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To cite this article: Richard Y. Kofie & Lasse Møller-Jensen (2011) Towards a framework for delineating sub-districts for primary health care administration in rural Ghana: A case study using GIS, Norsk Geografisk Tidsskrift, 55:1, 26-33, DOI: [10.1080/00291950119232](https://doi.org/10.1080/00291950119232)

To link to this article: <https://doi.org/10.1080/00291950119232>



Published online: 05 Nov 2010.



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# Towards a framework for delineating sub-districts for primary health care administration in rural Ghana: a case study using GIS

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Kofie, R. Y. & Møller-Jensen, L. 2001. Towards a framework for delineating sub-districts for primary health care administration in rural Ghana: a case study using GIS. *Norsk Geografisk Tidsskrift–Norwegian Journal of Geography* Vol. 55, 26–33. Oslo. ISSN 0029-1951.

This paper examines the need to carry out primary health care administration, programming and planning beyond the established 110 districts in Ghana. The framework for delimiting the sub-districts is offered by the availability of digital data such as the district boundary, site location, road network and population. Using the specified travel distance from predetermined sites, network analysis generates approximate polygons around the health centres to create functional areas – the health sub-districts. Additional sites are proposed based on a set of criteria which includes proximity, centrality, population and existing level of infrastructural development in an attempt to improve coverage and bring the total utilization of health facilities closer to 100% in the study area.

**Keywords:** *network analysis, primary health care, sub-districts*

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## Introduction

The art of delimiting regions to carry out government business and for the effective implementation of programmes has a long history. In Roman times, for example, censuses were conducted on a city and town basis for the purpose of collecting taxes. The localisation of this system of tax collection was probably meant to make it easier, as records of individuals and their backgrounds would be more readily accessible. Moreover, a more coherent community or functional area would make identification of the eligible taxpayer easier. States have been demarcated into regions, and regions into districts, communes, municipalities, wards, and boroughs. For various reasons, regions have been demarcated using such factors as population, cultural and ethnic homogeneity, accessibility to facilities, etc. In some cases the demarcations have been dictated by the exigencies of the day or for political expediency.

In Ghana, political administration has been devolved from the central government to basic units of government, the district assemblies. It is assumed that bringing policy decisions reflecting local conditions closer to the people will lead to a fuller participation in programmes, and that this will in turn bring about improvement in the well-being of the people. It also has the advantage of transferring competence to the local level (Nordberg 1995). The concept has been captured in a framework for planning which enjoins the co-ordination of plans from the various departments towards the national plan (NDPC 1995). For the effective implementation of policies and programmes, some of these departments have delimited regions into districts for the purpose of effectively implementing their administrative mandates. One such department is Health. The district level administrative machinery is referred to as the District Health Management Teams (DHMTs).

In some of the districts, local initiatives have been

developed to further delimit sub-districts on the basis of existing health care facilities – a strategy arguably described as ‘putting the cart before the horse’. The creation of sub-districts to administer health care has been dictated by the location of existing facilities. While this strategy cannot be condemned outright but judged as a dictate of available resources, there is the view that simple and unsophisticated digital methods can be used to delimit sub-districts using settlements and their population attributes, district boundaries and road networks.

### *Justification for localisation*

The paper employs network analysis, a utility of ArcView GIS (ESRI 1996), to delineate sub-districts into manageable and more coherent communities or into units for health care programming. It is also a step towards improving access to health services and serves as a strategy for the better targeting of health care towards local needs. The study was carried out in the Ga District of Ghana. It is thought that creating such sub-districts will bring several advantages. For example, it will improve understanding of local perceptions and needs, reduce resistance to change, increase management capacity, encourage community participation, allow for easier crossing of professional boundaries, and improve access to services (Rondinelli et al. 1989). Bullen et al. (1996) indicated that in the UK primary health care delivery has been backed by policies that favoured localism and community as an organisational basis for service delivery. The authors contended that, by basing health care planning on small geographical areas, recognizable and known to the public, there would be greater public involvement in, commitment to and understanding of the disposition of health care resources.

Amonoo-Lartson et al. (1984, 14–19) have also empha-

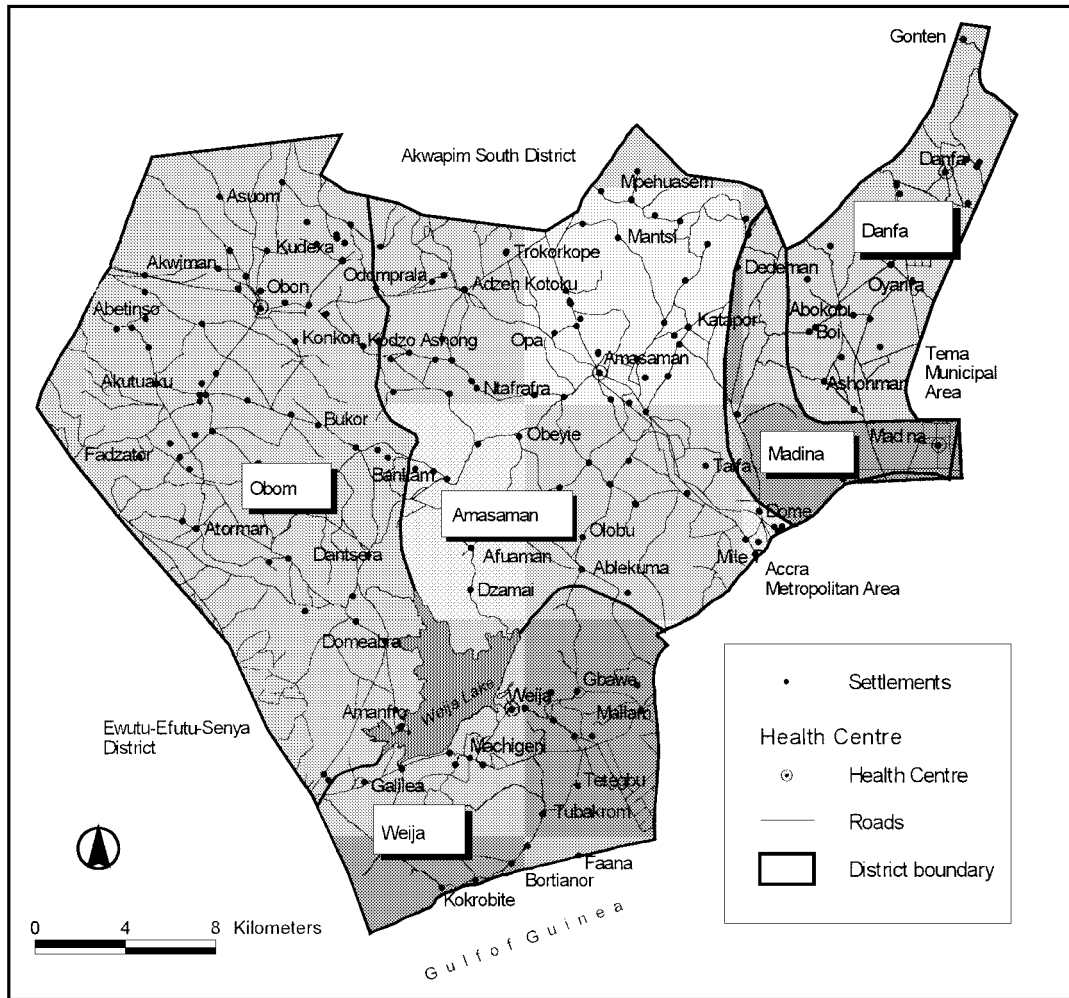


Fig. 1. Health sub-districts and location of major health centres in the Ga District, Ghana.

sised the importance of decentralizing health care programming and administration. They stated, for example, that primary health care should be carried out at the community level, because it is the community that knows how the health workers' knowledge can best be applied. There is therefore the 'need to get to know the community, be trusted by the people in it, and work with local people to provide the services they need.' They stated further that involving the communities in the identification of their needs, planning health programmes, implementing and evaluating them, raises the levels of awareness of their health and other problems and commits them to doing something about the problems. This also implies that by the time they are accepted such programmes are already tailored to the needs of the target group and fit in with their local traditions.

#### *Tradition of localism*

The practice of local level planning as a form of grass-roots government and administration in Ghana is not new. It has been a feature of the country's development programmes

since colonial times (MLGRD 1994, 2–7). Native authorities were, for example, empowered to administer law and order in their localities with limited involvement by the colonial government. Communities built around groups, traditions and cultures or around paramountcies and occupations facilitated the identification of regions for the implementation of government programmes and projects. The delimitation of enumeration areas for population censuses also characterized the colonial and post-colonial era. It is therefore possible to find in the census reports records of details such as the categories of amenities and facilities, occupation, migration, housing types and occupancy rates.

Other sectors of government business are replete with examples of local and community-based delimitation. Electoral areas form the basis for representation in the district assemblies. At present, there are 110 agricultural districts for the implementation of agricultural programmes and the promotion of extension activities. These coincide with the 110 basic units of government or the District Assemblies. In a similar vein, there are the education districts referred to as the District Directorates of Education.

The health sector has institutionalized the DHMTs in

Table 1. Institutions providing health services by sub-district in the Ga District, Ghana.

Sub-district	Ministry of Health institutions				Total health institutions
	Health centre	MCH/FP clinic	Quasi-govt. institutions	NGO built clinics	
Amasaman	1	0	0	2	3
Danfa	1	2	0	1	4
Madina	0	1	1	0	2
Obom	1	0	0	2	3
Weija	1	1	0	1	3
Total	4	4	1	6	15

Source: Ga District Health Management Team.

\* Maternal and Child Health/Family Planning.

every district. However, the availability of health care services at the sub-district level is of critical importance. Health services, even though more expensive to locate, in many cases are required beyond the established 110 administrative districts. For example, emerging diseases such as buruli ulcer require additional facilities for local treatment and monitoring. There is the need to further decentralize health care from the district level to the sub-district level in order to reduce the responsibilities of overcommitted central bureaucracies, and to facilitate community participation in health care. This will help produce the relevant information for planning and programming.

In a study of existing health information systems in East Africa, Nordberg (1995) indicated that surveys with local community and staff involvement can generate the data required and stimulate local initiative. Thus, decentralization and surveys are related and mutually supportive. The World Health Organisation (WHO) recognized the relevance of both intersectoral collaboration between service providers and of community participation in its 'Global Health for All' strategy (WHO 1981). This study contends that rural areas in Ghana do not have a well-developed road network system and should therefore have health services at close range. It is in the light of this that this paper proposes a framework for delineating sub-districts to enhance health care delivery, especially in the rural areas.

### Health care policy

The health system in Ghana is a combination of the government health system, private and non-governmental services, and the traditional health system. Primary health

care is based on a three-tier delivery system designed by the Ministry of Health (Ministry of Health 1978; Adjei 1989). These are A-, B- and C-level facilities. A-level facilities are located in the communities and are usually staffed with minimally trained health workers who provide basic curative services. B-level facilities are the first referral level for the communities' health workers and are intended to cover a radius of 8 km. They are usually staffed with a medical assistant, a community health nurse/midwife, a health inspection assistant and a senior field technician for communicable diseases control. C-level facilities are usually the management level for the entire system and are based on the district hospital. The management team is made up of at least one medical officer and provides mostly curative services including in-patient care and some preventive services.

Health care delivery in Ghana was, until the advent of structural adjustment programmes (SAP) in the early 1980s, based on government subsidies. The liberalization of the economy following SAP brought with it the 'cash and carry' (user fee) system where patients pay as they call. The problem associated with this policy has been the inability of most patients to afford services provided at the various health institutions, leading to the decline in the utilization of health services. The result is that the government's objective of achieving basic primary health care for 80% of the population of the country as far back as 1990 has still not been met. Accessibility to health resources has become increasingly dependent upon one's ability to pay. This has made the health system increasingly inaccessible to many rural and urban poor who have therefore resorted to unorthodox health practitioners for their health care. At present, the advocacy has been for health insurance schemes. The problem of economic accessibility has, however, not

Table 2. Ga District health sub-districts and population projection, 1998.

Sub-district	Approx. no. of communities in catchment area	Health facilities	1998 projected population	No. of outreach points
Amasaman	151	Amasaman Health Centre, Oduman Health Centre	87,482	46
Danfa	31	Danfa Health Centre, Abokobi Maternal and Child Health Clinic	22,809	29
Madina	13	Madina Maternal and Child Health Clinic/FP	43,222	14
Obom	101	Obom Rural Health Centre, Kwameanum Maternal and Child Health Clinic CDH, Communicable Diseases Hospital, Weija Public Health Nursing	43,045	90
Weija	24	Demonstration Clinic, Malam, Amanfro Health Centre	39,530	18

Source: Ga District Health Management Team.

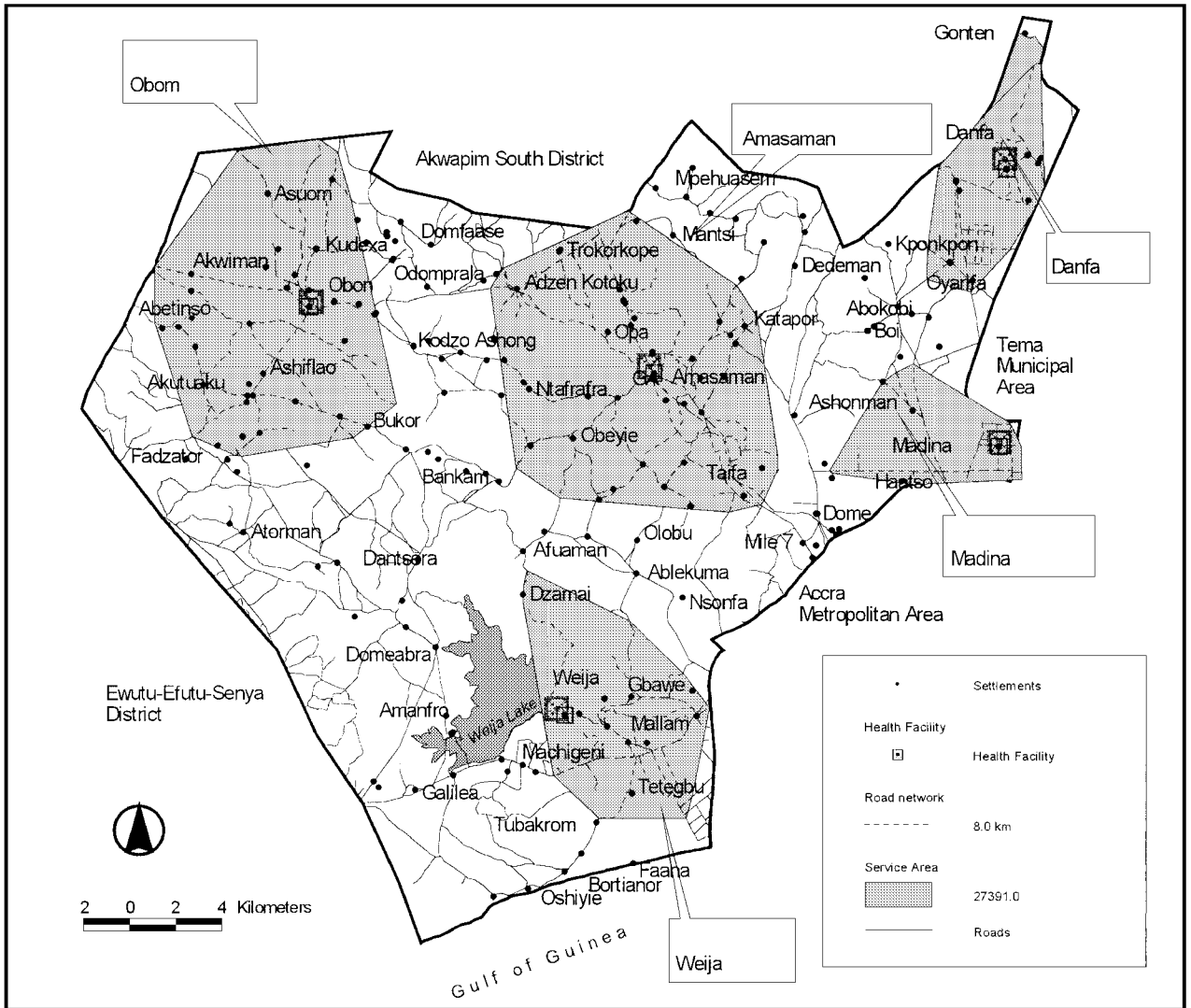


Fig. 2. Approximate polygons around health centres, Ga District.

deterred the government from pursuing its policy of decentralizing health care and carrying it down to the community level.

### The study area

The Ga District is one of the five districts which make up the Greater Accra Region and is predominantly rural, even though less than 80% of the population live in the rural areas. It is located to the west and partly to the north of the Region. It has a total land area of 859 sq. km. and a population of c. 300,000 (GDA 1996, 5–23). The district is divided into 42 electoral areas. There are about 21 departments, decentralized, semi-decentralized and centralized in the district, each carrying out central government-type activities.

For health sector planning and programming the district has been subdivided into five health catchment areas or sub-districts namely, Amasaman, Danfa, Madina, Obom and

Weija. Each of these sub-districts is host to a B-level health care facility. The five facilities serve c. 550 communities. Figure 1 shows the sub-districts and the main health centres after which they have been named.

Table 1 gives the number of government, quasi-government and non-governmental institutions providing health services in the district. Table 2 presents the main sub-district, the number of communities that constitute the catchment area for the health facilities, and the projected population for 1998. According to this projection the district's estimated population was 236,088 in 1988. In the light of estimates made by the District Health Management Team (DHMT) that were based on the routine immunisation exercises done, the total population was put at 290,000.

### Materials and methods

The Ga District is made up of five health sub-districts for

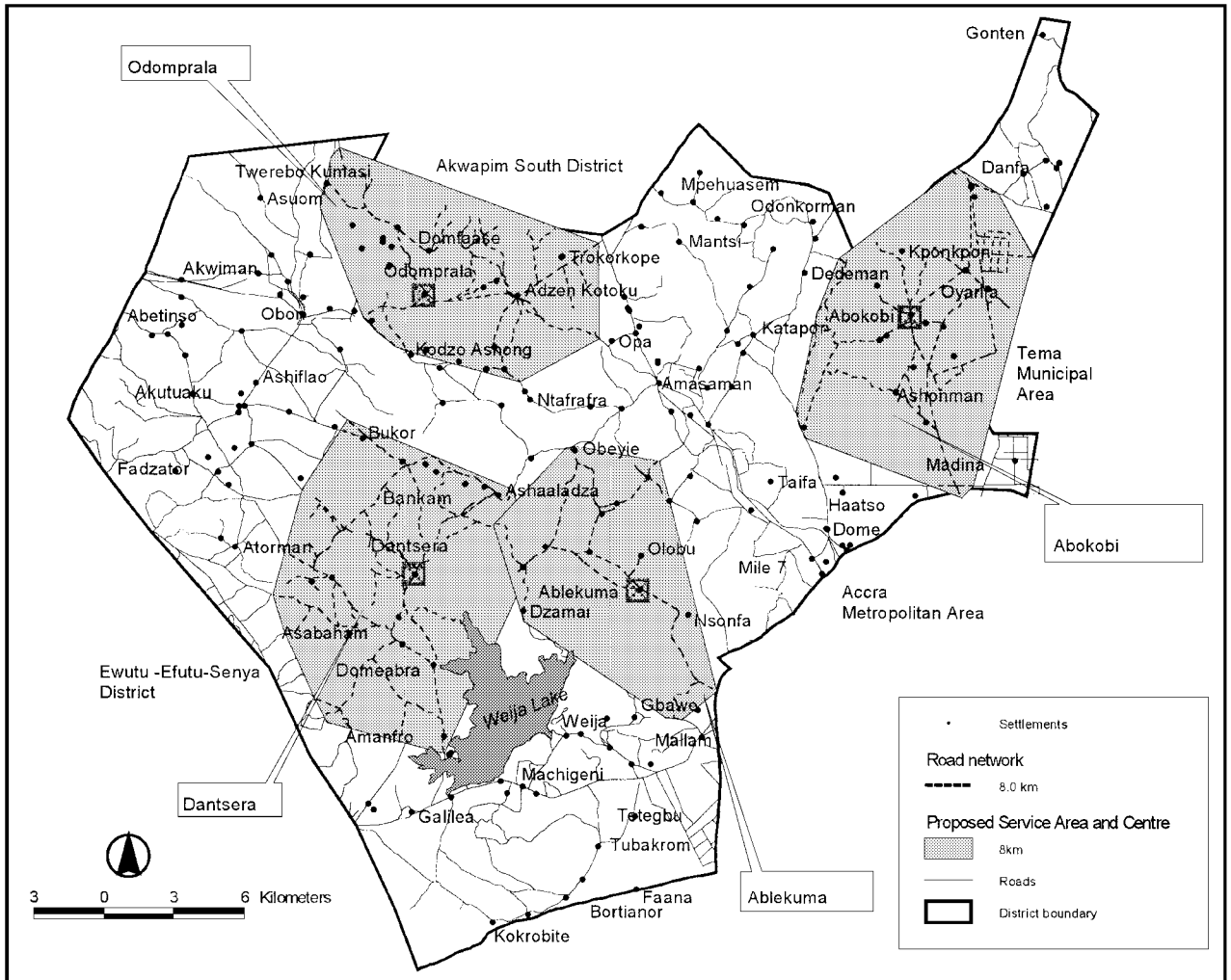


Fig. 3. Approximate polygons around proposed sites, Ga District.

health programming and health care administration. These sub-districts are to serve as catchment areas for the five MOH facilities and were delineated on the basis of their nearness to the communities closest by. Even though the rationale to locate health services near to communities and to delimit the catchment boundaries as small and manageable programming units could be seen as a step in the right direction, the geographical arrangement showed a spatial imbalance that has made accessibility to some of these facilities difficult for many communities. It is this arrangement that has led to the suggestion that these facilities are inadequate to meet the goals of primary health care in the district (Mensah-Quainoo 1997, 14). The study therefore aimed at finding ways of optimizing the location of the facilities as they are currently constituted based on digital road network data, in order to identify communities which fall within specified travelling distances to the facilities.

*Digital data and coverages*

A digital base map of the district was obtained from the

Remote Sensing Applications Unit of the University of Ghana. This provided the boundary outline and other basic data, such as settlements, population, road network and their attributes. The data sets had problems – a situation that is common to many areas in Africa where maps are generally out of date and even sets of more recent ad-hoc maps are heterogeneous and of questionable authority. The district boundary, for example, did not reflect the situation on the ground as many settlements were excluded completely from the district. Trips made in the company of some district

Table 3. Population and communities within 8 km distance from health care facilities along main road network.

Site	Population	Communities
Amasaman	40,123	113
Danfa	9,968	38
Obom	27,421	119
Weija	24,934	14
Madina	62,088	12
Total	164,534	296

Table 4. Population and communities covered by proposed sites.

Site	Population	Population of service area	No. of communities
Dantsera	628	7,700	35
Abokobi	1,028	14,311	62
Ablekuma	365	6,954	16
Odumprala	580	23,286	81
Total	2,601	52,251	194

Table 5. Improved level of accessibility to health care services.

	Population covered	No. of communities
Original facilities	164,534	296
Proposed facilities	52,251	194
Total	216,785	490

assembly officials with local knowledge of the district facilitated the location of many of the settlements with the aid of topographic maps and this enabled the boundary to be re-aligned. Supplementary digital data were obtained from the Survey Department of Ghana, which contained topographic information and, more importantly, the detailed road network data. In spite of this, additional road network data had to be generated by the use of a continuously logging 12 XL Garmin GPS. This took stock of new roads that had been constructed, since the original digital data sets were based on

analogue maps produced about 25 years ago and which have since not been updated.

Population data

The latest census from which all population information was derived is 16 years old. The study therefore relied on projections made to 1998 for the district. The annual growth rate of population for the district was 6.2%, which is 2.8% higher than the national average of 3.4%. All settlements in the district were covered by the population as attribute data.

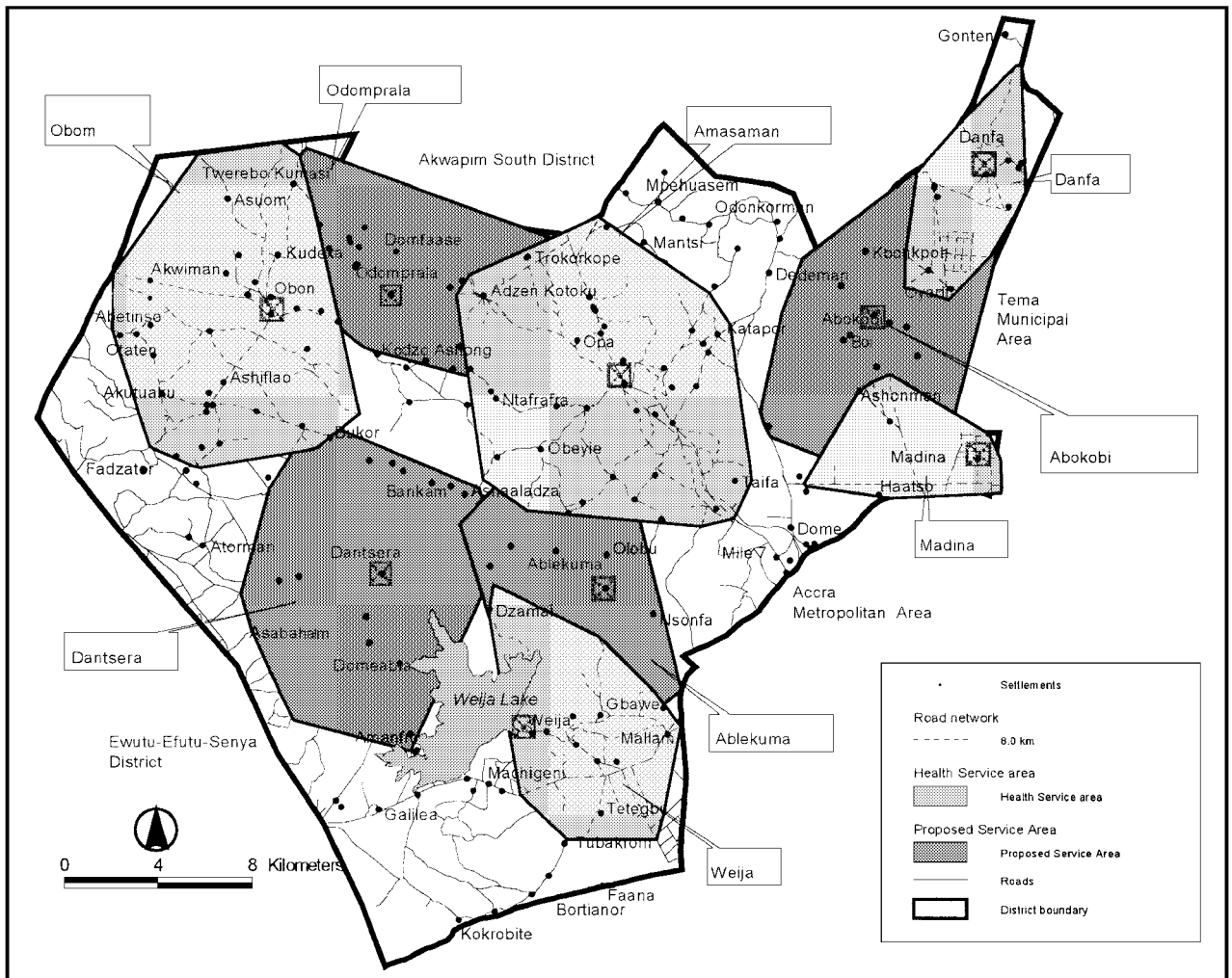


Fig. 4. Sub-districts of existing and proposed health centres, Ga District.

The first step was to specify centres or sites which represent the location of the five health centres around which the service areas or sub-districts were built. These sites were Amasaman, Obom, Weija, Madina and Danfa (Fig. 1). To determine the extent of the area around these health centres, a travel distance of 8 km was used. This is the maximum distance within which a B-level facility should be accessible to a community according to the national health policy (Ministry of Health 1978). What the network analysis did was to connect all communities lying 8 km from the specified sites or health centre. In this way, five service areas were generated showing the real 'catchment' area of each health centre and the road network to and from the centres. These are shown as polygons. It must be noted that the lines connecting the various communities are the existing road networks and it is these that are utilized by the network analysis.

Four additional sites were selected as candidate communities in an attempt to improve coverage, given that the five existing B-level facilities and the catchment areas they serve were inadequate. A number of methods are available for finding optimal locations in a road network (e.g. minimizing total travel time) and for computing the corresponding overall accessibility. In many cases, however, the selected sites are unfit for actual use due to a number of factors. The strategy of this paper has been to focus on a human guided approach that may be more suitable within the current planning context. Using the GIS platform, a number of factors may be examined and planners may experiment with new location scenarios based on their findings and general knowledge of the physical environment, accessibility, population, etc. The four additional sites suggested here should be considered as one possible scenario.

The basic criteria used to select the communities, which should host A-level facilities staffed with minimally trained health workers providing basic curative services, are proximity to the nearest B-level facilities, centrality to the communities that they are supposed to serve, the population of the catchment area, and the existing level of infrastructural development of the selected community.

## Results

Figure 2 shows the areas or approximate polygons generated around the five sites or health centres, namely Amasaman, Obom, Weija, Madina and Danfa. The road network and the settlements that were covered are shown inside the approximate polygons. The total population and number of communities thus covered by these centres are given in Table 3. Approximately 54% of the total number of communities or 64% of the population in the district has access to the health facilities. Given the criteria that the maximum travelling distance for access to health care is 8 km, these approximate areas could constitute functional areas for effective health care delivery. When compared to the original sub-district boundaries shown in Fig. 1, it is observed that the new approximate boundaries created are relatively smaller but reflect the true picture of accessibility, since these evolve from a specified distance. In rural areas

where the main form of transportation is on foot, it is vital to adopt a strategy that improves access to health care facilities by making them available within reasonable travelling distance or time.

The analysis shows that *c.* 46% of the communities and *c.* 36% of the population do not have access to the health care facilities. There is the need, therefore, to identify additional sites that could host new health care facilities in order to improve overall accessibility. This may be frowned at since it requires additional resources, but this paper contends that different levels of facilities may be required to address specific needs in specific areas. For example, the health care facility at Abokobi in the district is an outpost of the health centre at Danfa. In many of these communities the facilities are housed in one or two rooms provided by the communities or through the assistance of some NGOs.

Figure 3 shows that four sites were selected, namely Dantsera, Abokobi, Ablekuma and Odomprala. These sites have service areas with a population of over 52,000 and serve 194 communities. Table 4 gives the details of each site. Along with the population of service areas covered by the Amasaman, Danfa, Madina, Obom and Weija sites (Table 3), a considerable improvement in coverage was made. This is given in Table 5 where a total population of 216,785 and 490 communities have physical access to health care services. This brings the total coverage rate to 84% for the population and 89% for the communities. A combination of data sets of existing and proposed health centres, and the nine sub-districts created through this superimposition, is illustrated in Fig. 4. Quite evident is the fact that the sub-district boundaries overlap.

The analysis shows that health services are inaccessible to *c.* 16% of the population of the entire district, notwithstanding the increase in the total number of health care facilities from the existing five to nine. It also shows that only 11% of the communities will remain uncovered or will be without access at the 8 km specified travel distance. It has not been possible to achieve 100% coverage for the entire district owing to the geometry of the district, the nature of road network, the uneven distribution of population centres, and to the human phenomenon of bypassing facilities closest by even where there is good coverage.

## Discussion

The application of network analysis to delimit sub-districts has been prompted by the view that it is more objective and scientific. It aims at delimiting the sub-districts for health care programming on the basis of specified travelling distances. Traditional methods of delimiting districts or catchment zones have tended to use Euclidean distances and radii. In this paper, however, the view is that such criteria open real accessibility to question. First, nowhere will people be able to, or wish to, walk along straight lines between two points for the specified 8 km distance, especially in the rural areas. Second, the determination of catchment areas using radius only shows areas that are enclosed within a specified distance without considering whether such areas are actually accessible through any road network. Third, the impression is



created that large areas have been covered by the facility whereas in actual fact this may not be the case.

The additional sites proposed to improve coverage of health care services are not necessarily meant to increase the existing system of facilities but are to complement them as outreach points. The facility at Abokobi, which has been proposed in this paper, is already serving as an outstation of the Danfa Health Centre. Ablekuma, which falls within the Amasaman sub-district, could rightly serve as an outreach point for the Amasaman Health Centre, while the proposed site of Odumprala could serve as the outreach point for the Obom Health Centre. The site of Dantsera was proposed for geographical and population reasons. It is located not less than 12 km away from the nearest health facilities. Dantsera has a population of 971 within its immediate environs and would serve, at most, a population of 7,700. We agree with the policy where certain categories of facilities managed by certain categories of personnel are located at defined sites in an attempt to improve health care coverage.

## Conclusion

The increasing use of GIS for health studies and planning is exemplified by the works of Scholten & de Lepper (1991), Ritchie (1993), Kolars (1995), Yoon (1995), Cliff & Haggett (1996), and Clarke et al. (1997). Its use by health authorities, and more especially for health planning and profiling of local areas, has been demonstrated in recent times by Bullen et al. (1996). This study has been concerned with the aspects of delimiting sub-districts for the purpose of health care programming, especially within a rural context. It is possible to delimit already existing districts into sub-districts with the availability of digital data for effective health administration. Most localities in Ghana have been organised around ethnic groups or tribes and already form coherent spatial units for the implementation of government programmes. Health sub-districts have been delimited on the basis of the nearest facility, which has made accessibility difficult for some communities.

The use of GIS to enhance the process of delimiting the sub-districts is based on the availability of the following basic data sets: local boundary (polygon), settlements (points), population (attribute of settlements) and road network (linear). A GIS integrates these data sets and facilitates network analysis. The interactive querying of the database also enables the determination of population within the approximate polygons or sub-districts that have been created. The maps composed give a visual impression about the situations on the ground and therefore could help

planners, administrators and policy-makers take more informed decisions.

*Acknowledgements.*—The study was made possible through funding from DANIDA under the ENRECA Programme.

Manuscript submitted 27 January 2000; accepted 7 November 2000

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