DESIGN OF THE SOMALIA POST ENUMERATION SURVEY (1986-1987)

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1. INTRODUCTION

The Census of Somalia will be taken in two parts. The first part will be taken in November of 1986 and will cover all the settled areas of Somalia. These include the capital Mogadishu, large towns, and villages in the 86 districts of Somalia. The census of settled areas will begin on November 12, 1986; this date was chosen because it is just prior to the prophet Muhammed's birthday and so would be a date easily recalled by most of the population (like Christmas in the U.S.). The census of settled areas will be conducted in 15 days and should be complete by the end of November, 1986.

The second part of the census will be taken February 1-15, 1987; this part will be a census of nomads. Although several different methodologies were considered for taking the census of nomads, the Central Department of Statistics settled on a waterpoint approach. This entails stationing enumerators at each watering point for the entire census period and having them interview nomads as they bring their livestock in for watering at each point. There are three basic types of livestock in Somalia: cattle, sheep and goats, and camels. Cattle need to be watered every 2-3 days, sheep and goats every 4-9 days, and camels every 9-30 days, though research shows that the great majority (97 percent) of camels are brought in for watering within each 14-day period.

These dates were chosen for the census to try to minimize the possibility that the two groups would be counted in both census operations. November is in the rainy season, and nomads would tend to be further away from settled areas because of the greater availability of water and grazing. February is towards the end of the dry season, and after 3 months of the dry season most rivers and watering points have dried up. Nomads have very few areas left that are available for watering their livestock, in fact only about 3000 points, and so these points can be more easily covered in February. There is a fair amount of uncertainty regarding which watering points will still be in existence by the time the census and PES are conducted. From this standpoint it may be worthwhile to oversample watering points to ensure the proper number fall into sample.

The post enumeration survey for Somalia will cover the entire country, both settled areas and nomadic. The main purpose of a post enumeration survey is to provide estimates of the completeness of coverage in a census. It can also be used to determine the response reliability of some of the questions asked in the census. This paper describes the methodology to be used for the post enumeration survey in Somalia and presents some alternatives for its conduct. The paper includes a brief review of the literature available on the enumeration of nomads and on evaluation studies in general. Following that, there is a general description of the design of the PES, a review of estimation procedures, a description of the sampling plan to be implemented, suggestions for staffing in the field and interviewing procedures, a general description of the questionnaire, a summary of the matching procedures, a description of editing, keying, imputation, and weighting procedures, an outline of tables needed for analysis, and finally a timetable for the study. This document is meant to be a complete guide to the design of an evaluation study for a census of two disparate populations. Although ambitious, it does try to address serious methodological concerns about the research to be conducted in Somalia.

2. LITERATURE REVIEW

At this time there does not exist a great deal of literature on techniques for enumerating nomads. The detailed review of methods is found in a paper produced by the United Nations (1977). This paper describes the experiences of several African countries and a few West Asian countries in enumerating nomads in censuses and surveys. It excludes a general section on various approaches used to enumerate nomads and concludes with general guidelines.

A recent paper by Kalsbeek and Cross (1982) reviews the general approaches that have been used in enumerating nomads and then describes in detail the water point approach that was used for a survey in Somalia.

On the topic of dual estimation procedures there exists a publication edited by Karol Krothi (1978) that includes articles from various authors. The article discusses practical problems that arise in carrying out dual systems of data collection and reports in detail on selected surveys and experiences.

A recent publication by the Bureau of the Census (1985) on evaluating censuses includes detailed discussions on the various dual estimation procedures.

3. DESIGN OF THE PES

The PES will be conducted in two phases, one each immediately after each phase of the census. Following the first phase, that is, the census of the settled areas, the PES will be conducted in Mogadishu and a sample of districts in the rest of Somalia. Again immediately after the second phase, the census of the nomads, a PES will be conducted outside the Banaadir district at a sample of watering points throughout Somalia.

The PES questionnaire for each will contain basic geographic information which will identify where each interview is conducted. In addition, each questionnaire will ask for names of all persons in each family or household, age and sex for each

individual, and precoded questions on occupation. For the PES of nomads, additional questions will be asked to determine where each individual was on the prophet's birthday (the date of the census of settled areas) and other questions will be asked to determine the last date when livestock were brought to the watering point, and when the next date livestock would be brought to the watering hole. These last questions will be used to estimate how many nomads might have been missed by type of livestock since the interviewing period may be less than the span of time between waterings (especially for nomads herding camels). Finally, it might be advisable to ask herders if they use other nearby watering holes in addition to the one in sample, and how often. This information might be useful for making a multiplicity estimate of the nomadic population.

The questionnaire will serve multiple purposes; in addition to being the instrument of the PES, it will also be used for matching and keying. Space will be included for transcription of census information and to record the results of the match. The PES information, the census information, and the match information will be keyed and processed using programs written especially for estimation and variance estimation in this project.

Finally, when the keying is completed, the data will be edited, missing data will be imputed, missing responses will be accounted for with a noninterview adjustment, estimates will be generated, and variances calculated. The results will be reviewed and published shortly after census results are available. These steps will be reviewed in more detail in the following sections, as well as the timing.

4. ESTIMATION

Even though estimation comes at the end of the sequence of steps needed for the complete study, the estimation process drives the rest of the survey. The method used for estimation in this survey is termed capture-recapture or dual system estimation and is based on the premise that the census and the PES are two independent surveys of the same population. For the evaluation of coverage, a post enumeration survey is conducted shortly after the census. Cases enumerated in the survey are then matched to the census; a two-way table is then formed classifying cases as to whether they were found in the census or not found in the census. Because cases are weighted by their probabilities of selection, the totals are estimates of the total number of persons represented in the sampling frame for the PES. The two-way representation shows the distribution of known totals, including an estimate of the number of persons in the census not represented or found in the PES. Table 1 at the end of this article shows this distribution.

Besides the assumption of independence, one also assumes that there are no duplicates in the census, no mistakes made in the matching of the PES to the census, and that everyone in each data source has exactly the same chance of being enumerated. These assumptions and others of less impact are reviewed in Cowan (1984). Of particular concern for this study is the process of matching. To match from the PES to the census, one has to assume for settled areas that no one has moved in the time between the census and the PES. For the nomadic areas, one has to assume that the nomads consistently use the same watering points during the dry season for the period between the census and the PES. Further, for Somalia one has to assume that there will not be confusion as to the status of some individuals between the first census enumeration and the second census enumeration. As explained in the first section, the November enumeration date was chosen to minimize the possibility that persons who are truly nomads would be counted in villages, and the February date was chosen so that only nomads would be found at watering points. It seems, however, that there are opportunities, despite the best intentions of the researchers and the efficient use of screening questions, to count individuals as villagers in very small villages in the November census and as nomads at the watering points in the February census. It is also possible to miss some individuals by screening them out of both censuses because the screening questions would place them in the "other" census. The latter problem will be solved through normal capture-recapture procedures, so a supplemental match is being recommended to determine whether there was substantial double counting in some of the more rural areas. Finally, one has to assume that name of the household head and household composition will be sufficiently good identifiers for the matching process. Questions about livestock have been found to be too sensitive to identify the nomadic population, and tagging operations for herds in the census for reidentification in the PES were considered to be too expensive and sensitive. Herds are branded by the nomads, but there is insufficient identifying information and the brands look too similar to be of much use.

5. SAMPLING DESIGN

5.1 Settled Areas

Mogadishu, the capital of Somalia, is of sufficient import to and sufficient size in Somalia that a separate estimate will be generated for Mogadishu and the Banaadir region (which contains Mogadishu). Outside of the Banaadir district, there are 74 districts in Somalia which will be used the second stratum. In each district, each settled area has been divided into enumeration areas (EA's). EA's are supposed to be of size 200 households each, but the actual sizes have been found to be smaller and to vary considerably. To conduct the PES, then, whole EA's will be selected with equal probabilities as primary sampling units

(PSU's) and reenumerated to facilitate the match to the census. Since the whole EA will be used, this design is simply a stratified, 1-stage cluster design. Another reason for choosing whole EA's is that the further division of EA's would be difficult to do in Somalia given limited resources in the Somalia Central Department of Statistics while the census is being conducted.

With a sample size of 10,000 households (about 50,000 people), we would expect to draw 8 EA's in Banaadir, and 20 EA's in the remaining settled areas. This is calculated as 200 households per EA, 7 EA's in Banaadir, 20 EA's in the rest of Somalia, or 27 X 200 = 5400 households, with 1400 of those households in Banaadir. Table 2 shows the sample size calculations.

One concern in choosing whole EA's is that if there are problems at the boundaries of the EA's in the census enumeration, the same types of problems may accrue in the PES, but the problems will not be found. This will lead to a correlation between the two enumerations, as the same units would be missed for the same reasons. However, the Somali CDS has had two UN cartographic advisors working with them and a great deal of care has gone into the construction of the EA's, so they should be fairly problem free. The alternative to choosing the census EA's would require new mapping work to be done in the districts selected at the first stage of sampling, and that the matching within districts would cover several EA's in the census for each PES EA, increasing the amount of searching in the settled areas by a factor of four or five. Given limited resources, the EA's will have to be chosen as the final stage of sampling with all units within an EA being reenumerated.

5.2 Nomadic Samples

In each district there are also a number of watering points used by the nomads for watering their livestock. During the dry season most watering points dry up, and it is estimated that the number of watering points in all of Somalia is only 3000. These vary in size and type, with some quite large watering points accommodating more than 100 herders each day, but most accommodating a much smaller number. Some of the watering points are clustered because they are holes dug in river beds near each other. Although the river beds are dry, the water table is just below the surface (perhaps a meter down), and under this is bedrock which guarantees the underground water will continue to be channeled in the same area. These types of clustered watering holes are known as laas. There may be as many as 20 of these holes clustered 20 to 50 meters apart along a riverbed. Restriction of the matching to the sample of these may cause problems since there is no guarantee that nomads will return to the same watering holes along a river if several are clustered together. The match for the sampled watering points along a riverbed will probably require an extended search along the riverbed to areas that are nearby and possible alternate watering sites.

The other types of watering points may present similar problems for matching in that certain other water holes, like wars (large ponds surrounded by trees) may be sufficiently close that nomads may be indifferent in their choice of one watering point or another. A mapping function determining the distance between watering points will have to be used and a minimum search distance established.

5.3 Sampling with Equal Probability

When the cartographic work is complete, there will be a list of EA's within each district with approximate numbers of households for each EA, and a separate list of watering points within each EA with number of herders on average by day using each watering point. The EA's and watering points will be selected with equal probability.

One other consideration for the design of the sample is variance estimation. A straightforward sample design with EA's as the first stage clusters will lend itself well to the use of ultimate cluster techniques commonly used for variance estimation.

5.4 Drawing a Sample

Banaadir is estimated to have 14 percent of Somalia's population, the remaining settled areas to have 40 percent of the population, and the nomadic population comprises the remaining 46 percent of the population. The sample will be drawn separately for each of these areas, Banaadir, the other settled areas, and the nomadic areas in the proportions given above.

A list of all EA's will be prepared for each district, with the list ordered separately for urban and rural areas. The EA's will then be systematically sampled, urban first, then rural, to give an equal probability sample of EA's. The same procedure will be followed for watering points, except they will not be ordered by urban/rural.

6. STAFFING AND INTERVIEWING

Field staff chosen for this exercise should be the best enumerators in the census for each phase of the enumeration. However, the enumerators should not be assigned to redo their census areas but instead be assigned to cover a different area. By choosing the best enumerators and having them cover different areas we minimize the chance of contamination or correlation between the census and PES (we come closer to independence). Using the best enumerators minimizes the chance of systematic error being introduced into the process (different enumerators missing the same households because both repeatedly make the same error).

Interviewing for the PES will follow immediately after the census. Following the census of settled areas, about December 1, interviewing for the PES of settled areas should start and should take about 1 week. Interviewing should not start until all census materials for the sampled EA's are

sent to the CDS in Mogadishu, so that there is no chance of contamination of the PES by the census. Similarly for the nomadic areas, interviewing for the PES at the watering point should start when the census ends, about February 15, and run for about 4 days. Again, interviewing should not start until watering point materials for sampled watering points are mailed to the CDS in Mogadishu.

Interviewers should be gathered and trained in central locations just before interviewing starts. This means that interviewers will have to be transported immediately after the census ends to the district offices where the training is to be conducted, trained in 1 or 2 days, and then transported back.

In the EA's, regular interviewing procedures should be followed. At the watering points, teams of four enumerators should be used to enumerate 24 hours a day, since the nomads water their livestock at night since cattle cannot take the heat of the day. In both areas, enumeration rules will be the same as those in the census, except that no screening will be used at the watering points (i.e. all herders will be interviewed at each visit to watering points).

7. QUESTIONNAIRE DESIGN

The two questionnaires (one for settled areas, the other for nomads) will consist of four parts: geography, PES information, information transcribed from the census, and the results of the matching. The outer front cover will have information on the district, EA or watering point, and for EA's the housing unit number as it was marked in the census. In the census every housing unit in EA's will be marked with a unique number in chalk. If this number is still present at the time of the PES it can be recorded to facilitate the PES matching. Administrative information like date of interview should be recorded on the PES front cover also, and questions S1-S4, H1-H9 or N1-N3 from the census (for settled or nomadic areas respectively), except on the nomadic questionnaires there should be no skip instructions. Also on the nomadic questionnaire there should be questions asking how many days previously the herd was watered, and after this watering how many days until the next probable watering.

On the interior left page are the PES questions. A separate questionnaire should be completed for each household. (There may be more than one household in a housing unit.) Across the top of the page the questions are printed in columar form as was done on the census questionnaire. Down the left side in the first column is a listing of person numbers, 1 to 15. Following this is a space for each person's name (one person to a line), and questions on relationship to head of household, sex, age, education, occupation, and industry. The categories should be exactly the same as those used in the census, but the categories should be presented in a block at the top of the form so that there will be room for the remaining information needed on the form.

On the right interior page there should be a column for the census person number and relationship to head of household, sex, age, education, occupation, and industry. These items will be transcribed from the census form when a match is obtained. At the far right of the form there should be three final columns. The first is match status for cases of the same type as the census (settled area to settled area match or watering point to watering point match). The second column is to record a match of a subsample of cases to the opposite area from the current area (settled area to watering point or watering point to settled area). There will be further discussion of these crossmatches later. The third column is to obtain a match for a subsample of cases to neighboring EA's or watering points. This subsample will also be described later.

8. MATCHING

8.1 Primary PES Match

Since the post enumeration survey will be using the same geography as the census, geographic coding has already been taken care of. For the primary match, all questionnaires in the settled area EA's should be ordered by the chalked census housing unit number written on the front of the PES form at the time of interview. It is assumed that all questionnaires for an EA or a watering hole are stored in one area (in one box, with no questionnaires from neighboring EA's or watering points). If this is not true, all the questionnaires for an EA or watering point should be separated and stored in one container. They should also then be ordered within the container by housing unit number so that the PES and census forms are both in the same order. For watering holes, of course, there is no housing unit number so no ordering is possible for the PES or census form. Therefore, for watering holes the forms should be ordered in both the PES and the census by the first name written on the line of the head of the household.

Once in order, for settled areas forms with the same housing unit number should be compared by opening the forms and comparing the names on both forms. Where the names match, all the relevant census information should be transcribed from the census form to the PES form. If all the names on the PES form are found on the census form, this form is complete and can be sent to keying. Both forms can be put in separate PES and census complete piles.

For census forms for which there is no corresponding PES form, these census forms should be put to the side in a to-be-reviewed census pile. For PES forms for which there is no corresponding census form, these should be put aside in a further search pile. Finally, for the remaining PES cases these should be set aside for further matching. The first stage of the settled area match is done when all forms with census household numbers have been compared.

For the watering points, a similar match operation is performed, except the ordering is by first name of the household head. When this name matches between forms, the rest of the household heads name should be compared. This comparison should be done for all persons with the same initial name in both groups. Thus if there are five Abdullahs in the PES at a watering hole, and six in the census, there will be 5 X 6 = 30 comparisons to be made. For watering holes the overall number of comparisons should be small since most watering holes should not have many herders. When the household head names match, the other names in the household are compared. For each person that matches, the information is transcribed from the census to the PES. If all persons match on both forms, the forms are then set aside in the PES and census completed stacks. Forms which are partial or complete nonmatches are set aside for further review in separate stacks.

For settled areas, all remaining forms should now be ordered by first name of the household head. Then the match can proceed just as the match did for the matching hole forms. When the match is complete and all persons on both forms match completely, the forms can be set aside in PES and census completed piles. The PES completed forms can be sent on to keying.

For both watering points and EA's, the remaining PES forms should be only those that partially matched or did not match at all. The same is true for all forms remaining from the census. Each form remaining from the PES should now be matched, line by line, to all the forms remaining from the census. Forms completely matched for the PES can be sent on to keying. All remaining forms should go to supervisors for review, where essentially the same match will be conducted by higher level personnel.

All persons that match should have a value of 'M' coded in the primary match column. All persons who do not match in a household where some persons match (partial household match) should have a value of 'P' coded in the primary match column. All persons in settled areas who do not match in a household where no persons matched, but the housing unit numbers matched, should be coded 'H'. Finally, all persons who do not match a unit in the census (or there was no census number recorded in the PES) should be coded 'T'. For watering holes there should be no persons with a code 'H'. Nonmatch codes should only be assigned by supervisors at the final review.

8.2 Matches to Opposing Areas

One of the concerns in an operation like this where the work is conducted at two times is that some of the people may be double counted or counted in a different place. It is recommended that a match be done on a subsample of cases from the PES to the census, but in areas different from (though close to) the areas where the PES was done. The methodology would be as follows.

For the PES conducted in the settled areas, a 1 in 10 subsample of EA's would be drawn from the PES sample, and within those EA's a 1 in 10 subsample of households. For each EA in the reduced sample, a circle of radius 10 kilometers will be drawn on the district map with the center of the EA being the center of the circle. All watering points within the circle will be searched for this secondary match, using the same rules as the primary match, and the same match codes. In the match the forms can only be ordered by first name of the household head since there are no census household numbers at the watering points. Match results would be marked in the second match column.

A similar match would be conducted for cases which are in the PES sample for watering points. A 1 in 10 sample of watering points in the PES watering point sample would be drawn, and within that a 1 in 10 sample of households. On the district maps a circle of radius 10 kilometers would be drawn, and all villages or EA's within the circle would be selected. A match from the watering point to all villages in the circle would be conducted in the same fashion as that described above. Again match results would be recorded in the second match column.

8.3 Match to Neighboring Points

Using the same 1 in 100 sample as described in the previous section, we also would want to match to neighboring EA's for the EA sample and watering points for the watering point sample. This sample would detect duplicates and movement between points of enumeration. The match would be conducted as described in a previous section, and final match codes would be placed in the third match column.

8.4 Flexibility in Matching

The match as described above is based primarily on geography and names. Geographical information should always be present on the forms, but names may be missing, incomplete, or duplicated. In these cases and for other cases where there is doubt regarding the match, other information like household composition, age, and sex should be used to help determine the existence of a match.

9. EDITING AND KEYING

Before going to keying, each form should be edited for completeness to ensure match codes are filled in for each person. In addition, the form should be reviewed for general legibility.

After edit, forms should be batched and sent to keying. All forms should be keyed and verified. After forms have been keyed, a computer edit should be conducted for consistency and completeness.

10. QUALITY CONTROL

Although it has not been mentioned previously, at each stage of matching and during interviewing there should be a quality control system in place to ensure that all work is done correctly. Interviewers and clerks who make systematic errors or who are slovenly in their work can be retrained or dismissed.

11. NONINTERVIEW ADJUSTMENTS

11.1 Imputations

After all the data is keyed, an initial run through of the data will show that some items, including match status, will still be missing. A computer program will be developed to conduct a hot-deck imputation using areas from within the same EA or watering point as the deck. Where possible, cases within an EA or watering point should be matched to the person or household that is most similar in terms of personal characteristics to be able to impute missing values.

11.2 Whole Household Weighting

Some households in the PES will be a complete nonresponse, either because of refusals or incomplete field work. These cases should be tabulated by geographic area (EA or Watering Point), and assigned a weight of zero.

The remaining cases in the EA or Watering Point should receive a compensatory weight, calculated as the total number of households eligible for the PES divided by the number of households for which there are responses.

12. TABULATION AND ESTIMATION

Initial estimates can be obtained by tabulating the PES results and using the standard capture-recapture formulas. Tables should be generated in the format presented in table 3.

When the weighted tables are run, corresponding unweighted tables should also be run. Before the tables are printed, the unweighted tables should be checked to be sure that no table has less than five cases matched or less than 20 cases in the count N_D. Tables that do not meet these criteria should be collapsed across age categories with the nearest age group that has the smallest count of matched cases. Collapsing should continue until the criteria of 5 and 20 are met.

If random groups are used, the estimates obtained in this way are only preliminary, and the same tables would have to be run for each random group, with corresponding collapsing rules. The resultant population estimates and coverage rates would then be jackknifed to produce unbiased estimates and variances.

13. TIME SCHEDULE

A time schedule for activities in the Somali PES is as follows:

May 15, 1986:	Questionnaire Developed
May 31:	Interviewer Instructions Written
June 30:	Matching Instructions Written
Sept 30:	Quality Control and Edit Instructions; Data Processing Specifications Keying Instructions
Oct 31:	Sample Selected at CDS Translations of Questionnaires and Instruction Manuals Completed
Nov 30:	Interviewing Starts in Settled Areas
Dec 31:	Data Processing Coding and Testing Complete
Jan 31, 1987:	Primary Match of Settled Areas Complete
Feb 15:	Interviewing Starts for PES of Watering Points
Feb 20:	Matching Started on PES of Watering Points
March 3:	Primary Match Completed for PES of Watering Points Keying Complete for Primary Match for WP's
May 31:	Edit and Tabulation Complete for Primary Match for WP's Secondary Matches for EA's and WP's Complete
June 30:	Keying of Secondary Match Information Complete and Addition to Data Files Preliminary Estimates from PES Generated and Reported
July 31:	Further Analysis of Detailed PES Tabulations
Aug 31:	Draft of PES Report and Available for Review
Sept 30:	Review of PES Report Complete

14. REFERENCES

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Table 1: Two-Way Representation of Cases in the Census and PES

		Post Enumeration Survey: Enumerated	Post Enumeration Survey: Not Enumerated	Total
Census	Enumerated	M		N_C
	Not Enumerated			
	Total	N_P		N_T

where M is the (weighted) total of persons found in both the census and the PES

N_C is the total number of persons enumerated in the census

N_P is the (weighted) total of persons enumerated in the PES

N_T is the total number of persons in the population.

Because there are a certain number of people not counted in the census and not found in the PES, the count to be placed in the lower right hand corner of the table is unknown, and consequently the population total, N_T, is unknown but can be estimated. By assuming that the event of being found in the PES is independent of the event of being counted in the census, one can make an estimate of the population total as:

$$\hat{N}_T = \frac{N_C \, N_P}{M} .$$

Table 2: Sample Size Calculations for Somali PES

Area	Population: # People	Population: %	Population: # Units*	Sample: # People	Sample: # Units
Banaadir	700,000	14%	140,000	7,000	1,400
Other Settled Areas	2,000,000	40%	400,000	20,000	4,000
Watering Points	2,300,000	46%	460,000	23,000	4,600
TOTAL	5,000,000	100%	1,000,000	50,000	10,000

*Units = Housing Units or Extended Family Units, assuming 5 persons per unit on average and 200 units per EA or Watering point.

Table 3: Format for Tabulation of PES Results

Area: (Banaadir, Settled Urban, Settled Rural, Nomadic, Total)
Age: (0-10, 11-20, 21-30, 31-40, 41-50, 51-60, 61-70, 70+, Total)
Sex: (Male, Female, Total)

	Post Enumeration Survey		
	Enumerated	Not Enumerated	Total
Enumerated	M		N_c
Not Enumerated			
Total	N_p		N_t

$\hat{N}_t = N_p \times N_c/M$ Census Coverage Rate = M/N_p

where N_c is the census count for the age/sex/geography specified,

N_p is the weighted sample total for the PES for the same age/sex/geographic split,

and M is the weighted estimate of the number of persons matched from the PES to the census for the specific age/sex/geographic group