stocked locally. In fact, the major manufacturers now ensure that their local technicians are regularly trained at their regional training centres on the models sold within a particular country. It is no longer acceptable for an agent - or the Census Cartographer - to take a photocopier to a neighbouring country to have it repaired or serviced.

85) Map printing machines and photocopiers are often categorized by their output volume - either high, medium or low. High volume machines are relatively expensive, and low volume machines will suffer breakdowns if they are overworked at enumeration time. Medium volume machines will usually be sufficient and more cost-effective, and it is usually better to have two medium volume machines rather than one high volume one. This applies to both printing machines and photocopiers.

86) It is clear that EA maps are not printed in large numbers of few maps, but in small numbers of many hundreds of maps. Five or ten copies of each of the EA maps - for the enumerators, supervisors, district census officers, etc, may be sufficient for the enumeration. Therefore, it may be false economy to have high volume printing machines and photocopiers in the cartographic office when the feature is seldom required. Where the output will usually be less than 1,000 running metres (or about 5 pkts each of A1 and A0) on the map printing machine, or 5,000 photocopies per month - only medium volume machines are required. It is worth repeating that to ensure against breakdowns at peak periods, two printing machines and two photocopiers are required.

87) The most important feature to look for when purchasing a map printing machine or photocopier for census mapping purposes is a **50-200% zoom lens** to change the scales of the base maps.

88) The key to providing good, clear EA maps for enumerators is to ensure that the (standard) scales are approximately proportional to the densities of population of the areas covered by the maps. And the quickest and easiest way to change the scale of a base map is to use the zoom lens on a map printing machine or photocopier. The days of using pantographs, Grant projectors, proportional dividers and proportional squares for enlarging and reducing map scales are out! And when zoom lens printing machines and photocopiers have been obtained, it is also no longer necessary to have access to a photographic dark room with a process camera and film. This method, though accurate, is also extremely expensive.

89) However, as the cost of a map printing machine with a zoom lens is much higher than ones with only same-size capabilities, it is only necessary to have one zoom lens printing machine in a cartographic office, the other can be a same-size model. But with photocopiers, the costs of zoom lens copiers are now so reasonable that the purchase of two of them is entirely feasible - and practical if delays at critical periods are not to occur.

### **3. GPS Satellite Receivers:**

90) The Global Positioning System (GPS) is an American satellite navigation system designed by the US Department of Defence, originally for military purposes. It consists of 24 'NAVSTAR' satellites which orbit the earth twice a day at an altitude of 11,000 miles (17,700km), transmitting their precise position and elevation.

91) The signals received from the satellites allow the GPS to compute the precise distance from the best placed satellites above the horizon to the user's location. This is done by measuring the time between transmission and receipt of the signal. Once the receiver has calculated this data for at least three satellites, it's approximate coordinate location on the earth's surface can be determined, and if data from at least four satellites is computed, it will more accurately locate the user in three dimensions, ie, the coordinates and the altitude.

92) Older, basic GPSs can track up to 8 satellites (out of 24) at the same time, and the latest models can track 12 satellites at once, so giving quicker fixes. They have a built-in antennae that receives signals from all GPS satellites that are visible from the user's position. The GPS should be held so that it is flat to the horizon, with a clear view to the sky. The GPS will then automatically lock onto the strongest signals in view from horizon to horizon.

93) The system was originally designed for military purposes in the '80s, but the availability and suitability of receivers for civilian use was not widespread until the '90s. In the early days there was sometimes the problem of their acceptability by the military for civilian use, and by the local Lands and Surveys department, who felt that the Census Office was doing their job. However, nowadays their use is becoming widespread in the region, and because of increased sales, the prices have come down. Even five years ago the cost of GPS receivers was too high for census organizations to purchase in large numbers for cartographic field teams. But recently their cost has fallen markedly and they are now an indispensable tool for census mapping.

94) The introduction of reasonably-priced GPSs (eg, \$250 each) in the past few years is starting to transform the accuracy of census mapping, particularly in the rural areas, for which they are most suited. Before, when villages were plotted 'by eye', errors of more than 1 km were commonplace and not easily verified, but nowadays we expect villages to be plotted within 100 metres of their true positions.

95) **When ordering GPSs, the following points should be considered:**

- As a rule, census mapping does not need highly-accurate and expensive receivers with moving maps, US databases and detailed specifications for navigation. Basic models with accuracies of between 25-100 metres are sufficient, and they now show the *expected* accuracy of coordinates on screen, so that parameters can be set;

- Supplying one GPS receiver per field mapping team is usually sufficient, though every team member should be trained how to use it. GPSs are needed for plotting coordinates of villages, tracks, EA boundaries, administrative boundaries, social features, etc, in the rural areas and, additionally, plotting street junctions in urban areas;

- One problem with GPSs is that they do not give accurate coordinates if the user is standing next to a large building, because the GPS cannot 'see' sufficient satellites. So updating urban maps with scales of 1:2,500 or 1:5,000 can still largely be done 'by eye' in the towns. But if urban GPS mapping is required, (eg, plotting high density unmapped areas), then one high-accuracy (5 metre) Differential GPS (DGPS) receiver and a radio-beacon for position corrections could be purchased. But in general it is a waste of money to give expensive DGPSs to field teams who may easily lose them, drop them and not need their features;

- Look for models that have a **memory** of at least 250 or 500 coordinates. Otherwise, for example, when plotting waypoints (coordinates for tracks that are stored in the memory when travelling in a vehicle), you will have to keep stopping, reviewing the memory contents and writing them in notebooks (or downloading them into a hand-held or laptop);

- Look for models with at least 100 map datums stored in the memory, or you may find that you cannot programme the GPS to the datum(s) applicable to your country;

- Look for models that can be connected to a hand-held or laptop computer in the field. At current prices, it is clearly not cost-effective to supply many field teams with hand-helds, but the feature can be useful if, for example, the Census Cartographer himself is doing some updating;

- Choose models that are of rugged construction, small and light-weight, have internal antennae and can be connected to the



vehicle cigarette lighter. This will save the batteries when working in the vehicle. Cigarette lighter adapters and carrying cases should also be ordered with the GPSs, but external aerials are not necessary;

- Another problem with GPSs is that they consume a lot of batteries. They work for only about 24 hours continuously before the batteries have to be replaced. They have automatic shut-down but field teams must be instructed to turn them off when not in use and to use the vehicle cigarette lighter adapter when travelling in the vehicle. Order models that use common alkaline AA batteries available in rural trading centres, and ensure the teams are supplied with funds to buy batteries;

- Finally, choose well-known makes with well-written manuals and quick-start instructions, eg, Garmin, Trimble, Magellan or Topcon. Servicing is not required unless they are damaged, but select models that have local agents where advice can be given, and they can be sent back to the manufacturers for service if required.

#### **4. Radio Communications Equipment:**

96) One of the most serious problems encountered with cartographic field work is **lack of communication with the field teams**. It may be argued that if the teams are out of touch, then they are out of control. If the Census Cartographer does not know what is going on at all times in the field, it can seriously hamper progress and affect the quality of the work, particularly in countries that have a poor telephone network. In these circumstances the purchase of radio communications equipment is recommended.

97) It is too expensive to have every field team equipped with a two-way radio, so the solution is to have the two or three overall supervisors, who supervise the teams and, for example, deliver their petrol in drums, to have radios and aerials on their vehicles. In addition, a base station radio and aerial are required at the cartographic office. Before ordering the equipment, the first step is to obtain a government licence to use it. The local agent will help with this and will undertake installation and servicing.

#### **5. Camping Equipment::**

98) The initial cost of purchasing camping equipment is high, particularly for large imported field tents. And there are many other items to buy as well - mattresses, pillows, blankets, cooking utensils, etc, etc. But savings are made in the long-run because the costs of keeping cartographic field teams in district rest houses or in renting local houses is even higher. And providing sufficient field allowances to cover buying food over long periods are, again high. Furthermore, if the tents are good quality and well-stored, they can be used in subsequent censuses or surveys. Another problem with staying in rest houses or renting is that they are often far from the actual work areas, so the cost of fuel increases.

99) In some countries there is little 'camping tradition', and, for example, teams are able to stay with villagers for the price of a chicken, or in local mosques in emergencies. But nowadays, the possibilities of staying with local people are limited. For these reasons, the purchase of good quality camping equipment for cartographic field work is recommended, and a list of the main items required is shown in Annex I.

## 6. Vehicles:

100) In our example, 'How Many Field Teams to Budget for?', we noted that with a population of 30 million, about 62,000 EAs would have to be demarcated, and for this to be done in two years, 26 field teams would have to be deployed, each with a vehicle. **It is absolutely essential for each field team to have its own vehicle.** If teams have to share a vehicle the work goes so slowly that it is no longer cost-effective. We also noted that two vehicles would be needed for two overall supervisors, and one would be required by the Census Cartographer for field trips and local running. In addition, a truck would be needed. Thus 30 vehicles would be required in total.

101) However, the provision of sufficient 4WD vehicles for cartographic field work has proved to be difficult. This is partly due to the increasing costs of vehicles, fuel and maintenance, and partly because donors are reluctant to supply new vehicles for second censuses. Because of high running costs, statistical offices are unable to keep a large pool of vehicles in the inter-censal period, and then find it difficult to increase the pool at census time. These start-up problems involving vehicles have in turn led to delays in completing census mapping within the specified schedule, and in turn, some governments have had difficulties in supplying sufficient vehicles for the enumeration itself.

102) The donor's view is that for subsequent censuses, governments are responsible for census transport, and that the census, being a national exercise and not a project of the statistical office, so should be given the highest *national* priority. They also cite numerous past instances of vehicle mis-use, hi-jackings, of donor-supplied vehicles being sold privately, vehicles being transferred to other departments after the census instead of being used for the inter-censal survey programme, etc, etc.

103) There is no easy answer, and some statistical offices have had to resort to hiring vehicles at great cost because they are not available from government sources. Whilst this may be a satisfactory short-term solution for census enumeration - where vehicles are only required for a few days at a time, it is not satisfactory for cartographic field work, where they are required for two years and have to undergo rough treatment on impassable roads in the bush. Private hire drivers will not subject their vehicles to this and may refuse to cooperate. One country had a government-run 'public vehicle hiring organization' (PVHO) where government departments could hire used vehicles on a monthly basis. This is a good idea if the rates are reasonable.

104) The most suitable 4WD vehicles for cartographic field work are station wagons that have a large carrying capacity, such as the Land Rover Defender, the

Toyota Land Cruiser and the Nissan Patrol, and they should be supplied with roof-racks (and extra fuel tanks for the Land Rovers). Administrators tend to look only at prices rather than specifications, and in the past have sometimes ordered small Suzukis without realizing the size of a field team. However, small Suzukis are not suitable, particularly over rocky terrain, they can turn over and they vibrate continuously. They are also too small for a field team, so field mapping assistants are in no fit condition for continuous field work in rural areas.

## **7. Choosing GIS Software:**

105) The cartographic field work consists of three main strands: updating base maps, undertaking quick-counts, and demarcating EAs. When these have been completed in the field and the final EA maps have been produced on paper and printed for the census enumeration, the next step is to establish and maintain a Geographical Information System (GIS). A GIS may be defined as:

*- A GIS is a system designed to enter, store and manipulate data which relates to locations on the earth's surface. GIS computer technology may be used at scales ranging from global to municipal depending on the nature of the problems being addressed and the detail of the data.*

106) The main reason for choosing a GIS is functionality, ie, the features it has, and it is important that the GIS has the features that the user needs. However, the more features it has, the more it will cost, and a lot of features means a large system with extensions, which also cost money. On the one hand one should not buy more than is required, but on the other, buying less than is needed may lead to failure to attain goals and cause frustration among users. Since a package may not contain all the functions which one thinks one needs, one may have to buy more functionality than required. But a comfort in this situation is that one can probably use more functions than one first imagines, as the GIS develops.

107) After functionality, the main criterion for most users is the type and quality of the support available, such as training and documentation, ie, the clear manuals. The Environmental Systems Research Corporation (ESRI) has a great advantage in this respect, in that it has a large distribution network and can offer international support. This is one reason for its large market share and its success internationally.

108) ESRI produces ARC/INFO, which is a complete professional GIS with lots of features, and ArcView, which is a more user-friendly desktop mapping and GIS tool that enables users to quickly select and display different combinations of data and to creatively visualise information. The United Nations Statistical Division also produces geographic database software, PopMap and MapScan for Windows, which have very detailed manuals, and they hold regional training workshops on their use.

#### **IV. Recruitment and Training of Cartographic Personnel:**

##### **1. External Training:**

109) It is essential that the Census Cartographer and his staff - at headquarters and in the field - are not only knowledgeable about the contents of their jobs, but also have the skills to perform the tasks efficiently. Training is therefore a very important component. **The quality and intensity of training of cartographic staff at all levels will have an impact on the entire census operation.** Apart from developing individual skills, one of the primary purposes of training selected officials is to equip them with the ability to train others. And since the majority of the cartographic staff are recruited and assigned duties at short notice, training has to be organized and held as soon as possible to equip them for their tasks.

110) However, the Census Cartographer may require specialised external training at a regional or international workshop in, for example, 'Establishment of a Geographical Information System (GIS)'. A suitable course on this subject, lasting six weeks during the months of August-September, is currently available at the International Programmes Centre (IPC), US Bureau of the Census, Washington DC.

111) Another GIS training course, though not specifically based on census mapping, is available from Ordnance Survey International, Southampton, UK, and lasts for 8 weeks. The course contents are as follows:

Contents: OS International - GIS certificate course:

- Introduction to computing
- Introduction to GIS
- GPS
- Environmental studies
- Digital mapping
- Cartographic practice
- Thematic mapping
- Statistical methods
- GIS (developing the concepts).

112) The Census Cartographer however, may be professionally well qualified, and it might be useful to refresh his knowledge rather than to give him formal training. In this case he would benefit from a study tour, eg, visiting the cartographic department in a selected country in the region that has carried out census cartography successfully. These training assignments should be arranged well in advance, because as the cartographic work picks up tempo, it becomes increasingly difficult to release professional staff who combine management and technical skills. This expertise has to be available at the appropriate time.

## **2. Training of Cartographic Office Staff :**

113) With regards to local training, some of the staff, for example, may have transferred from the Lands and Surveys Department or have graduated in surveying and cartography from a technical institute, but there may be a nucleus of drawing staff who can be trained on-the-job provided they have a basic understanding of geography, and have an interest in maps and show some initiative.

114) The topics covered and their intensity will depend on the qualifications and aptitude of the staff, the work programme, and the time available, but may include the following:

### **On-the-Job Training of Cartographic Office Staff :**

#### **Pre-Enumeration:**

**Map reading:** Understanding rural and urban scales; Changing map scales; Map legends; Administrative and census mapping boundaries;

**Technical drawing:** Use and cleaning of Rotring pens; Hand lettering; Use of Rotring lettering stencils, Rotring NC-Scriber and Kroy lettering machine;

**Compilation of base maps:** Air-photo and satellite imagery interpretation; operation of a zoom-lens photocopier and map printing machine;

**Plotting of GPS coordinates:** UTM, and latitude and longitude;

**Quality control:** Checking of field returns.

#### **Post-Enumeration:**

**Area measurement:** Operation of manual and digital planimeters;

**Publication mapping:** Preparation of report maps and graphs;

**GIS work:** Assisting with maintaining the GIS.

115) Once they are on-the-job, office staff are given specialized jobs by the Census Cartographer according to their abilities and the work in hand, such as: drawing urban base maps; compilation of rural base maps; photocopying and map printing; checking of field returns; preparation of final EA maps; making area measurements; drawing report maps; administration: buying materials or in charge of census map sales; storekeeping, etc.

## **3. Preparation of a Field Training Manual:**

116) The census manuals are the most important documents for the enumeration and are an essential input in the training programme. A comprehensive training manual for the cartographic field teams must be prepared in advance of recruitment. It may be prepared along the following lines:

Title: 'Instructions for Census Mapping Teams':

Chapters:

Field Organization: General reasons for the field work; Duties of field staff; Discipline and cooperation; Working arrangements; Use and payment of guides; Meeting local officials; Relations with the general public; The driver and the vehicle.

Map Scales: Understanding map scales; Rural and urban census map scales;

Map Reading: Orientating the map; The map legend; Other marginal information; Census mapping boundaries; Approx Positions and Distances; Measurements with a Vehicle Trip Recorder;

Operating the GPS: Care of the GPS; Batteries; Cigarette lighter adapter; Satellite status page; Position page; Menu page; Waypoints;

Plotting GPS Coordinates: UTM grid zones; UTM grid coordinates; Plotting UTM coordinates at different scales.

Updating Maps: Rural and urban base maps; Updating the base maps; Sketching trading centres with a GPS;

Method of Work: Instruction on one of the following: Household listing; Household quick-counts; Population quick-counts; Structure counts.

Completion of Field Forms: UTM coordinates form; EA and locality listing form; SA listing form; Guides payment form.

Demarcation of Enumeration Areas (EAs): Definition; Size ranges for rural and urban; how to demarcate EAs.

Annexes:

Examples of field forms

Census map bar scales

Map legends

A glossary

GPS quick reference guide

GPS keypad - what each key is used for

GPS menus - main page sequence

Map: UTM grid zones for the country

Examples of plotting UTM coordinates at standard scales

Lists of drawing and camping equipment.

Map of the country showing 1st order administrative divisions.

**4. Training of Field Mapping Teams:**

117) The cartographic field staff should be recruited regionally (for local languages) **and trained for five to six days, followed by a final test.** Straight lecturing is sometimes ineffective, so in addition to the manual and its annexes, the training should be enhanced with other materials such as rural and urban maps (and air photos if used). **There must be very thorough explanations of the purposes of the field forms and demarcating EAs,** and the lecturer must stress that all their field returns will be thoroughly checked under the quality control system.

118) The training in the office should preferably be in small classes - perhaps regionally - and the trainees must be split up into small groups for **practical field**

**exercises** carried out locally. The overall field supervisors, who should be experienced permanent staff, should also attend the training and assist the Census Cartographer in leading the practical field exercises.

119) The trainees must be told about the final test before training begins, and that their employment is dependent on the results. Their attitude will then be more serious. Team leaders can be selected by either previous experience or test results, and are additionally instructed, for example, on how to manage and submit fuel and guides payments accounts to Census Office. Part of the practical training can include 'how to put up the tents' and other advice about living in tents in the rural areas, eg, the employment of a camp cook, camping next to the traditional courts where there are water supplies, etc, etc.

### **Conclusion:**

120) Firstly, it is clear that the various activities making up the different stages of pre-enumeration mapping are very closely linked and interdependent. The success of the cartographic work - and the success of the census itself - will depend on how well these activities have been integrated into a well thought out - and efficiently executed - plan of operations. But it must be realised that careful planning will not guarantee success. The mapping programme also needs time, strong technical inputs and an assurance of adequate financing of operations.

121) A mapping programme cannot be organized and carried out at short notice. Mainly owing to late commencement, pressures to shorten the timetable often build up. Some short cuts may be possible, but in general, trying to go too fast - combined with insufficient technical support - can be a waste of time, and results in unreliable and poor maps, which in turn affect the conduct and credibility of the census itself.

122) The initial planning of cartographic activities therefore, must start well in advance of other census operations, and the duration can depend on whether there is already a permanent cartographic office (with equipment and materials) and trained technical staff. The preparatory work for a census is by necessity, long in duration and involves many distinct operations. But a large part of pre-enumeration activities is devoted to the cartographic work. Sometimes the mapping can take 90% of the pre-enumeration time and consume 90% of the available funds, particularly if the operations are started from scratch. **But it is clear - it is not possible to do a census without maps.**

123) An on-going programme will result in a core cartographic staff being able to handle inter-censal surveys and they will be ready to train extra staff needed for a census. **To achieve all the mapping output required for accurate censuses and statistical surveys, an on-going mapping programme within a permanent cartographic office must be established as an integral part of the Statistics or Census Office. And it is worth repeating: even with an on-going mapping programme, the lead time for pre-enumeration mapping should not be less than three years.**

**List of Basic Cartographic Equipment and Materials**

**Office Equipment::**

Drawing tables  
Drawing chairs  
Filing cabinets  
Steel cupboard  
Steel safe  
Light table  
Scissors  
Staplers  
Heavy duty stapler  
Long-arm stapler  
File punch  
Digital planimeter  
Manual planimeter  
Lead paper weights  
Calculators  
Plan trimmer  
Guillotine

**Map Filing Equipment:**

Horizontal filing cabinets  
Vertical filing cabinets  
Roll storage boxes

**Map Printing Equipment::**

Xerox map printing machine (with 50-200% zoom lens)  
Xerox map printing machine (for same-size copies)  
2 Photocopiers (with 50-200% zoom lens)

**Photo Interpretation Equipment :**

Mirror stereoscope  
Hand stereoscope

**Drawing Equipment:**

Steel rulers - 1.25m, 1m, 50cm, 30cm.  
Steel straight edges - 1.25m, 1m, 50cm.  
T-square  
Set squares - 45° and 60°  
Stanley knife  
Scalpel holders and blades  
One-sided razor blades  
Cutting mats - A1 and 2m x 1m  
Drop compass  
Erasing shield  
Protractor - 360°



Rotring pens - 0.13, 0.18, 0.25, 0.35, 0.5, 0.7, 1.0, 1.4, 2.0mm  
Rotring nibs - for the above sizes  
Rotring pen cleaning unit  
Rotring circle templates  
Rotring plastic rulers - 15cm  
French curves  
Flexible curve  
Symbol templates  
Register punch

**Lettering Equipment::**

Rotring stencils - upright and italic - 1.8, 2.5, 3.5, 5.0, 7.0mm, 1.0, 1.4, 2.0cm  
Rotring stencil guides  
Rotring NC-Scriber  
Kroy lettering machine  
Kroy lettering tapes - 1", ½", opaque and clear

**Field Equipment::**

GPS satellite receivers - with batteries, cases and cigarette lighter adapters  
Digital compass / rangefinder  
Field compasses  
Pedometers  
Hand-held computer  
Clipboards

**Camping Equipment :**

Field tents - with groundsheets  
Mattresses  
Pillows  
Pangas  
Hurricane lamps  
Torches and batteries  
First aid kits  
Sun hats / caps  
T-shirts with census logo  
Rain coats with hoods  
Wellington boots  
Walking shoes  
Paraffin stoves  
Cooking and serving utensils  
Plastic plates, bowls, cups and cutlery  
Plastic jerry cans for water  
Steel jerry cans for petrol / diesel  
Steel drums - 40 gallons, for fuel

**Expendable Items - for Drawing:**

Tracing paper - sizes 20m x 59.4cm and 20m x 84cm  
Drafting film - sizes 10m x 59.4cm and 10m x 84cm  
Drawing ink - black, 50ml and 300ml bottles  
Rotring pen cleaning fluid

Pencils / Notebooks / Duplicate books

Erasers - Pelikan BR40 and Staedtler plastic

Sellotape - 1" and ½"

Scotch magic tapes 1" and ¾"

Masking tapes - 1" and 2"

Packing tapes - 2"

Cow gum / glue sticks / white out (correction fluid)

Metric graph paper - rolls, 84cm and 59.4cm

Metric graph paper - pads, A3 and A4

Metric graph paper - translucent

Marking pens - Pentel large, bullet point, black, red and green

Marking pens - Pentel Sign Pens - black, red, green, blue, brown and yellow

Bic Crystal ball point pens - blue, black, red and green

**Expendable Items - for Map Reproduction:**

Xerox printing paper - pre-cut sheets: A0 and A1

Xerox printing paper - rolls: 175m x 84cm

Photocopy paper: A3 and A4

Toner cartridges for map printing machines and photocopiers

**Computer Mapping Equipment :**

Desktop and laptop computers with pre-installed software

GIS software

GPS software

Digitizer - A3

Large format scanner - A0

Pen plotter - A1

**Radio Communications Equipment :**

3 - mobile radio kits and aerials

1 - base station kit and aerial

**Field Vehicles:**

Land Rover station wagons (or similar) - 10 seater, with extra fuel tanks and roof racks. (those for overall supervisors, with 2-way radios)

1 Truck - flatbed, with 2-way radio.

**Selected References :**

- Mapping for Censuses and Surveys - US Bureau of the Census, 1978.
- Training Workshop on Census Cartography for English-Speaking East and Southern African Countries - ECA, 1989.
- Handbook of Population and Housing Censuses - Part 1: Planning, Organization and Administration - UN Statistical Division, 1992.
- Principles and Recommendations for Population and Housing Censuses - UN Statistical Division, 1998.