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State of Cartographic Services among the East African Community Member States

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Abstract

The East African Community is a regional block that brings together Kenya, Uganda, Tanzania, Rwanda, Burundi and South Sudan into various forms of economic partnership, the eventual dream being to achieve political federation. The current activities within this community, plus the block's further development, require the generation and sharing of much geo-information to support the attendant decision-making. Such geo-information can be best served through a harmonized cartographic service with common standards. Such a harmonized service is not only lacking, but even the status of the current national services is also largely unknown. This paper reports on a study undertaken to establish this status, as represented by twelve elements of a cartographic service that the authors are able to establish. Results of the study have shown that the present national services are characterized by inadequate basic datasets that remain largely analogue. In addition, there are non-uniform spatial reference systems, inadequate cartographic human resources and lack of common mapping standards; further, funding for mapping activities remains low in national budgets. Given that over 80% of decisions are influenced by geo-spatial data, these findings point to an urgent need to improve, harmonize and digitize these services as the way forward, if the East African Community is to remain globally competitive.

Keywords

Cartographic Services, National Cartographic Service, Geo-Information, East African Community

1. Introduction

1.1. The East African Community (EAC)

The East African Community is a regional block dating back to 1900 when a customs collection centre for Uganda was established in Mombasa, Kenya. Sub-

sequently, the actual EAC, as a partnership of Kenya, Uganda and Tanzania was established in 1967, collapsed in 1977, and was again re-established in 1999. Rwanda and Burundi joined the Community in 2007 followed by South Sudan in 2016 [1].

1.2. The Need for a Harmonized Cartographic Service

The EAC is based on the EAC Treaty, which states, inter-alia, that "*the Partner States undertake to establish among themselves and in accordance with the provisions of this Treaty*, *a Customs Union*, *a Common Market*, *subsequently a Monetary Union and ultimately a Political Federation in order to strengthen and regulate the industrial*, *commercial*, *infrastructural*, *cultural*, *social*, *political and other relations of the Partner States to the end that there shall be accelerated*, *harmonious and balanced development and sustained expansion of economic activities*, *the benefit of which shall be equitably shared*". The realization of these objectives requires a robust cartographic service to provide accurate and reliable cartographic information and services in an effective and efficient way as sustainable development requires access to data, information, knowledge and understanding about the environment and natural resources including socio-economic opportunities [2]. In addition, the EAC countries currently share key infrastructure such as the railway and road networks, airports, coastal ports etc. The management of these, plus the rise in cross-border activities which involve geo-information exchange (such as the Lake Victoria development projects, navigation on the lake, management of population dynamics, climate change, terrorism, etc.), has increased the demand for cartographic information such as maps, plans and the associated digital data sets, which can be best shared in a harmonized cartographic service. Finally, the cartographic services of East Africa are very significant in the development of National Spatial Data Infrastructures (NSDI) in the individual countries, which could in time be linked into an East African Regional Spatial Data Infrastructure (RSDI) for even better data sharing and information commerce in the region. Such SDI development is still at very initial stages in all the countries (except Rwanda), and hence the need to document the state of cartographic services in the different countries; if these are improved, each country will move a little closer to the realization of its NSDI [3] [4] [5].

1.3. Study Objective

Despite the clear need for a credible and harmonized cartographic service in East Africa, previous studies such as [4] [6] and [7] have found only a disjointed and disharmonized service and no particular policy towards establishing a better and harmonized service. To begin any work towards improving and harmonizing the existing cartographic services in the different countries of East Africa, one must start by establishing the baseline, *i.e.* the current state of the said services in each country. This baseline remains largely unknown, and hence, the key objective of

this study is to determine the present status of cartographic services in the EAC member states.

2. The Study Area

The research aimed to study the six EAC member states of Tanzania, Rwanda, Kenya, Uganda, Burundi and South Sudan, which are illustrated in Figure 1.

The physical area covered by these countries is approximately 2.5 million square kilometers, and they have a joint population of about 173,583,000 as per 2017 estimates. Lake Victoria, the world's second-largest fresh water lake is shared by Uganda, Tanzania, and Kenya. East Africa is also home to the highest mountain in Africa, Mt. Kilimanjaro (5895 m) in Tanzania. East Africa has

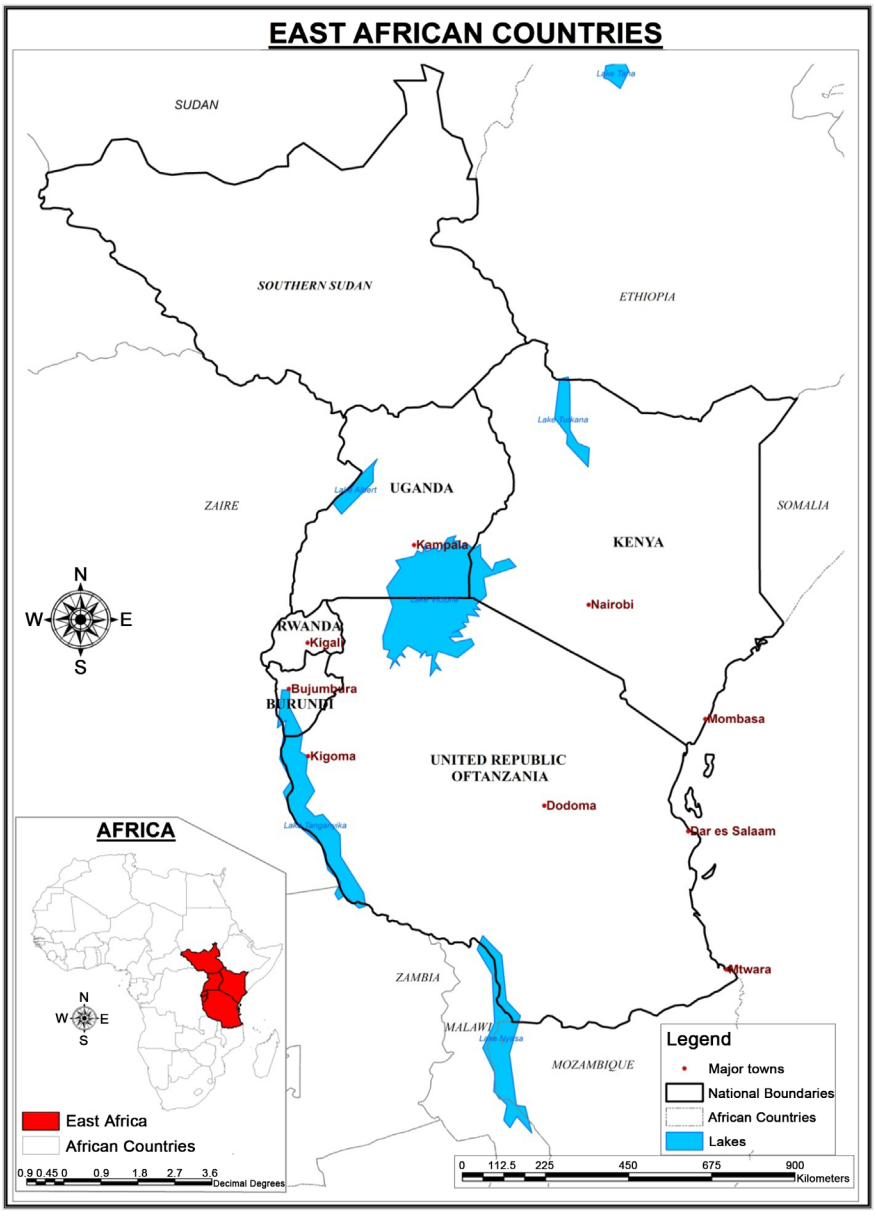

Figure 1. The study area.

extensive habitat for large herds of big game animals, mountains for great apes, and enough prey for the big cats such as lions and cheetahs. Most of the inhabitants here earn their living through the practice of rural agriculture. The official languages of the EAC are English and Kiswahili with the latter designated for development as the lingua franca of the community; there are also numerous local languages spoken across the region. Although Rwanda's and Burundi's official language is French, this is slowly changing to English since their entry into the EAC. South Sudan was eventually excluded from the study due to the poor security situation there, which could not allow safe entry and movement for data gathering.

3. Methodology

3.1. Research Design

The study was accomplished through a survey which provided an opportunity to get views from a diverse group of respondents using both qualitative and quantitative techniques. Semi-structured questionnaires were distributed to 255 respondents in national mapping organizations, private mapping organizations and academic institutions. The target population was the geo-information community comprised of surveyors, cartographers, photogrammetrists, GIS professionals, senior geo-information managers and relevant academic staff. Stratified purposive sampling was adopted whereby the geo-information community was divided into three units exhibiting within-unit homogeneity resulting into three categories; the National Mapping Organizations (NMOs), Private Mapping Organizations (PMOs) and academic institutions, as illustrated in Table 1. Although the different categories responded to common questions, (e.g. Give your job description) each also had some specific questions (e.g. State your basic mapping scale, for NMOs only). Within each category, purposive random sampling was used ensuring that only target informants were surveyed thus increasing the reliability. Proportional allocation was used to determine the sample size from the total population. In proportional allocation, the size of samples from different strata are kept proportional to the size of the strata, that is, if P_i represents the proportion of population included in stratum i, and n represents the total sample size, the number of elements selected from stratum i is $n.P_i$ [8]. In this study, the sample size was 50 from each country to be drawn from an

Table 1. Number of questionnaires administered and returned per stratum in each country.

Country/Organization	Burundi		Kenya		Rwanda		Tanzania		Uganda	
National Mapping	20	7	20	20	20	12	20	20	20	19
Private Mapping	25	1	25	18	25	8	25	11	25	16
Academia	6	5	6	6	6	4	6	5	6	6
Total	51	13	51	44	51	24	51	36	51	41

approximate population of 2000. The target number of respondents from the six countries was 306 but non-response from south Sudan reduced this to only 255. In addition to the questionnaire, desk study of diverse documents and unstructured interviews were used to provide any information that was not captured by the questionnaire.

3.2. Data Collected

The research eventually succeeded in collecting data that could enable the comparative evaluation of the following twelve elements of a cartographic service. In the conceptual model for the research, these twelve were identified as the independent elements that contribute to the dependent element that is the cartographic service.

1) Relevant policies and laws.
2) Spatial reference systems.
3) Key geospatial datasets.
4) Basic mapping scales.
5) Mapping standards.
6) National atlas.
7) National gazetteer of geographic names.
8) Mapping technology.
9) Professional human resource for cartography and geo-information.
10) Available cartographic training.
11) Availability of relevant professional associations and their affiliations.
12) Funding for mapping.

For protocol reasons, data could only be collected, especially for the countries outside Kenya, after obtaining the necessary authorizations from the relevant authorities.

4. Results

The results obtained from the study are as summarized in Table 2.

5. Discussion

The results clearly show that there exists much disharmony in the cartographic services offered by the different EAC states. Each element of the services is now analysed in turn.

5.1. Relevant Laws

Although each country has a legal basis for mapping and geo-information management, some of the prescribed procedures and standards for the different countries will be at variance. Many of the laws and regulations are also very old, and may have been overtaken by technological advances.

5.2. Spatial Reference Frames

The different spatial reference systems in use in the different countries are

Table 2. Summary of results.

Variable	Burundi	Kenya	Rwanda	Tanzania	Uganda
Relevant Laws	Decree No. 100/241 of 29 October 2014	Survey Act Cap 299 of 1961, currently under review	Organic Law, 2005	Land survey and surveyors ordinance Cap 390, Professional Surveyors Act, 1977	Survey Act of 1939, Cap. 232 (2000 edition)
Spatial Reference Systems	WGS84; Gauss Kruger projection, UTM projection; Clarke 1880 modified ellipsoid	Arc 1960, local datum; UTM, Cassini projections; Clarke 1858 and 1880 ellipsoids	Arc1960; WGS84, ITRF 2005; Gauss-Kruger and UTM projections; modified Clarke 1880 ellipsoid	Arc1960; WGS84, various local systems; UTM and TTM projections; Clarke 1880 ellipsoid	Arc 1960; WGS84; UTM projection; Clarke 1880 ellipsoid
Key Geospatial Datasets Available	Geodetic framework, administrative and watershed boundaries, transportation network, hydrography, Ortho-photography for Gitega and Bujumbura cities, Aerial photography, Topomaps and DEM for the whole country. No metadata. (*further details available in the map catalogue available at IGEBU*)-*Gitega*	Geodetic framework, Hydrography, Vegetation, Utilities, Administrative boundaries, Transportation network, parcel boundaries, DEM, Digital imagery, Topomaps and Geographical names. No metadata (*further details available in the maps catalogue available at SoK*)-*Nairobi*	Geodetic network, Cadastral data, Geographical names, Ortho-imagery, Elevations, Transportation network, Hydrography, Government land boundaries and Administrative boundaries. Some limited metadata. (*further details available in the map catalogue available at RNRA*)-*Kigali*	Geodetic network, Topographic maps, hydrography, Cadastral data, aerial photography, Geographical names. No metadata (*further details available in the map catalogue available at survey and mapping department*)-*Dar es Salaam*	Geodetic network, Hydrography, Administrative boundaries, Cadastral data, DEM, Aerial photography, Geographic names; Topo maps. No metadata. (*further details available in the map catalogue available at the department of survey and mapping*)-*Entebbe*
Basic Mapping Scales	1:50,000 In 42 sheets	Y731 series 1:50,000-512 sheets and Y633 series 1:100,000 in 89 sheets	1:50,000 In 52 sheets	1:50,000 series Y742 In 1294 sheets	Y732 series 1:50,000 in 325 sheets
Map Making Standards and Specifications	Burundi specifications for 1:5000, 1:25,000 No published national standards	East African specifications for topographical maps, unpublished digital symbol specifications for 1:2500 and 1:5000 by SoK	Metadata standards by ESRI, No published national mapping standards.	East African specifications for topographical maps, No published national standards	East African specifications for topographical maps, No published national standards
National Atlas	Available in French, analogue	Available 5th ed. 2003, English, analogue and digital formats	Available in French, analogue	Available in English, of 1976 and analogue	Available, digital (PDF) in English, of 1967
National Gazetteer of Geographic Names	Not available	Available, analogue, 2nd edition of 1977	Available, analogue	Available, analogue, date of publication unknown	Available, analogue, of 1971
Mapping Technology: Hardware	Computers, scanners, plotters, DPWs, Wild B8S stereo plotter, digitizing tables and GNSS sets	Computers, GNSS sets, digital cameras, scanners, plotters, light tables, printers, technical pens and scale rulers, DPWs, Total stations and map filing cabinets	Computers, GNSS sets, Total stations, plotters, printers and scanners	Computers, Total stations, GNSS sets, digital levels, printing machines (analogue) and stereo plotters (dysfunctional)	Computers, GNSS sets, scanner, plotter, technical pens, scale rulers and rubbers, DPWs, Total stations
Software	ArcGIS and Micro station (license based) MapSource, QGIS (FOSS) AutoCAD, ILWIS and Arc view 3.2	ArcGIS 10.0; Adobe C55; Global Mapper; Mercator 7.2, QGIS, Erdas Imagine and AutoCAD	ArcGIS 10.1, 10.0, and 9.3, Arc view 3.2 and AutoCAD	ArcGIS, Erdas, Info system, LPS, Arc Info, Arc view-(license based) and QGIS (FOSS)	QGIS (FOSS) and ArcGIS (without license)

Continued

Professional Human Resource Cartography and Geo-Information	Largely Bachelor's degree level urban planners who attempt to double up as cartographers and geo-information managers.	Cartographers available at Diploma and Higher Diploma levels. Geoinformation management also involves surveyors and photogrammetrists who are available at all levels up to doctoral.	GIS professionals are available, mainly at Bachelor's level; they manage geo-information and double up as cartographers	Cartographers available at Diploma and Higher Diploma levels. Geoinformation management also involves surveyors and photogrammetrists who are available at all levels up to doctoral.	Cartographers available at Diploma and Higher Diploma levels. Geoinformation management also involves surveyors and photogrammetrists who are available at all levels up to doctoral.
Available Cartographic Training	None	Diploma and Higher Diploma	None	Certificate and Diploma	Diploma
Relevant Professional Associations and Affiliations	None	ISK; admits surveyors, cartographers and photogrammetrists. Affiliated to FIG and ICA	None	IST; admits only surveyors. Affiliated to FIG and ICA	ISU admits only surveyors. Affiliated to FIG and ICA
Funding for Mapping	Available from government and donors but inadequate	Available from government and donors but inadequate	Available from government and donors but inadequate	Available from government and donors but inadequate	Available from government and donors but inadequate

Acronyms: DEM: Digital Elevation Model; DPWS: Digital Photogrammetric Workstations; FIG: International Federation of Surveyors; FOSS: Free Open Source Software; GIS: Geographical Information System; GNSS: Global Navigation Satellite System; ICA: International Cartographic Association; ISK: Institution of Surveyors of Kenya; IST: Institution of Surveyors of Tanzania; ISU: Institution of Surveyors of Uganda; QGIS: Quantum GIS; SoK: Survey of Kenya; TTM: Tanzania Transverse Mercator; UTM: Universal Transverse Mercator; WGS84: World Geodetic System 1984.

definitely an impediment to regional data sharing, and in some cases, even to national data sharing. They represent a very strong case for regional integration in terms of these frames.

5.3. Key Geospatial Datasets

In 2008, the UN Economic Commission for Africa defined a set of recommended fundamental datasets for African countries (*geodetic control*, *imagery*, *elevations*, *hydrography*, *boundaries*, *geographical names*, *land management units*, *transportation*, *utilities and services*, *and natural environments*). Based on this list, it is observed that all the studied countries have a large percentage of them. The main challenges therefore revolve around the fact that most of the datasets are in analogue form, and some of them are in French for Rwanda and Burundi. The data sets may also have gaps and overlaps in the border areas. Lack of metadata for any digital datasets is almost universal in the region.

5.4. Basic Mapping Scales

The basic mapping scale is uniform at 1:50,000 for all countries except for Kenya, which has used a smaller scale for some parts of the country that are less productive agriculturally. However, such parts have now assumed increased economic importance due to livestock production (e.g. Marsabit) or mining (e.g. Oil in Turkana) and this justifies their re-mapping at a larger scale.

5.5. Map Making Standards and Specifications

The general observation is that there are no published such standards for most of the countries, with any specifications being ad-hoc at best. This would make it very difficult to design and publish any regional maps

5.6. National Atlas

This is available in every country, and the two shortcomings that stand out are the need for updating and also the fact that the atlas in Burundi is in French and therefore difficult to share.

5.7. National Gazetteer

This clearly needs much attention, in order to address its non-availability in Burundi and its availability in analogue and outdated form in the other countries.

5.8. Mapping Technology

Although there are signs in all countries of attempts to upgrade to modern technology, the technological facilities are not available in sufficient quantities, and in terms of software, acquisition and/or upgrading remains a challenge. According to [9], only Kenya and Uganda were, as of 2017, among the top 7 internet using countries in Africa.

5.9. Cartographic and Geo-Information Human Resource

Although there are significant levels of GI human resource in all countries, people specifically trained in cartography are available only at Higher Diploma level and below, and only in the original partner states of Kenya, Uganda and Tanzania. It has been observed that maps made by people without specific training in cartography often lack critical elements of cartographic design, which impacts negatively on their cartographic quality [10] [11].

5.10. Available Cartographic Training

This is only available in Kenya, Uganda and Tanzania, the highest level being Higher Diploma. It suggests the need for intra EAC cooperation in order to make this training available to Rwanda and Burundi, and to improve it where it exists.

5.11. Professional Associations

The results show this to be an area of great deficiency, since no dedicated cartographic associations exist in any country, and only in Kenya do cartographers have any professional affiliation to the Institution of Surveyors. This situation cannot promote or sustain cartographic professionalism in the region.

5.12. Funding for Mapping

The results indicate that mapping in all the countries studied is generally under-

funded, with funding mainly coming from governments and donor support, which almost always is still channelled through the same governments. The role of the private sector in funding public mapping is still very small.

6. Conclusion

This appraisal of the state of cartographic services in the East African Community member states has found that these services are characterized by inadequate basic datasets whose level of computerization remains low. In addition, there are non-uniform spatial reference systems, inadequate cartographic human resources plus the associated training facilities. The concepts of metadata and the regular use of mapping standards have also not taken root. In order to facilitate seamless geo-spatial data sharing across the EAC region that is needed for regional operations and development, these cartographic services clearly need urgent improvement, including digitization and harmonization.

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Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

References

[1] Protocol on establishment of the East African Community Common Market. https://www.eatradehub.org

[2] Ottichilo, W. (2006) Geo-Information Capacity Building Activities in Africa. *International Archives of Photogrammetry, Remote Sensing and Spatial Information Science*, **36**, 295-299.

[3] Hopfstock, A. and Grunreich, D. (2009) User-Oriented Map Design in the SDI Environment Using the Example of a European Reference Map 1:250,000. *International Cartographic Conference*, Frankfurt. https://icaci.org/files/documents/ICC_proceedings/ICC2009/html/refer/3_8pdf

[4] Mwange, C., Mulaku, G.C. and Siriba, D.N. (2016) Reviewing the Status of National Spatial Data Infrastructures in Africa. *Survey Review*, 1-10. [Online]

[5] Report on the National Spatial Data Infrastructure (NSDI). Forum Held in Kigali, Rwanda. https://www.servirglobal.net

[6] Kalande, W. and Ondulo, J. (2006) Geo-Information Policy in East Africa. *Proceedings XXIII of International FIG Congress* (*TS* 62-*SIM-Policy and Strategy*), Munich, 8-13 October 2006, 1-25.

[7] Tukugize, C. (2005) Evaluation of Geoinformation Market Environment in East Africa. http://www.itc.nl/library/Papers_2005/msc/gim/tukugize.pdf

[8] Kothari, C. and Garg, G. (2014) Design of Sample Surveys in Research Methodology: Methods and Techniques. New Age International Publishers, Delhi, 59-61.

[9] IT News Africa. https://www.itnewsafrica.com/2017/03

[10] Baariu, S.N. (2017) Cartographic Design Awareness; a Prerequisite for Informed Decision Making. *Surveyors' Journal*: *A Publication of the Institution of Surveyors of Kenya*, **9**, 14-17.

[11] Laygo, K. (2010) What Makes a Good and Bad Map? http://www.katrinalaygo.blogspot.co.ke