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CARTOGRAPHY FOR CENSUS PURPOSES\*

\* The attached document, issued by the Statistical Office of the United Nations in collaboration with the Cartography Section of the Resources and Transport Division of the Department of Economic and Social Affairs, was prepared by Marvin F. Gordon, Associate Professor, Department of Geography and Regional Science, George Washington University, United States of America, as Consultant to the Secretariat.



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CONTENTS

	<u>Paragraphs</u>
I. NEED FOR MAPS IN CENSUS OPERATIONS . . . . .	1-4
II. FUNCTIONS OF AN OFFICE OF CARTOGRAPHY AND GEOGRAPHY . .	5-19
A. Work assignments and objectives . . . . .	5-13
B. Staffing requirements and problems . . . . .	14-19
III. CENSUS MAP REQUIREMENTS . . . . .	20-41
A. General considerations . . . . .	20-31
B. Characteristics of enumerator's maps . . . . .	32-36
C. Needs of census offices . . . . .	37-41
IV. MAP ACQUISITION . . . . .	42-43
V. OPERATIONAL STEPS IN A MAPPING PROGRAMME . . . . .	44-53
A. Inventory . . . . .	44-48
B. Base map preparation . . . . .	49-51
C. Field work programme . . . . .	52-53
VI. MAP AND GRAPHICS PUBLICATION . . . . .	54-59
ANNEX I. Glossary of terms	
ANNEX II. Statistical areas	
ANNEX III. Organization of a geography office	
ANNEX IV. Table of organization, cartography and geography office	

## CARTOGRAPHY FOR CENSUS PURPOSES

### I. NEED FOR MAPS IN CENSUS OPERATIONS

1. A census of population and housing must have a spatial framework for which data are to be gathered, tabulated and reported. Areas must therefore be delineated for this purpose; it is the task of the map maker to provide a tool of high quality which will facilitate this kind of work. Accordingly, a strong case can be made for the compilation and use of maps which are current and precise, since they can render certain tasks easier and ensure an order of census accuracy not normally possible without them. Maps are used to establish the location of many types of boundaries, to prevent omission or duplication of information, to aid enumerator canvassing, to facilitate co-ordination between various offices and between office and field staff, to settle administrative jurisdictional problems, to identify segments used in area sampling, to help determine the number and distribution of enumerators and supervisors to be employed and to foster comparability of data from census to census. Maps furnish some indications of the speed with which the enumeration can take place; they help provide a framework in which to measure internal migration and the rate of urbanization. Maps gathered during initial phases of the work also may be helpful in providing background information which can then be used in planning and operational activities. They can, for example, indicate the capabilities of the transportation network, show settlement types and location of housing or reveal land use patterns. The organization encharged with the responsibility of preparing maps and establishing area controls can also lay out statistical areas, develop maps for publication and perform a variety of post-census tasks.

2. It is for the foregoing reasons that statistical gathering agencies are becoming increasingly aware of the advantages accruing to the use of maps of high quality in all types of censuses. Accordingly, numerous reports and meetings have called attention to the need for maps and accurately defined areas.<sup>1/</sup>

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<sup>1/</sup> Secretaria Permanente del Tratado General de Integración Económica Centroamericana. Primer Seminario de Cartografía para Estadística, Panama, 1964 and Segundo Seminario de Cartografía para Estadística, Guatemala, 1966. Report of the Expert Group on Problems of Internal Migration and Urbanization (United Nations document SA/Dem/EGIM/L.22), 1967.

It need hardly be added that the time required to do cartographic work for any upcoming censuses in 1970 is growing short. Some of the most troublesome mapping problems must be faced by many emerging nations, whose areal coverage is often poor, whose finances are limited and whose staff may be too small or lack the specific skills needed for the job. Nevertheless, the situation shows marked signs of improvement, since sizable portions of Latin America, Africa and Asia have been, or are in the process of being photographed and mapped.

3. Whereas it is the objective of this paper to describe cartographic operations for population and housing censuses, it should be pointed out that similar tasks and objectives may often be involved in other kinds of enumerations, such as those dealing with agriculture or certain economic activities. Inter-censal sample surveys also require maps, usually of a high order of accuracy.

4. This paper will concern itself with the cartographic and geographic aspects of census taking. It will cover the following general subjects: the functions of a geography office; census map requirements; map acquisition; operational steps in a mapping programme; and map and graphics publications. In Appendix A will be found a Glossary of some of the terms used in the text of this paper.

## II. FUNCTIONS OF AN OFFICE OF CARTOGRAPHY AND GEOGRAPHY

### A. Work assignments and objectives

5. A geography office given the job of supporting a national statistical office would have a considerable number of tasks assigned to it. In general terms, it would have two objectives: to delineate boundaries and supply maps of those areas for which the census is to report data and to aid in making data more reliable. In more specific terms, its work can be described under three different categories, dealing with development of maps and determination of boundaries, the establishment of statistical areas and the publication of maps.

6. The first job is to prepare maps for use in censuses of varying types and frequency. These maps would be of many different kinds, depending upon the needs of the user. Those destined for regional offices, for example, would require less detail than those needed by local field units. Maps for rural areas would differ in a number of ways from those required for urban centres; those used for

sampling would have to be more accurate than average. Preparation of these maps implicitly assumes that the geography office will prepare a complete listing of all places for which data are to be reported, by means of a geographic code. The listing would, of course, be developed in accordance with the decisions and specifications of the statistical authorities involved.

7. It is also necessary for the geography office to ascertain the location of the boundaries of all places for which the census is to report information. This is often a difficult chore, since administrative boundaries may be poorly defined. Honduras distritos, Panama corregimientos, Viet-Nam communes and United States magisterial district (Kentucky) boundaries can all be cited as past cases in point. Indeed, clarification of administrative lines may often be considered a side benefit which stems from census work. However, the statistical agency can normally do no more than point to boundary discrepancies; decisions to rectify the situation are normally not within the scope of its delegated authority.

8. A wide range of data may often be sought from censuses in order to formulate programmes for specific areas. Such information might be used, for example, in economic development work or in national or urban planning. It would be useful if the places for which data are gathered, regardless of the type of inquiry, were kept the same. This would facilitate the establishment of a statistical series covering a wide range of topics for the same area. A geography office obviously can and should assist in work of this type by attempting, if possible, to retain the boundaries of areas used in other inquiries. However, there are two problems associated with such a meritorious undertaking, which should be kept in mind. First, each subject matter division planning a census specifies to the geography office the kinds of areas it wishes delineated. Thus, it is only within this restrictive framework that the map maker can try to retain boundaries of enumeration areas which were used for other censuses. Co-operation between the various subject matter offices involved in such cases would, of course, be critical. Second, physical, socio-economic and political changes in an area may often require that new boundaries be chosen for it. This is especially true in such places as urban centres which may be experiencing rapid growth.

9. Another important function of a geography office is map reproduction. It is imperative that copies be obtained cheaply, quickly and in sufficient quantities to meet the operational demands of the census agency.

10. The delineation of statistical areas, undertaken in accordance with the specifications laid down by the census authorities, may often become another task assigned to a geography office. These areas are usually defined for data gathering purposes and do not therefore correspond to governmental or administrative divisions, which are officially designated area components of the State.<sup>2/</sup> Most developing countries, however, cannot afford tabulations of both statistical and administrative areas. Furthermore, definition and mapping of the latter is a job of sizeable magnitude and must remain the prime imperative of countries with poor coverage and limited funds. For this reason, the description of statistical areas has been placed at the end of this paper, in Appendix B; it is not here implied that establishment of these types of reporting areas is unimportant, but rather that, on a priority basis, there is much less urgency in doing so, in many emerging nations.

11. The preparation of published maps, graphs and charts which help reveal the spatial relationships of statistical data, remains another task of the geography office. If presented in meaningful fashion, such graphics enhance the value and usefulness of the census figures. One further requirement, in this regard, is to prepare maps which show the boundaries of areas and the location of places for which data are being reported. These are fairly simple to construct and inexpensive to publish.

12. Post-census operations involve the updating and qualitative improvement of maps and a continuing programme of map acquisition and compiling. Contact is maintained with the Government agencies of those places for which data must be reported, so that the geography office can keep abreast of all boundary changes. Field work may be also undertaken to establish statistical areas for the next census. Maps may be prepared for sample surveys and other special enumerations. It might be noted that these chores often are held to a bare minimum as a result of budgetary cuts. The impact of such decisions are felt, however, when an attempt is made to construct new maps within a comparatively short period of time before the enumeration.

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<sup>2/</sup> A. Archer. The Use of Maps in Census Work, U.S. Bureau of the Census, ms., 1958.



13. The geography office must finally consider, as a mandatory task, the establishment of close working relationships with other mapping agencies in its Government. It should also maintain active contact with private and international organizations which can help supply it with maps and with information which will be of value in taking a census.

B. Staffing requirements and problems

14. The table of organization of a cartography and geography branch of a statistical agency is shown in Appendixes C and D. The former briefly indicates the functions which might be performed by such an office. Since it is generally of a non-permanent type, and since skilled personnel may be hard to find, its staffing problems, particularly for many emerging nations, will doubtless be a source of much concern. Necessity may require that all sorts of expedients be attempted to circumvent this difficulty. In the final analysis, however, there can be no substitute for the competent professional employee; the quality of the work will normally suffer as a result of staff inadequacies.<sup>3/</sup> Accordingly, training programmes for census geographers and cartographers should be started as soon as is feasible. Appropriate faculty from institutions of higher education might be used profitably in order to teach or upgrade skills of employees.

15. There are generally four kinds of workers whose skills are required in census mapping operations. The first is the draftsman, who needs no special geography training, although such a background is naturally desirable. The second is the cartographer, who must have a good working knowledge of techniques of map compilation, editing, reproduction and publication. Such an individual must be well aware of current technological changes in his field. Since good cartographers are in short supply, emerging nations, in particular, may have to rely on persons who may simply have taken a cartography course or are skilled and able draftsmen. On the job training and refresher courses at institutions

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<sup>3/</sup> J. Zarur. Geography and Cartography for Census Purposes in Latin America. Inter-American Statistical Institute, Washington, D.C., 1947, p. 6.

of higher learning can often effectively improve the quality of such a neophyte staff. The third type of employee with special skills is the geographer. He should, ideally, have a good background in cartography, quantitative geography, demography and economics. Since demand will probably outstrip supply, it may be necessary to resort to further formal instruction during, or in advance of, the census mapping programme, in order to satisfy the need for skilled personnel of this type. The last kind of employee, the clerk, can often be trained on the job in order to perform the necessary tasks. Such persons must be able to demonstrate that they can read maps easily.

16. It should be noted that many personnel can, and probably will, of necessity, be shifted from one type of operation to another. Hence, their training should, preferably, not be restricted to work of a limited scope. Cartographers, for example, may have to do the work of geographers and vice versa; draftsmen, as noted, may have to substitute as cartographers.

17. On-the-job training might include subjects such as drafting, aerial photography interpretation, boundary delimitation techniques and methods of map reproduction. Acquisition of an adequate, albeit limited, background of this sort is possible for most persons with the equivalent of a secondary school education. However, one difficulty which may arise in this regard is that the personnel qualified to give such instruction may be limited in number and busily engaged in many other activities because of the shortage of competent employees.

18. Map acquisition is another important operation in census mapping and it is assumed that training individuals for such jobs would probably be necessary in many emerging nations. On-the-job training would be time consuming, however.

19. Aside from secondary schools and colleges, other sources for recruiting qualified employees might include organizations having a map facility; surveying agencies, planning departments, construction and transportation firms and public utilities. It may also be possible, under certain special conditions, to make use of personnel in the cartographic branches of the armed forces.

### III. CENSUS MAP REQUIREMENTS

#### A. General considerations

20. Maps may differ widely in terms of the subject covered, the size of area encompassed and the mode of presentation. They can show such varied types of information as topography, weather conditions, ethnic distributions or statistical patterns for large and for small areas. There are maps prepared for many different types of users; these people may be navigators, blind persons, petroleum prospectors or law enforcement authorities. A census organization is no different in this regard. It needs many kinds of maps, depending upon such variables as the type of unit being enumerated, the kind of area in which the canvass is to take place and the needs of the different offices and employees of the census agency. There is not, then, a standard map which can be used by an enumerator for all censuses or often for the same census. For example, what is an adequate map in a rural area may not be so in a village; what is adequate in a small urban place may not be in a large city. Such considerations, however, do not negate the possibility that many maps could be used interchangeably, for various kinds of censuses, with little or no change.

21. Certain general statements can be made in regard to all census maps. First, distance and accuracy are less important than the portrayal of features which are in proper relationship to each other. Whether a dwelling unit lies fifty or one hundred metres from the road is less important than whether it is placed, on the map, on the correct side of the road. Second, all boundaries which are needed to demarcate separate reporting areas must be shown as clearly and as accurately as possible in relation to other features of the landscape. Third, maps should be simple and show little information which is not germane to the needs of the user, as this will only serve to confuse; most individuals involved in census operations are normally not well versed in map use. Fourth, features and names must be shown clearly, since most maps will be reproduced many times. If copies are blurred, the utility of the map may decrease sharply. Fifth, map distance should be shown by means of a graphic (horizontal) scale, since it then does not have to be altered in case the map is enlarged or reduced in size. Last, it is important that all names of agglomerations and important

features be spelled correctly and reflect any recent change; place names must be those which are commonly used by local people.

22. It might also be worth observing that the map paper and the ink used should be of a sort which withstands rough and often protracted use. This is a very practical and important consideration, since poor quality material may impair the usability of the map and delay operations until it is replaced. Lamination is a protective device which could be used on those maps which might have to withstand a great deal of abuse. In this process, a thin plastic film is appended to the paper. However, it should not normally be necessary to protect maps to this degree in census work. Regardless of the materials used, however, it would probably be beneficial to include some mention of the need for careful handling of maps during the enumerator's training period.

23. As a general rule, features should be included on a census map if they assist the user in determining his position, if they help to identify the boundaries of a designated area, or if they show the location of the census units being enumerated - in this case, people and housing. Some of these features are itemized below.

24. (a) Physical features. Topography is shown for the reasons noted above. It will often have a direct bearing on the size chosen for an enumeration district. Boundaries at times can be drawn along crest lines if they are distinct barriers to transverse travel and are sparsely populated. It is often hard, however, to connect such lines with features in surrounding low lying areas. Rivers and streams generally are good boundaries, although care should generally be exercised to avoid intermittent streams, if possible. Water bodies and marshes also can serve as convenient lines of demarcation.

25. (b) Cultural (non-physical) features. Highways, roads, streets and trails should be shown. Those which pass through the centre of a village are not always the best boundaries, since they normally will then bisect a socio-economic unit. Quality of the roads is important, since it provides some indication of the ability to sustain vehicular traffic and can also help in estimating the travel time needed for canvassing. This information is also important if the time of enumeration coincides with particularly cold weather or a rainy season. In the event that road names are unavailable, they must be described

("road from town x to town y"). Other features which can be useful, if shown, are transmission lines; telephone and telegraph lines; railroads; canals, and large permanent irrigation and drainage ditches.

26. Normally, the best boundary is one which can be seen easily on the ground. Nevertheless, since it is necessary to adhere to administrative area limits, many imaginary lines must be used. In such cases, however, a respondent will often know where he lives in relation to such a boundary. At times, fence lines or even property lines may be used to divide areas; off-set lines (short, imaginary lines connecting visible features) can also be drawn, if necessary, to complete a boundary.

27. If several names are commonly used for one place, they should all be shown on the map, if possible. Since it is important to obtain correct names on census maps, attention should also be called to sources of information in this regard. For example, the gazeteers and other publications of the United States Department of the Interior, Board of Geographic Names, and the United Kingdom Ordnance Survey, Permanent Committee of Geographic Names might be helpful. However, it should be understood that large scale maps, such as those used by enumerators, may require place names which often cannot be obtained from sources such as those mentioned.

28. Since boundaries of places in some countries may be subject to fluctuation, it may be desirable to establish a cut-off date, after which further changes will not be reflected in the census statistics. If this is not done, a great deal of time and effort can be expended in keeping the maps current. One difficulty in using a terminal date, is that it may confuse both enumerator and respondent, since the map will not then represent the true situation. It is therefore more desirable to attempt to pass a law or issue some type of edict which would prevent boundary changes from taking place after a certain date, except under rather unusual circumstances; several countries concerned with such problems (such as Brazil) have taken measures of this type to fix boundaries prior to the census.

29. In addition to the features noted above, census maps must show areas peripheral to the place which has been delineated. The purpose of this

requirement is to help the map user to locate boundaries on the ground. If recognizable points outside such lines are shown on a map, the limits of an area can be easily ascertained.

30. Settlement patterns should also be shown. Detailed map information dealing with villages in rural areas can be shown as insets or enlarged and shown on separate sheets. If the location of buildings is not definitely known, it is safer to omit them from the map; users become more confused by erroneous information than by lack of features. However, in such a case, an estimate of the living quarters in the area should be obtained from field personnel.

31. Maps prepared for special purposes usually require special care. Sample surveys taken on an area basis fall into such a category. Since fewer maps are involved, however, this does not present any major problems. In the United States, the enumeration area can often form the frame from which sample segments are obtained. Choice of such districts are up to the subject division, however. Special efforts are usually expended to upgrade the quality of the map once a selection has been made.

#### B. Characteristics of enumerator's maps

32. There are more enumerator's maps prepared than any other kind. It is important that they be of good quality so that a high order of accuracy in data gathering is maintained. Following are some of the features which must be shown on these maps:

- (a) A north arrow, for use as a directional guide.
- (b) A graphic scale (see Appendix A, Glossary of Terms). The enumerator is not trained to interpret other representations of scale, such as fractions or word statements (for example, one inch to one mile, or 1:63,360).
- (c) An identifying geographic code number which will also indicate those major and minor civil divisions which are used in the census, and in which the enumeration district is located.
- (d) A legend which explains all features on the map.
- (e) Peripheral area, to help fix boundary locations.
- (f) Names of physical and cultural features, printed clearly.
- (g) Roads with double lines. This makes clear that a boundary, running down the middle of the street, includes one side but not the other. If single

line roads were used as boundaries, the enumerator might not remember his instructions and could canvass both sides. An alternative, to be followed only when necessary, is to include an explanatory statement on the map.

(h) Boundaries are shown by a coloured line, preferably red or orange. Since this must be applied manually, it is time consuming. Aside from the original map in the central office, all other enumerator's maps can show this boundary by means of a black, wiggly line with tight meanders; this reproduces adequately for whatever use it is put by other personnel. While not mandatory, a word description of the boundary is desirable and should be included.

(i) All buildings, as well as other structures occupied as living quarters, should be shown if their location can be fairly accurately ascertained. Thus the map should ideally include detached dwellings, multi-dwelling buildings and non-residential buildings such as schools, industrial plants, commercial buildings or barns, and it may also include other structures or places occupied as living quarters, such as ruins or caves. If possible, symbols should be employed for buildings which contain at least one set of living quarters and special symbols should be used for multi-dwelling buildings and marginal housing units.

33. It is the responsibility of supervisors to number city blocks for canvassing and to field check new construction, areas of recent rapid growth and doubtful boundary lines. Arrangements should be made so that supervisor's training includes practical experience of this sort.

34. Several common mistakes in construction of enumeration maps are listed below. First, the map may be made of paper which deteriorates rapidly with use. Second, it may be of a scale which makes it too large to handle easily in the field. Third, the features and names shown may be too small, and they may therefore be hard to read or subject to misinterpretation. Such maps may often not reproduce well. Fourth, if the peripheral zone does not extend out far enough to cover an identifiable point beyond the area being enumerated, the location of the boundary may not be clear. Fifth, doubtful boundaries, particularly those following imaginary lines, must be field checked; if this is not done, the margin for error is increased. Sixth, single line roads, as noted, enhance the chances for inaccurate enumeration. Finally, if dwelling

units and other buildings are incorrectly located on the map, they tend to confuse the interviewer. Under such conditions, the possibilities of omission or duplication of information are enhanced. This situation also applies to the misplacement of other physical and cultural features on the map. It has been pointed out that there is a certain tolerance of error on census maps as regards distance, but not in terms of the proper relationship of one feature with another. It must be stressed that it is the responsibility of the supervisor to check out all major map problems; the enumerator can make simple changes on his map but he must not be relied upon to interpret ambiguous features. For example, he can often determine whether a house is located within an urban centre bounded by imaginary lines by asking the respondent; he can add or delete roads, bridges, houses, and other features as long as such change is minor. However, if a boundary has been changed and is not shown on the map, or if a new road complex has been built, or if a great deal of new construction has obliterated or masked the old settlement pattern, then he needs assistance from his supervisor.

35. The size of the enumeration area will vary as a result of a number of different factors. For example, the type of terrain and the ability to traverse it during the season of the year in which the census is taken, will have a bearing on size. The quality of the roads, the kind of vehicle which might be used for transporting enumerators, and the length of the enumeration period must be taken into consideration. The level of education of the enumerator and the respondents, the length of the questionnaire and the density of the area will also affect size. Finally, rural enumeration areas almost invariably tend to be larger than their urban counterparts. Basically, however, the size of the enumeration area will reflect the desires of the subject matter division conducting the census. Old enumeration areas can be subdivided into acceptable sizes for a sampling survey by means of standard map chunking and segmenting methods.

36. In view of the foregoing paragraphs, it should be fairly easy to determine the extent of map training which enumerators should receive. They should be taught something about scale, orienting maps, canvassing techniques, boundary recognition, legend symbol identification and standard procedures for changing and correcting maps. The latter task might include the addition of new information



on the maps as well as the deletion or alteration of incorrectly placed features. Apropos of this, it also should be stressed that all maps, without exception, should be returned to the Geography Office.

### C. Needs of census offices

37. The central office requires a map of the entire country, showing major population agglomerations, terrain features and drainage and the transportation network. It must be clear enough so that jurisdictional boundaries of census regions can be outlined, in order to avoid overlap. Copies should normally be sent to regional offices. Simple maps must also be available which show boundaries of administrative areas and the relative location of all places for which data are to be reported and published.

38. Regional offices require full map coverage, including contiguous areas. Maps of intermediate and minor civil divisions, as well as those of supervisors, crew leaders and enumerators are also needed. Originals of all these maps are filed at the central headquarters.

39. District or local offices require coverage of pertinent administrative areas, plus copies of crew leader's and enumerator's maps. Copies of the latter can be used to replace maps in the field which are lost, mutilated or destroyed. Supervisor's maps should show most pertinent physical and cultural features of the area involved, although the detail would not necessarily be as great as that depicted on enumeration district maps.

40. The magnitude of the map reproduction job is indicated by the foregoing paragraphs. For example, a copy of an enumerator's map must be made available to the central, regional and district offices as well as to the enumerator himself. Furthermore, since peripheral areas have to be included, the base map from which a "cut-out" map comes, must in turn be reproduced several times. This is because the base map, which contains a certain number of enumeration districts, could not be cut up to furnish the exact same number of enumerator maps.

41. Scale denotes the relationship between distance on the map and actual distance on the ground. Generally speaking, small scale maps cover comparatively

large areas and vice versa. Enumerator's maps are large scale; as a rule, they vary from 1:5,000 to 1:12,000 in urban areas to 1:10,000 to 1:25,000 in rural areas. If the scales are smaller than those indicated, names often are not legible; if larger, they are too big and unwieldy to handle in the field. (The representative fractions noted indicate the actual map and ground distances, regardless of the unit of measure. Thus, 1:5,000 could be defined as one inch to 5,000 inches or one centimetre to 5,000 centimetres.) As a result of the differences in areal sizes of enumeration areas, the line used to demarcate the end of an urban place and the beginning of a rural region also represents a transition from one scale of map to another.

#### IV. MAP ACQUISITION

42. Maps can be obtained from a variety of sources. Government agencies, for example, may have maps, sketches, aerial photographs or special information which may be of value to census operations. Highway agencies can have maps of the road network; departments of interior or conservation may have maps of special areas such as forests, river basins or reservations; an agricultural ministry may have soil and land use maps; a geological survey agency may have topographic sheets, or maps showing locations of mining camps; defence agencies may have coverage of training areas and other installations of an unclassified nature, as well as maps of ports, coastal areas and boundary regions. Maps showing construction housing starts, hydrography or postal routes can also often be available and helpful. Other sources of information may be planning departments, development banks and area development organizations, and health and education agencies. Local governments might furnish maps from cadastral records, city files, or from police, fire, highway, health and sanitation departments. Other sources might include air, rail and trucking firms, construction companies, utilities, engineering organizations, farm co-operatives, libraries, insurance companies and cartographic firms. International agencies and geographic institutes may also have usable maps. The American Geographical Society, the International Geographical Union or the Pan American Institute might be cited in this regard. Exchanges with other countries is also possible.

As for emerging nations, the general impression seems to be that adequate maps may be harder to obtain. However, this situation may apply only to internal sources; other nations and international agencies may often have good coverage for large areas. Here the skills of an individual well versed in map acquisition are needed. Large portions of Latin America and Africa, for example, have been photographed and mapped.

43. Maps can be obtained by contract or by co-operative effort with other agencies. If private organizations are involved, care must be exercised to ensure that copyright laws or other legal privileges are observed. Often, a promise is made that these maps will not be used for anything but census purposes.

## V. OPERATIONAL STEPS IN A MAPPING PROGRAMME

### A. Inventory

44. The first step in determining the magnitude of the job of preparing maps for a census is to take a complete inventory. This entails the establishment of a list of all areas for which data are to be reported. It is not always a simple task, since many of these areas may not be known. For example, if the urban definition is couched in terms of agglomeration size, then those villages on the lower end of the population spectrum may or may not be included in the final report. In order to ensure coverage, all marginal cases have to be considered as eligible. Armed with this listing, the map collection is then examined in order to determine both quantitative and qualitative coverage. It should be understood that the inventory must be made in close collaboration with the subject division in charge of the census; only such an office can determine the framework in which the enumeration is to take place.

45. The inventory table should have a listing of all administrative or statistical areas for which data are required. This stub is arranged in hierarchical order from major to minor civil divisions. Columns must be included which will furnish pertinent information in regard to scale, dates of coverage, sources and boundaries. In the last column, a qualitative assessment is made of each map and recommendations are then formulated. For example, maps may be rated as satisfactory or they may be noted as requiring **updating**, field work,

further compiling or correcting. Areas for which maps are missing are also listed. The entire table should be designed so as to conform to a geographic code which is then to be used in facilitating all data processing operations. The code is established by the geography office in conformity with the requirements of those subject departments concerned with categorizing data by specified type of area.

46. The inventory at this juncture can provide the geography office with some fairly clear indications of the time required, the cost of the operation, the size of the field staff, the equipment needed and the amount of field work probably entailed. It also can furnish the priority order of work, since the first tasks should normally be concerned with those areas having sizable populations but poor or non-existent map coverage.

47. Only general statements can be made in regard to the financial aspects of census mapping, since expenditures depend on a large number of variables. However, as a general rule, the cost of the maps needed will range from 5 to 15 per cent of the amount set aside for the census operations, up to and including the period of enumeration. One of the major cost items would be field work. It accounts, for example, for almost one half of the amount spent in producing expensive United States of America quadrangle (topographic) maps from an aerial photo base. Some countries have decreased these costs by relying heavily upon the work of local individuals in supplying necessary information. In addition to these considerations, it can be pointed out that the delineation of statistical areas will also raise the cost of the operation, as will the use of aerial photography.

48. It is difficult to develop an accurate time schedule for mapping operations. Obviously, there will probably be a close relationship between time expended and the magnitude of the job. Batchelet and Archer,<sup>4/</sup> two United States geographers, maintain that the time needed must depend on the number of employees, the size of the country and the results of the map inventory. It is their contention that a three-year period, on an average, is needed to do the work; however, as noted, this estimate is subject to change for many reasons. In any event, allowance of too short a time-span for the work enhances the chances that the quality of the final product will deteriorate. As a rule of thumb, an inventory should probably

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<sup>4/</sup> C. Batchelet and A. Archer. Comments on Geography and Cartography for Census Purposes. Inter American Statistical Institute, IV session of the Committee on Improvement of National Statistics, 1956, p. 1.

be made two to three years in advance of the enumeration and map collection should start at least two years before the terminal date. All maps should be available at least three months before the census is to be taken<sup>5/</sup> and maps needed for establishing enumeration areas should be available at least six months before the enumeration. It is generally wise to allow more time than appears to be needed if much field work or outside contracting is involved.

B. Base map preparation

49. If the original census map or one subsequently acquired is suitable in terms of scale, mode of presentation of features and age, it is then used as a base map. It may also be used when there is insufficient time to prepare a better map; this is often the case if the size of the job, the skills of the staff and the allotted time are all at variance. Maps may also be serviceable as bases if the changes required are not numerous. New maps are usually constructed if the previous coverage is extremely poor and if new sources of information, such as aerial photographs, are made available. Updated information is obtained in many ways. By way of illustration, it can come from corrections on previous census maps; from surveys taken by various agencies, such as health or education; from new maps which cannot be used as bases; from census field offices; from local officials. In the last census for Uruguay, for example, local authorities were asked to enter the number of living quarters, by street and block, on maps for their locality. This information was then used in delineating enumeration areas. Compilation, tracing, editing and other techniques used to develop base maps are not described here, since they are no different from standard cartographic methods. The end product of the process for field work is a "cut-out" map which can be used for enumeration purposes.

50. Aerial photographs, if current, show physical and cultural features in their correct perspective and may be of great help in base map preparation. However, their use as maps is limited because of the constraints imposed by time and costs. For example, whether the photos are used as such or whether they are converted into

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5/ Principles and Recommendations for the 1970 Population Censuses (United Nations publication, Sales No.: 67.XVII.3), para. 53; Principles and Recommendations for the 1970 Housing Censuses (United Nations publication, Sales No.: 67.XVII.4), para. 60.

maps, all pertinent names, administrative boundaries and scales have to be indicated. This usually involves enlargement of the photo and costly field work by staff from the central office. Furthermore, if the photos are used directly as enumeration district maps, an extra effort must be expended in training the interviewer to read them. It must be assumed, in such cases, that the enumerator has an adequate education or is capable of absorbing such training and that the additional time and money for this training are available.

51. Some countries prepare census control lists some time before the census enumeration and use them to help determine the size of the enumeration areas. If time allows, it would be advantageous if the enumeration areas could be delineated prior to the listing and finally determined after information is received from local authorities or regional census offices. However, close working arrangements between census and geography personnel would be required; given the limitations on time involved in map preparation, it may not always be feasible to attempt such an undertaking, desirable as it might be. Apropos of this type of work, it might be mentioned that the outer boundaries of large urban centres (urbanized areas) in the United States of America in 1960 were defined after the census was taken.<sup>6/</sup> This method of boundary determination is unusual, however, and requires a good deal of co-ordination between census offices.

#### C. Field work programme

52. Field work is required under a variety of conditions: if acceptable maps are not available; to obtain locations of administrative boundaries and names; to establish certain kinds of statistical areas. There are side benefits to this work, since culture can be added to the maps during the course of the operation. Thus, for example, living quarters can be placed on the map and roads can be classified. It should be mentioned, as a general precaution, that a field team should not normally be sent into an area without at least some rudimentary sort of map from which to start its work.

53. It has been stated that some field work can be done by local authorities, such as police, teachers, government officials or soldiers. If the programme is

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<sup>6/</sup> R.C. Klove and A. Archer, "The Development of Urbanized Area Base Maps for the 1960 Census". Surveying and Mapping, vol. XXIII, March 1963, p. 86.

carefully conceived and administered, the requisite information can be obtained at comparatively low cost. This was done, for example, in Bolivia and Panama. Often, however, the quality of the end product is very uneven. Furthermore, if aerial photos are used, few local people can be relied upon to have the requisite skills to work with them. Nevertheless, given the limited budgets, particularly of some emerging nations, this type of field work may represent a feasible solution; information can be obtained cheaply and can be, comparatively speaking, fairly accurate. In the United States of America, it is anticipated that some local officials will be called upon to help in map editing and the preparation of an address coding guide for certain places in 1970.<sup>7/</sup>

#### VI. MAP AND GRAPHICS PUBLICATION

54. One of the required tasks of a geography office in a census organization is to prepare area identification maps for publication. These show the boundaries of areas and the location of places for which data are to appear in print. A location code guide is set up so that a place identified by a grid number in a table can be found easily on an appropriate accompanying map. No other cultural or physical detail need be shown.

55. The publication of data in map and chart form is a fairly inexpensive yet advantageous way to show some of the results of the enumeration. Generally, the viewer can readily comprehend the patterns revealed by these statistical maps and other graphics. The subjects are also not limited solely to population numbers and distribution or settlement types. Data can be shown which deal with vital statistics, growth rates, urban-rural dichotomies, ethnic structure, economically active or inactive populations, migration, education, age and sex, housing conditions and land use. Although most methods should conform to cartographic convention, modifications permit a fairly wide latitude of choice in presenting census information. Charts, for example, can be superimposed on maps; the results can be gratifying if combinations are constructed with a discerning eye. Census information can also be used to make maps in which data

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7/ W.T. Fay, The Geography of the 1970 Census. U.S. Bureau of the Census, ms., 1966.

are not simply described but analysed within a spatial framework. These maps, for example, may show various kinds of migration streams, centres of population gravity or potentials (shown by isopleths, which are lines passing through points having a constant value), market areas or degree of settlement dispersion.

56. It should be kept in mind that a proper presentation of the geographical distribution of statistical data requires professional staff skills of a high order. Ability to present information in map form is certainly not a capability unique to geographers; accordingly, many hands are often involved in the formulation and final selection of maps and graphics. At times, as a result, some census atlases tend to be overly simple or, on occasion, much too complex.

57. The objective of a map showing statistical information is to reveal distribution patterns which are not as easily grasped in tabular presentation of data. If the map only shows what is already common knowledge and does that in overly simple terms, then it contributes little. By contrast, if it attempts to show too much or if the scale of the published map is not adequate to the task, the map becomes hard to read and loses much of its value.

58. Some maps can be misleading. For example, it would be incorrect to stress area size if population size were implied. Thus, if the area of Kiruna, Sweden, one of the largest cities in the world in terms of acreage, were shown on a map depicting urban centres in the country, the conclusion might be reached that its population exceeded that of Stockholm. Density maps, commonly shown in census atlases, can tend to project erroneous impressions also. The usual (choropleth) map of this type shows population distribution as evenly spread throughout a certain designated area; in actual fact, such an apportionment is more unusual than usual. Furthermore, since simple arithmetic density does not refine attributes of people or type and use of land area, any correlation between this measure and other characteristics of the landscape which may be inferred from the map is not necessarily of a causal nature. Dot maps, which show location and density as well, tend to be more accurate in showing distribution.

59. Perhaps the only conclusion which can be reached in regard to map and chart publication is that extreme care must be taken to make sure that the presentations are meaningful. Maps can reveal spatial patterns with relative precision if they are judiciously constructed. It needs to be stressed that emergent nations, particularly, should seriously consider the mapping of census results. Costs are comparatively low and the benefits to the data user can be appreciable.



ANNEX I

Glossary of terms

1. Choropleth map. A quantitative areal map in which a symbol representing a certain value is applied to a defined place. A wide variety of subjects can be used. For example, population or housing density per square kilometre, sex ratio or percentage urban might be represented on maps of intermediate or minor civil divisions.
2. Graphic scale. A map scale which depicts distance by means of a line of designated size which is divided into standard lengths. It is also called a horizontal scale or a long line scale.
3. Isopleth. A line on a map passing through points having the same values. It can be used to show a variety of types of distribution, both physical and cultural.
4. Map culture. Map information relating to man-made features, such as roads, houses, bridges, transmission lines or boundaries of administrative areas.
5. Map scale. Expresses the relationship of distance between features on a map with the actual distance on the earth's surface. It may be represented in graphic form (see Graphic scale), as a word statement (such as "one inch to one mile"), or as a representative fraction (such as 1:100,000). The latter refers to equivalent areas on the map and on the ground, using the same type of measure. Thus, in the fraction 1:100,000, one inch (or centimetre) measured on the map is equal to 100,000 inches (or centimetres) on the surface of the earth.
6. Quadrangle maps. Maps of varying scale which show selected physical and cultural features. Rigid standards are set by the developing agency so that a high order of accuracy in cartographic representation is obtained. Maps of this kind generally appear in a series.



## ANNEX II

### Statistical areas

1. Statistical areas are defined by criteria established by a national statistical office. They are delineated for data gathering purposes and differ from administrative areas. The latter are civil divisions of a country which are defined and controlled by an agency of the government. Most emerging nations have done little work in developing reporting areas of this kind.
2. Statistical areas are usually defined in terms of some sort of cultural or economic homogeneity. Boundaries are very often drawn by a national statistical office in conjunction with the recommendations of local officials or important members of the community or communities involved.
3. There are several different types of statistical areas. For example, census divisions, such as those found in Canada, define areas which have similar social characteristics and market functions. They vary in size, being comparable to counterpart intermediate and minor administrative divisions. Economic areas and subregions, such as those found in the United States, also delineate areas having similar socio-economic conditions; in this case, counties (intermediate-size civil divisions) tend to be the smallest units used. Connurbations are large urban areas, defined in the United Kingdom, whose boundaries are determined on the basis of urban land use. Tracts are small homogeneous portions of cities which are also defined for data gathering purposes.
4. The advantages of having statistical areas are manifold. For example, it should be possible to obtain a more meaningful series of data if they are gathered for homogeneous areas. Thus, urban planners could make good use of separate tabulations for a central business district or for the squatter settlements (bidonvilles, callampas, barriadas, etc.) which are characteristic of many of the larger cities in Africa, Asia and Latin America. Furthermore, as noted, since boundaries do not readily change for statistical areas, comparable data can be provided from census to census. This is important mainly in those countries in which boundary changes of administrative areas are common. Lastly, the

boundaries of statistical areas are chosen so that they generally follow visible features on the ground. Since these lines are used in delimiting enumeration areas, they can then serve as an aid in making sure that the interviewer finds his boundaries easily.

5. It has been noted that many countries have done little work in defining statistical areas. As a result, urban places are often not clearly bounded, so that data suffer accordingly. This is one of the reasons why information on rural-urban migration tends to be less reliable than it otherwise might be. Work also needs to be done in defining areas in those countries where agglomerations are large but are not classed as urban.

## ANNEX III

### Organization of a geography office

1. A geography and cartography office must be flexible in terms of its table of organization. This is particularly true if the office is a small one in which personnel are often switched from job to job. Certain functions must be performed, however, regardless of staff size or functional subdivision. For this reason, the various duties of the geography office, as well as staffing requirements, are categorized under several different types of activities. A simple table of organization is shown in chart form in appendix D.
2. Cartography operations. This type of work would involve the compiling, editing and reproduction of maps. It would require personnel skilled in preparing and interpreting maps and aerial photographs. Employees would also have to be able to develop maps and graphics for publication, often in the form of a census atlas. Attached to this core of professionals would be a complement of draftsmen whose knowledge of mapping techniques, concepts and skills need not be of a very high order. The job of measuring areas in order to obtain density data could be handled by this group; the work would mainly be of a clerical nature.
3. Administrative areas delimitation. The collection and revision of maps showing officially defined administrative boundaries would be one of the major chores involved in this assignment. Accordingly, communications must be established with all organizations controlling places for which data are needed; if boundaries are altered, or are in question, field work may be required. People doing this work must also keep track of the boundaries of special areas, such as designated forest regions, territories, reservations or large plantations. One of the most important over-all tasks, however, would be to ensure that there are no omissions or duplications of areas shown on maps of intermediate and minor civil divisions. This operation should be headed by a geographer, but much of the work can be done by a clerical staff; professionals may become involved in questions dealing with the resolution of boundary problems.
4. Enumeration area delineation. The drawing-up of boundaries from the base map prepared by the cartography group requires some professional judgement, so

that it would generally be advisable to have trained geographers do the work. For example, the following decisions require some exercise of professional skill: the determination as to when old enumeration area lines should be adhered to and when they should not; the ability to know when to depend on map information and the degree of such dependence; the delineation of boundaries so that homogeneous areas may result. These determinations must, of course, accord to the general specifications laid down by the proper census authorities. The tasks involved are usually given to clerks, however, since professionals are normally in short supply at this time. About the best way to maintain control over the situation is to make sure that geographers serve as supervisors and review all work.

5. Statistical areas delineation. This work would involve the determination and testing of criteria for establishing boundaries of statistical areas. Staff members in such operations should be geographers with backgrounds in statistics. Assignments involve field as well as office work.

6. Headquarters functions. Some sort of centralized operations must be performed, not only for administration and personnel management, but for a variety of other duties as well. For example, it is important to maintain liaison with other organizations and to operate a library in which maps can be filed and stored. It may also be necessary to assist in map training for enumerators and to engage in various types of special field work activities.

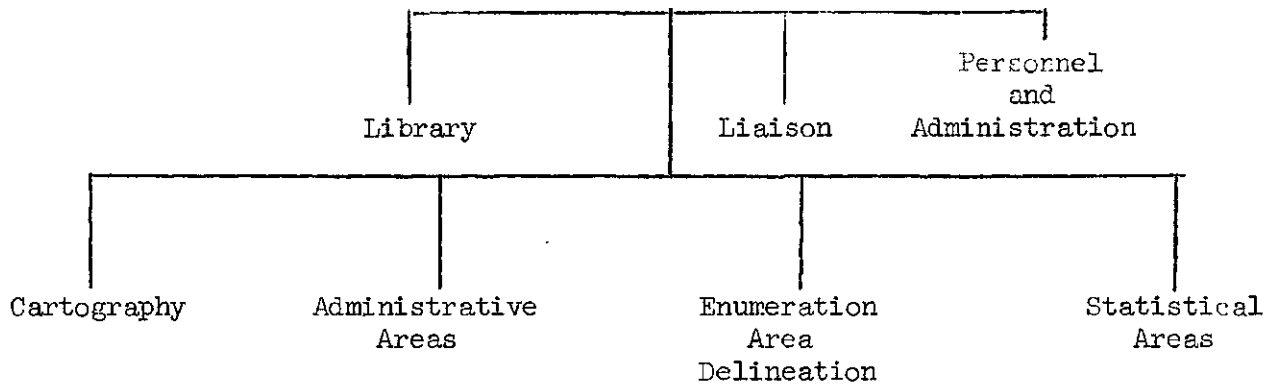
7. The equipment for the office is made up of those cartographic tools and machines which are needed to make and reproduce maps. Their complexity ranges from the simple and inexpensive to the complicated and costly. It is not within the scope of this paper to list and describe these machines. Nevertheless, it should be pointed out that, as a minimum, access to cheap and fast duplicating equipment is mandatory. Map filing cabinets are desirable, but low cost shelving can be made to substitute for them if funds are not available.

ANNEX IV

Cartography and Geography Office

Table of Organization

Headquarters







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