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ATLAS MAPPING IN TANZANIA: AN AFRICAN CASE STUDY

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Mike Shand,
Department of Geography & Topographic Science, University of Glasgow
and
Eugene Silayo,
*Department of Surveying, University College of Lands and Architectural Studies,
University of Dar es Salaam.*

ABSTRACT

The continent of Africa has a long history of atlas production at both regional and national levels. The countries of East Africa are no exception to this, hence the history of atlas production in Tanzania can be mirrored in many other countries across the African continent.

The first part of this paper will review the history of atlas publication in Africa and Tanzania, making special reference to the source data and base maps; atlas contents, formats and scales; and the cartographic production methods adopted for atlases of Tanzania. Six separate editions of a "national" atlas of Tanzania have been published to date, one of German East Africa, three of Tanganyika and two for the Republic of Tanzania. In addition there have been numerous general, specialist/thematic and school atlases published by educational establishments and commercial companies for both East Africa and Tanzania.

Atlas production can be a time consuming and costly process requiring a large collaborative effort by several organisations and many individuals with scientific and cultural expertise in both physical and human geography and in the field of mapping and topographic science for the map production process. The second part of this paper will discuss the impact of current digital mapping technology on national and commercial atlas production, with a view to (i) the revision or production of a new edition of a national Atlas of Tanzania, (ii) the production of a demographic atlas and (iii) the creation of a small scale cartographic data base. A series of completed sample atlas sheets of Tanzania, created by digital mapping methods and utilising desk top publishing technology, will be cited in this part of the paper. The discussion will concentrate on a comparison of analogue and digital atlas production methods and consider their role in the future of atlas publication in Tanzania and Africa.

1. INTRODUCTION

A geographical atlas has traditionally been defined in general terms as "a book of maps"; in technical terms as "a collection of maps to be kept (bound or loose) in a volume" (ICA 1973); and in the case of a national atlas, as "an atlas that depicts different aspects of one country" (ICA 1973). Today the word "atlas" is used in a much wider context, and can be used to describe any collection of spatial and non-spatial data sets which have been "mapped" using digital or analogue methods to form a hard copy or on-screen graphical image. So in addition to the geographical atlas (e.g. Atlas of Tanzania), we may also have an astronomical atlas (Atlas of the Moon) or even an anatomical atlas (e.g. Atlas of the Brain or Nervous System). For the purpose of this paper the word "atlas" will refer to the "geographical atlas" only and the term "national atlas" to atlases of one nation depicting maps portraying general and specialist/thematic information on multiple topics.

An atlas, be it in hard copy form or as a digital data set, can be grouped or classified according to the geographical area represented, the information portrayed or the purpose for which it was created.

Two main groupings for atlas classification have been put forward in a discussion paper by Stams (1977). They are:

- (1) according to territorial extent,
- (2) according to content.

Atlases will vary by the territorial extent or spatial area that they cover and may be classified as either International, Multi-national, Single-nation, or Intra-national. If this classification is adopted, an "international" atlas will cover all countries of the world, a "multi-national" atlas more than one country, a "single-nation" atlas one country only and an "intra-national" atlas a specific area or areas within a single country. When classifying atlases, the term "regional atlas" should be used with caution since confusion may occur as to the actual boundaries of such a region which may not have any defined limits or political significance (e.g. Tropical Africa - An Atlas for Rural Development). Furthermore a "region" in such an atlas could portray a region or regions of the world (e.g. Atlas of the Middle East and North Africa), a region of a continent (Regional Atlas for East Africa) or a region within a country (Regional Economic Atlas: Mainland Tanzania). The scale of maps portrayed in an atlas and their physical size when they are printed or plotted are directly affected by the territorial extent or spatial area covered by the atlas.

The content of an atlas can also vary and, according to Keates (1989), "maps in atlases are not confined to any particular type, either of subject or purpose". Atlas content can be classified according to the general or specialist themes portrayed by their maps.

The most popular form of atlas is the general atlas which will normally incorporate a comprehensive range of maps for the purpose of portraying all aspects of the physical and natural environment. The main purpose of a general atlas will be to convey an overview of a geographical area or country at a certain point in time to atlas users such as planners, researchers, scholars and students. Typical of this type of atlas are the "Atlas of Africa" (Jeune Afrique) and the National Atlases of Tanzania (and Tanganyika) which have incorporated maps of the physical environment (geology; soils; climate; relief; hydrology etc.) and maps of the natural environment portraying aspects of both biogeography (flora and fauna; conservation; natural resources etc.) and human geography (population; culture; industry; commerce; communications etc.).

Another form of general atlas is the educational or school atlas, which is often adapted or derived from general or national atlases to match the educational requirements of the proposed user in primary, secondary or tertiary education. Published school atlases for Africa include "Philip's Modern College Atlas for Africa", the "Oxford Atlas for East Africa" and the "Atlasi Kwa Shule za Msingi Tanzania".

Another major and increasingly popular type of atlas is the specialist or thematic atlas which will normally contain maps portraying a more restricted range of topics or themes than the general atlas. The purpose of such an atlas will be to convey to the user a more detailed view of a topic or subject area with maps of an analytical nature rather than factual representations of data. Examples of specialist or thematic atlases for Africa include the "Climatological Atlas of Africa", the "East African Livestock Survey" and the "Regional Economic Atlas of Tanzania".

2. ATLASES OF AFRICA

The continent of Africa has been well served by the international and national publication of atlases. Current information, as summarised below in Table 1 and Figure 1, indicates that approximately 274 atlases of Africa and its individual countries have been published to date including over 150 single-nation atlases for the 53 countries of Africa.

ATLAS CONTENT	TERRITORIAL EXTENT				Totals
	International	Multi-national	Single-nation	Intra-national	
General (Schools)	24 (4)	34 (11)	128 (37)	19 (0)	205 (52)
Specialist / Thematic	17	10	27	15	69
Totals	41	44	155	34	274

Note: Figures include all editions of each published atlas.

Table 1: AFRICA - Published Atlases Classified by Territorial Extent and Atlas Content

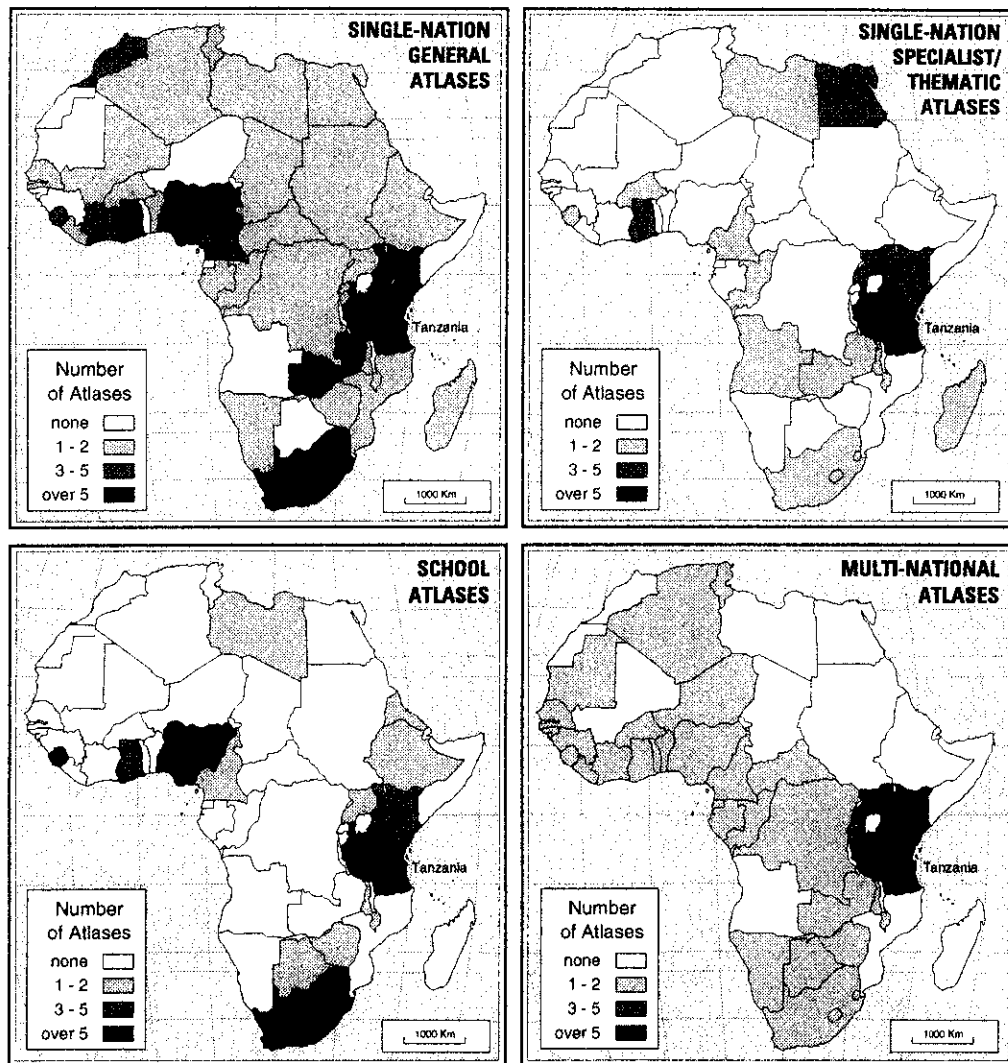


Figure 1: AFRICA - Distribution of Published Single-nation, School and Multi-national Atlases

Atlas production in Africa originated in the late 19th century during the colonial period of African history and has continued apace with the transition from colonisation to the creation of independent sovereign nations. As can be seen from Figure 2, approximately 70% of all single-nation (general and specialist/thematic) atlases of Africa were published between 1955-1975 during a twenty year period when almost 80% of the countries of Africa became independent sovereign nations.

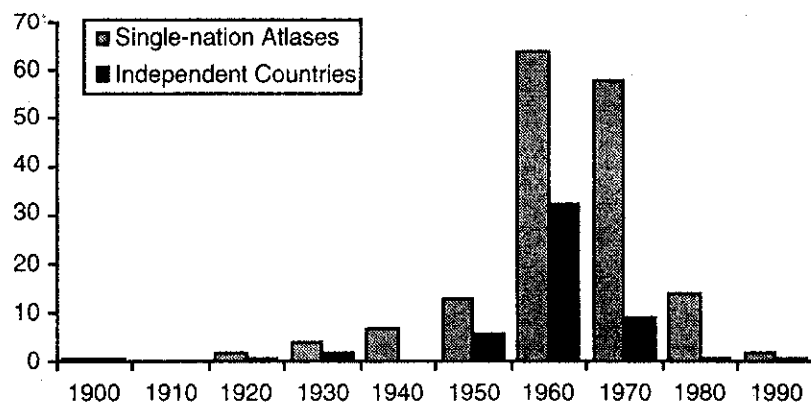


Figure 2: AFRICA - Dates of Published Single-nation Atlases and Declarations of Independence

It can also be observed from Figure 2 that single-nation atlas production in Africa followed a steady upward trend of 5-10 atlases published per year during the pre-1950 colonial period, and reached its peak of 64 atlases published in the 1960's during the period of Africa's nations gaining independence. Single-nation atlas production has now fallen back to the levels of fewer than 5 atlases per year that were achieved during the 1920's and current information sources indicate that so far only one single-nation atlas has been published in Africa during the 1990's. The probable causes for this lack of atlas production are the severe financial constraints affecting many African countries and the generally low priority rating given to investment in national mapping against other priority areas such as health, social welfare and education.

3. ATLASES OF EAST AFRICA

3.1 General Atlases of East Africa

3.1.1 East Africa (1954 - 1961)

This loose leaf atlas published at 1:3,000,000 scale was produced by the Directorate of Colonial Surveys (DCS) and latterly the Directorate of Overseas Surveys (DOS) from information supplied by the Royal Commission to East Africa. This full colour atlas contains 12 map sheets portraying information relating to topography, communications, boundaries, population, rainfall, tsetse fly and land units. The maps appear to have been produced by traditional methods such as pen and ink drafting for linework, a combination of solid colour masks and a limited number of line screens for area fills and typeset lettering for the map names. The number of printing inks and colours used varies according to the requirements of each map.



Figure 3: Extract from the population, tsetse fly, and rainfall map - DOS Atlas of East Africa

3.1.2 Oxford Atlas for East Africa (1966, 1967, 1971)

The Oxford Atlas of East Africa contains a total of 21 pages on Africa within its 65 pages. Tanzania and East Africa are covered by 21 maps at a range of scales between 1:3,200,000 and 1:12,500,000.

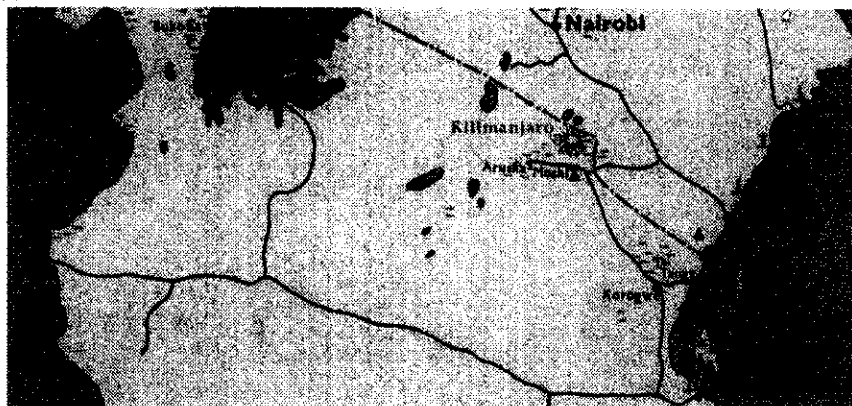


Figure 4: Map extract from the Oxford Atlas for East Africa

In addition, there are 1:126,720 scale urban maps of Dar es Salaam, Nairobi, Mombasa and Kampala. The majority of the maps for East Africa in this atlas are simple specialist/thematic maps as illustrated in Figure 3. The quality of the linework and use of percentage screens leads one to the conclusion that the atlas has been produced by scribing and masking techniques. The atlas has been printed in six inks - red, green, blue, brown, grey and black.

3.1.3 Other General Atlases for East Africa

Two other general atlases for East Africa have been published by McMillan Educational. The first My East Africa Atlas, was a small format atlas published in 1960 and comprised 48 map pages at various scales. The second was another small format atlas entitled A Map Book of Eastern Africa, Zambia and Malawi published in 1974.

3.2 **Specialist/Thematic Atlases of East Africa**

3.2.1 Handbook of Natural Resources of East Africa (1961, 1969, 1973).

This atlas contains 7 full colour maps of East Africa at 1:4,000,000 scale portraying information relating to the physical and natural environment. The atlas has been produced by pen and ink techniques and the number of printing inks varies between 3 and 9 according to the requirements of each individual map sheet. The topographic base map used for this atlas is a reduced scale version of the base map created for the previously mentioned East Africa atlas published by the Directorate of Overseas Surveys.



Figure 5: Physical map extract from the Handbook of Natural Resources of East Africa

3.2.2 Other Specialist/Thematic Atlases for East Africa

Other specialist/thematic atlases have been published for East Africa including the East African Livestock Survey published in three volumes by the United Nations in 1967 in association with the Food and Agriculture Organisation; a small format atlas titled Tribal Maps of East Africa and Zanzibar containing 8 map pages and published in Kampala by the East African Institute of Social Research; the 16 page Atlas of the Diocese of Zanzibar, Nyasaland, Masasi, N. Rhodesia and S.W. Tanganyika published by the Universities' Mission to Central Africa in 1954; and the Road Atlas of East Africa published in 1952 by the Royal East African Automobile Association and containing 227 pages.

3.3 **School Atlases for East Africa**

At least two small format school atlases have been published for East Africa, Philip's School Atlas for East Africa (1956 and 1967) containing 32 map pages and a similar size of atlas published in 1968 as Nelson's School Atlas for Kenya, Malawi, Tanzania, Uganda and Zambia containing 64 map pages.

4. ATLASES OF TANZANIA

The four maps of Africa, illustrated in Figure 1, clearly show that Tanzania has been one of the leading nations in Africa for the publication of atlases. A major factor that has influenced the publication of atlases of Tanzania has been the availability of up-to-date topographic maps - usually the minimum pre-requisite for any atlas. The history and current state of topographic mapping in Tanzania has been well documented (Liwa 1994; Petrie & Liwa 1995; and Silayo 1988) and leads one to conclude that Tanzania has also been one of the leading nations in Africa for the publication of topographic mapping.

Current information on published atlases indicate that over 20 atlases of Tanzania have been published during the period 1906-1988. In addition, Tanzania has also been included in approximately 41 international atlases of Africa and 10 multi-national (sometimes called regional) atlases of East and Tropical Africa. These figures include general, school and specialist/thematic atlases illustrating many topics or single specialist topics.

The first atlas of Tanzania (Deutsch-Ost-Afrika (ix) Atlas), was published in 1906 by the German administration, followed in 1942, 1948 and 1956 by national Atlases of Tanganyika and in 1967 and 1976 by the national Atlases of Tanzania.

A number of specialist/thematic, schools and other small scale atlases were produced during the 1960's, 1970's and 1980's. Many of these specialist/thematic atlases were produced in Tanzania by academic researchers at educational establishments; in contrast to this, the majority of school atlases were produced by commercial cartographic companies based outside Tanzania. A full listing of the published atlases for Tanzania and East Africa appears in Appendices I and II.

4.1 General and National Atlases of Tanzania

General and national atlases which have attempted to portray all aspects relating to the physical and natural environment of Tanzania have been published within and outwith Tanzania by both government and non-government organisations. Six such atlases have been published during the period 1906 to 1976. The full index of the contents for each of these atlases appears in Appendix III.

4.1.1 Deutsch-Ost-Afrika (ix) Atlas (1906)

Although published as an atlas, it may be incorrect to define this publication as an "atlas" in the true geographical sense since it contains only two maps; nor would it be correct to define it as a "national atlas" as it only portrays the southern part of German East Africa. However this "atlas", published in 1906, richly deserves its place in the atlas history of Tanzania as the first atlas to record the physical and human geography of the country.



Figure 6: An enlarged extract from the Deutsch-Ost-Afrika Atlas

This "atlas", which was compiled by Dr. D. Fulleborn and published in Berlin as volume nine of a twelve volume set recording the physical and natural history and geography of German East Africa, contains an extensive collection of photographs of the landscape and its indigenous peoples, supplemented by comprehensive descriptive text panels and the two maps.

The main map is at a scale of 1:1,000,000 and covers the area enclosed by the southern part of Lake Tanganyika, the northern part of Lake Nyasa, the River Ruvuma and the Indian Ocean and extends as far north as Dar es Salaam and Morogoro. The second map is at the scale of 1:510,000 and only covers a small area around the north of Lake Nyasa. The maps identify numerically the location of all photographs and contain information on relief, drainage, settlement and communications. They may have used as their source the 1:300,000 scale maps produced during the same period by the Department of Surveying and Agriculture or the earlier maps in seven volumes at 1:500,000 scale by Dr. Franz Stuhlmann. The maps are printed in 5 colours - black, grey, red, blue and green - with the quality of the image suggesting that the maps may have been produced by engraving techniques using copper or zinc plates.

4.1.2 Atlas of the Tanganyika Territory (1942, 1948)

The first official national atlas of the country was produced in 1942 at the Survey Division, Department of Lands and Mines, Dar es Salaam. This atlas was also significant as it was the only national atlas published in the whole world during the years of World War II. The atlas, printed in full colour and containing 29 pages incorporating 44 individual maps at various scales, a statistical section and tables, short descriptive text panels and a gazetteer, was published in a book format measuring 56 cm. in height and 59 cm. in width. The majority of the 18 full size map plates are at a scale of 1:4,000,000 and portray topics relating to the physical and natural environment. A further 9 plates contain 23 reproductions of historical maps at various scales.

A second edition of this national atlas was published in 1948 with revised information and the addition of 5 new maps and graphs of mineral production. The new maps portrayed soils, hydrography, vegetation, malarial areas and principal mines.

4.1.3 Atlas of Tanganyika (1956)

A third updated edition of the national atlas was published in 1956 by the Survey Division, Department of Lands and Surveys, Dar es Salaam and renamed the Atlas of Tanganyika. Another minor but subtle change, was the change from the "colonial" red binding of the two previous editions to a more "independent" green binding.

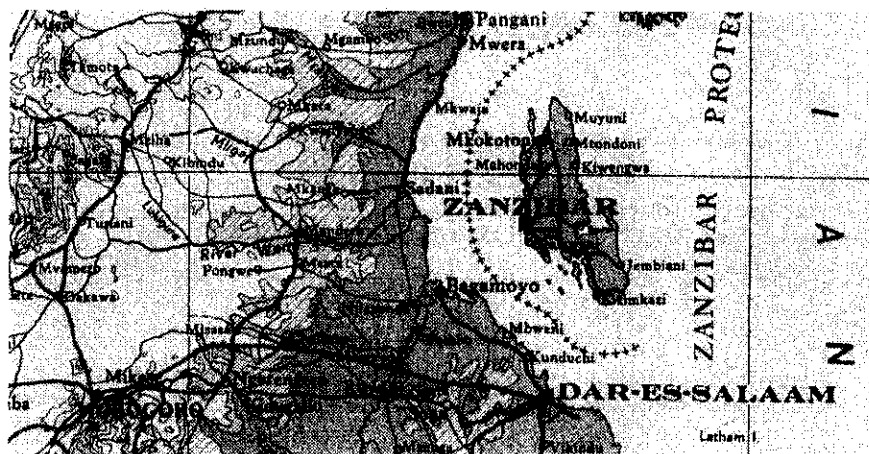


Figure 7: Physical map extract from the 1956 National Atlas of Tanganyika

The major changes in the contents from the previous edition included the increase in scale of the majority of maps to 1:3,000,000, the combination of the three population maps (and their additional printing on transparent overlays), the complete removal of the historical section and

the addition of 5 new map plates giving a total of 27 map plates. The 5 new map plates portrayed meteorological data, the distribution of labour, main labour routes, water supplies and extracts from published large scale maps of Dar es Salaam, Tanga, Dodoma and Morogoro at various scales.

4.1.4 Atlas of Tanzania (1967, 1976)

Following the independence of Tanganyika in 1961 and its subsequent union with Zanzibar and Pemba to form the United Republic of Tanzania in 1964, the first edition of a national Atlas of Tanzania was published by the Surveys and Mapping Division, Ministry of Lands and Housing and Urban Development, Dar es Salaam in 1967. The atlas retained its map scale of 1:3,000,000 but varied significantly in content from the three previous atlases of the country with the omission of 4 map plates and 1 graph plate and the addition of 6 new maps giving a new total of 24 map plates plus 3 full plates of graphs and statistical diagrams. Several of the existing maps have also been extensively revised and redesigned. The map format has changed as the atlas is now available as a complete volume in a more convenient loose-leaf binding form and, since 1969, it has also become available as individual map sheets.

Among the changes to content are the omission of the physiographic map, the tribal and ethnographic map, the labour maps and the mineral production graphs. New major additions to the map plates include a map of potential land use, a geophysical map, a rainfall probability map, an antiquities and monuments map, a fisheries map and a set of maps, figures and texts depicting population characteristics. What is significant about some of the new maps is the move from factually based maps such as a geology map to a more analytical type of map such as potential land use map.



Figure 8: Vegetation map extract from the 1976 National Atlas of Tanzania

A fully revised and extended second edition of the national Atlas of Tanzania was published in 1976 again by the Surveys and Mapping Division, Ministry of Lands and Housing and Urban Development, Dar es Salaam. Statistical data for 1972 was utilised where available, the exception to this being the use of the 1967 population census data. In addition to changes in the map content, other major changes included an increase in volume and an extensive rewrite of the descriptive text panels together with the inclusion of many new photographs and diagrams.

4.1.5 Map Production for Tanzanian National Atlases

The base maps used for all editions of the national atlas are compiled and derived from the 1:2,000,000 scale topographic map since this is the largest published scale that covers the whole of the country on a single sheet. Technical production initially involved the use of traditional analogue techniques such as pen and ink drawing, combined with the use of typeset lettering and positive masks. Area fills rely on a limited selection of glass line screens and pre-printed adhesive tones and patterns.

The limitation on area fills have a significant influence on the number of printed inks used in the atlas and the visual appearance of the areas. On a complex chorochromatic map such as the vegetation map in the 1956 edition, the 27 vegetation categories require an estimated 7 printing inks to enable each category to be easily identified by the user. Despite some skilful decisions on the design of the area fill combinations, the coarseness and angles of the line patterns are sometimes visually disturbing. Similarly on a choropleth map in the same atlas, the relief map requires 10 printing inks to portray the base map and maintain an even gradation between the 7 altitude layers. The use of extra printing inks avoids the excessive use of line screens by allocating a separate solid colour to all but one of the altitude layers.

The latest (1976) edition of the atlas has seen the introduction of stable polyester films as the base material for the cartographic production process utilising scribecoat and deepetch for linework, peelcoat for masking, and photographic stripping film and wax for name and symbol stick-up. Higher resolution percentage line and dot tints screen were also available for the creating of higher quality area fills and positive working colour proofing on white opaque astrofoil was also introduced.

4.2 Specialist/Thematic Atlases of Tanzania

4.2.1 Tanzania in Maps (1971, 1975)

According to the author, Prof. L. Berry, this book is aimed primarily at the people of Tanzania both within and outwith formal education who wish to know more about the spatial aspects of their country and to those outside Tanzania who require a general overview of the country and its economy.



Figure 9: Vegetation Associations map extract from *Tanzania in Maps*

The book, printed in monochrome black, contains 89 maps, 61 tables, diagrams, statistical data, extensive descriptive text and a comprehensive bibliography of the information sources used. The book includes chapters and maps of the physical environment (geology; soils; climate; relief; hydrology, etc.) and maps of the natural environment portraying aspects of both biogeography (flora and fauna; conservation; natural resources etc.) and human geography (population; culture; industry; commerce; communications etc.). The first edition of the national Atlas of Tanzania is acknowledged as a major source for the cartographic data with several government ministries and non-government organisations contributing to the non-spatial data and statistical information.

The majority of maps were drawn at the scale of 1:3,000,000 and reduced to the scale of 1:7,700,000 for publication. The maps were all drawn by the cartographic staff of the Department of Geography, University of Dar es Salaam using traditional analogue methods such as pen and ink drawing, dry transfer lettering and pre-printed adhesive backed tones and patterns.

4.2.2 Atlas of Africa (1973, 1983)

While the Atlas of Africa published in Paris by Jeune Afrique in 1973 and 1983, is not strictly an atlas of Tanzania, it is however significant among other international atlases in that each country, including Tanzania, is portrayed on separate maps. In the 1983 edition, Tanzania is covered by two full colour maps at 1:5,000,000 scale with accompanying text pages.



Figure 10: Map extract from the 1976 Atlas of Africa

The first map is a general topographic map containing information on relief, drainage, settlement and communications. The second map is a specialist/thematic map entitled "Economy", and contains information on agriculture, forestry, livestock, fishing, mineral resources and industrial activity overlaid on the same topographic base map minus the relief information. Both maps are of a very high standard in purely cartographic terms and have almost certainly been produced by analogue cartographic methods using scribecoat, peelcoats and stick-up overlays for text and symbols. Five printing inks have been used - black, red, blue, green and yellow.

4.2.3 Other Specialist/Thematic Atlases

The Regional Economic Atlas of Mainland Tanzania was published in 1968 as a research paper by S.B.A. Jensen of the University of Dar es Salaam and contained 18 maps at various scales.

A report on the relative location of health and population in the rural regions of Mainland Tanzania by I.D. Thomas of the University of East Anglia, U.K. comprised a series of volumes including volume 3 which was published as a regional atlas of the Population and Health Facilities in Tanzania, 1978. This atlas, which covers mainland Tanzania only, contains a complete volume of monochrome pen and ink maps at various scales using proportional circles to plot population data against health care.

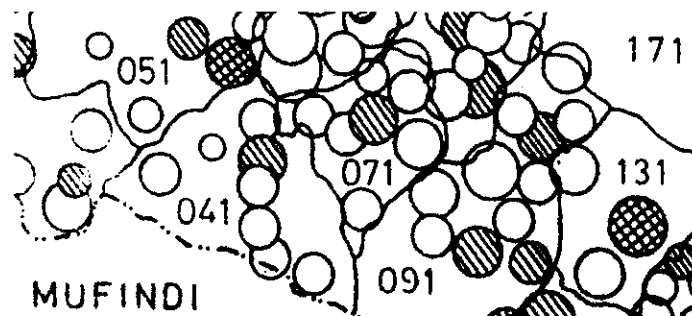


Figure 11: Extract from the regional Atlas of Population and Health facilities in Tanzania 1978

4.3 School Atlases for Tanzania

It should be noted that school atlases are often referred to as being atlases for a particular country rather than an atlas of a country. This distinction is important since these atlases, while they may contain a specialist and detailed section on Africa and the home nation, also contain maps of the rest of the world as the major content within the atlas. Since the majority of school atlases for Tanzania and East Africa have been produced since the 1960s, they have benefited from the availability of national atlases as source data and changes in technology. These technological changes have seen the introduction of high quality cartographic production processes using scribecoat, peelcoat, and photographic films. The use of full colour illustrations and photographs in these atlases has been a major factor in the introduction of the four-colour production process and the move from letterpress printing to the offset lithographic printing process.

4.3.1 Ramani kwa Shule za Primary (1963)

This primary school atlas, also titled "Tanganyika - Our country", is published in Swahili and may have been the first school atlas published for Tanzania. Like many school atlases, this atlas has been published in a small format with a series of simplified general and specialist/thematic maps at various scales for Tanzania and for the rest of the world.

4.3.2 Atlasi yenye picha kwa Shule za Msingi za Tanzania (1969-1983)

Intended as a foundation or secondary school atlas and again published in Swahili, this full colour atlas dedicates a total of 18 of its 40 pages to Africa and Tanzania and also contains many small illustrations as a complement to its maps. Tanzania is covered by 4 maps at scales of approximately 1:7,000,000 and 1:10,000,000, Zanzibar and Pemba are covered by two maps at the unusually large scale for a small format atlas, of approximately 1:300,000 and 1:500,000 respectively.

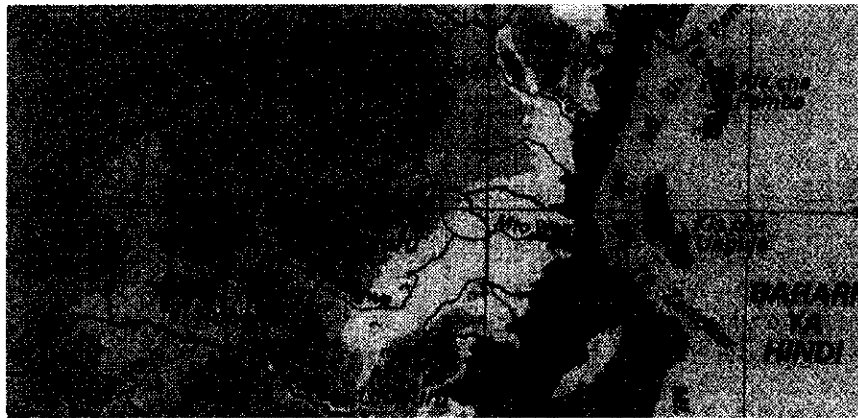


Figure 12: Extract from the Atlasi kwa Shule za Msingi Tanzania

4.3.3 Atlasi kwa Shule za Msingi Tanzania (1987)

This is another Swahili language atlas published by McMillan, and appears to be an updated, redesigned and extended version of the above atlas. A total of 37 of its 66 pages are dedicated to maps of Africa and Tanzania. It contains 14 maps of Tanzania at approximately 1:7,000,000, 1:10,000,000 and 1:20,000,000 scales and a special 10 map section on Zanzibar and Pemba. Numerous statistical graphs, charts, diagrams and tables have been added to this atlas and the illustrations of the previous atlas have been substituted by full colour photographs.

4.3.4 New Secondary School Atlas for Tanzania (1988)

Published in English by the Longman Group and intended for secondary schools in Tanzania, this atlas probably contains the most comprehensive set of maps for Tanzania published to date in a school atlas. A total of 61 of its 152 pages are dedicated to maps of Africa and Tanzania. It contains 25 maps of Tanzania at 1:5,000,000 and 1:12,000,000 scales and includes a special 10 map section on Zanzibar and Pemba at approximately 1:1,000,000 scale, and 2 urban land use maps of Dar es Salaam. The maps in the atlas are complemented by the extensive use of graphical images such as full colour photographs, statistical graphs, charts, diagrams and tables.



Figure 13: Physical map extract from the New Secondary School Atlas for Tanzania

This atlas is one of the first atlases in which the cartography, produced by Wm. Collins & Sons, contains maps generated by digital mapping and desk top publishing technology. The maps of Tanzania and East Africa have been created on a PC-based manual vector digitising system and the map design and specification has been completed on an Apple Macintosh system utilising vector based graphics and desk top publishing software. The output of the cyan, magenta, yellow and black final film separates for plate making was generated on a high resolution (1,240 - 2,400 dpi) raster imagesetter.

5. CURRENT TRENDS IN ATLAS PRODUCTION

The mapping industry has seen a dramatic increase worldwide in the use of digital mapping methods for map and atlas production during the past five years. In the world of commercial cartography, it is now clear that digital map and atlas production is today's preferred option. Commercial atlas production has been revolutionised by the adoption of digital techniques and many atlases are now becoming widely available as "electronic" atlases in their own right or as an additional option to complement existing digitally produced hard copy printed atlases.

In the developed world, where the availability of powerful state-of-the-art computing equipment is often the norm for commercial and government atlas and mapping organisations, traditional analogue methods employing scribing and masking techniques are now being used less frequently for new cartographic projects and are often reserved purely for the role of revision where existing cartographic materials require to be updated and reused. The introduction of digital methods is seen in the developed world as a means to allow faster production and a reduction in map production costs coupled with the creation of a more flexible product.

The trend in less-developed countries is not so easily defined since capital equipment costs often greatly outweigh skilled labour costs and so place economic restrictions on access to suitable computing equipment. In Africa, the speed of development in digital mapping technology has been further hampered by unreliable power supplies, unsuitable operating

environments and by inadequate maintenance agreements for computing equipment that has been imported or donated as part of foreign aid programmes. Since very few atlases have been published in Africa during the 1990's, at present there is no clear trend in the way forward for atlas production or publication in Africa and, in the near future many countries may be faced with the dilemma of whether to go digital or remain with existing analogue methods.

5.1 Digital Atlas Production Software

The first step in digital atlas production is to generate the spatial data in digital form by digitising existing maps or by importing data from existing digital data sets. Currently the leading PC- and workstation-based digitising software packages used for data capture are MapData (MapData Management Ltd.), VTRAK (Laserscan); ArcCad (ESRI Ltd.), Intergraph MicroStation, AutoCad, MapInfo, and Digit II (GIMMS Ltd.).

The current practice in many commercial atlas publishers, is to import the raw digital data into specially designed cartographic software (e.g. Cartopia - used by Dorling Kindersley; LaserScan LAMPS - used by Philip's) or into general purpose graphics software packages (Bartholomew Harper/Collins - Macromedia Freehand; Lovell Johns - Adobe Illustrator; Oxford Cartographers - Corel Draw), for data re-structuring, cartographic design and production.

The final stage in the digital atlas production process involves the use of page design and layout software to facilitate the combination of final maps, graphics, text and marginalia to create the final atlas pages for output as film separates which can be sent for plate making to the printer. This task is currently undertaken by specialist page make-up software packages such as Adobe Pagemaker, QuarkXpress or Corel Ventura which are used extensively in the desktop publishing industry.

The output of final map files for checking and proofing is achieved by printing a full colour image (or colour separates) at 300-600 dpi on a raster colour ink-jet or laser printer. Final files are output after proofing on a very expensive high resolution raster imagesetter e.g. those from Barco, Agfa, Intergraph, etc. at 1,240 - 2,500 dpi as right- or wrong-reading film positives or negatives for platemaking or direct to printing plate as in a new Barco device.

5.2 Commercial Digital Data Sets

An increasing number of high quality and detailed international digital data sets, which include coverage of Tanzania, are now available commercially at a range of scales suitable for digital atlas production. Commercial data at 1:1,000,000 scale is available from the Digital Chart of the World (DCW) data set. Also several leading commercial atlas publishers in the U.K. (e.g. Bartholomew, Lovell Johns and Philips) offer international digital data sets at scales ranging from 1:1,000,000 to 1:40,000,000 in several different file formats (e.g. EPS; DXF, TIFF; NTF; Illustrator; Freehand; and Corel Draw).

The Digital Chart of the World is one of the most comprehensive topologically structured world data sets available in digital form and is used extensively within other commercial data sets (e.g. Cartesia World Data Bank), in electronic atlases (e.g. the Dorling Kindersley World Atlas) and in interactive maps on the Internet. The Digital Chart of the World has used as its main source material the 1:1,000,000 scale Operational Navigation Charts (ONC) and the 1:2,000,000 scale Joint Navigational Charts (JNC) produced by the United States Defense Mapping Agency. This data set comprises numerous layers or coverages containing digitised data for relief, drainage, communications, settlement, selected land cover, etc. and is available in Vector Product Format (VPF), Autocad (DXF), ArcInfo and Atlas*GIS file formats.

The Bartholomew 1:5,000,000 World database, which covers all countries in Africa, is suitable for direct input into digital mapping and atlas software such as ArcInfo, Atlas*GIS,

MapInfo, LaserScan Horizon or for conversion to other commonly used general graphics and digital mapping file formats. The database contains digitised point, line, polygon and text in the following layers:

Annotation	Heights
Administrative	National Parks
Communications	Other Lines
Contours & Bathymetry	Other Water
Deserts	Points
Drainage	Reserves
Graticule	Urban Areas

High quality international digital data sets also are available under licence from another U.K. company, the atlas publishing house of Philip. This fully feature-coded worldwide data set was captured at a scale of 1:35,000,000 on the Mercator Projection and is suitable for transformation to other scales or projections. The 232 country maps, including that of Tanzania, show coastline, major rivers, contours, principal towns/cities, main roads, railways and international/administrative boundaries and are held as Macromedia Freehand vector or TIFF raster file formats.

Digital data for Tanzania is also included in a number of less complex cartographic data sets such as Cartesia World Data Bank, Mountain High Maps and Frontiers, Terra Forma WorldWide and Maps in Minutes which are available commercially in a range of both Macintosh and PC raster and vector file formats. The main areas of use for these digital data sets are as high quality print or multimedia graphics as required in the world of advertising, publishing and broadcasting. The data is best suited for image manipulation and graphic design in desk top publishing and graphics software packages such as Adobe Illustrator and Photoshop, Macromedia Freehand and Corel Draw.

6. THE FUTURE OF ATLAS PRODUCTION IN TANZANIA

Atlas production can be a time consuming and costly process requiring a large collaborative effort by several organisations and many individuals with scientific and cultural expertise in both physical and human geography and in the field of mapping and topographic science for the map production process. The production of up-to-date general, national or specialist/thematic atlases of Tanzania will require the consideration of many cartographic options for them to be viable propositions.

6.1 The National Atlas of Tanzania

The major single nation general atlas published in Tanzania is the "national atlas" produced by the Surveys and Mapping Division. It is here that the need for atlas revision is the greatest, since the latest edition of this atlas was published in 1976. It is now 20 years since the last publication of this national atlas, the longest period without a revision since the first atlas was published in 1942. During this period, the country has seen some major changes to the natural environment caused by political and economic activities (Liwa 1994), resulting in nationwide population movements during the "villagization" programme of the 1970's and changes to the landscape due to economic activity related to the completion of the TAZARA railway in the south of Tanzania. Two national censuses have also been conducted during this period and topographic mapping coverage has been achieved nationally at the basic scale of 1:50,000. Both events are significant nationally due to their importance as major sources for up-to-date spatial and non-spatial data of the country.

In the desire to have a new edition of a national atlas, the dilemma that many national mapping organisations in Africa may be faced with is whether to selectively revise and reprint existing atlas sheets using original materials and to redraft new and revised atlas sheets on similar materials or to consider the option of moving to a totally digital production process for the purpose of creating a new atlas.

6.1.1 New Edition from Existing Materials

If the first option was chosen, i.e. using existing materials, consideration must be given to the fact that the original paper or plastic-based cartographic and reprographic materials may have been exposed to unsuitable environmental conditions over an extended period. Therefore dimensional instability and some deterioration of the base material and surface images such as peelcoat emulsions and stripping film may have occurred. It would also be a labour intensive, time consuming and problematic exercise to use this existing material, especially where revision requires the extensive reworking of existing linework scribes and area masks. Many would rate this as the least desirable option since it may result in an unsatisfactory end product after the expenditure of a great deal of effort due to the possible deterioration and unreliability of the original materials. It would of course be the least expensive option with regard to material costs and the fact that all the processes could be undertaken in-house.

6.1.2 New Edition using Traditional Analogue Methods

The second option of creating new or revised atlas sheets by redrafting on similar plastic materials such as scribecoat and peelcoat could be considered as a sensible and viable option provided that the required cartographic materials and drafting tools are available in-house together with the necessary skilled technical expertise and manpower support. This option would also benefit from relatively low capital costs and the ability to undertake all processes in-house without the problems of re-working old material. It would of course also be a labour intensive option and would require a high level of cartographic technical skill and attention if it was desired to match the cartographic styles used on the previous edition of the atlas.

6.1.3 New Edition using Digital Mapping Methods

The third option of creating a totally digital atlas production process for the purpose of creating a new atlas could, under certain circumstances, also be considered as a viable option. A new edition of the Atlas of Tanzania could be undertaken by digital production processes either in-house, by outside commercial contract or as part of an assisted project.

If undertaken in-house, it would be necessary not only to invest in the purchase or acquisition of suitable computing hardware and software, but also to re-train selected cartographic and digital mapping staff for the tasks of data capture, map design and map production using the specialist digital technology required for atlas production. This option could reduce labour costs and increase production schedules, but would of course incur high capital costs, especially if a large format raster imagesetter requiring a controlled environment has to be purchased for final film output. The possibility of sending final files to a bureau for final output would considerably reduce capital equipment costs but would almost certainly create logistical problems due to the present lack of such a facility in Tanzania.

A reduction in cartographic, reprographic and printing capital and labour costs could be achieved by the reduction of the basic map scale to 1:5,000,000, the page size to A3 (420 x 297 mm) and the introduction of the four-colour (cyan, magenta, yellow, black) printing process. A team of approximately six specialist digital cartographers may be adequate to undertake the production of a new national atlas within a one year period, provided that all the source data and material was readily available.

Although this option would have an initial high cost element in setting up a digital atlas system, the future benefits of such an investment in computing hardware / software and the valuable additional expertise and experience gained by the digital mapping staff would be considerable. Such a digital atlas system could also provide the foundation for sustainable development through utilisation as a stand-alone system

or in combination with existing digital mapping equipment for other mapping or desk top publishing projects. Such a system could be utilised for the commercial production of tourist related maps and publication material; customised mapping for government and commerce; reports and research papers; derived mapping; or to create a resaleable national digital data base to commercial digital data suppliers and atlas publishers.

A digital atlas could be undertaken by sub-contracting the production to a commercial atlas publisher, as has been the practice in the past for school atlases. This would of course require the outlay of a one-off capital sum for the supply of the final product (the atlas), without the benefits of having further access to the digital data.

Another possibility could be the setting up within or outwith the country an assisted project or technical co-operation programme for the specific purpose of producing a national atlas, whereby a training and equipment element is incorporated within the project or programme. An advantage of such a project or programme would be that the development of such an atlas production system and trained staff could be sustained at the end of the project. Recently as Senior Cartographer in the Department of Geography & Topographic Science at the University of Glasgow, the first author (M.Shand) has been directly involved as cartographic supervisor to a British Council Geography Link Programme between the Universities of Dar es Salaam and Glasgow. This programme has resulted in the extensive and successful training in Glasgow of the Tanzanian cartographers from the University of Dar es Salaam in both traditional and digital cartography. It has also resulted in the publication of several new high quality multi-colour maps of Tanzania at both large- and small-scales (e.g. see Figure 14 - Dar es Salaam Visitors' Map). In this, way technical co-operation can work successfully given the right personnel and motivation of those concerned.

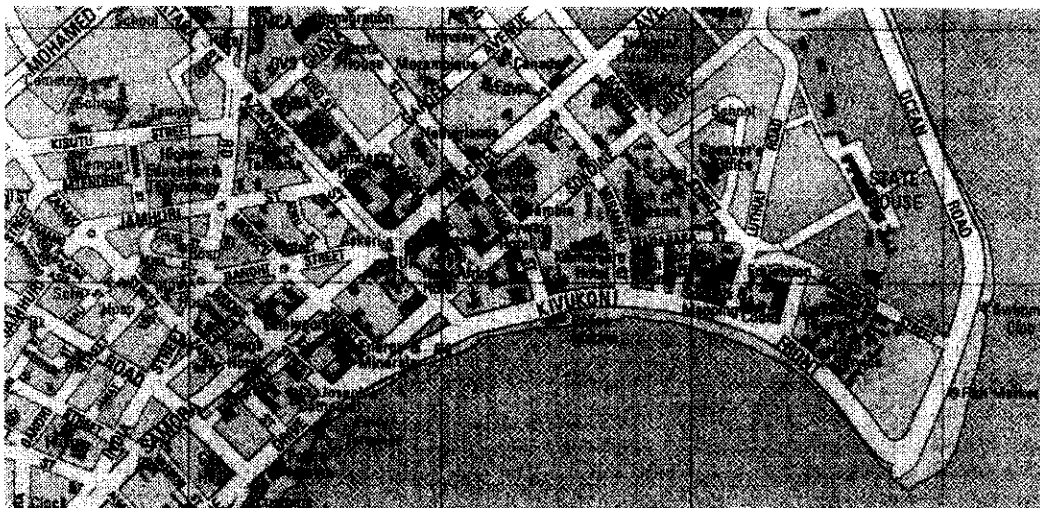


Figure 14: Extract from the Dar es Salaam Visitors' Map produced in the University of Glasgow by cartographers from the University of Dar es Salaam

6.2 Specialist/Thematic Atlases of Tanzania

Atlases that can be considered to fall in the specialist/thematic category include atlases produced on single or restricted topics such as population, health, education and specialist areas of research. The area of population cartography is especially suited to digital mapping methods for atlas production since such atlases are often required to combine large numerical/statistical data sets with low volumes of spatial data often limited to polygonal boundaries and point locations. Such spatial data as required for digital population atlases can readily be prepared prior to a national census in preparation for the input of the population statistics.

6.3 Evaluation of a Demographic Atlas for Tanzania

The usefulness of a population census depends not only on how a census agency collects the census data about the population, but also on how well the resulting statistics are linked to geographic areas, and on how the information is presented. In many countries, including Tanzania, a lot of enthusiasm, effort and resources have been put into the gathering of population census data, but after completion of the various statistical tasks and the tabulation of results, little or no graphical analysis such as mapping is undertaken. To be of any use to decision makers and researchers, the results of a population census have to be presented cartographically and made available to users as soon as possible after completion of the census. Maps are the best medium for presenting census information since they enable users to have a clear and comprehensive overview of the spatial distribution and characteristics of the population as a whole, particularly in terms of its location, distribution and magnitude.

6.3.1 Census Mapping in Tanzania

Essentially census mapping consists of two activities, namely pre-census mapping and post-census mapping. Pre-census mapping is concerned with the acquisition and revision of base maps, the delineation of the boundaries of census areas such as enumeration districts, and the preparation and production of the maps required for the census enumeration. On the other hand, post-census mapping is typically a special subject mapping process that uses population census data. The creation of a demographic atlas based on a national census should be one of the major output objectives of post-census mapping.

So far, the results from the 1978 and 1988 Population Censuses of Tanzania have not been published as a graphical component of the Atlas of Tanzania. Of the small number of post-census maps published from the census data, two are small scale monochrome maps (A4 size) which accompanied the 1978 Population Census Preliminary Report - one representing annual average growth and the other representing population density at District level. Another set of post-census monochrome maps were published in the atlas of "Population and Health Facilities in Tanzania 1978" which only covers the mainland Regions of Tanzania. After the 1978 census, a Regional Village Population Size Map Series was prepared by the Bureau of Statistics from the results of the census for the whole country. However these maps were only produced in dyeline form and, as such, they were meant to meet immediate user needs and were not intended for publication and widespread distribution. For each Region, a map showing village locations and village population statistics was prepared using the population census statistics. These maps (at scales varying from 1:100,000 to 1:500,000) are the largest-scale maps that represent the population at village level. These maps portray the following information: (1) These areas which are inhabited and the areas which have no villages; (2) sizes of villages in terms of their populations; and (3) whether villages occupy most of the land area or are widely spaced (Thomas, 1982). This information is basic to all forms of development planning but the 1978 Population Census had a special significance in that the census took place two years after the 1974-76 peak of the (national) villagization programme during which over 85% of the rural population had been moved from scattered homestead settlements to nucleated settlements. This census is the only complete source of information to indicate the distribution of the rural population after completion of this vast national programme and any map representation of this data is especially valuable.

6.3.2 The Application of Digital Mapping to Census Data

Special-subject maps produced from census data can be made by traditional (manual or analogue) techniques, computer based techniques or by a combination of these techniques. Traditional manual cartographic techniques have been deployed with varying degrees of success for the abstraction, manipulation and graphic representation

of census data. The amount of demographic data collected from census operations continues to increase as nations develop and mankind's needs and problems increase. As a consequence, the number of topics and therefore the number of maps that need to be made keeps increasing.

Manual techniques are inherently slow and involve a lot of repetitive operations. Therefore a lot of time is required to produce a map using these methods. This results in the data becoming out of date and of little immediate use to potential users. Furthermore, if the volume of statistical data is large, considerable time is required for its manipulation. If the number of maps needed is large with the time interval to produce them being short or if the required maps are to be produced at different scales and with different content and design, then the difficulties increase.

In such a situation, the adoption of digital mapping techniques may relax or remove many of the constraints imposed on traditional map production. Once the base map has been captured in digital form and with the availability of a suitable computer and software, statistical data can be integrated easily with the base map data to produce suitable maps for various purposes. The use of computers in mapping (numerical) census data has a number of merits over the traditional techniques. In particular, computers eliminate the need for repetitive drawing of the base map and the accompanying diminution of accuracy commonly encountered in manual techniques whenever a map at a different scale has to be produced from the same base map. Computers allow greater flexibility in the manipulation of data before graphic representation can be effected. They also allow the user to experiment with the data and with different map elements to find the symbolism, map contents and scale that best communicate information about the data being mapped. By combining all these elements, computers speed up the entire process of map production and so reduce the time interval between the publication of the census results and the publication of the special subject maps.

6.3.3 Application of the GIMMS Software

A study was made by Silayo (1988) to apply a digital mapping program (GIMMS) to prepare a digital data set for all of Tanzania's Regions and Districts and to produce special subject maps from the 1978 census data. The generation of an easily replicable digital outline (base) map for the study eliminated the time-consuming and repetitive task of redrawing every census map, as is currently practised using traditional manual techniques, particularly where the maps are to be produced at different scales and/or on different projections. The availability of such a master digital base map in a form that is easy to replot or print on demand, would make it possible for a census agency to quickly meet requests for specific maps illustrating spatial relationships of various types of census data. The use of computer-assisted techniques in this particular study proved very useful since the total number of maps to be made within a very limited time frame was large.

For this study, two main types of information were used: a published topographic base map of Tanzania at 1:2 million scale, and the published reports for the 1978 census. The map showed topographic information, administrative boundaries of Districts and Regions, communication routes and urban centres, while the census reports were in the form of written reports and numerical tabulations. The District boundaries, outlines of lakes and District administrative centres were traced onto a polyester material from the 1:2 million scale base map and reduced photographically to the scale of 1:3 million. The resulting positive film was then digitized in vector point mode by manual digitising using the DIGIGIMMS digitising program, (Today a similar result could be achieved more easily using the MapData or DIGIT II digitising software).

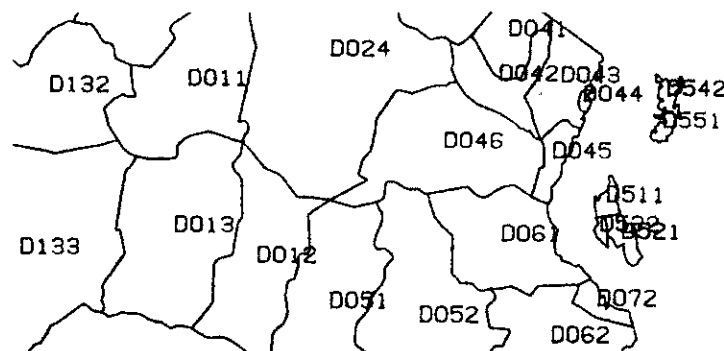


Figure 15: Extract from digital base map created with the DIGIGIMMS program

Data processing and manipulation was implemented by using the Geographical Information Mapping and Manipulation System (GIMMS) which is a general purpose thematic mapping package. GIMMS is a software package that has been used widely for population mapping in the U.K. and North America. It can be used to generate both spatial data files and statistical files. The spatial data files contain data describing the locations of points, linear features and area boundaries, while the statistical files provide the data associated with the spatial points, the lines and the areas. Data capture from the base map of Tanzania and the input of the corresponding statistics into the computer was therefore structured and coded in such a way that it was compatible with the GIMMS system of operation. After inputting the locational and statistical data into the computer, these files were processed and the resulting graphic output displayed on a graphics screen before being plotted in the form of hard copy maps

A large variety of maps could easily and quickly be generated from the census data, but, for the purpose of this particular project, only 18 maps were produced. These maps show the density, size, distribution and the composition by sex of the total population of Tanzania at District level and are useful both as historical documents and for analysing longer term changes. In particular, they are important documents to the Surveys and Mapping Division which is responsible for the Atlas of Tanzania, and to the Bureau of Statistics which is responsible for the census. Other institutions which can make direct use of this work include the Institute of Resource Assessment and both the Department of Geography of the University of Dar es Salaam and the East African Statistical Centre located at the same University. Besides this, maps such as these provide a very useful basis for future census mapping as part of information gathering about the size, distribution, structure, and socio-economic characteristics of a community or district within Tanzania or of the whole nation.

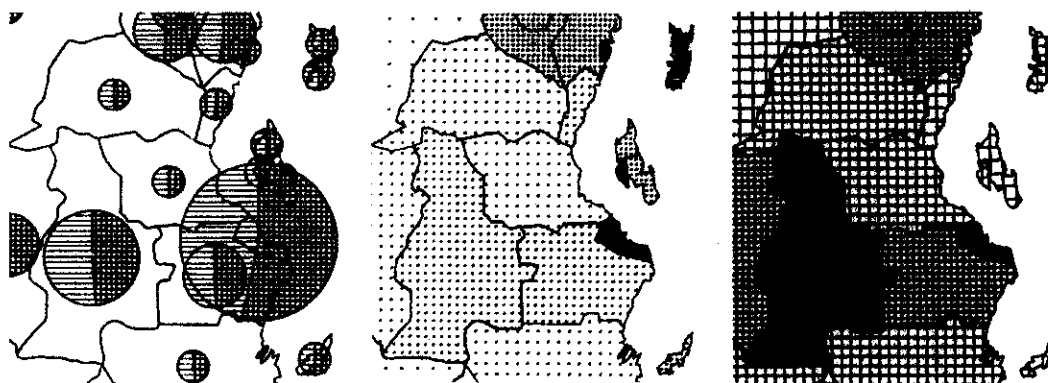


Figure 16: Extracts from digital sample maps created with the GIMMS program

In this study, the use of the GIMMS package showed that Tanzanian census data could be processed much faster than using manual methods. Decision graphics such as frequency histograms were produced prior to the making of final maps and the actual process of plotting the final maps could be executed in a matter of a few minutes, thus making the time taken by computer-assisted techniques a tiny fraction of the time it would have taken to make the same map manually. This implied that, using computer-assisted techniques, census data can be mapped as soon as it becomes available, especially if the spatial datasets, map design and layout were prepared prior to the national census in preparation for the input of the population statistics.

Given that in the past the Bureau of Statistics in Dar es Salaam has only been able to produce monochrome dyeline census maps at District level after a census, it is clear that, by using computer assisted techniques, the census data of Tanzania can be made fully available to help solve contemporary development problems. Since this study was completed, the Bureau of Statistics has installed the "SMILE" digital mapping system from Sweden (which is similar to GIMMS) to assist with the production of its census mapping.

6.4 A National Atlas Digital Database for Tanzania

One of the most useful products that could readily be established in Tanzania is a national small-scale digital database. Currently a project is under way at the University of Glasgow to produce a series of sample atlas sheets using digital mapping techniques, as a pilot study for a new Atlas of Tanzania (see Figure 17) which would also result in the creation of a small - scale digital database .

This study will investigate the optimum possibilities for data capture that will ensure the maximum flexibility of the digital data for file translation and the re-use of the data at a range of map scales. Data capture is being undertaken using manual digitising and on-screen digitising methods on a range of PC - and Apple Macintosh - based software packages. Data manipulation, map design and production is being undertaken using general graphics and image manipulation software with final page design and layout using desk top publishing software. Output will be achieved initially on colour raster devices such as a 400 dpi inkjet plotter and a 600 dpi laser printer with final film separates being generated on a 1,250 - 2,500 dpi raster imagesetter. The creation of such an up-to-date resource could be of significant value to those involved in the use of spatial and geographic information within or outwith Tanzania.

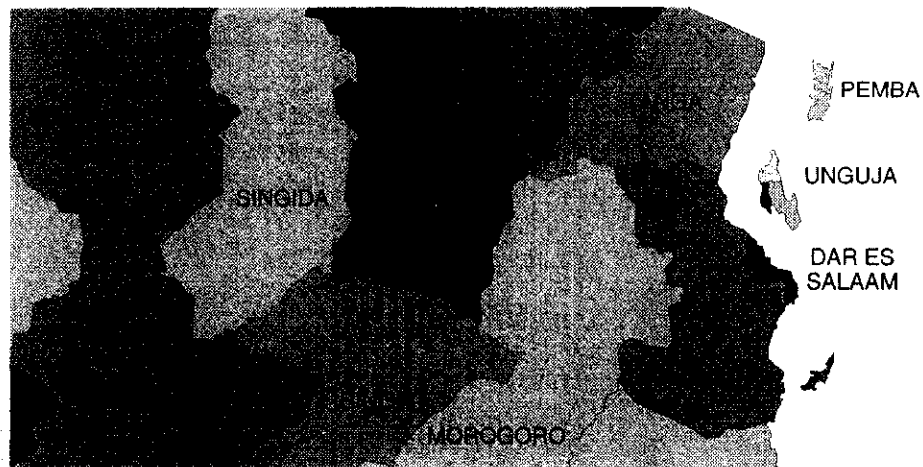


Figure 17: Map extract from the Atlas of Tanzania pilot study

7. CONCLUSION

During the long history of atlas production in Tanzania and Africa, cartographers have continued to make a valuable contribution to the provision of regional and national maps and atlases. In doing so, they have had to adapt continually to the substantial technological changes that have occurred in cartography over the past hundred years. The copper and zinc engraving skills have now all but disappeared while pen and ink techniques have given way to scribing, masking and typesetting methods. Now these skills are making way for the digital mapping revolution which is currently influencing all aspects of map and atlas production worldwide.

Digital mapping technology is now being adopted by a number of national mapping organisations in Africa. In Tanzania, two of the major mapping organisations, the Survey and Mapping Division and the Bureau of Statistics, have both introduced digital techniques to their mapping operations in recent years.

Having been confronted with the problems of data collection it has become clear to the present authors that the lack of up-to-date atlas maps of Tanzania is a major restriction for planners, researchers, scholars and students both within and outwith Tanzania. It may be easy to conclude that the demand exists for a new Atlas of Tanzania, a demographic atlas or for a small scale digital database, but to provide the answer to the problem, that of satisfying the demand, is much more difficult given the economic circumstances that prevail in the country.

The Minister for Lands, Housing and Urban Development in his foreword to the 1976 Atlas of Tanzania, concluded that "a work of this nature will portray a false picture unless updated, amended, and changed systematically". This is the challenge that is faced by Tanzanian cartographers.

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APPENDIX I National and School Atlases of Tanzania

Atlas Title	Year of Publication	Place of Publication	Editor/Publisher	Printed Format	Size (cm)	Number of Map Pages	Map Scales
Deutsch-Ost-Afrika (ix) Atlas	1906	Berlin	Fulleborn, F. Dietrich Reimer	Book		1 + text and photos.	1:1,000,000
Atlas of the Tanganyika Territory (1st Edition)	1942	Dar es Salaam	Dept. of Lands and Mines	Book	56 x 59	27	1:4,000,000
Atlas of the Tanganyika Territory (2nd Edition)	1948	Dar es Salaam	Dept. of Lands and Mines	Book	56 x 59	34	1:4,000,000
Atlas of Tanganyika (3rd Edition)	1956	Dar es Salaam	Dept. of Lands and Surveys	Book (+overlay)	56 x 59	29 + text	1:3,000,000
Atlas of Tanzania (1st Edition)	1967 (1969)	Dar es Salaam	Min. of Lands, Housing and Urban Development	Book (Folios)	46 x 56	28 + text and photos.	1:3,000,000
Atlas of Tanzania (2nd Edition)	1976	Dar es Salaam	Min. of Lands, Housing and Urban Development	Book (Folios)	46 x 56	38 + text and photos.	1:3,000,000
Tanzania in Maps	1971, 1972 1975 (revised)	London New York London	Berry, L. University of London Press	Book	29 x 23	65 + text	1:7,700,000
Regional Economic Atlas of Mainland Tanzania	1968	Dar es Salaam	Jensen, S.B.A. Bureau of Resource Assessment and Land-use Planning (BRALUP)	Book	25 x 20	18 + text	
Population and Health Facilities in Tanzania 1978 (Vol. 3) Regional Atlas	1983-84	Norwich, UK	Thomas, I.D. O.D.G. and University of East Anglia	Book	30 x 21	1 vol.	Various
Atlas of Africa - Tanzania	1973, 1983	Paris, London	Jeune Afrique	Book	30 x 40	2 + text	1:5,000,000
Tanganyika. Our Country Maps for Primary Schools	1963	London, Nairobi	McBain, F.C.A. Oxford University Press	Book	25 x 19	24	Various
Ramani kwa Shule za Primary							
Atlasi yenye picha kwa Shule za Msingi za Tanzania	1969, 1974, 1979, 1983	Dar es Salaam	Tanzania Publishing House Ltd. (MacMillan Ed.)	Book	29 x 22	38	Various
Atlasi kwa Shule za Msingi Tanzania	1987	London	MacMillan Publishers Ltd.	Book	29 x 22	52	Various
New Secondary School Atlas for Tanzania	1988	Harlow, U.K.	Longman Group UK Ltd. Collins - Longman Atlases	Book	28 x 22	128	1:5,000,000 - 1:12,000,000

APPENDIX II Multi-National and School Atlases of East Africa

Atlas Title	Year of Publication	Place of Publication	Editor/Publisher	Printed Format	Size (cm)	Number of Map Pages	Map Scales
Philip's School Atlas for East Africa	1956 (1967)	London	Fullard, H. George Philip & Son, Ltd.	Book	28 x 23	32	Various
Nelson's School Atlas for Kenya, Malawi, Tanzania, Uganda, Zambia	1968	London	Ominde, S.H. Clarke, P.J.H. Thomas Nelson & Sons, Ltd.	Book	28 x 22	76	Various
Oxford Atlas for East Africa	1966, 1967, 1971	London, Nairobi	McBain, F.C.A. Oxford University Press	Book	19 x 26	65	1:3,200,000 1:6,300,000 1:12,500,000
My East African Atlas	1960	London	MacMillan & Co., Ltd.	Book	28	48	Various
East Africa	1954-1961	Tolworth, U.K.	Directorate of Overseas Survey (DOS)	Folios		12	1:3,000,000
Handbook of Natural Resources East Africa	1969, (1973)	Tolworth, U.K.	Directorate of Overseas Survey (DOS)	Folios	39 x 60	6	1:4,000,000
East Africa Livestock Survey	1967	Firenze	United Nations UNDP, FAO	Book	58	3 vols.	
Tribal Maps of East Africa and Zanzibar	1960	Kampala	Goldthorpe, E.J and Wilson, F.B. East African Institute of Social Research	Book	25 x 18	8	
Road Book of East Africa	1952	Nairobi	Royal East African Automobile Association	Book	24	227	

APPENDIX III National Atlases of Tanzania - Map Index

Atlas Title	Physical Geography	Biogeography	Human & Cultural Geography	Industry & Commerce	Statistical Section	Other Maps
Atlas of the Tanganyika Territory (1st Edition) 1942	<p>Physiographical map</p> <p>Physical map</p> <p>Geological map</p> <p>Av. rainfall distribution</p> <p>Mean min. temperature</p> <p>Mean max. temperature</p> <p>Magnetic variation</p> <p>Isogonic lines</p>	<p>Forest reserves</p> <p>Game distribution & Game reserves</p> <p>Tsetse map</p>	<p>Native population map</p> <p>European & Asiatic population map</p> <p>Tribal map</p> <p>Provinces & Districts</p> <p>Medical facilities</p> <p>Educational facilities</p>	<p>Agriculture</p> <p>Cattle densities</p> <p>Minerals</p> <p>Air, road and rail communications</p>	<p>Imports & exports</p>	<p>23 historical maps dating from 1000BC to 1941</p>
Atlas of the Tanganyika Territory (2nd Edition) 1948	<p>Physiographical map</p> <p>Physical map</p> <p>Geological map</p> <p>Soil map</p> <p>Av. rainfall distribution</p> <p>Hydrography</p> <p>Mean min. temperature</p> <p>Mean max. temperature</p> <p>Magnetic variation</p> <p>Isogonic lines</p>	<p>Vegetation</p> <p>Forest reserves</p> <p>Game distribution & Game reserves</p> <p>Tsetse map</p>	<p>Native population map</p> <p>European population map</p> <p>Asiatic population map</p> <p>Tribal map</p> <p>Provinces & Districts</p> <p>Malaria map</p> <p>Medical facilities</p> <p>Educational facilities</p>	<p>Agriculture</p> <p>Cattle densities</p> <p>Minerals</p> <p>Principal mines</p> <p>Air, road and rail communications</p>	<p>Imports & exports</p> <p>Mineral production</p>	<p>23 historical maps dating from 1000BC to 1941</p>
Atlas of Tanganyika (3rd Edition) 1956	<p>Physiographical map</p> <p>Physical</p> <p>Geological</p> <p>Soil</p> <p>Mean annual rainfall</p> <p>Hydrography</p> <p>No. of days of rain</p> <p>Vapour pressure</p> <p>Maximum temperature</p> <p>Minimum temperature</p> <p>Magnetic variation</p> <p>& Isogonic lines</p>	<p>Vegetation</p> <p>Forest reserves</p> <p>Game distribution & Game reserves</p> <p>Tsetse & Sleeping sickness</p>	<p>Population density</p> <p>Lands and Surveys</p> <p>Tribal & Ethnographic</p> <p>Provinces & Districts</p> <p>Malaria</p> <p>Medical facilities</p> <p>Educational facilities</p>	<p>Principal distribution of labour</p> <p>Main labour routes</p> <p>Water supplies</p> <p>Agriculture</p> <p>Cattle densities</p> <p>Mineral occurrences</p> <p>Chief mineral areas</p> <p>Communications</p>	<p>Imports & exports by value</p> <p>Mineral production</p>	<p>Town plans</p> <p>- Dar es Salaam</p> <p>- Tanga</p> <p>- Dodoma</p> <p>- Morogoro</p>

APPENDIX III (contd.) National Atlases of Tanzania - Map Index

Atlas Title	Physical Geography	Biogeography	Human & Cultural Geography	Industry & Commerce	Statistical Section	Other Maps
Atlas of Tanzania (1st Edition) 1967	Physical Geology Soils Potential land use Geophysical Hydrology Mean annual rainfall Rainfall probability	Vegetation Forest reserves Game conservation Fisheries	Regions & Districts Population density Population characteristics Antiquities & monuments Educational facilities Medical facilities Tsetse fly and Sleeping sickness Malaria	Agriculture - main cash crops Cattle distribution Mineral occurrences and chief mineral areas Water supplies	Imports and domestic exports Government revenue and expenditure Distribution of employees	Extracts from standard topographic map sheets
Atlas of Tanzania (2nd Edition) 1976	Physical Geology Soils Capability of soils for agriculture Geophysical Hydrology Mean annual rainfall Rainfall probability Climate (four aspects)	Vegetation Forest reserves Game conservation and Tourism Fisheries	Administration Population distribution Population characteristics Antiquities & monuments Educational facilities Medical facilities Tsetse Disease Improved water supply	Main export crops Food crops Cattle distribution and Marketing Urban development - Dar es Salaam - Administrative HQ - Urban centres - Ujamaa villages Internal communications Communications statistics Mineral resources Industry Socialization of trade	International trade Government revenue and expenditure Employment	General map of Africa