

**A WEB-BASED SPATIO-TEMPORAL DECISION SUPPORT TOOL FOR  
HUMANITARIAN SUPPORT DISTRIBUTION**

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**Mr. Ongaya Kizito**

Cert. (ESRI), BLIS (Mak), PGDPPM (GU), MSc.IS (Mak)  
E-mail: [kizitoongaya@yahoo.co.uk](mailto:kizitoongaya@yahoo.co.uk) / Tel: +256 782 316676

**Dr. Peter Jehopio**

BSc (Hons), PGDE, MSc, MEd, PhD.  
Institute of Statistics and Applied Economics Makerere University.  
E-mail: [jehopio@yahoo.com](mailto:jehopio@yahoo.com) / Phone: +256-772-488849

**Dr. Elwin Koster**

Consultant / Manager GIS Competence Center  
Atos Origin Netherland B.V. / SI-ES-TUBS  
[elwin.koster@atosorigin.com](mailto:elwin.koster@atosorigin.com) / Phone: +31 6 3018 9941

**Abstract**

*There are a number of NGOs providing humanitarian support to people suffering with HIV/AIDS in Gulu District. However, frequently, the NGOs end up with uneven distribution of aid resources. There is no easy way for donors to verify that the activity they are funding is being accomplished by another NGO in an area. The aim of the study was to develop spatio-temporal decision support tool for effective improvement of distribution of humanitarian support. ArcIMS was used to implement the project. The study found out that humanitarian support was not reaching all parishes and spatio-temporal activities of the NGOs are without analysis of what sister NGOs have to offer and therefore resulting to duplication of services. It also showed that it was possible to have a web-based GIS for coordinating NGOs.*

## **Introduction**

Today, the system of storing and sharing information is undergoing rapid change driven mainly by the success of the internet and world wide web. The Internet is a communication network linking computers worldwide (Mamadouh, 2003) and Web services are modular, self-describing applications that can seamlessly interoperate directly across the Internet (Kanagwa and Mugisa, 2007). As such, it is both a communication medium and an organizational infrastructure. The web can be an instrument for collective action; web-based arenas (such as BBS forums for help and support for Microsoft Windows which is public space of the Internet) offer new arenas for collective actions. Web-based applications allow for new forms of communication characterized by interactivity, hyperlinked literacy, and multimedia; and, at the same time, the Internet itself is a stake (Mamadouh, 2003). Researchers argue that web-based technologies constitute new media for human communication; consequently, they offer the capability to create new types of information systems (Turoff and Hiltz, 1998). Web sites can be characterized historically as graphically intense hypermedia systems, they have now evolved from cyber-brochures into database-driven information systems that must integrate with existing back office applications within the organization, and often need to connect with trading partners and other stakeholders facilitating individuals and organizations to share information through it, it can therefore be used successfully as a decision support system/tool (Vidgen, 2002).

Decision support systems span many technologies and applicability including spatial decision support systems /Geographical Information Systems (GIS). Geographical Information System is a special type of DSS that deals with analysis of geo-spatial data (Rolf *et al*, 2001). It is being used in analysis of spatial data in many disciplines of human knowledge including urban planning, analysis of natural hazards, geological engineering, forestry (Rolf, 2001), mapping habitat and biological diversity in the ecosystem (Oindo and Skidmore, 2003), disease and epidemic modeling and control (Margarida, 2006),

weather services (Lowe, 2003) etc. Because of its range of applicability, it is catching attention of researchers' world wide.

Decision making today, have become complex and can not rely on artistic talents acquired over long period of time through experience (learning by trial and error). Decision making was considered an art because a variety of individual styles could be used in approaching and successfully solving the same types of managerial problems which were based on creativity, judgments, intuition and experience rather than on systematic quantitative methods grounded in scientific approach ( Turban *et al*,2001). Today, managers require accurate and quick information for taking right decisions. In order to take effective decisions, they have to employ modern technologies like databases, model bases, computer networks, internet and intranet (Janakiraman and Sarukesi, 2004). These technologies which help in decision making are termed as "Decision Support Systems (DSS)". To effectively utilize these DSS technologies in the right mix, managers have to be aware of their potential.

Geographical information system can be integrated with the web to make a web-based spatio-temporal decision support system which can be accessed on internet on the world wide web. This creates an opportunity for a distributed decision support tool for a number of organizations and individuals (Hendriks and Dirk, 2000). Applicability of a Web-based spatio-temporal DSS has been recognized by other researchers for different purposes such as environmental planning and watershed management (Sugumaran, 2003) , solid waste management (Shanklin *et al.*, 2003), drought assessment (Kozal *et al*,2002) etc.

Many organizations both private and public sectors due to the nature of their activities often covering geographical areas greatly need GIS to support their decisions based on geo-references. According to Open GIS Consortium (OGC), activities such as community development programs, government operations in different districts can be more facilitated by use of GIS technologies (OGC, 2006). Organizations which rely on donations can extend the capabilities and liberty for decision making of their donors to

fund specific activities in a specific geographical location by use of a web-based system of GIS. GIS can also help organizations analyze their own operations in a spatial environment and make appropriate decisions based on geographical location of an area.

Humanitarian organizations that are providing support to those infected with HIV/AIDS can use mapping and web-based system to create a network for their activities. This will help them avoid duplication of activities. For instance, the mapping done by Uganda AIDS Commission (UAC) revealed intriguing results such as many intervention activities in many districts, however, most of those activities did not reach the rural poor and mostly extending radius of between 5km to 10km around urban centers (UPCHA, 2005).

In Gulu District there are a number of NGOs providing medical and non medical support to those infected with HIV/AIDS. Some of which include The World Vision providing (nutritional support, medical expenses, and Agricultural), The Aids Support Organization (TASO) providing (food supplies, counselling and medical services), Comboni Samaritan providing Antiretroviral drugs (ARVs), educational expenses of orphaned children, medical expenses, repair of huts, counseling etc), CARITAS providing counseling.

Due to lack of appropriate decision support tool to help in coordination of NGO activities, there has been uneven distribution of humanitarian support/aid resources to the communities of displaced and dispersed people of Northern Uganda (TASO, 2006) [68]. The uneven distribution of humanitarian support/aid resources to dispersed needy people implies that there are some communities which have access to support and others do not. Therefore, there is need for a web-based spatio-temporal decision support tool for humanitarian support distribution which is sharable among aid agencies.

### **Data Sources and Methodology**

In this study, literature review, properties of displaced and dispersed communities in which location of infected persons were identified (UN-OCHA, 2005);

Properties of the stakeholders involved in aid/support distribution, that is, interview was carried in four selected NGOs (TASO, World Vision, Comboni Samaritan, and Health Alert) to elicit requirements on the following areas. The data was collected for the year 2006 and year 2007 for the same organizations, to enable findings of the trends in the NGOs activities areas of expansion in the two years.

Web-based spatio-temporal decision support tool for dispersed community's method. The web-based DSS was made to be accessible to all stakeholders over the internet so that it is sharable among aid agencies. Concepts of software development and data base designs were used.

The following tools were used in the implementation of the web-based spatio-temporal decision support tool for aid distribution. (i) ArcView 3.2, (ii) ArcMap 9.2, (ii) Java2 Platform standard edition (J2SE), (iii) Arc Information Management Information System (ArcIMS), (viii) Hypertext Transfer Protocol (HTTP), (ix) Extensible Marked up Language (XML)

The system was validated by two methods:

#### 1. Demonstration to stakeholders

Prototype demonstration was done to the management of some of the NGOs that were involved in the study. They were allowed to criticise or appreciate the tool. See appendixes for their reports.

#### 2. Actual Testing of the Prototype

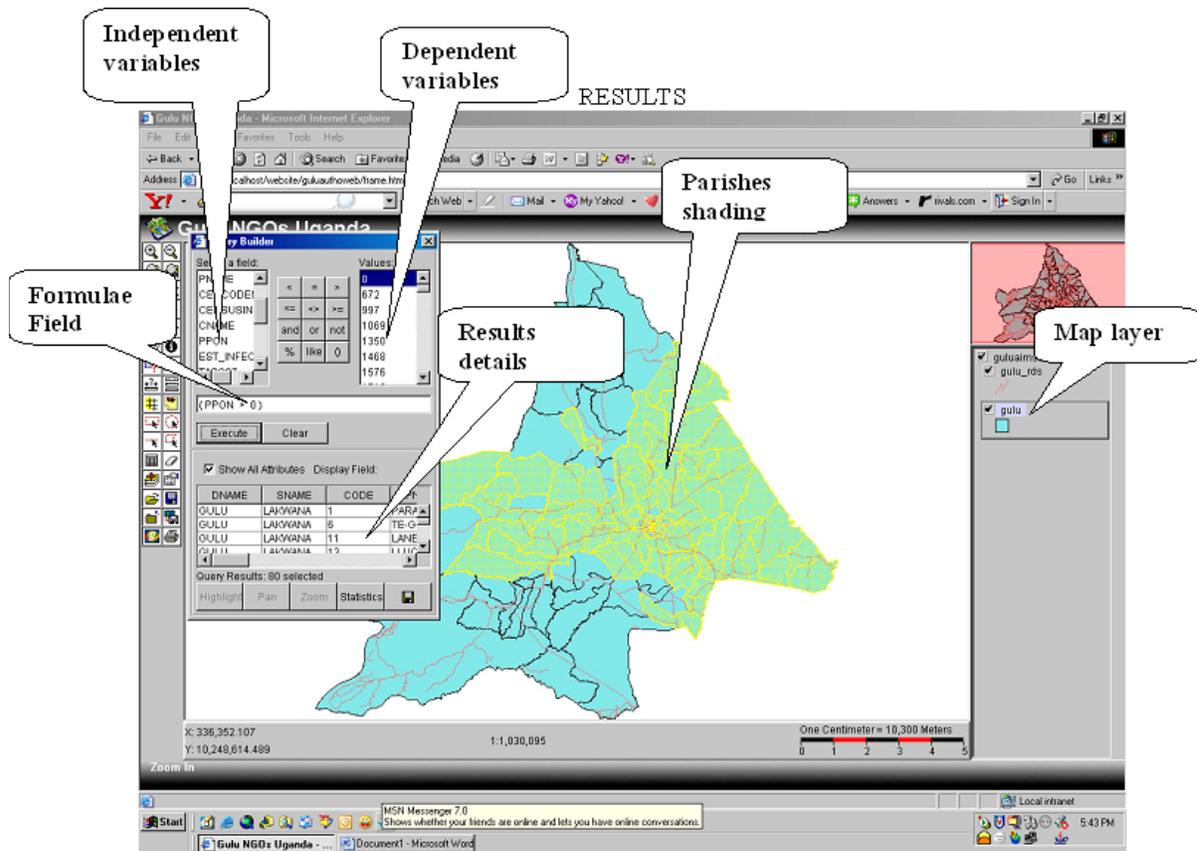
The information system used by Local Government and the District NGO Forum are largely manual. There is no web-based system that can be used coordinate NGO activities in the district. Hence the motivation for a web-based system.

Humanitarian support provision is a spatial problem. The prospective NGOs, operating NGOs and Donors would like to provide aid/support to categories of persons who do not have access to existing services without duplication of activities in aid provision. The choice of a parish for aid provision depends on answers provided for the following questions which the tool was be able to provide and critical for decision making:

- showed the NGOs providing aid/support to a given parish.
- showed form of aid/support is being delivered by such an NGO.
- showed the number of people (population distribution) that are living a parish.

-showed the estimated number of infected people of a parish.  
 -showed the number of people accessing an NGO aid/support in that area.  
 An NGO interested to provide aid to such an area with above characteristics can therefore make self assessment and make a decision. If the kind of aid is unique from the description above, then it will be a relevant support. If the aid is the same as described for a given location, then it will become irrelevant and therefore choice of a different location would be a better option.

### Components of a web-based spatio-temporal DSS tool



### Independent Variables

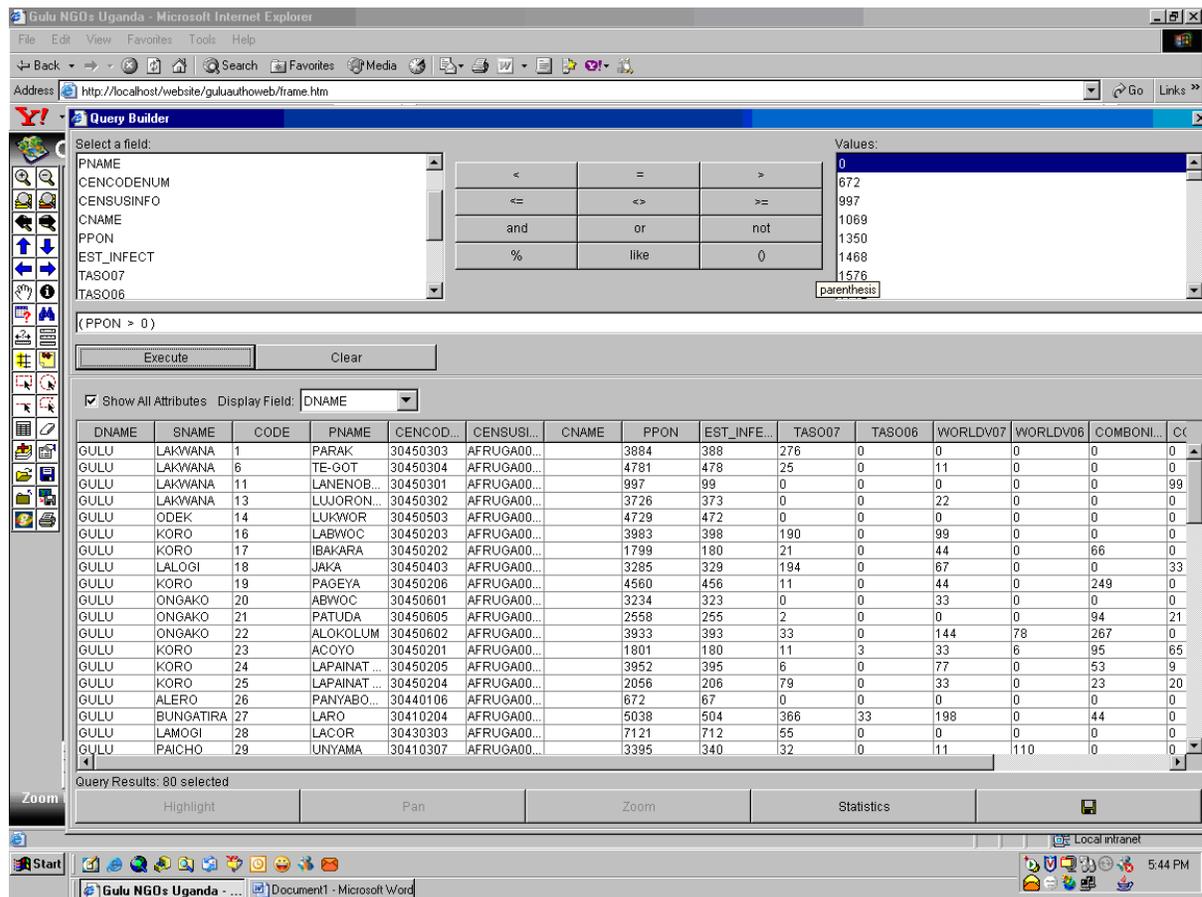
These are variables that were kept constant with changing values of other parameters. Other parameters (dependent variables) were tested against them. For this report independent variables include; the population, estimated infection per parish, TASSO6, TASSO7 etc, they are actually the fields.

### Dependent Variables

These are variables that can be changed and effect(s) of change observed. In this report, the values of each field constitutes the dependent variables. When dependent variables were changed, shadings will be seen to have changed also in the different affected parishes.

### Table of Results

Figure 4.1: Web-based GIS showing details of parishes affected.



### Possible Decisions that can be made with help of the tool:

- (a) If results shows an NGO is already working in a parish

Decision making alternatives:

(i) Coordinating agencies assess the activities of the incoming NGO(s) in relation to existing one. Similar activities will be directed to other parishes, and only unique aids that were not being provided will be recommended for that parish.

(b) If results show high infection rate in certain parish

Decision making alternatives:

(i) An NGO(s) with more resources could be assigned that parish.

(ii) HIV/AIDS campaign can be intensified and directed to most infected parishes

(iii) Donors can allocate more aid resources to such a parish

(c) If results shows the number of people accessing aid as less than the estimated infection of a parish.

Decision making alternatives:

(i) Some people infected have not yet been identified, there is therefore need to put more effort in identifying the sick people who need aid resources. Activities such as voluntary counseling and testing be emphasized.

(ii) It may be that an NGO has limited capacity to care for all the number of patients in such a parish, therefore, there is need to identify another NGO that can supplement the efforts of the existing ones.

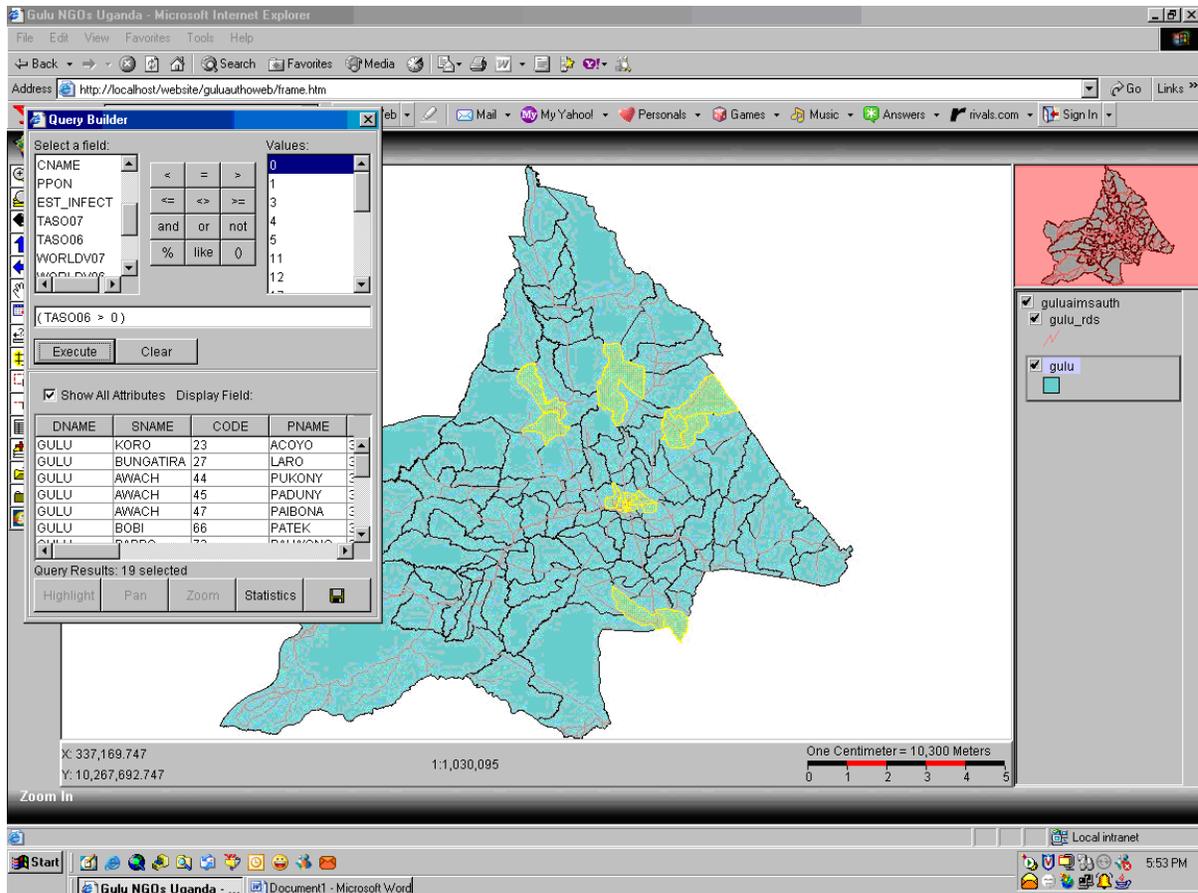
(iii) An NGO operating in such a parish may be lacking funding, it may be recommendable for it to seek for more funding.

## **Spatio-Temporal Analysis**

The spatio-temporal analysis (change in service location with respect to time) was carried out for The Aids Support Organization (TASO), World Vision, Comboni Samaritans Organization, and Health Alert. For each scenario deduction was made and implication to policy formulation asserted. Note that service location was determined by the location of beneficiaries for respective parishes and whom/which patient was getting what aid in a given location, was out of scope for this research. The research was concerned with how many patients were accessing support from which organization in a given parish.

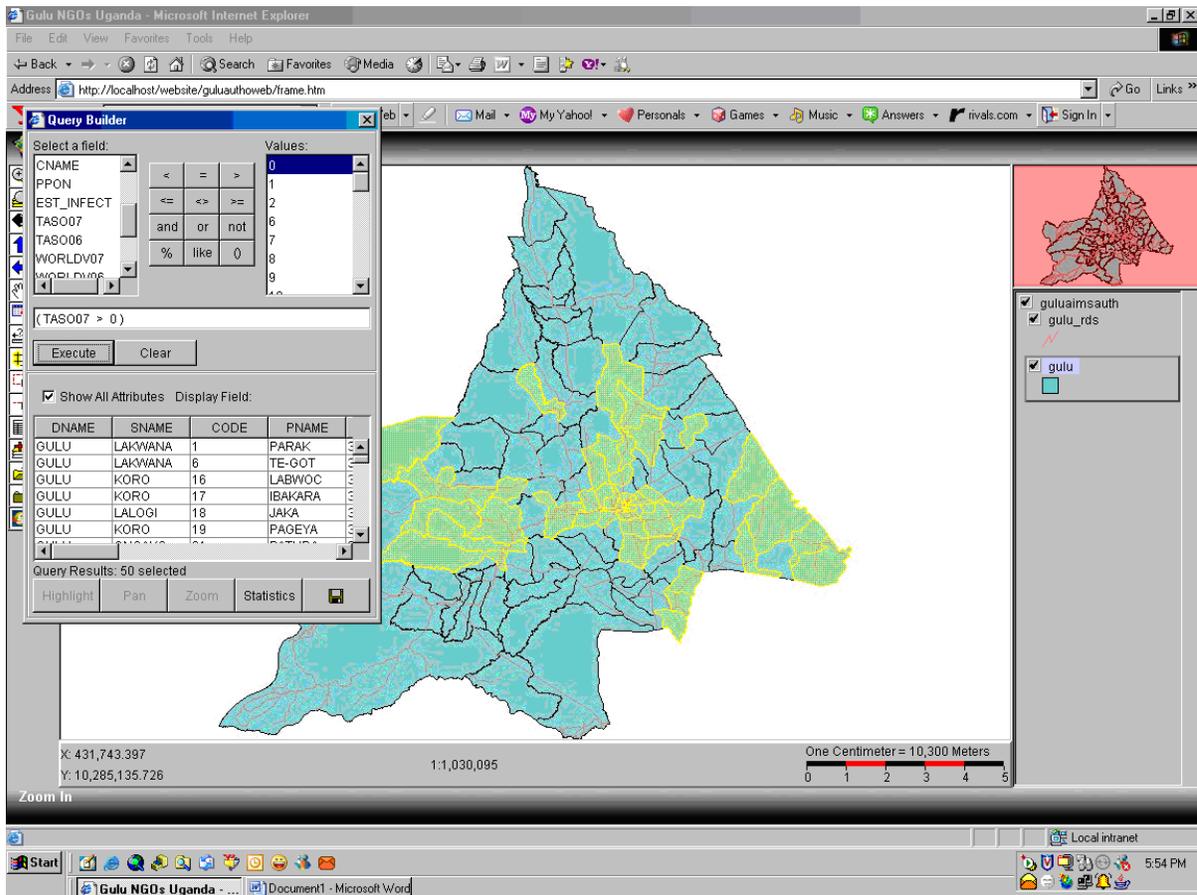
## TASO Spatio-Temporal Aspects

Figure 4.5: Web-based GIS showing TASO operation areas in 2006.



Enter the values ( TASO06 greater than 0), meaning, display all areas where TASO was operating in the year 2006. We can see that, during the year 2006, TASO was concentrating its activities in the urban areas and a few other parishes in the district. Infact TASO was one of the new organizations which had just come in the District in 2004. It was about two years old only in 2006.

Figure 4.6: Web-based GIS showing TASO operation areas in 2007.



When you execute the query to show operation areas in 2007 ( TASO07 greater than 0 ), we can see that TASO has spread its activities to numerous parishes almost tripling the previous year.

### Deduction

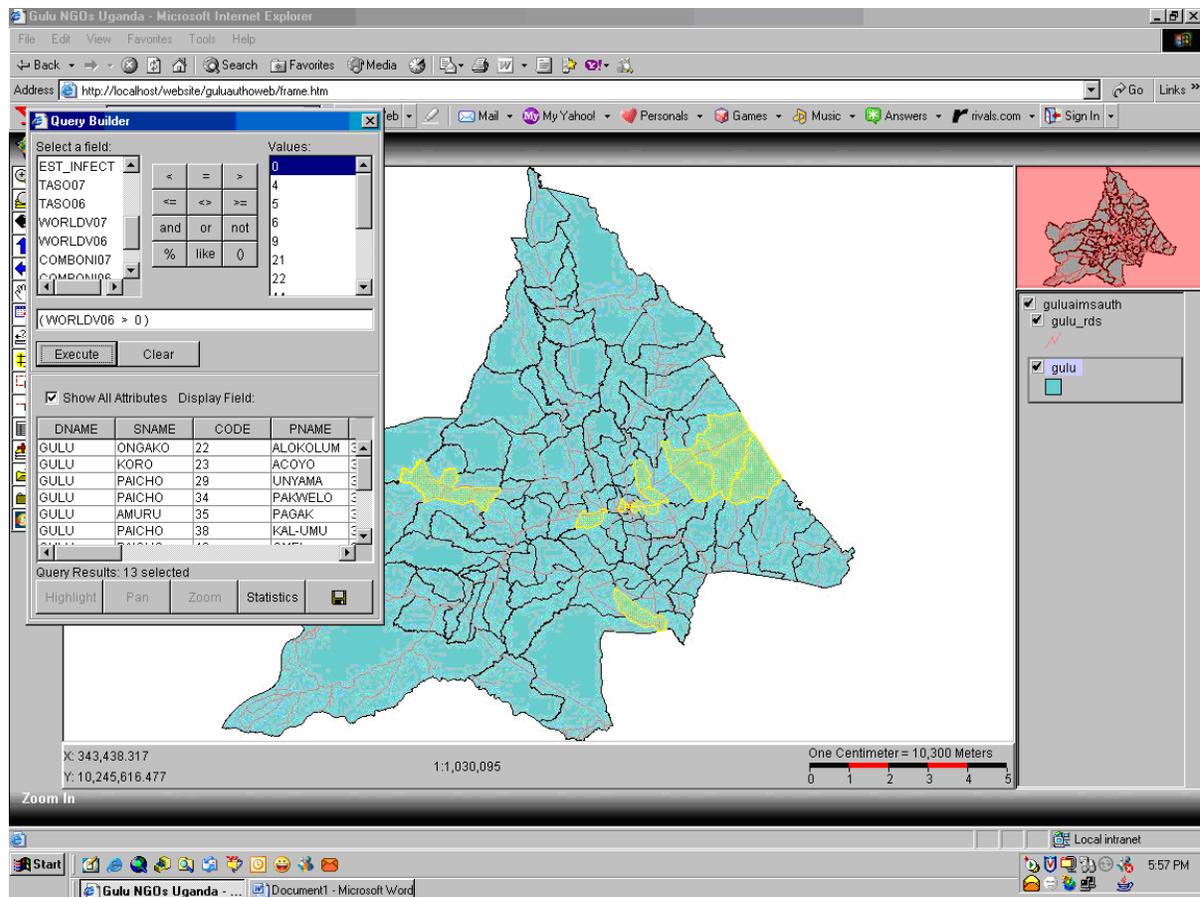
The differences in the two map query results indicate change in service location with time (spatio-temporal aspect) executable using the tool. This is important in monitoring progress of such organization by Donor agencies.

### Implication to Decision and Policy Formulation

Since the activities of TASO are provision of antiretro-viral drugs and counseling services, NGO coordinating agencies such as District NGO Forum, can be able to advise new NGOs that are providing similar aid/support to HIV infected/affected persons to target parishes where TASO is not operating in, if the services are also provision of antiretro-viral drugs and counseling. This will therefore be a perfect solution to avoiding duplication of services. Also, from the donor perspectives, they can fund TASO for activities it is carrying out in the locations shaded, while funding can be allocated to other sister organizations in other areas. Policies can be set to guide NGOs as to how expansion should be achieved and procedures involved so that sister organizations are made aware.

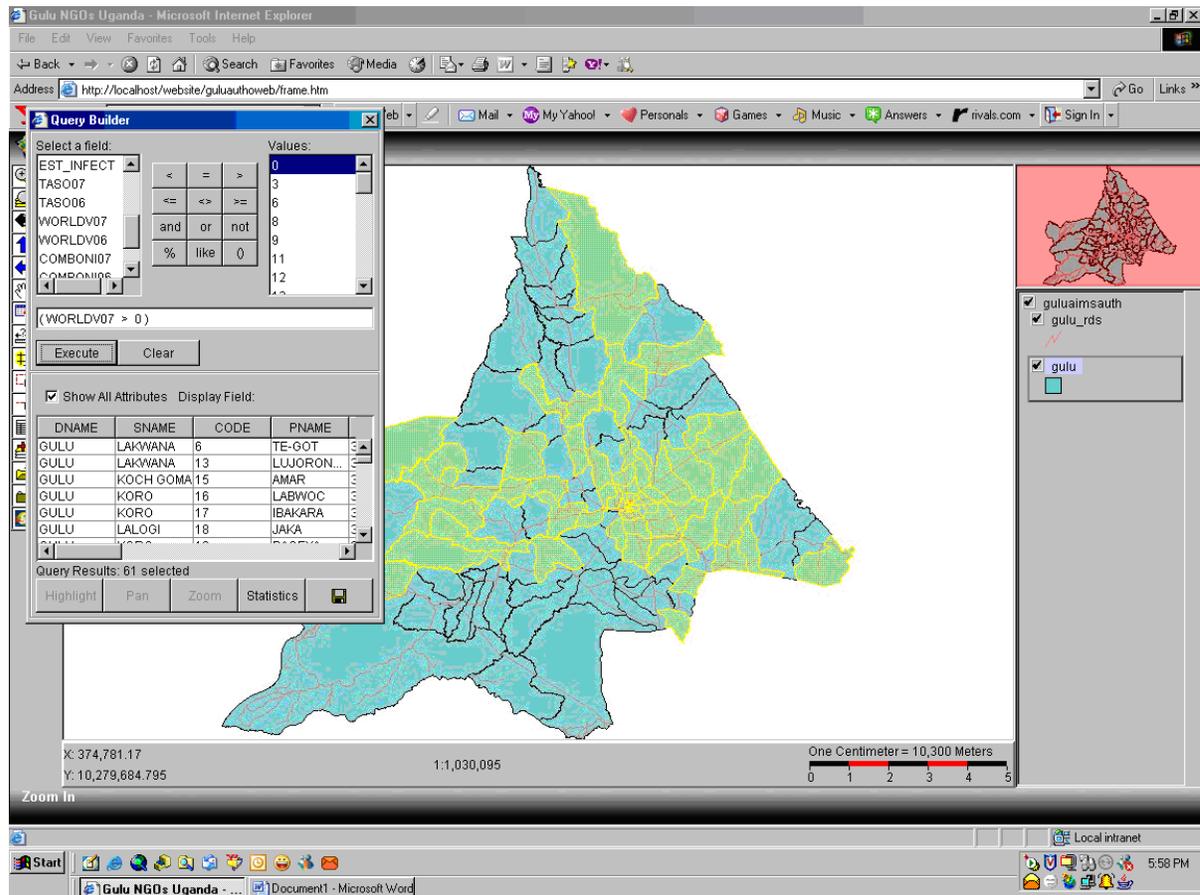
## World Vision Spatio-Temporal Aspects

Figure 4.7: Web-based GIS showing World Vision operation areas in 2006.



Similarly, execution of query for operation areas of World Vision in the year 2006 and the year 2007, it was noted that where World Vision was operating in 2006 were fewer parishes than in 2007.

Figure 4.8: Web-based GIS showing World Vision operation areas in 2007.



It is essential that the coordinating agencies are updated with detailed workplans of every organization in every parishes so that they are able to make informed decision and advise correctly. Policies and guidelines can be set by NGOs coordinating agencies to spell out intervals/durations for which reports must be submitted about individual successes and failure of an NGO operation. This will help to synchronize NGOs operations and enable them complement each other.

## Comboni Samaritans Organization Spatio-Temporal Aspects

Figure 4.9: Web-based GIS showing Comboni Samaritans Organization operation areas in 2006.

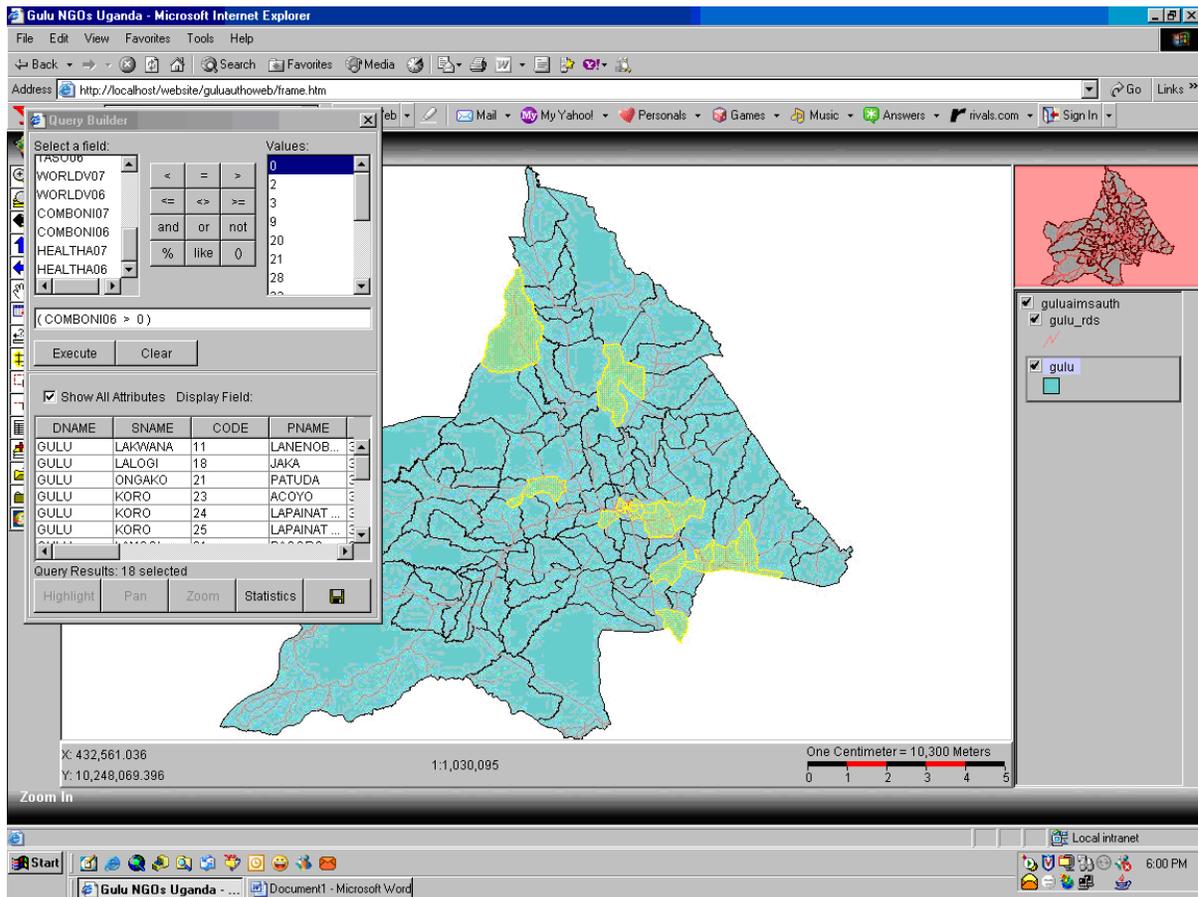
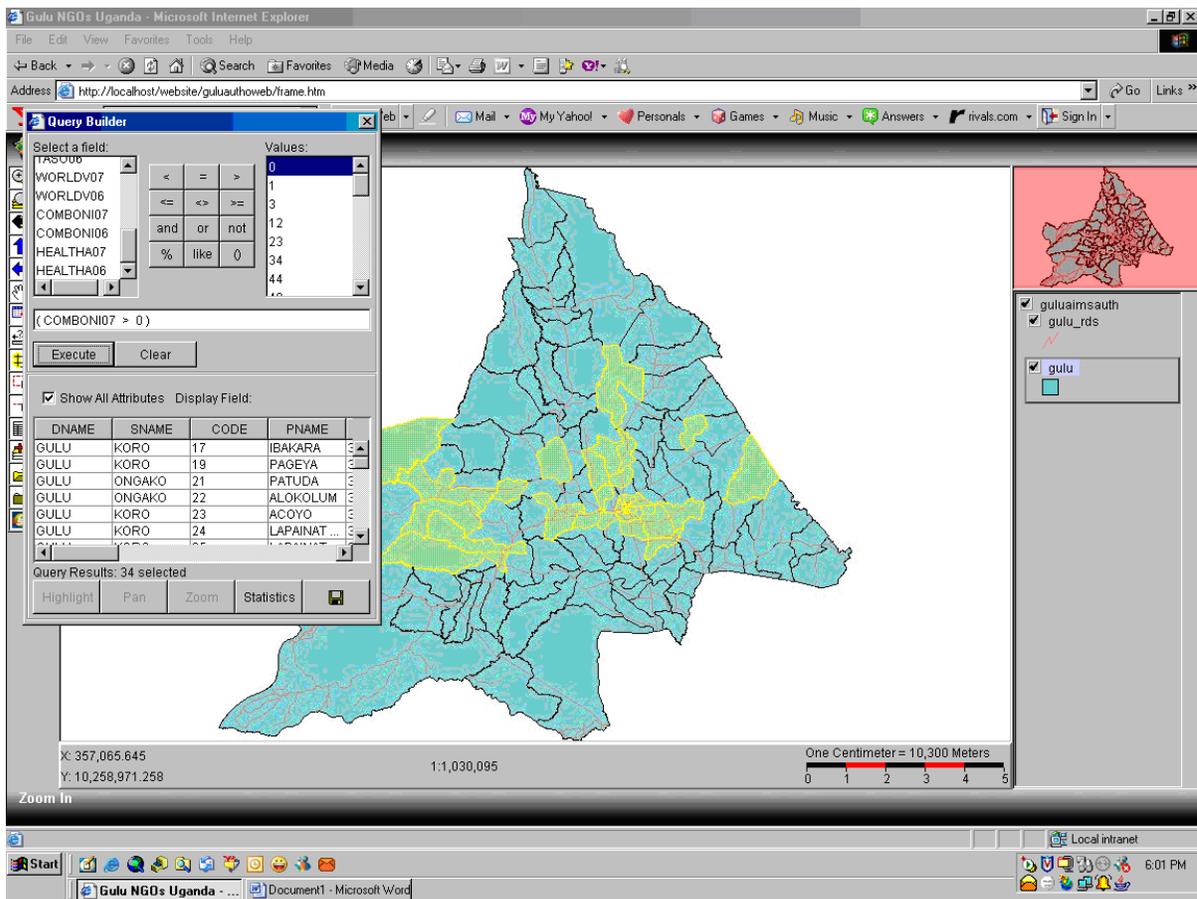
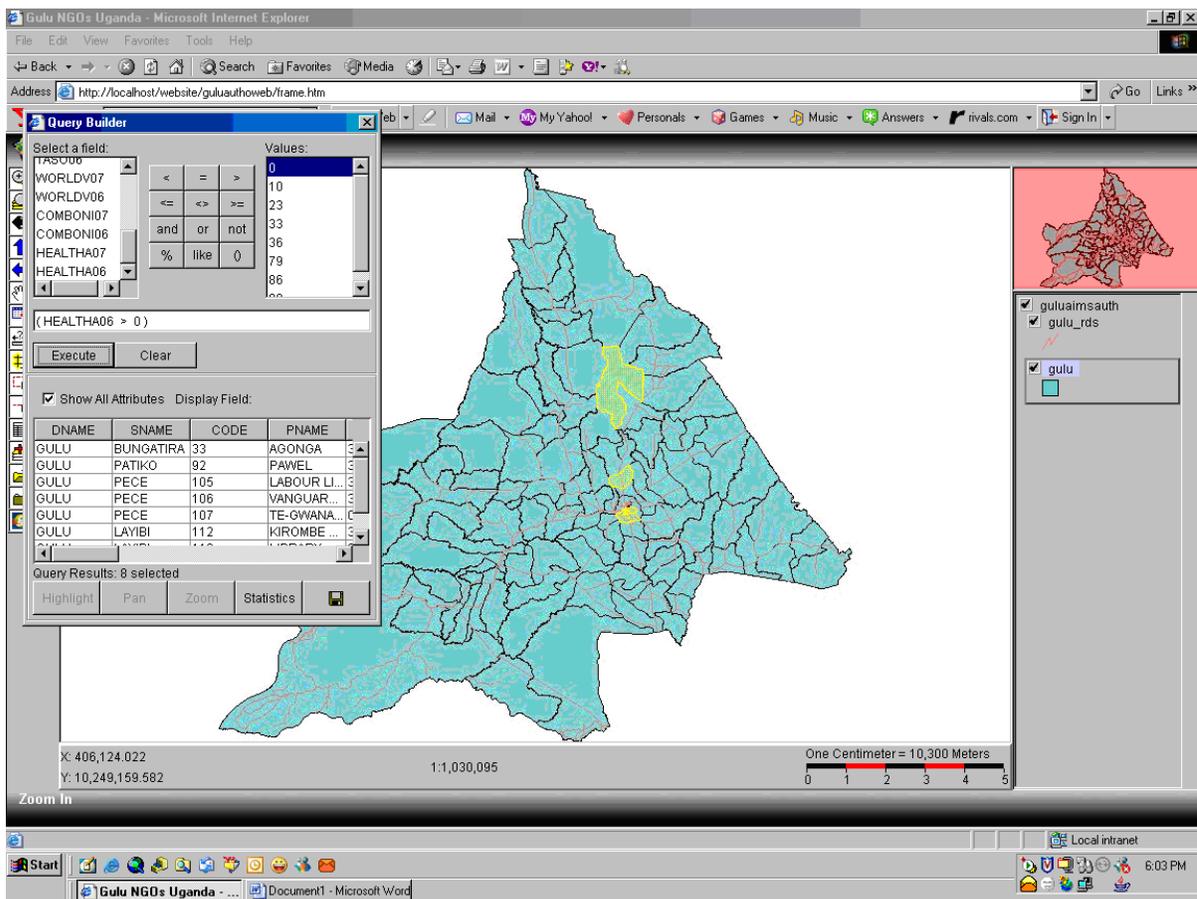


Figure 4.10: Web-based GIS showing Comboni Samaritans Organization operation areas in 2007.



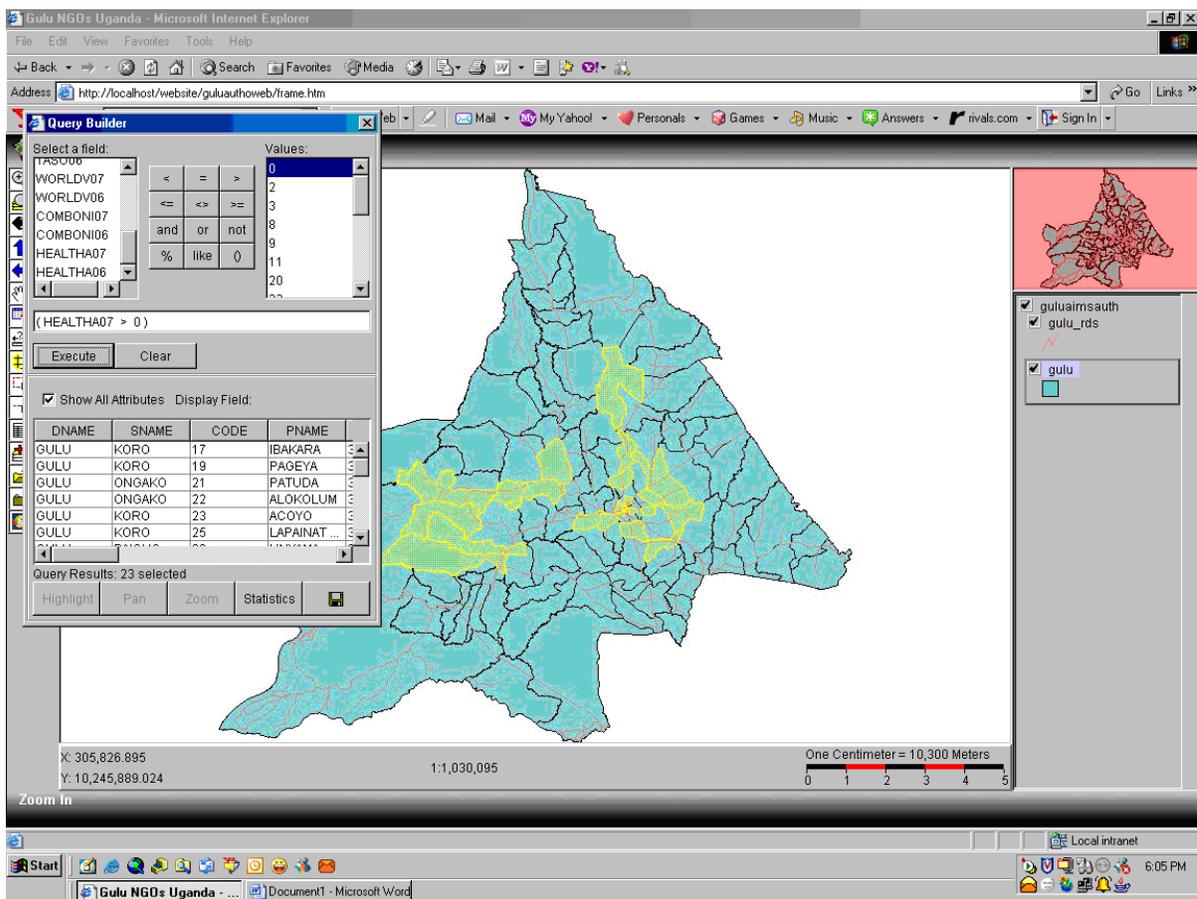
## Health Alert Spatio-Temporal Aspects

Figure 4.11: Web-based GIS showing Health Alert operation areas in 2006.



Health Alert program to intervene on HIV/AIDS infection was a recent development. Infact, the program was hardly making two years old by the time of this Research Project.

Figure 4.12: Web-based GIS showing Health Alert operation areas in 2007



## Deduction

Health Alert is an organization whose major activities were to identify HIV/AIDS patients and make referrals. They have also expanded their activities to many parishes in the year 2007.

### **Implication to Decision and Policy Formulation**

The web-based spatio-temporal DSS tool can help them to move strategically to worst infected parishes to identify the patients other than having random parish selection for operation.

### **Discussion**

The purpose of the study was to develop spatio-temporal decision support tool for effective improvement of distribution of aid resources reaching target groups of people at the right time where ever they may be dispersed in a given region (e.g Gulu and neighboring districts). Based on literature review, it was established that web mapping is not a new concept (Johnson and Jasmin, 2006), it was used for natural resource management (Fedra, 1995), investigate certain workplace accidents, diseases and dangerous occurrences (Norma, 2002). Although there are many web-based mapping that have been used for different purposes, in the research literature accessed by the researcher, there was hardly any literature that show that it has been used for mapping humanitarian aid for cases such as HIV/AIDS. The web-based DSS tool for aid distribution is an example of web-mapping that can be used for a number of purposes. In the this research project, the actual web-based system was implemented from Nairobi (Kenya) and demonstration was done on a stand alone system (ArcMap 9.2). The right software called Arc Information Management System (ArcIMS) that was required to demonstrate a web based system was not provided because it is commercial. Because there was no trial/demo version of ArcIMS, ESRI East Africa provided a demo version of ArcMap with duration of 60 days expire to enable the researcher demonstrate some aspects of the implemented system.

### **Strengths of the Tool**

Through this tool, a number of proposals can be generated by NGO coordinating agencies (District NGO Forum and District Local Governments) to donor agencies basing on identified weaknesses or strenght of the operating NGOs and their spatial characteristics. The tool can improve monitoring and evaluation of NGO performances, given the data on the number of people being supported and those not being supported can be analyzed for each parish. It also withdraws attention of aid providers to areas where it would otherwise

be difficult to identify, and yet are potential areas to concentrate activities. In some cases, a parish may be getting aid from an NGO, however, the number of people supported may not be equal or close to the estimated number of infected persons. This can be pointed out with the tool using individual click of a parish to view statistics. In such a case, another NGO may still be allocated to such a parish despite the presence of the existing one. The ability of being web-based, gives unique potential of the tool to serve a number of NGOs both within the district and outside the district. Donor agencies that are not based in the district can be updated easily. The web-based DSS tool for aid distribution is a cost effective way for easy data analysis for prospective NGOs that would want to intervene in the district on HIV/AIDS matter. There is usually waste of resources in facts finding research that can be minimized by this tool. For the District Local Government, it provides unique potential as a quick reference for information relating to population distribution, HIV/AIDS diffusion, aid/humanitarian support, and NGOs intervening on HIV/AIDS related issues in the district up to parish level.

### **Weaknesses of the Tool**

The disadvantage of the tool is that, it requires constant up to date information. The tool does not automatically updates information, update is dependant on the system administrator. The tool does not have a robust online capability of data entry, as such, there is need for one central place where data is delivered and updated on regular basis affected. Another disadvantage is that, the software involved are not easily available. They are expensive for individuals and organizations. For it to have required impact, many components have to work together simultaneously (e.g database, servers, services, map etc). It also require specialized skills to trouble shoot problems that accrue from time to time during operation and a strong system administration department. The web-based DSS tool for aid distribution requires some bit of training before one can really explore and reap benefits out of it. The mathematical symbols involved in constructing formulas require requires some knowledge of what they mean. For example the boolean logic is not a very familiar aspect of the tool. Once the final stage is reached, it is difficult to make corrections in the system. Customization of the tool requires complex programming skills especially in java programming language which many people are not familiar with.

## **Conclusion**

This Project Report shows that it is possible to have an internet GIS based decision support tool for guiding individual NGO as well as donors in decision making and policy formulation on spatio-temporal basis. The web-based spatio-temporal tool as demonstrated is capable of making spatial analysis and its a very useful tool to coordinate NGOs activities in the District. It was also noted that spatio-temporal expansions by the NGOs are coming without real analysis of what sister NGOs have to offer. This means that duplication of services are real since services offered to HIV/AIDS infected/affected person are similar. The tool can be used for decision support to avoid duplication of aid provision by aid agencies and formulation of policies governing their expansion in a geographical location.

## **Recommendation**

From the discussion above, it is clear that there are duplication of NGO activities in the same problem domain since the parishes shadings repeat certain parishes while others are blank. Parishes which show repeat of shadings implies duplication of services to patients there. Parishes which were blank were those that do not have access to service. It is therefore, recommended that spatio-temporal expansion of service areas should be done on consultation of sister NGOs, NGO Forum and District Local government so that duplication of services are avoided and parishes should be assigned to specific NGO(s) for a specific service. Duplication of services is a waste of resources from the donor side, it is also recommended that donor agencies allocate HIV/AIDS funds according to intensity of infection of a parish. NGOs are advised to direct support basing on infection status of a given parish other than being driven by ambiguity in lack of clear empirical data on the district status of HIV/AIDS diffusion. There is need for NGOs to set a robust policy to aquire information on "who is doing what and where" supported by the coordinating agencies and the District Local Government. Such a policy need strong technology support of spatial database system to make it easy to comprehend and implement. It is also important that NGOs keep updating the District Local Government

and District NGO Forum in a periodical basis on what they are doing so that effective decisions can be made in coordination activities.

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