MEASURE Evaluation PRH

Working Paper Series

GIS Data Linking to Enhance Multi-sectoral Decision Making for Family Planning and Reproductive Health: A Case Study in Rwanda

October 2012

WP-12-129

MEASURE Evaluation PRH is funded by the U.S. Agency for International Development (USAID) through cooperative agreement associate award number GPO-A-00-09-00003-00 and is implemented by the Carolina Population Center at the University of North Carolina at Chapel Hill, in partnership with Futures Group, Management Sciences for Health, and Tulane University. The opinions expressed are those of the authors and do not necessarily reflect the views of USAID or the U.S. government.

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GIS Data Linking
To Enhance Multi-Sectoral Decision Making
For Family Planning and Reproductive Health

A Case Study in Rwanda

Prepared for the
MEASURE Evaluation
Population and Reproductive Health
Associate Award

October 2012

Acknowledgements

Based on their significant contributions to the development of this publication, special thanks are extended to the following individuals:

- For supporting the initiation of this activity in Rwanda: Dr. Fidel Ngabo, Director of Maternal and Child Health (MCH), Rwanda Ministry of Health (MOH), and Dr. Charles Ntare, Head of Integrated Health Management Information Systems / HMIS, Rwanda MOH.
- For identifying GIS data linking and analysis opportunities and for elucidating the GIS architecture being implemented by the HMIS unit: Mr. Randy Wilson of Management Sciences for Health, who serves as Senior Advisor, Health Information Systems and Data Use for the HMIS unit at the MOH.
- For providing family planning commodities distribution data tracked by the USAID | DELIVER PROJECT in Rwanda and for reviewing derived products: Mr. Norbert-Aimé Péhé, Country Director, USAID | DELIVER PROJECT, John Snow, Inc., and to Mr. Max Kabalisa, Mr. Jovith Ndahinyuka, and Mr. Charles Nzumatuma, also of the USAID | DELIVER PROJECT in Rwanda.

MEASURE Evaluation PRH also extends sincere appreciation to everyone in Rwanda who participated in or facilitated stakeholder interviews conducted in September 2011, in particular representatives of the MCH and HMIS units at the MOH, the USAID Monitoring & Evaluation Management Services (MEMS) Project, and MEASURE Evaluation. Janine Barden-O'Fallon of MEASURE Evaluation PRH and Andrew Koleros, Joseph Mabirizi, James Stewart, Andrew Inglis, John Spencer, Becky Wilkes, and Martha Priedeman Skiles of MEASURE Evaluation are acknowledged for their contributions to this activity.

Acronyms

CDC	U.S. Centers for Disease Control
CYP	Couple Year(s) of Protection
DHIS 2	District Health Information System, version 2.x (www.dhis2.org/)
DHS	Demographic and Health Survey
E2G	Excel to Google Earth (www.cpc.unc.edu/measure/e2g)
ESDA	Exploratory Spatial Data Analysis
FOSS	Free and Open Source Software
FP	Family Planning
GIS	Geographic information system(s)
HMIS	Health Management information system
M&E	Monitoring and Evaluation
MCH	Maternal and Child Health
MEMS	USAID Monitoring and Evaluation Management Services Project
MOH	Ministry of Health
NISR	National Institute of Statistics of Rwanda
NSDI	National Spatial Data Infrastructure
NMA	national mapping agency
PBF	Performance-Based Financing
PEPFAR	U.S. President's Emergency Plan for AIDS Relief
PRH	Population and Reproductive Health
QGIS	Quantum GIS (www.qgis.org/)
RH	Reproductive Health
SCM	Supply Chain Manager
SCMS	Supply Chain Management System
SDP	Service Delivery Point
USAID	United States Agency for International Development

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Executive Summary

Need for an integrated data approach to decision-making

Family planning and reproductive health (FP/RH) services help provide the foundation of a stable, healthy, and economically viable society. Past global strategies, however, have often led to a vertical implementation of FP/RH programs and policies, despite the value for integrated approaches to meeting health needs.

As a result, decision-making for FP/RH can be hindered by a lack of information from other sectors, including other health areas, such as maternal and child health (MCH) or HIV/AIDS. Likewise, sectors outside the realm of public health, such as food security, education, physical infrastructure, and poverty, among others, are not routinely taken into account. Additionally, these other sectors do not typically have access to FP/RH data to contextualize their policies and programs.

Linking, visualizing, and analyzing data using a GIS

Linking multi-sectoral data sources is often deterred by information systems that are developed and maintained independently of other information systems, leading to datasets that are unconnected or 'stovepiped.' Through its ability to link data using common geographic identifiers, a geographic information system (GIS) can help overcome this stovepiping of data. Once multi-sectoral data links have been established, a GIS can also be used to enhance the visualization and analysis of FP/RH program data. Enhanced data visualization and analysis can make program data much easier to understand and to use for evidence-based decision making.

The benefits of linking multi-sectoral data using a GIS include the following:

- provides useful ways to visualize and communicate program data;
- establishes a foundation for data analysis within a geographic context;
- increases access, use, and value of data from multiple sectors;
- supplies a point of reference for discussion among stakeholders; and
- facilitates better targeting of resources.

To explore these benefits, the MEASURE Evaluation Population and Reproductive Health (PRH) Associate Award, which is funded by the United States Agency for International Development (USAID), sponsored an activity to investigate and document the process of using a GIS to link FP/RH data with data from multiple sectors. Rwanda was selected as a case study, and an assessment of available data and possible opportunities for linkages took place in the fall of 2011.

Rwanda was selected as a case study for two primary reasons:

(1) It has been designated by the USAID Office of PRH as a priority country for the support of FP/RH programming.
(2) It possesses a spatial data infrastructure that is mature enough to facilitate GIS data linking and analysis.

New spatial tools and solutions for limited-resource settings

New mapping tools have become available that help to overcome some of the historical limitations of GIS; specifically, the tools have become less expensive and more accessible. Some of these tools are presented here, along with an explanation of their outputs and suggestions for using the tools effectively. It is hoped that FP/RH researchers in countries with limited access to commercial GIS resources will be able to use the tools to increase their capacity to strengthen monitoring and evaluation (M&E) of FP/RH programs.

Goals of this guidance document

To meet the needs of FP/RH stakeholders, the goals of the current document are to offer GIS data linking solutions to help overcome the problems of unconnected and therefore underused data sets from multiple sectors, and to show how a GIS can help visualize and analyze linked, multi-sectoral data to enhance evidence-based decision making. To these ends, the current document is organized as follows:

- **How** to use a GIS to link and analyze multi-sectoral data.
- **Examples** of GIS linking, visualization, and analysis based on data for Rwanda.
- **Lessons learned** from the Rwanda experience, including **considerations** for linking, visualizing, and analyzing multi-sectoral data.

The section on how to use a GIS to link multi-sectoral data includes a discussion of essential GIS needs of FP/RH programs, provides an overview of a few free and open source GIS solutions that can meet those needs, and presents a short discussion on geographic identifiers for linking key data sources for FP/RH programs. The free and open source nature of the GIS tools discussed makes them particularly useful in limited resource settings.

Introduction

A GIS allows FP/RH programs to link standalone data sets from multiple sectors and sources and thereby enables a more integrated, multi-sectoral approach to decision making. Such an approach can increase data sharing and data use within a country and lead to more evidence-based decisions.

Linking data from multiple sectors and sources is made possible through the use of common geographic identifiers, such as district names or codes. Once a geographic link is established between datasets, the spatial patterns of multiple variables can be examined in a common, real-world framework.

To meet the needs of FP/RH stakeholders, the goals of the current document are to offer GIS data linking solutions to help overcome the problems of unconnected and therefore underused data sets from multiple sectors, and to show how a GIS can help visualize and analyze linked, multi-sectoral data to enhance evidence-based decision making. To these ends, the current document is organized as follows:

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The GIS needs and recommendations presented in this document are based on interviews conducted with FP/RH stakeholders in Rwanda in September 2011. However, recommendations and examples are presented based on their applicability to FP/RH programs globally.

How to use a GIS to link and analyze multi-sectoral data

Understanding how to use a GIS to link and analyze multi-sectoral data for FP/RH programs necessitates a discussion of data linking methods, such as the use of common geographic identifiers, and GIS software options.

Using common geographic identifiers to link and analyze multi-sectoral data

Standard Codes for Administrative Divisions

The primary consideration for linking data sources is to understand the common geographic identifiers contained in those sources. Because geographic boundaries can change it is important to ensure that data that will be linked use the same base geography. They should have the same number of administrative units and have names or codes that are consistent between databases. Ideally, they should use standard codes to identify the geography as opposed to names. The use of such codes make linking much easier, as it eliminates the risk of errors due to spelling variations.

Many countries maintain an official list of standard codes as part of their national spatial data infrastructure (NSDI) program, and the list of codes can be obtained from the NSDI program coordinating agency, such as the national mapping agency (NMA), national census bureau, or office of central statistics.

In Rwanda, standard administrative codes are available from the National Institute of Statistics of Rwanda (NISR), and can be downloaded from their Web site (www.statistics.gov.rw). These codes are also available in the health facility database for Rwanda that is available from the Ministry of Health (see www.moh.gov.rw) Linking, mapping, and analyzing multi-sectoral data for Rwanda was greatly facilitated by the use of these standard administrative codes.

Geographic Identifiers for Key Data Sources

There are several key data sources that can be used to inform the decision-making process for FP/RH programs. Many of the key data sources used for the case study in Rwanda are also available in other countries, although possibly with different collection dates or originating organizations. As with standard administrative codes, data from a variety of sectors in Rwanda are available through the NISR Web site. The central data repository provided by the NISR site offers an excellent example of how to make national, multi-sectoral data available to potential users.

For the case study presented in this document, key data sources were linked to the administrative divisions provided in the MOH database using common geographic identifiers. The key data sources used in the document, and the sectors they represent, are as follows:

- Demographic and Health Survey (DHS) from MEASURE DHS: FP/RH, HIV, Education, and Nutrition
- USAID | DELIVER PROJECT: FP (commodities)
- National Agricultural Survey, 2008 (NISR): Food Insecurity
- "The Evolution of Poverty in Rwanda from 2000 to 2011: Results from the Household Surveys (EICV)" (NISR, February 2012): Poverty

To see an example of how geographic identifiers in key data sources were linked to the standard administrative division codes for Rwanda as well as the geographic entities contained in the MOH database, see Table 1.

Table 1: District-Level Crosswalk of Administrative Codes for Rwanda

DHS_DIST	NISR_DIST	NISR_CODE	MOH_DIST	MOH_CODE
Bugesera	Bugesera	57	BUGESERA	0507
Burera	Burera	44	BURERA	0404
Gakenke	Gakenke	42	GAKENKE	0402
Gasabo	Gasabo	12	GASABO	0102
Gatsibo	Gatsibo	53	GATSIBO	0503
Gicumbi	Gicumbi	45	GICUMBI	0405
Gisagara	Gisagara	22	GISAGARA	0202
Huye	Huye	24	HUYE	0204
Kamonyi	Kamonyi	28	KAMONYI	0208
Karongi	Karongi	31	KARONGI	0301
Kayonza	Kayonza	54	KAYONZA	0504
Kicukiro	Kicukiro	13	KICUKIRO	0103
Kirehe	Kirehe	55	KIREHE	0505
Muhanga	Muhanga	27	MUHANGA	0207
Musanze	Musanze	43	MUSANZE	0403
Ngoma	Ngoma	56	NGOMA	0506
Ngororero	Ngororero	35	NGORORERO	0305
Nyabihu	Nyabihu	34	NYABIHU	0304
Nyagatare	Nyagatare	52	NYAGATARE	0502
Nyamagabe	Nyamagabe	25	NYAMAGABE	0205
Nyamasheke	Nyamasheke	37	NYAMASHEKE	0307
Nyanza	Nyanza	21	NYANZA	0201
Nyarugenge	Nyarugenge	11	NYARUGENGE	0101
Nyaruguru	Nyaruguru	23	NYARUGURU	0203
Rubavu	Rubavu	33	RUBAVU	0303
Ruhango	Ruhango	26	RUHANGO	0206
Rulindo	Rulindo	41	RULINDO	0401
Rusizi	Rusizi	36	RUSIZI	0306
Rutsiro	Rutsiro	32	RUTSIRO	0302
Rwamagana	Rwamagana	51	RWAMAGANA	0501

Abbreviations used in Table 1: DHS = Demographic and Health Survey 2010. NISR = National Institute of Statistics of Rwanda. MOH = Ministry of Health.

Free and Open Source GIS Software Options

GIS programs are valuable tools for making linkages between data, which can break down data silos, and for mapping and analyzing the resulting linked datasets. Some of the challenges sometimes faced when attempting to use a GIS are software cost and learning curve. To respond to these challenges, there is a growing number of free and open source software (FOSS) options in the GIS realm. As evidence of their utility, some of these software packages were used to create all of the maps in the following sections. The list of select free and open source software packages is as follows:

- Excel to Google Earth (E2G) for basic maps (www.cpc.unc.edu/measure/e2g)
- Quantum GIS (QGIS) for publication-quality maps and advanced GIS analysis (www.qgis.org)
- GeoDa for exploratory spatial data analysis (ESDA) (geodacenter.asu.edu)

To provide a better understanding of these three software programs, this section provides an overview of each program and discusses how each might be used by FP/RH stakeholders.

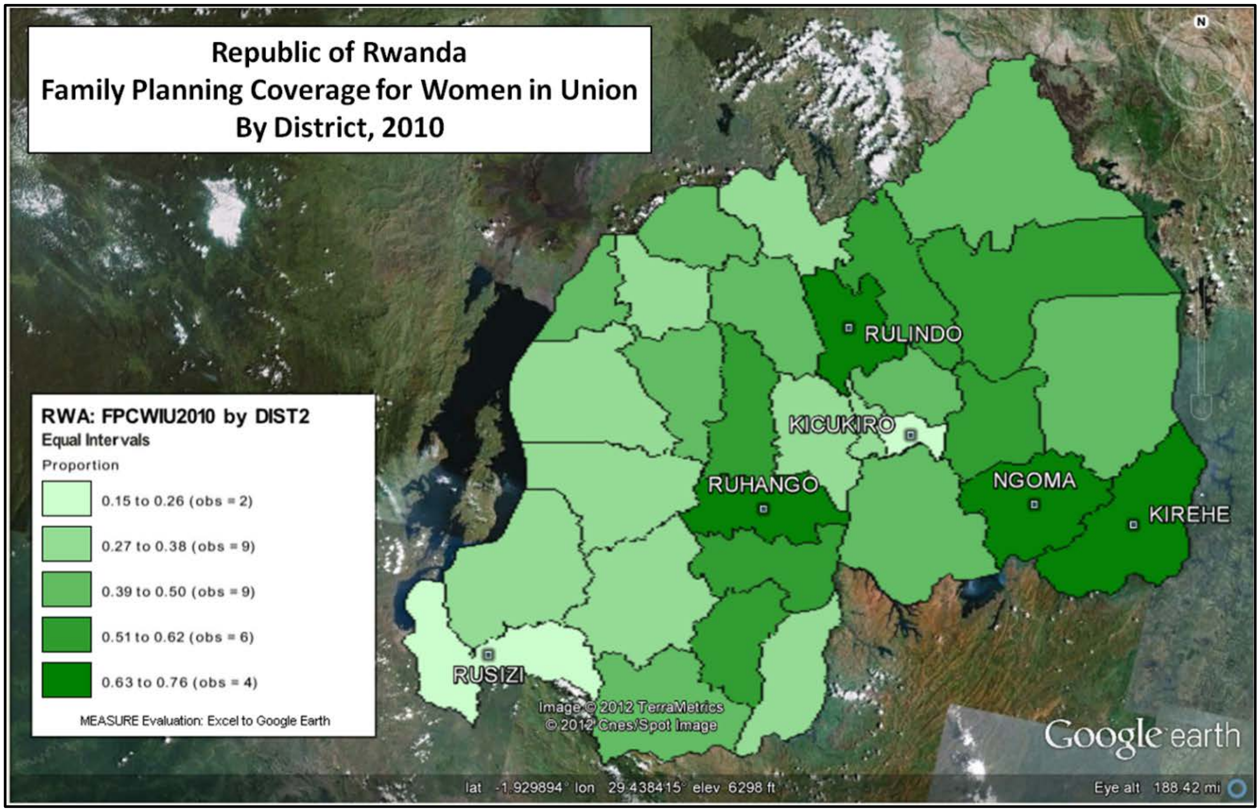
Excel to Google Earth (E2G)

The E2G mapping tool is a quick and simple program from MEASURE Evaluation. Using the E2G tool, a user can create a color-shaded (choropleth) map of a single variable using data stored in an Excel spreadsheet without the learning curve of a full-featured GIS. The resulting map, which is displayed on top of Google Earth's rich base map of high-resolution satellite imagery, can be used for visualizing spreadsheet data, performing data quality checks, or illustrating reports. Because the E2G tool requires minimal time and effort to set up and use, it is a good option for non-GIS specialists, including high-level decision makers.

The E2G tool can be used to link multi-sectoral data stored in an Excel spreadsheet by displaying combinations of maps for single indicators in Google Earth. Another way to link multi-sectoral data using the E2G tool is to display a choropleth map for one variable in Google Earth and to superimpose a second layer of point-based data on that map. This can be accomplished using one of the widely available free and open source applications for creating point-based maps in Google Earth.

For more information on the E2G mapping tool, including a list of the 40 countries for which administrative division boundaries are available, please visit www.cpc.unc.edu/measure/e2g.

Figure 1: Example of an E2G Map Created Using MCH Data for Rwanda



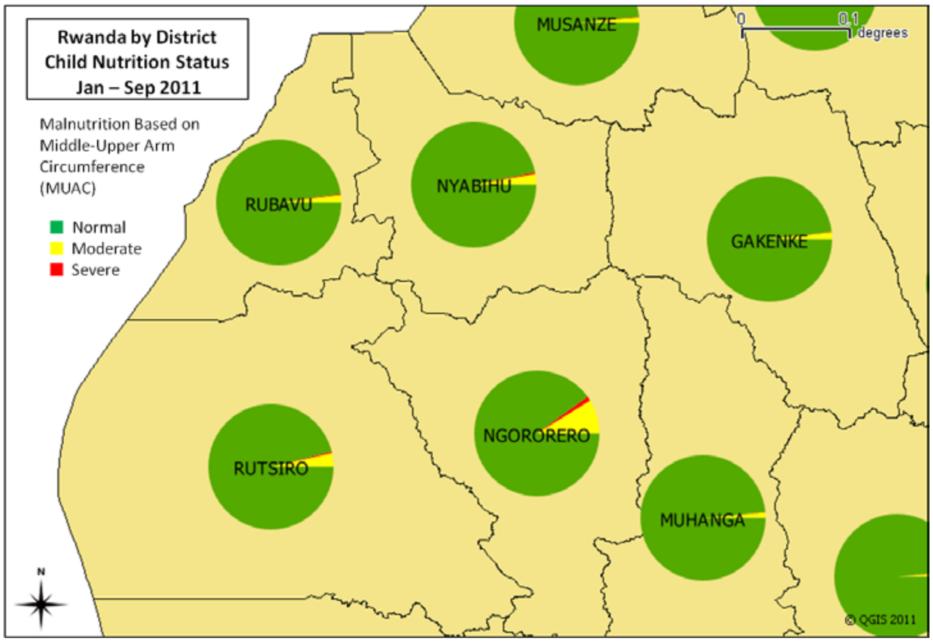
Source: Maternal and Child Health Unit, Rwanda Ministry of Health, September 2011, unpublished data from the HMIS. Note that the title of the map was added using PowerPoint; the rest of the map is a screen shot as it appeared in Google Earth

Quantum GIS (QGIS)

QGIS is a free, open source GIS program that offers considerable functionality. It can be a strong solution for those wishing to link multi-sectoral data geographically. Based on its breadth of functionality, QGIS can also be used to produce publication-quality maps and perform advanced GIS analysis. Some of the key capabilities of QGIS are as follows:

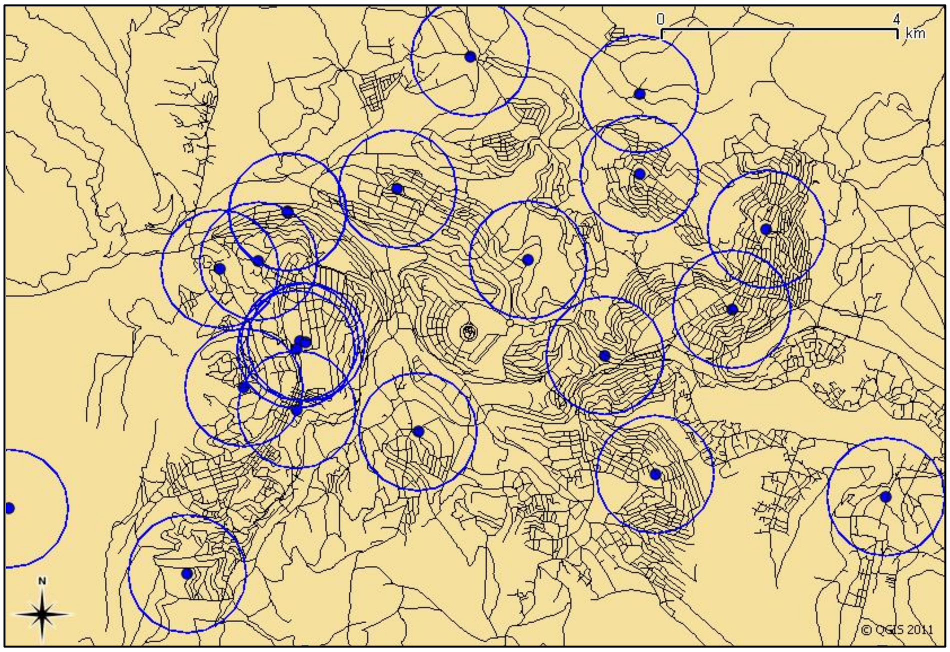
- Generate publication-quality maps with custom colors and labels, including map elements such as legends and scale bars.
- Create proportional symbol maps using data associated with administrative divisions. This will allow two or three variables to be viewed simultaneously using proportional symbols as an overlay on top of a choropleth (shaded polygon) map.
- Construct bar chart and pie chart overlays for maps using data associated with either administrative divisions or point-based locations. Varying colors and symbol sizes will allow for the comparison of multiple variables on a single map.
- Conduct advanced spatial analysis, such as the development of catchment areas for health facilities and the querying of other geographic layers based on those catchment areas.

Figure 2: QGIS Pie Chart Map Showing Child Nutrition Status by District from the Performance-Based Finance (PBF) System for Rwanda



Source: www.pbfrwanda.org.rw, October 2011

Figure 3: QGIS Hypothetical Catchment Areas for Health Facilities in Kigali Using Circular Buffers with a 1-Kilometer Radius



Source for health facilities: Rwanda Health Facility Database, April 2011, Rwanda Ministry of Health (www.moh.gov.rw). Source for roads: Open Street Map 2011.

GeoDa

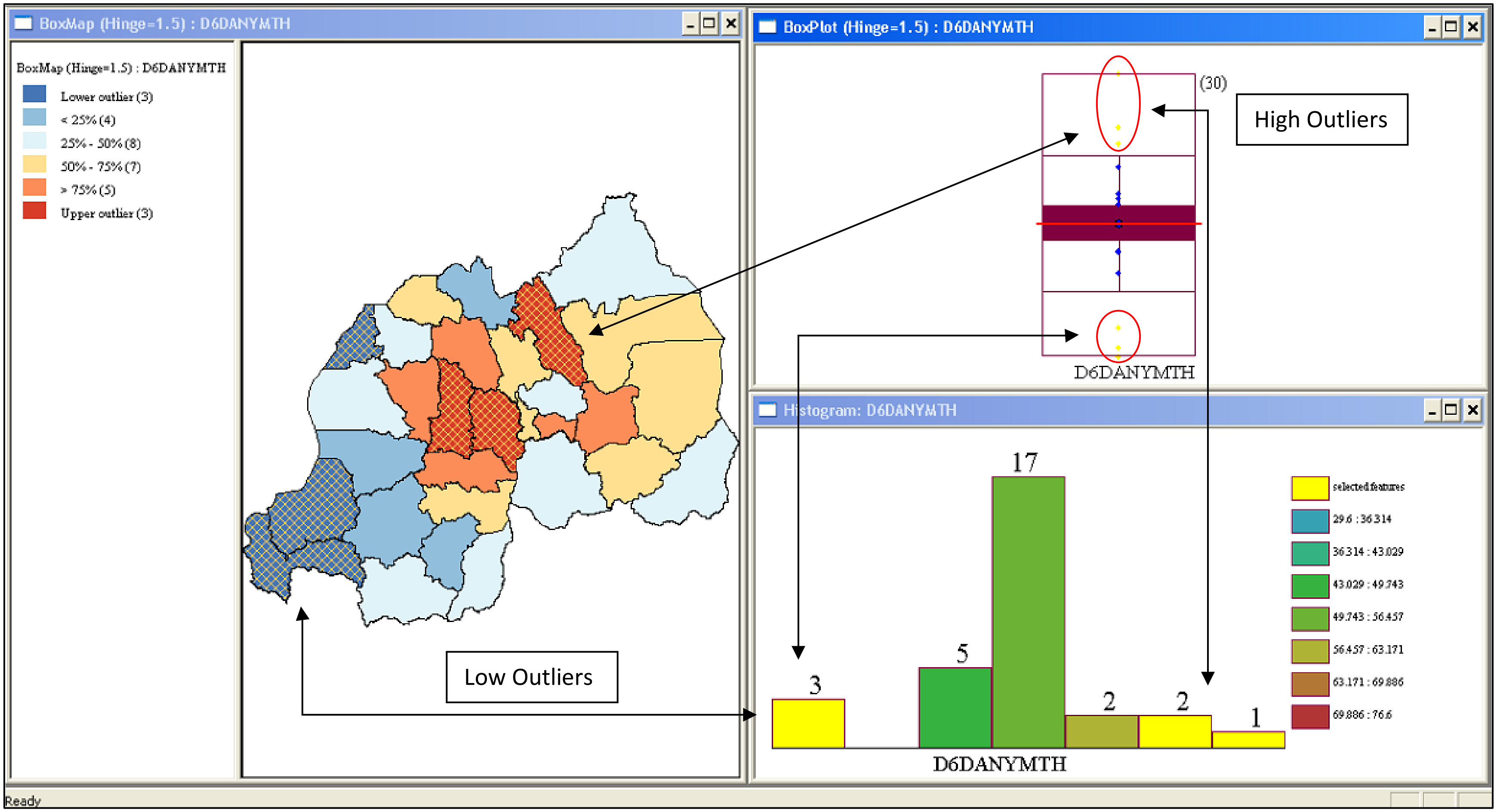
GeoDa is a free and open source software tool for exploratory spatial data analysis (ESDA). The program provides an easy-to-use interface for exploring the spatial variations that exist in either single variables or combinations of variables for a given geographic area. The ability to see multiple, linked views of the data is especially valuable for exploratory spatial analysis of multi-sectoral information. The linked views allow features selected and highlighted in one view, such as outliers selected in a box plot view, to be selected and highlighted automatically in other views, such as a map or histogram view (see Figure 4).

In order to use GeoDa, the geographic data to be explored must be stored as attributes in a common geographic file format known as a shapefile[1] Attribute data stored in database format, such as FP/RH indicators in an Access database or Excel spreadsheet, can be joined to a shapefile containing administrative divisions or health facilities using common geographic identifiers (e.g., district or province names or codes) as the link.

For GeoDa documentation and tutorials, or to download this free and open source software program, see http://geodacenter.asu.edu.

[1] A shapefile is one of the most common formats of geospatial data available, and can be used in most GIS software programs. A shapefile is actually a group of files stored together to make a whole. It consists, at a minimum, of three files that use the following extensions: .shp, which describes the points, lines, and polygons that form the geographic features of interest, .dbf, which contains the attribute data for the geographic features; and .shx, which contains an index. Other shapefile components might have the extensions .prj, .xml, .sbn, and .sbx.

Figure 4: GeoDa Linked Data Views for Rwanda by District:
Outliers for Percent Married Women Age 15-49 using Any Method of Contraception



Data Source: DHS 2010, Table D.32

Examples of GIS linking and analysis based on data for Rwanda

Introduction

The purpose of this section is to illustrate how the recommended GIS tools and methods can be used to link FP/RH data to other data sources and to map and analyze the results. The examples given in this document are organized in relation to questions of a geographic nature that might typically be asked by FP/RH researchers. Although the examples are specific to Rwanda, the concepts are applicable to other countries.

The dataset that provides the base map of administrative division boundaries and facility locations used in this section is the health facility geodatabase from the MOH (see www.moh.gov.rw/). The examples provided would not be possible without this base map.

The FP/RH and related data presented in the maps are derived from public sources that are available in other countries, primarily the DHS. This was a conscious decision in order to make the Rwanda examples applicable to as many countries as possible. The one notable exception is the example based on data extracted from the Supply Chain Manager (SCM[2]) system maintained by the USAID | DELIVER PROJECT. The USAID | DELIVER PROJECT should be considered a willing partner to share FP commodities data with the MOH.

Linking FP/RH and HIV Data using the E2G Tool

Family Planning and HIV data for Rwanda are available down to the district level in the DHS 2010 final report. After establishing a link between the district names contained in the DHS report and the district names contained in the map file for administrative divisions provided by the MOH, single indicators at the district level for both the FP and HIV sectors can be linked and mapped using the E2G tool.

With respect to contraception use data that can be mapped using the E2G tool, the DHS 2010 provides Table D.32, Current Use of Contraception, which shows the "Percent distribution of currently married women age 15-49 by contraceptive method currently used, by district, Rwanda 2010." The DHS report also provides Table D.91, HIV Prevalence, which shows "Percentage HIV positive among women and men age 15-49 who were tested, by district, Rwanda 2010." These tables require a fair amount of time and effort to digest, and are therefore lacking as presentation tools. Also, based on the tables alone, it is difficult to see, analyze, and understand the relationship between contraception use and HIV prevalence at the district level in Rwanda. Some quick maps, however, such as basic thematic maps created with the E2G tool, can help researchers better accomplish these tasks.

Contraception Use

Generally speaking, a little more than half of married women of reproductive age in Rwanda are using a method of contraception. Figure 5 seeks to understand that distribution in a little more detail, using the

[2] In Rwanda, FP/RH commodities are tracked by the USAID | DELIVER PROJECT along with other commodities using a database known generically as the Supply Chain Manager (SCM), whereas the USAID Supply Chain Management System (SCMS) project focuses on providing "a reliable, cost-effective and secure supply of products for HIV/AIDS programs in PEPFAR-supported countries." Source: http://scms.pfscm.org/scms/about, December 2011.

E2G tool to group the data into five data classes based on *equal intervals*. Using equal intervals to map the data is the spatial equivalent of using a histogram to see whether there is a normal distribution of values, i.e., whether there is a bell-shaped curve with no gaps or skews in the data values. If the data are normally distributed, the map will classify the majority of geographic entities into the middle classes. The resulting map shows that the highest percentages of women using any method of contraception are located near the center of the country, and the lowest are in the west and southwest.

Figure 5: Single Indicator (Contraception) Map Created Using the E2G Tool

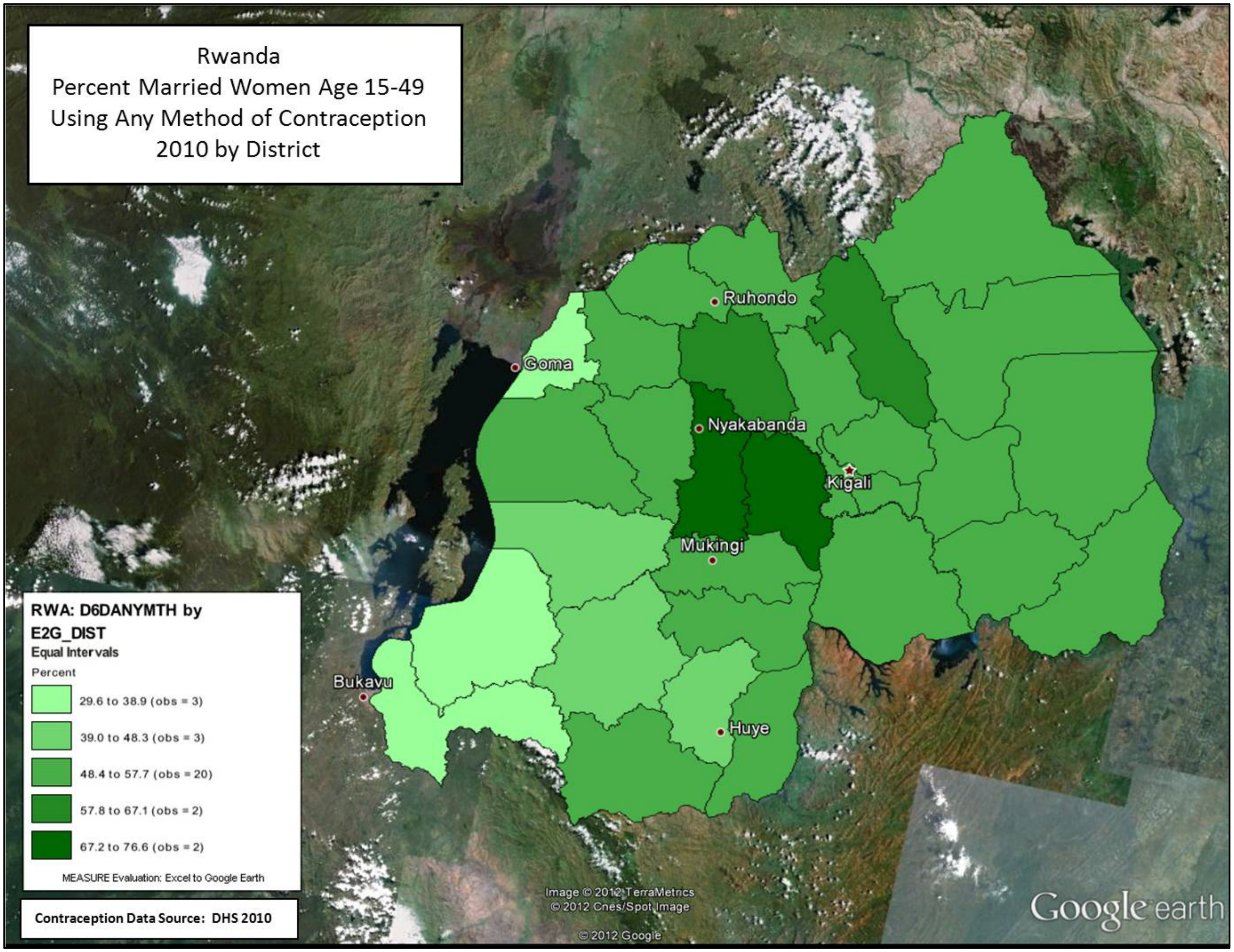
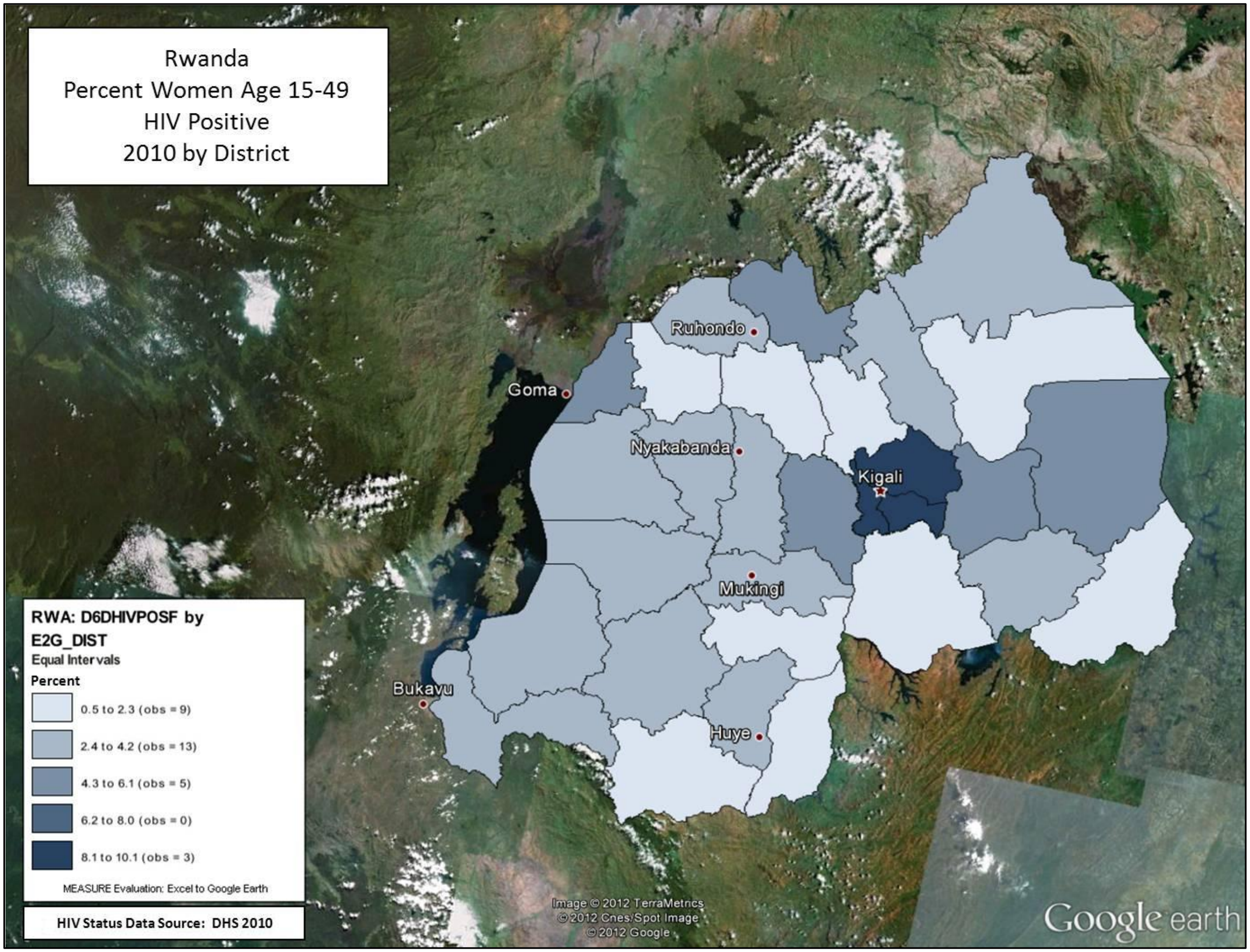


Figure 6: Single Indicator (HIV) Map Created With E2G Tool



HIV Prevalence

Figure 6 examines another DHS variable, HIV prevalence among women of reproductive age. This map shows a strong rural/urban influence, with urban districts in the Kigali showing highest incidence, and rural outlying districts showing lowest.

Comparing the Two

Though each of these maps is univariate, the comparison of them provides a visual analysis of multivariate, multi-sectoral information. What is notable about viewing the two maps side by side is that there is no spatial overlap between the districts that exhibit the highest percent of women using contraception and the three districts in the City of Kigali where the highest HIV prevalence is observed. Also, the districts with the lowest level of contraception use do not appear to coincide with either a lower or higher HIV prevalence. The side-by-side comparison of these maps illustrates that among women of reproductive age in Rwanda there is no discernible correlation between the general use of contraception, which includes both traditional and modern methods, and HIV prevalence.

The E2G tool provides a basic level of spatial data exploration capability for people who are not GIS specialists. When unexpected patterns emerge or gaps exist in program data, E2G maps can readily show them. The E2G tool can also be useful for data quality checks and data reporting, which are essential GIS needs of FP/RH programs.

Linking Multi-Sectoral Data using QGIS

Linking Contraception Use and HIV Prevalence

QGIS offers significant GIS functionality: it can be used to link data based on common geographic identifiers, conduct advanced data visualization and analysis tasks, and create publication-quality maps. Unlike the E2G tool, it can be used to display multiple variables on a single map. As a result, it can serve as a key tool for linking FP/RH program data with data from other sectors, and for mapping and analyzing the results.

Figure 7, for example, shows a district-level QGIS map for Rwanda that presents contraception use as a choropleth (color-shaded) layer of information with HIV prevalence superimposed as a graduated symbol. Note that the size of the symbols is related to the percent of women of reproductive age who are HIV positive, with larger symbols representing higher HIV prevalence. There are three symbols based on the selection of three equal intervals for classifying the data.

The FP and HIV data layers shown in Figure 7 are derived from the same DHS 2010 tables used to create the E2G maps presented in the previous section. This time, however, the link between the DHS data and the MOH district-level administrative units was based on common administrative codes rather than names (see column MOH_CODE in Table 1), as the district names in the DHS report and the district names in the MOH database do not use a consistent spelling (one set of names uses all capital letters, whereas the other set of names uses just initial capital letters). Because of the many spelling inconsistencies that can exist between different sets of geographic identifiers, linking data sets based on common codes is generally much easier.

Figure 7 suggests a weak but positive relationship between general contraception use and HIV prevalence in the three high outlier districts in relation to contraception use. This might be the result of increased FP/RH program activity in response to the level of HIV found in those districts. The map also suggests that contraception use has not yet caught up with the spike in HIV prevalence that exists in the City of Kigali, and that contraception uptake lags relatively far behind HIV prevalence in the low contraception outlier district in the northwestern corner of the West province.

Reversing the positions of variables being mapped can provide fresh insights into program data. Figure 8, for example, shows contraception use by method as a pie chart superimposed on HIV prevalence as a choropleth base layer. The map indicates that there is no method of FP practiced by a large percentage of the women of reproductive age in most of the districts in Rwanda, although the lack of FP uptake is generally lowest in the districts of the West province. The map also shows that HIV prevalence is unusually high in the City of Kigali, even though the percentage of women of reproductive age who are using modern contraception methods in Kigali is fairly similar to that of other districts with lower HIV prevalence.

Figure 9 illustrates how QGIS can be used to zoom in to a smaller geographic area, in this case the City of Kigali, to show a more detailed level of linked FP and HIV data. The additional detail on the use of modern contraception methods that is available in the map shows the preference of women of reproductive age for injectables as their primary method of contraception, followed by the pill. Implants and the male condom appear to be next in importance.

With respect to the relationship between contraception use and HIV prevalence, Figure 9 indicates that there is a generally low use of male condoms, despite their prophylactic benefits. Interestingly, the district that exhibits the highest HIV prevalence, Kicukiro, also has the highest proportion of women in the City of Kigali who are using a traditional method of contraception.

Figure 7: QGIS, Standardized Contraceptive Prevalence versus HIV Prevalence, Rwanda by District in 2010

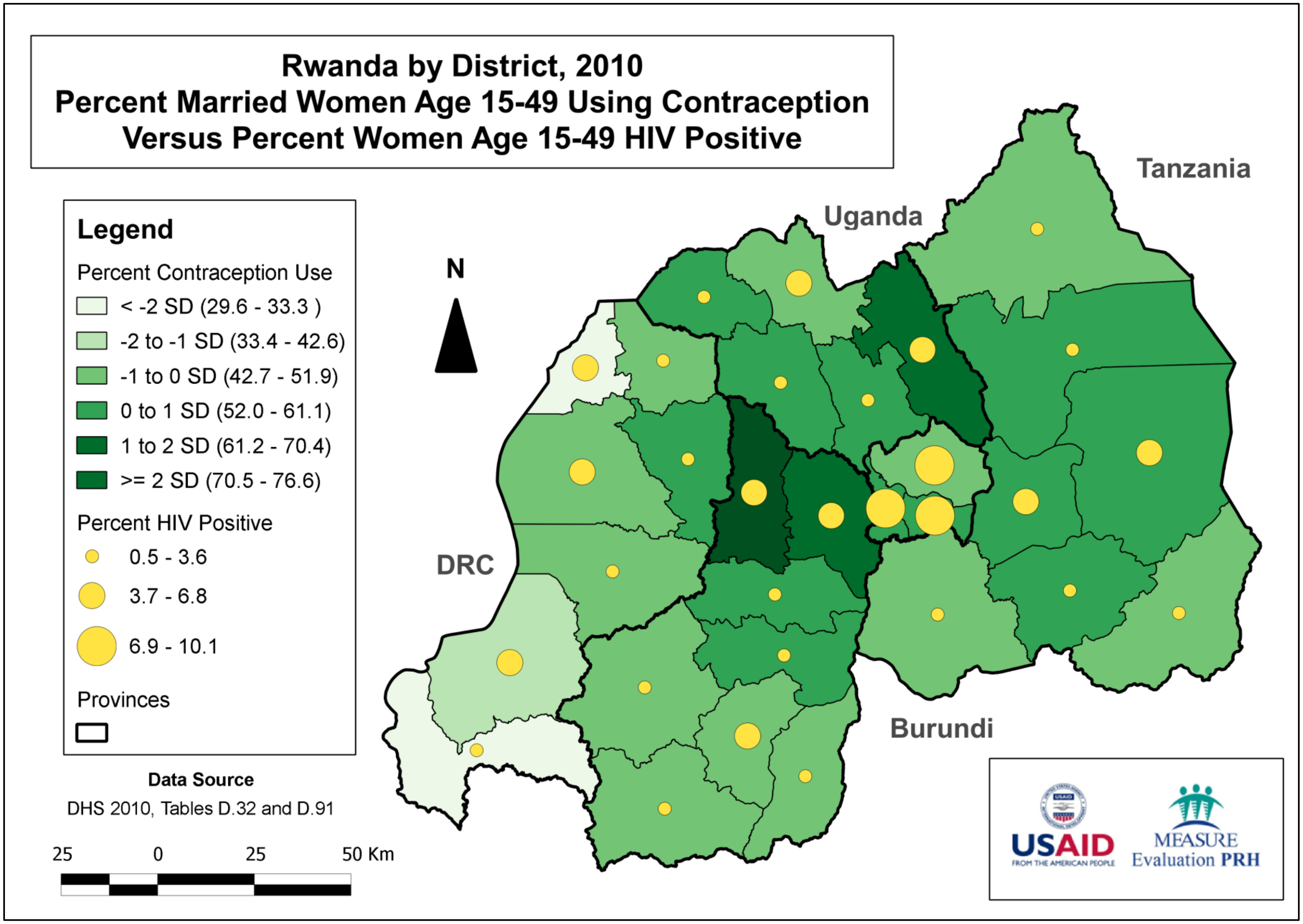


Figure 8: QGIS, Pie Chart of Contraception Use by Method versus HIV Prevalence, Rwanda by District in 2010

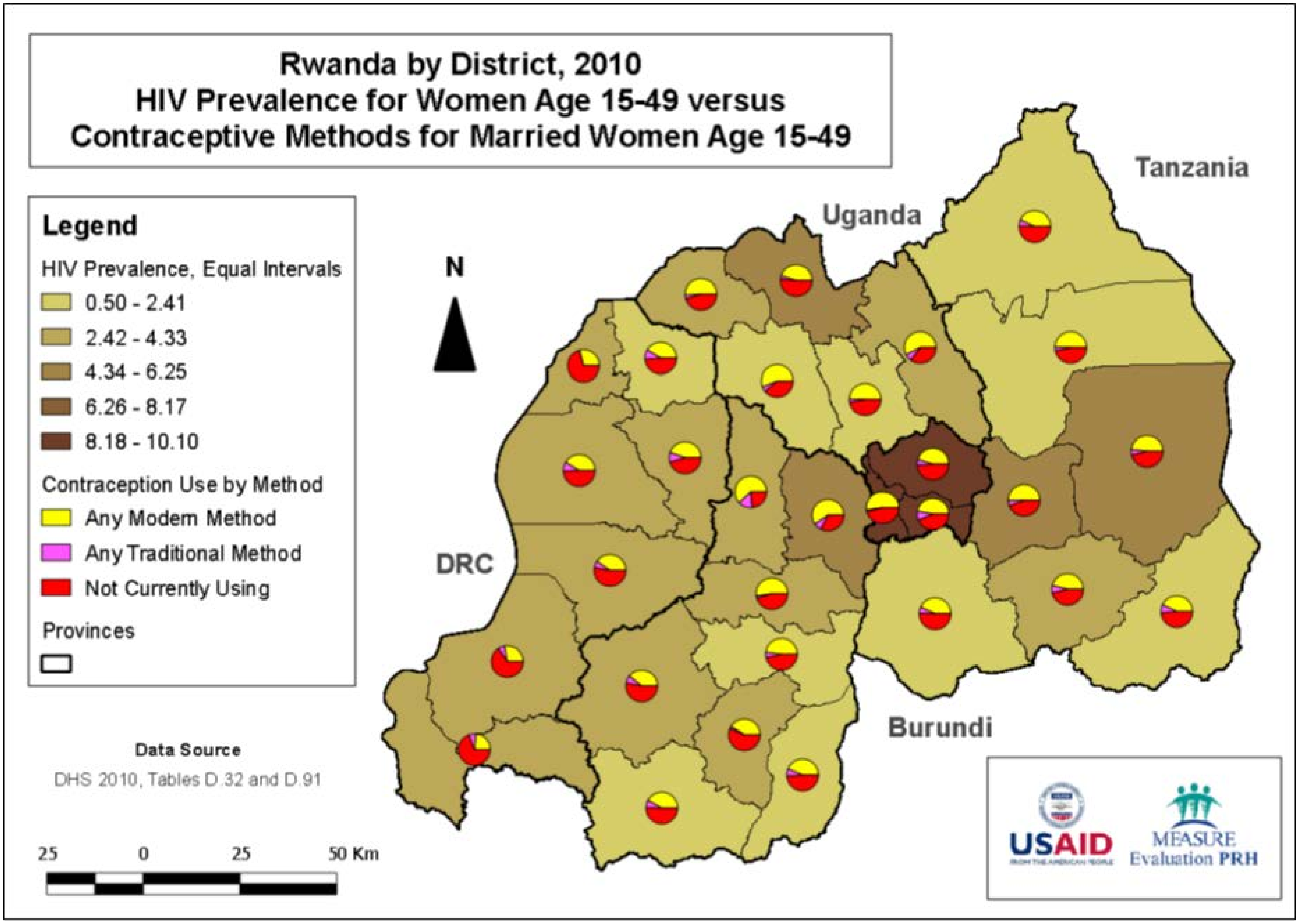
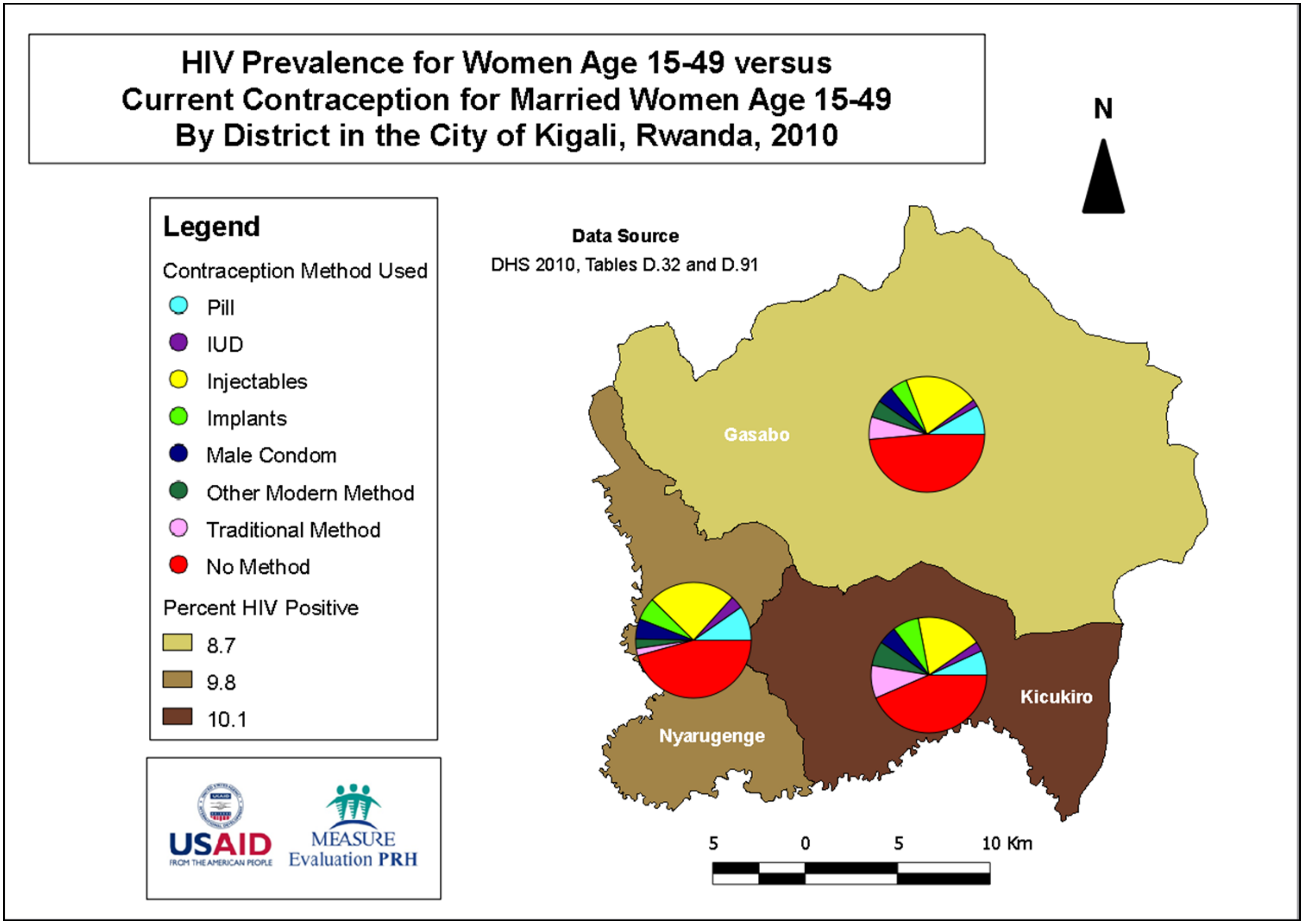


Figure 9: QGIS, Pie Chart of Contraception Use by Method versus HIV Prevalence, City of Kigali by District in 2010



Linking FP, Education, and Poverty Data

The intent of the Figure 10 is to help understand the relationship between unmet need for FP, education, and poverty in Rwanda. The map shown in Figure 10 is the result of integrating FP and education data from the DHS 2010 with poverty data from "The Evolution of Poverty in Rwanda from 2000 to 2011: Results from the Household Surveys (EICV)" (NISR, February 2012). According to the DHS, unmet need for family planning is defined as the percentage of married women who want to space their next birth or stop childbearing entirely but who are not currently using contraception. In Rwanda, unmet need is accepted to be highest among women who are the poorest and least educated.

Figure 10 shows that women in the City of Kigali are generally more educated than elsewhere in Rwanda, that the women there experience a relatively low level of poverty, and that they have a relatively low unmet need for FP. Conversely, women in the outer, "corner" districts of Rwanda (top and bottom of the East and West provinces) have a lower level of education, higher level of poverty, and a much higher unmet need for FP. These outer districts warrant closer scrutiny to understand the underlying causes of the spatial pattern observed. A simple way to read Figure 10 at a glance is that the larger red and orange circles identify the areas most in need of intervention.

Linking FP, Nutrition, and Food Insecurity Data

The decision to use family planning methods is made in the context of the environment in which people live. That environment includes not only cultural and societal norms, but also the context of other demands of time and attention in a person's life. To that end, contextual data such as food security can be valuable in not only understanding family planning choices made, but can potentially assist with integration of programs. For instance, interventions could be designed which not only address food insecurity issues, but at the same time address family planning use.

Figure 11 integrates DHS 2010 data for unmet need for FP (Table D.33) with that on the nutritional status of women (Table D.60) and the level of food insecurity from the National Agricultural Survey 2008 (Table A 4.7.5a). Since all of the data were at the district level, it was a simple matter to link the three sets of data using district names.

Figure 11 suggests that there is not a strong association between unmet need for FP and either the nutritional status of women or food insecurity. The map generally shows a convergence of low unmet need for FP and low food insecurity in the center of the country, but with two exceptions:

1. The district of Nyarugenge, which forms the western third of the City of Kigali. This district exhibits a high level of food insecurity against a backdrop of relatively low unmet need for FP.
2. The district of Kamonyi, which lies just to the west of Nyarugenge. This district also has a relatively low unmet need for FP, but exhibits a fairly high level of food insecurity as well as the highest percentage in the country of women with low nutrition.

Overall, the map indicates that low nutrition and food insecurity are more prevalent in the southern districts of Rwanda, irrespective of the unmet need for FP, and that unmet need for FP is highest in the outlying, "corner" districts, which are located at the top and bottom of the East and West provinces.

Linking FP/RH Data from the DHS 2010 and the USAID | DELIVER PROJECT

Example 1: Women using Any Modern Method of Contraception versus Couple Years of Protection

Figure 14 provides an example of how FP commodities data from the USAID | DELIVER PROJECT can be integrated with existing datasets at the district level, which will complement analyses at the national or provincial level. Integrating FP commodities data from the USAID | DELIVER PROJECT represents a significant data linking opportunity for many FP/RH programs, and relies on the same data linking principles used in the previous sections. As a result, this example can be used as a model for integrating USAID | DELIVER PROJECT data into an existing HMIS.

To effect a link between the DHS 2010 and the SCM database maintained by the USAID | DELIVER PROJECT was a relatively straightforward matter based on matching district-level geographic identifiers. After locating the common geographic identifiers needed for data linking, the FP commodities data in the SCM were summarized by district as couple years of protection (CYP). CYP is the quantity of a given FP commodity (e.g., male condoms) multiplied by a conversion factor to estimate the length of time a couple will be protected by the contraception method chosen. CYP can generally be calculated fairly easily using routinely collected data. For more information on CYP, see the USAID site at http://transition.usaid.gov/our_work/global_health/pop/techareas/cyp.html or the MEASURE Evaluation site at http://www.cpc.unc.edu/measure/prh/rh_indicators/specific/fp/cyp.

It should be noted that CYP is a simple indicator that describes the volume of FP commodities distribution for a given geographic area. As a simple sum of estimated contraceptive method durations, it does not take into account the size of the underlying population and is therefore unsuitable for choropleth (color-shaded areas) mapping. To be able to use a choropleth map to compare CYP and DHS indicators by district, it was first necessary to normalize the calculations based on the proportion of the district populations that corresponded to women of reproductive age. For consistency with DHS indicators, CYP were normalized by the district-level population totals derived from the DHS 2010 sample frame (see Table A.1 of the DHS 2010).

Normalizing CYP for Rwanda

District-level CYP values were calculated based on the quantities of FP commodities reported to the USAID | DELIVER PROJECT by public sector health facilities as being dispensed in calendar year 2010. Public sector health facilities account for about 90 percent of FP commodities distribution in Rwanda. Based on a health facility reporting rate of around 95 percent, the USAID | DELIVER PROJECT was able to impute missing values and adjust the quantities dispensed to reflect a 100 percent reporting rate.

Quantities of FP commodities dispensed were converted to CYP using conversion factors obtained from USAID in September 2011 (see Appendix B).

To normalize the district-level CYP values for mapping and analysis, the raw CYP calculations were divided by the estimated population of women of reproductive age by district. The estimated population of women of reproductive age by district was calculated using total district population data from Table A.1 of the DHS 2010, which was derived from the preparatory frame for the 2012 census, in combination with the percent of the female population in that age group from Table 2.1 of the DHS 2010, which shows household population by age, sex, and residence.

Based on Table 2.1 of the DHS 2010, it was estimated that women of reproductive age constituted 27.8 percent of the population living in the three districts of the City of Kigali, and comprised 24.4 percent of the population in all other districts. The estimates were based on classifying the districts in the City of Kigali as urban and those in the rest of the country as rural.

CAUTION: Normalized CYP values are significantly influenced by the size of the population used for the denominator when normalizing, as a larger denominator will return a lower normalized CYP and a smaller denominator will return a higher one. As stated in the DHS 2010, the source of the district-level population data in Table A.1 is the preparatory frame for the 2012 census. The total population shown in Table A.1 is 9,057,170. As acknowledged in the DHS 2010, these data reflect an under-estimation in comparison to the Rwanda National Population Projection 2007-2022 (see http://statistics.gov.rw/publications/national-population-projection-2007-2022), which estimates the population of Rwanda in 2010 for the medium growth scenario to be 10,412,820. A third population data source is LandScan (see http://www.ornl.gov/sci/landscan/), which provides a 2010 population estimate for Rwanda of 11,115,454.

To illustrate the sensitivity of normalized CYP values to the size of the population, below are three different CYP calculations. They have been derived using the same numerator, the total 2010 CYP for FP commodities tracked in the USAID | DELIVER PROJECT's SCM database, versus the estimated number of women of reproductive age extracted from the three different population data sources referenced above.

- Total 2010 CYP / (DHS 2010 estimated population * 0.248[3]) = 589,759/(9,057,170 * 0.248) = 0.263
- Total 2010 CYP / (NISR 2010 population projection * 0.248) = 589,759/(10,412,820 * 0.248) = 0.228
- Total 2010 CYP / (LandScan 2010 est. population * 0.248) = 589,759/(11,115,454 * 0.248) = 0.214

For a comparison of district-level estimated populations of women of reproductive age derived from the DHS 2010 and LandScan 2010, see Figure 12. For a comparison of CYP for 2010 normalized by population data from these two sources, see Figure 13.

[3] Based on Table 2.1 of the 2010 Rwanda DHS, women of reproductive age represented 24.8 percent of the DHS sample frame.

The end result of normalizing CYP calculations using district-level population figures from the DHS 2010 sample frame, which are probably under-estimated, is that the CYP values will probably be over-estimated. This should be taken into account when interpreting normalized CYP, especially when attempting to draw conclusions about the normalized CYP value for an individual district. Nonetheless, if the population data used for normalizing the CYP calculations are reasonably accurate, normalized CYP will provide an indicator of FP commodities coverage that can be compared more readily than raw CYP values across geographic areas that have different sizes and populations.

Interpreting Figure 14

Prior to reviewing Figure 14, one would expect to see a map that shows a relatively low volume of FP commodities distribution in areas where there is little demand for modern methods of contraception, and a relatively large volume of distribution where there is a high demand. For Rwanda in the year 2010, however, such an orderly association of FP commodity distribution and use does not appear to exist throughout the country. Although Figure 14 shows a fairly stable, positive relationship between the two indicators, there are some inconsistencies.

The most notable inconsistency appears to be in the district of Nyarugenge, which is within the City of Kigali. Athough the normalized CYP value indicates that the volume of FP commodities distribution per woman of reproductive age is highest in Nyarugenge, this district is not in the highest category with respect to the percent of married women using any modern method of contraception. This could be the result of a higher demand for modern contraception among non-married women in the City of Kigali, especially since the DHS 2010 reports Nyarugenge as having the lowest district-level percentage of women of reproductive age who are in a union (either married or living together), which for 2010 ranged from 44.8 to 62.4 percent.

Another potential reason for the higher than expected normalized CYP value in Nyarugenge might be that the district's central location and more advanced health services infrastructure are attracting a significant number of FP commodity users from other districts. If this were the case, the quantities of FP commodities dispensed would be higher than expected in relation to the size of the district's population. This hypothesis is potentially reinforced by the relatively low normalized CYP values observed in the two neighboring districts within the City of Kigali, Gasabo and Kicukiro.

A third explanation for the occurrence of the highest normalized CYP value in the district of Nyarugenge might be that the district population used for the DHS 2010 sample frame was significantly under-estimated. Although not definitive, Figure 12 suggests that this might be the case.

According to Figure 12, the district populations could also be significantly under-estimated for some of the other districts, such as Gicumbi, Ngoma, Burera, and Rusizi, which would lead to an over-estimation of normalized CYP. Figure 13 supports this idea. If true, this would be of most concern for the district of Rusizi, which already exhibits the lowest normalized CYP value for the country.

Beyond the potential issues already discussed, Figure 14 suggests there might also be a lack of correlation between the two mapped indicators in the districts of Rulindo, Nyabihu, and Rubavu. Figure 12 suggests that the population of Rulindo and Nyabihu might be under-estimated, which would lead to over-estimated normalized CYP values. This would be of most concern for Nyabihu, which already shows a relatively low volume of FP commodities distribution. Interestingly, the population of Rubavu from the DHS 2010 sample frame is potentially over-estimated, which means the true normalized CYP value for that district might actually be even larger than what is symbolized on the map. As a result, Rubavu stands out as a district that warrants further investigation to understand why the volume of modern contraception commodities dispensed is so high in relation to the percent of married women who are using modern contraception.

Although Figure 14 does not explain the observed spatial relationship between the two indicators that have been mapped, it does assist decision makers in developing hypotheses to explain the relationship. Such hypotheses can help guide programmatic decision making.

Example 2: Women Desiring to Limit Childbearing versus Couple Years of Protection

Figure 15 provides a second example of how FP/RH data from the DHS can be integrated with CYP data calculated using FP commodities data from the USAID | DELIVER PROJECT. The map shown in Figure 15 suggests that there is a generally stable and positive relationship between the desire to limit childbearing and the quantities of FP commodities dispensed by public sector health facilities that report to the USAID | DELIVER PROJECT. Similarly to the first example, however, there are some districts in which this stable, positive relationship is not readily apparent.

For instance, just as with example 1, the normalized CYP value for the district of Nyarugenge appears to be much larger than expected in relation to the DHS indicator. Likewise, the normalized CYP values for the other two districts in the City of Kigali appear to be relatively low by comparison. Rulindo and Rubavu also appear to have anomalous values for normalized CYP. Although the normalized CYP value for Rulindo could simply be an over-estimation based on the district population, the normalized CYP value for Rubavu is most likely under-estimated. This once again draws particular attention to Nyarugenge and Rubavu as requiring further investigation to understand the observed pattern.

The handful of potential discrepancies identified between the DHS indicators and normalized CYP values shown in Figures 14 and 15 provide the impetus for further investigation of the underlying data sets. Such an investigation can lead to the identification and resolution of data quality issues and/or a better understanding of the source data. The end result would be a more solid foundation for evidence-based decision making.

Linking FP/RH and PBF Data

Multi-sectoral data are available for Rwanda and many other countries from the performance-based finance (PBF) system, which is designed to provide a financial incentive to improving the quality of a country's health services[4]. PBF data can be integrated with FP/RH data from a variety of sources, including the SCM database maintained by the USAID | DELIVER PROJECT, based on common geographic identifiers. For Rwanda, PBF and SCM data can be linked and mapped at the facility, sector, district, or province levels.

[4] For more information on the PBF system, see http://www.msh.org/Documents/upload/AS-Two-handbook.pdf.

Figure 10: Integrating FP, Education, and Poverty Data

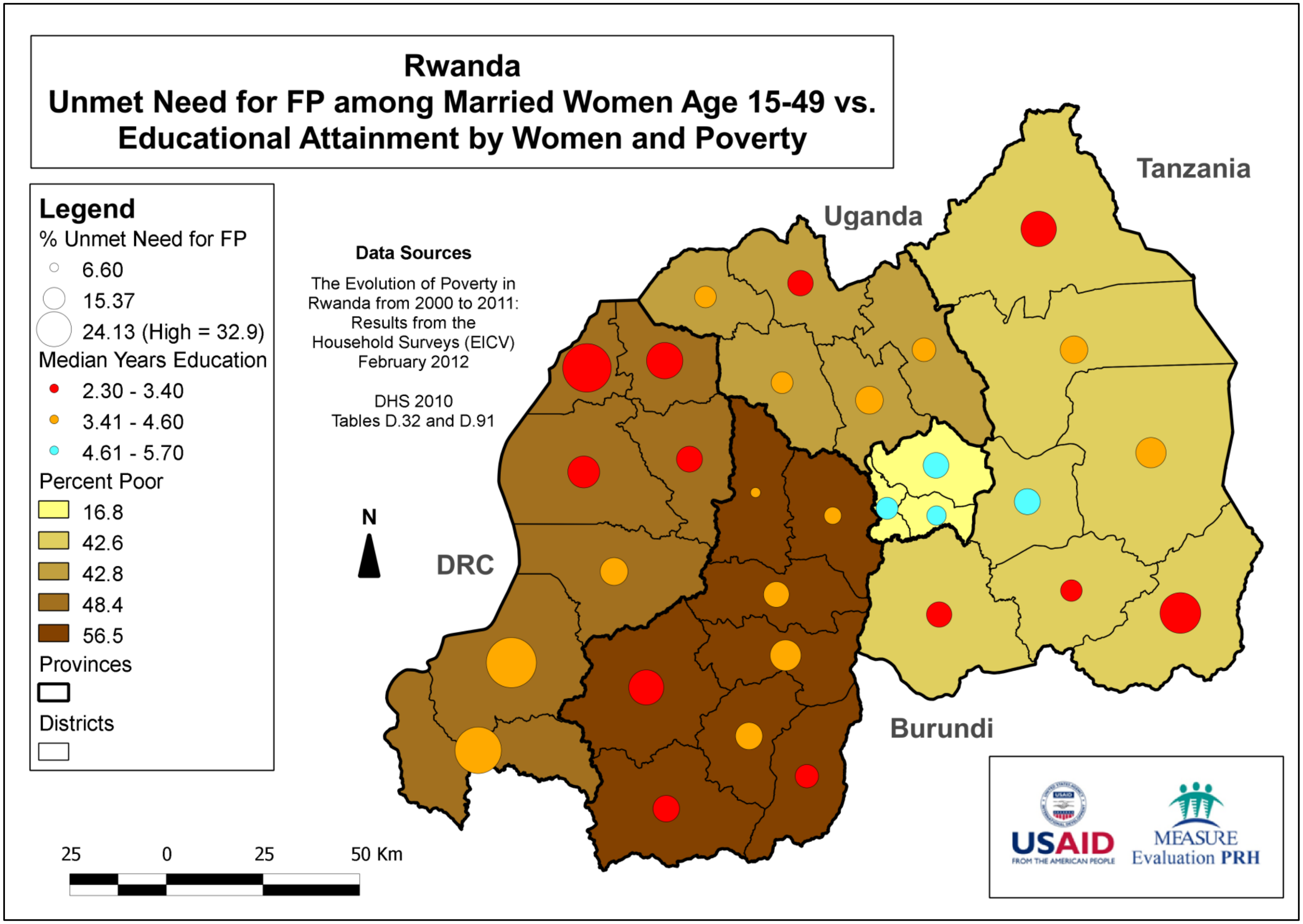


Figure 11: Integrating FP, Nutrition, and Food Insecurity Data

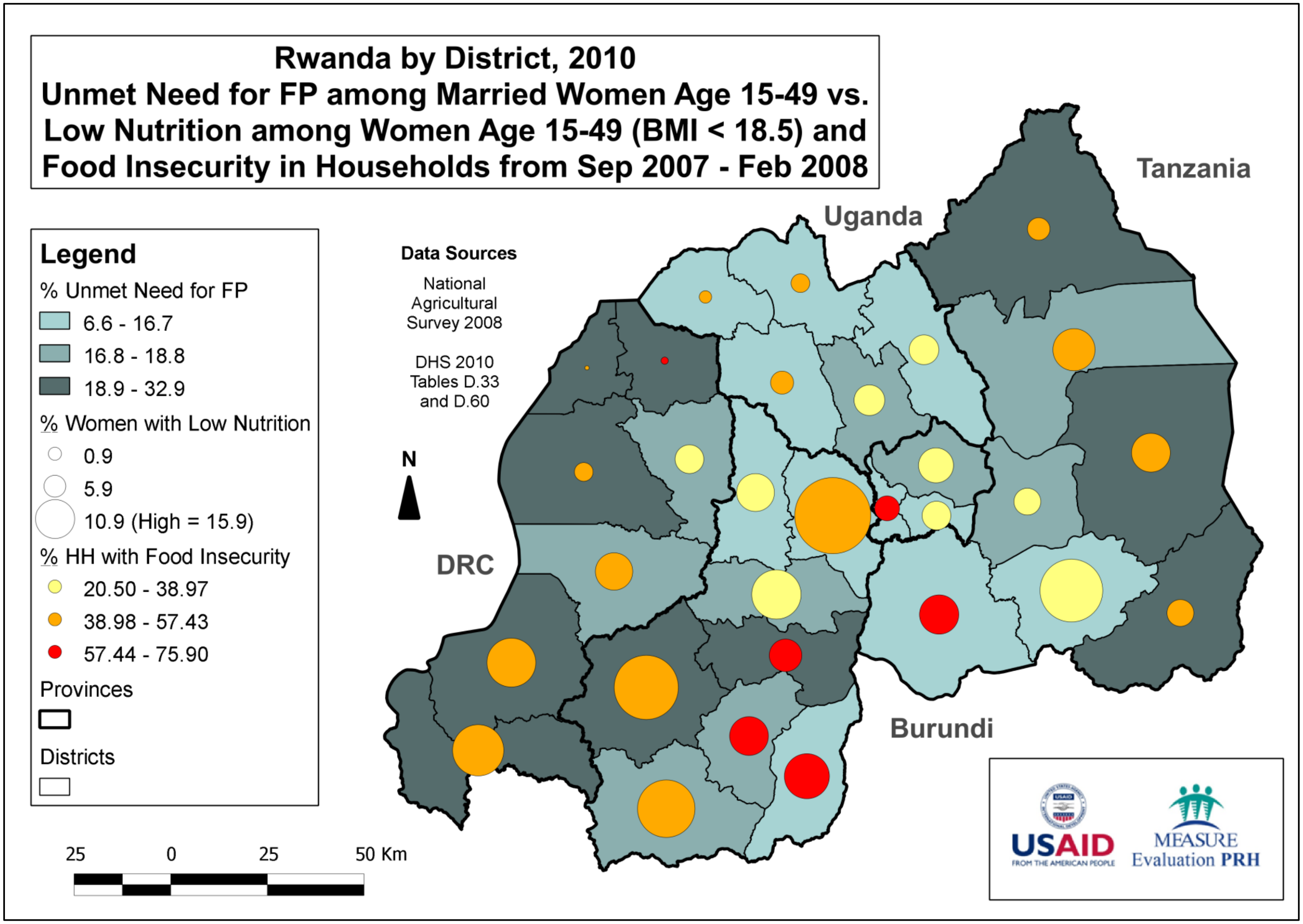


Figure 12: Comparison of 2010 District-Level Population Data Sources for Rwanda

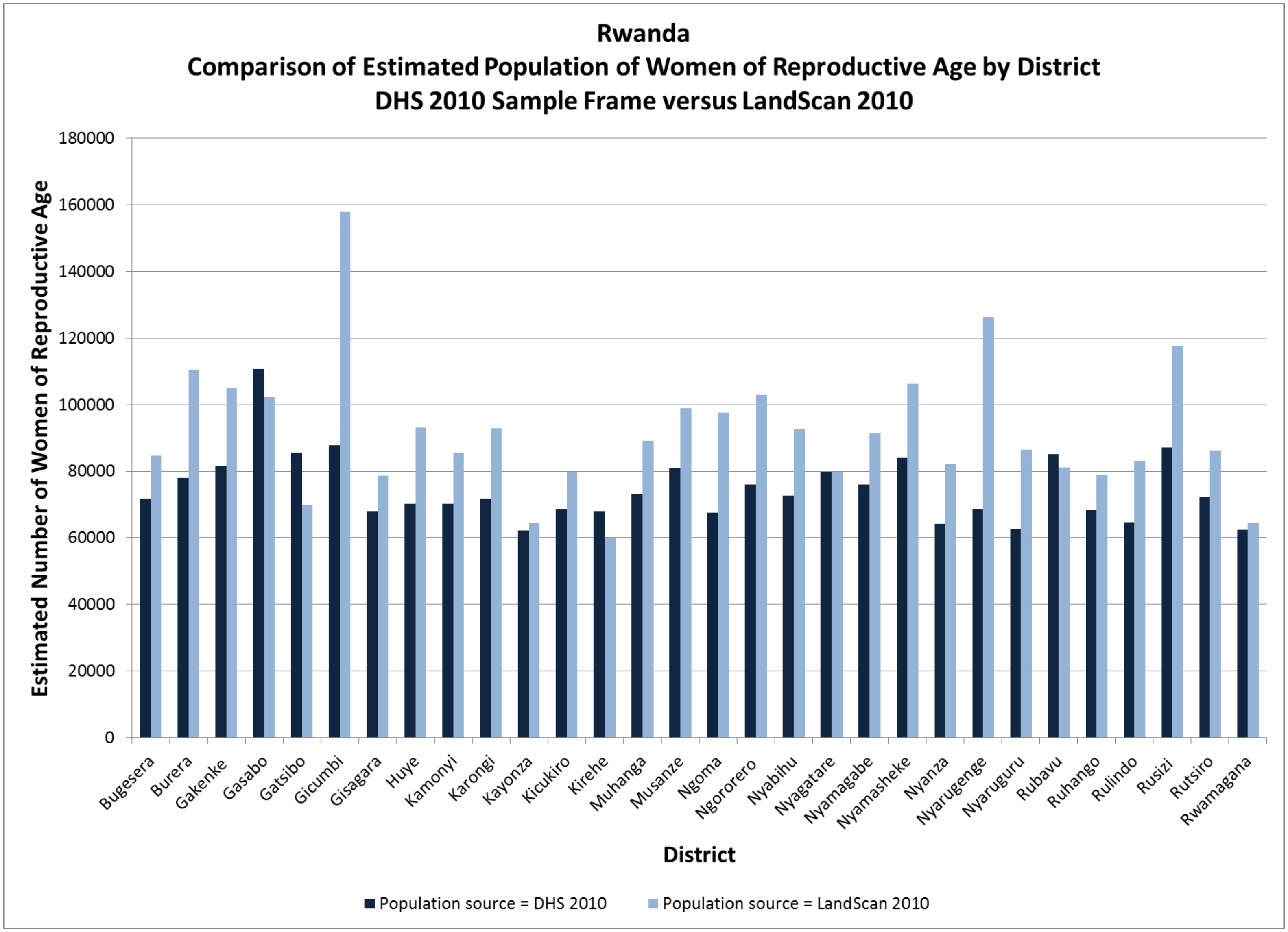


Figure 13: Comparison of Normalized CYP for 2010 using Different Population Data Sources

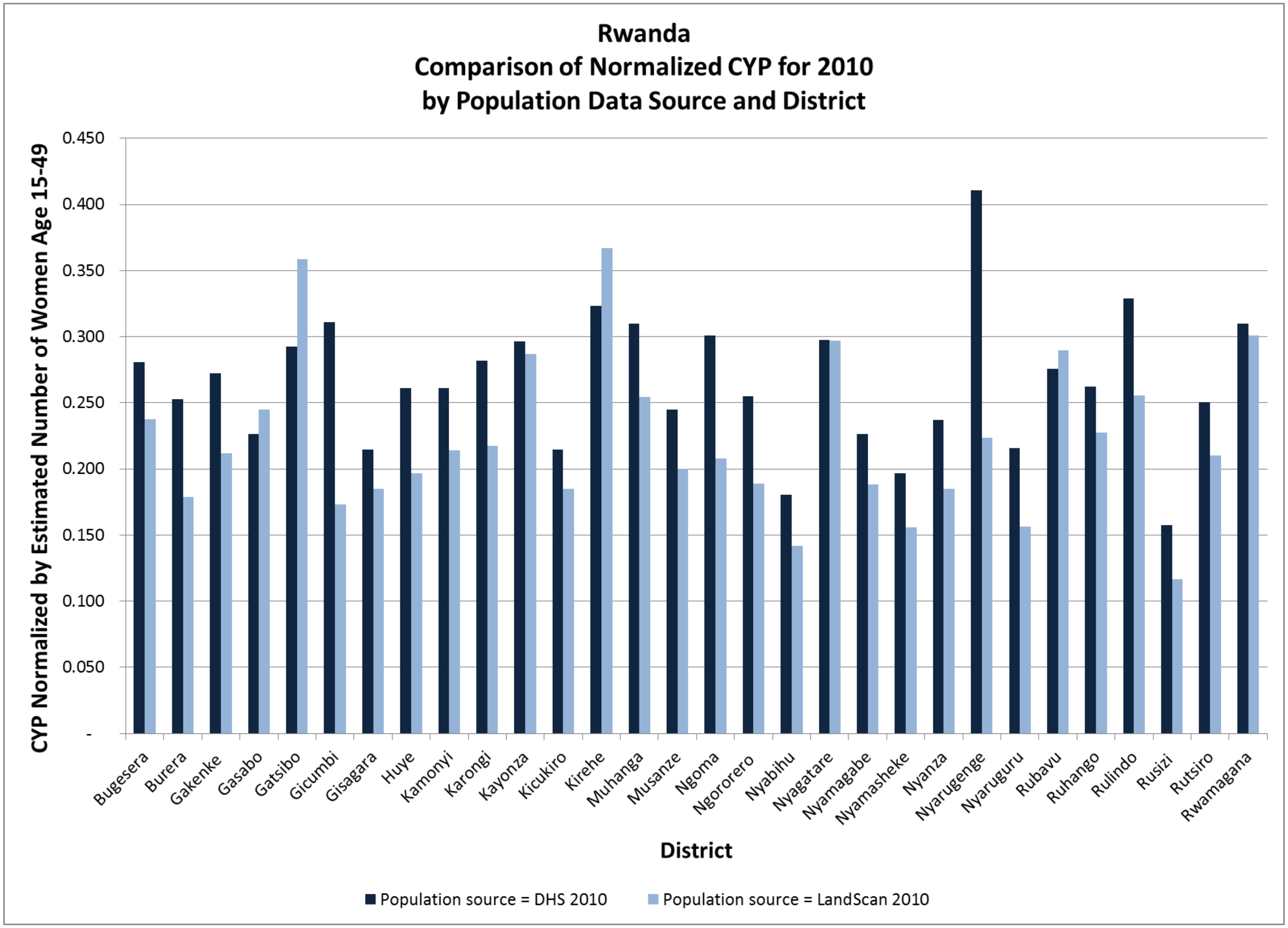


Figure 14: Integrating FP/RH Data from the DHS 2010 and the USAID | DELIVER PROJECT, Example 1

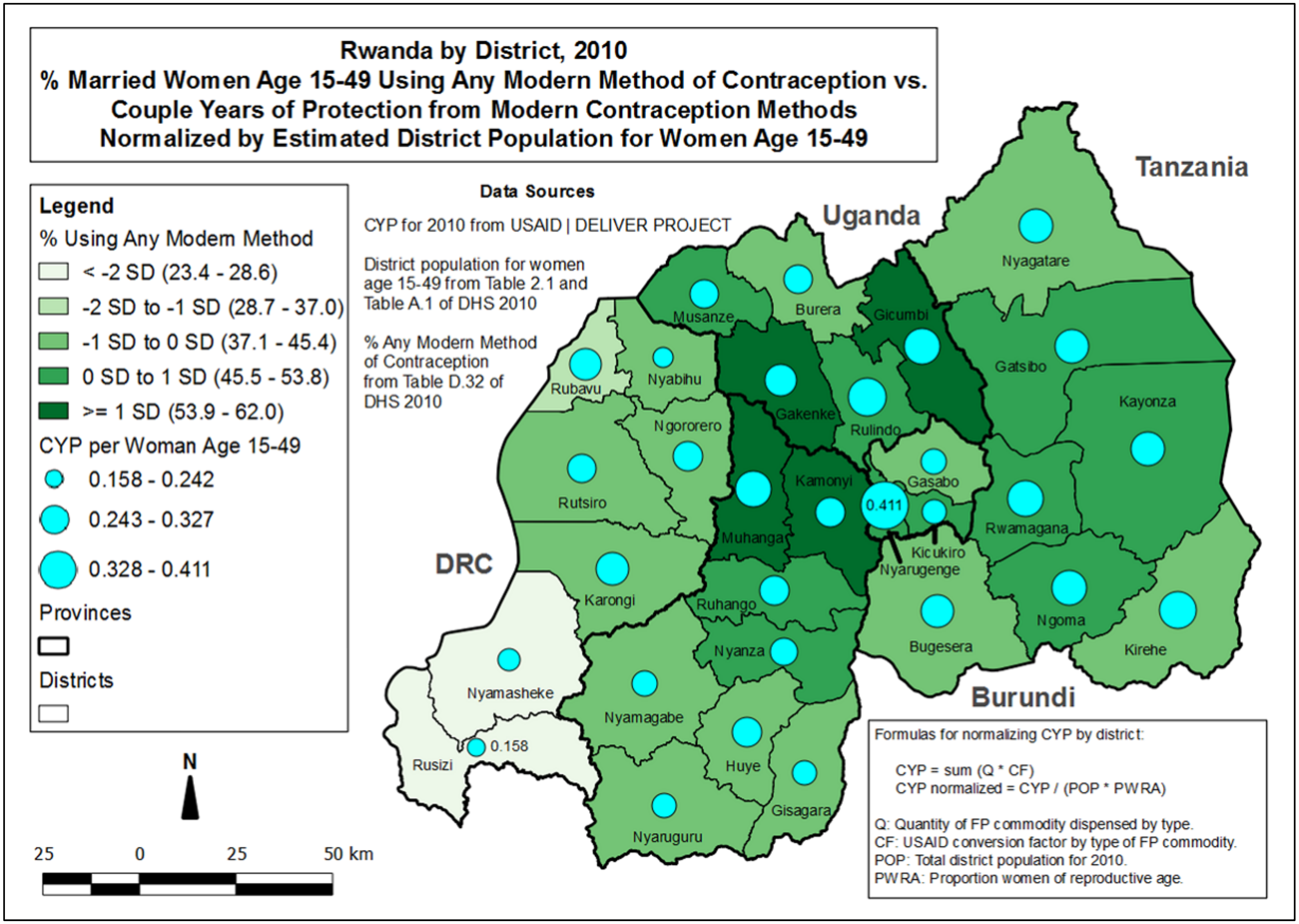
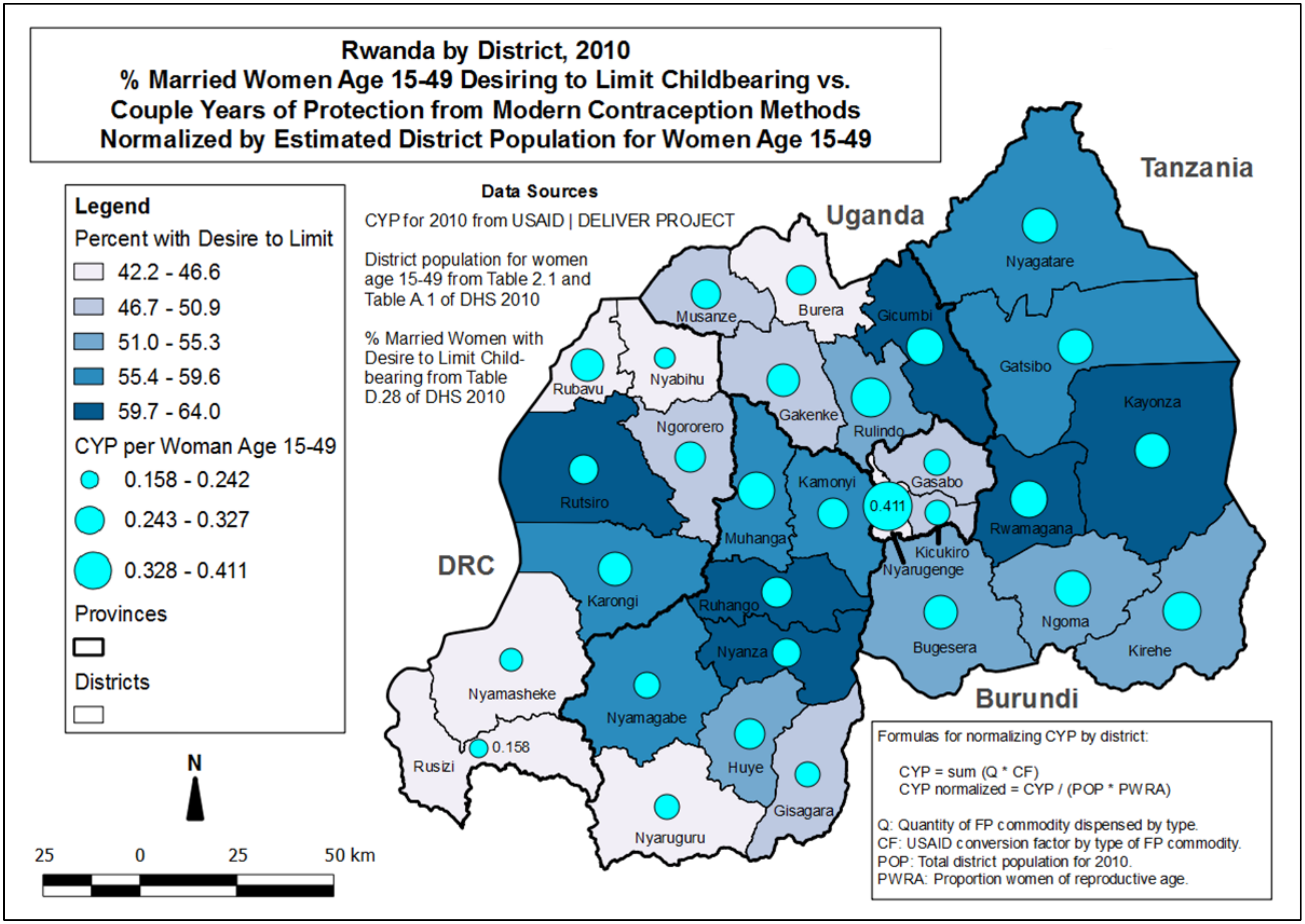


Figure 15: Integrating FP/RH Data from the DHS 2010 and the USAID | DELIVER PROJECT, Example 2



GeoDa for Exploratory Spatial Data Analysis (ESDA)

Linking Contraception Use and HIV Prevalence

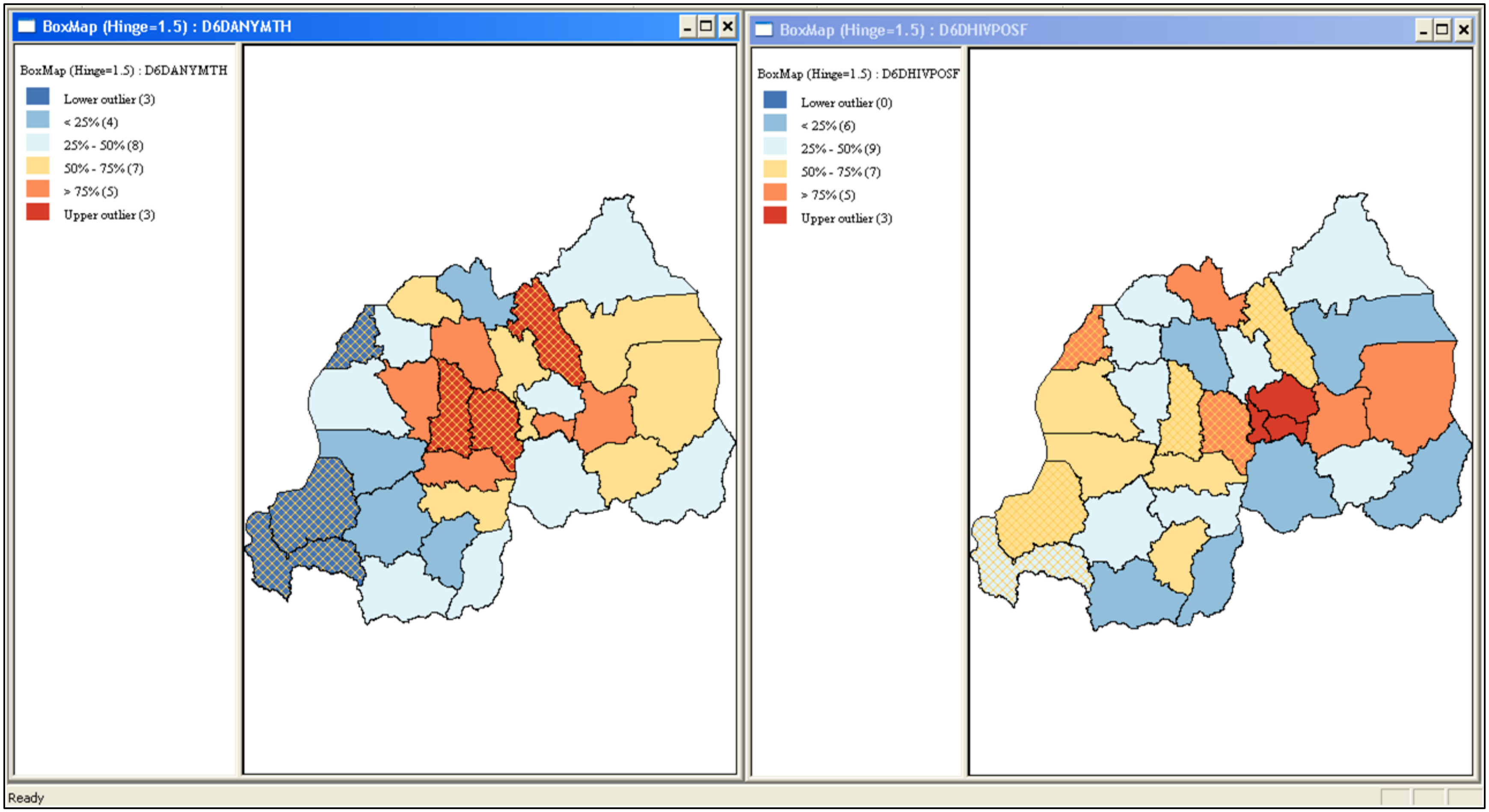
GeoDa provides a variety of tools and methods for visualizing and analyzing combinations of variables in a multi-sectoral context. Figure 16, for example, shows GeoDa linked data views at the district level in Rwanda for the percent of women of reproductive age using any method of contraception versus the percent of women of reproductive age who are HIV positive. Although similar to the E2G maps shown in Figures 5 and 6, the linked GeoDa maps in Figure 16 provide additional detail regarding which districts are considered statistical outliers. Comparing the two maps shown in Figure 16 indicates that there is a low correlation between contraception use and HIV prevalence among women of reproductive age in Rwanda.

Linking Women's Education and HIV Prevalence

In addition to allowing side-by-side comparison of maps, GeoDa provides some simple but powerful statistical tools for analyzing the relationships between multi-sectoral variables. One such tool is the scatter plot, which displays the values for two variables according to an x- and y-axis, and which computes the correlation between the two variables. To compensate for the different scales of data values that can exist for two variables, GeoDa allows the creation of a scatter plot based on standard deviations rather than raw values.

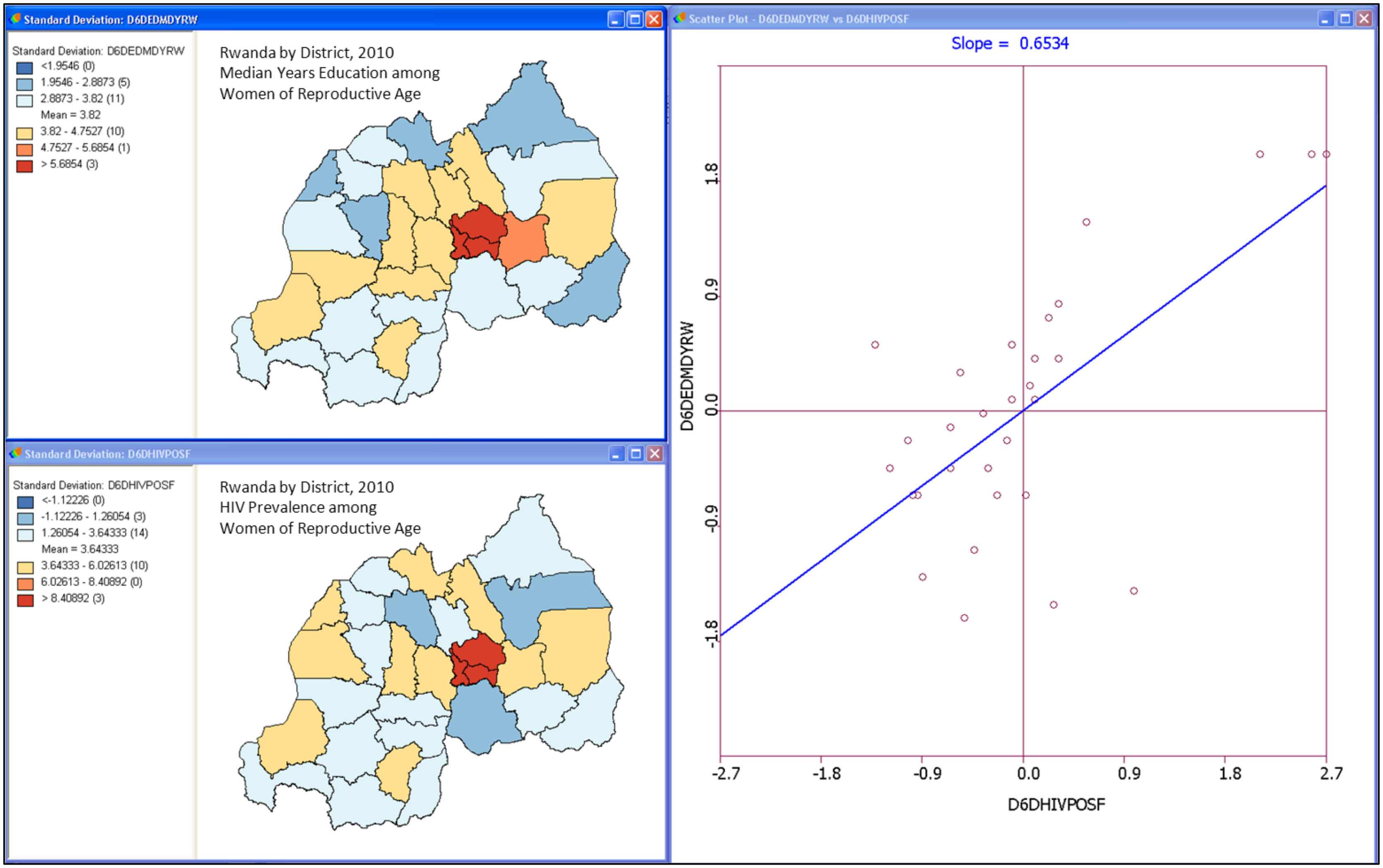
Figure 17 shows an example of such a standardized scatter plot for median years of education versus HIV prevalence for women of reproductive age at the district level in Rwanda based on data from the DHS 2010. The scatter plot shows a relatively strong, positive correlation between a woman's education and her seropositivity, which means that higher education is generally associated with higher HIV prevalence among women of reproductive age in Rwanda.

Figure 16: GeoDa Linked Data Views for Rwanda by District:
Percent Married Women Age 15-49 Using Any Method of Contraception (D6DANYMTH) vs.
Percent Women Age 15-49 who are HIV Positive (D6DHIVPOSF)



Data Source: DHS 2010, Table D.32 (Contraception) and D.91 (HIV)

Figure 17: GeoDa Linked Data Views for Rwanda by District:
Median Years Education among Women Age 15-49 (D6DEDMDYRW) vs.
Percent Women Age 15-49 who are HIV Positive (D6DHIVPOSF)



Data Source: DHS 2010, Table D.11.1 (Educational Attainment) and Table D.91 (HIV)

Lessons Learned from the Rwanda Experience

Using a GIS to develop multi-sectoral data links in Rwanda led to several lessons learned that can help guide FP/RH programs in other countries. The lessons learned can be organized into three categories: key data sources, common geographic identifiers, and software.

Key Data Sources

As in other countries, multi-sectoral data for Rwanda are available from a variety of sources. Some of the data sources can be accessed easily, such as the DHS reports and associated data sets. Others, however, are more difficult to obtain and use because of obstacles such as data access restrictions, lack of prioritization for data sharing, data confidentiality concerns, and geographic scale issues.

One of the obstacles encountered in the development of the current report was the lack of access to current FP/RH program data from the Rwandan HMIS and the community-based system known as SIScom. As a result, the majority of the data used in the report were obtained from publicly available sources, primarily the DHS.

Some of the key data sources for Rwanda, along with a discussion of the relevant lessons learned, are presented below.

Health Facility Database

The Rwanda health facility database, which can be downloaded from the Web site for the Rwanda Ministry of Health (www.moh.gov.rw), contains digital representations of the administrative division boundaries and health facility locations for Rwanda. Linking, mapping, and analyzing data for Rwanda using a GIS would not have been possible without this information.

It is unusual for current health facility locations and administrative division boundaries to be so readily available for a country, which makes Rwanda relatively advanced with respect to the availability of these baseline data sets. Health facility locations are generally not available, and it is often necessary to seek out alternative sources for administrative division boundary files, such as the United Nations Web site for the Second Administrative Level Boundaries (SALB) project (www.unsalb.org). This site is valuable because the administrative divisions provided there have been vetted by the national mapping agencies in the countries represented. The site also provides contact information for the national mapping agencies, which can facilitate data requests from the health sector.

Demographic and Health Survey (Standard DHS)

The DHS provides well-documented, high-quality, population-based data for a variety of indicators from multiple sectors. It is available for a variety of countries, and is therefore one of the primary survey-based data sources for evaluating health conditions in a country. The report and associated survey datasets are available from www.measuredhs.com. DHS data for 2010 were available for Rwanda at the district level.

Based on the higher degree of difficulty associated with obtaining multi-sectoral data from other sources, the publicly available DHS reports and data sets should be considered primary multi-sectoral data sources for GIS data linking.

USAID | DELIVER PROJECT Supply Chain Manager (SCM) Database

The SCM database tracks the supply of essential FP commodities in Rwanda, such as oral and injectable contraceptives, implants, and condoms. Data are tracked at the level of the service delivery points (SDPs), which are most often the individual health facilities, and can be aggregated to higher levels of the administrative hierarchy. There has never been a geographic link established between the SCM and HMIS databases in Rwanda, which has prevented an analysis of the relationship between FP commodities distribution and uptake of FP/RH services to try to understand the impact of commodity-related events. One of the key FP indicators that can be calculated using FP commodities from the SCM is couple years of protection (CYP).

With respect to calculating CYP using FP commodities data from the USAID | DELIVER PROJECT, it is necessary to work closely with USAID | DELIVER PROJECT staff in a country in order to understand whether quantities of FP commodities dispensed by health facilities have been adjusted to compensate for a reporting rate less than 100 percent. It is also highly important to have accurate population data for normalizing CYP. These are the two primary requirements for being able to map and analyze CYP data with confidence. The USAID | DELIVER PROJECT is eager to work with the MOH in any given country, and should be considered a willing partner in creating multi-sectoral data links for FP/RH programs.

Service Provision Assessment Survey

The Service Provision Assessment (SPA) is part of the MEASURE DHS project (www.measuredhs.com). It is "a facility-based survey designed to extract information about the general performance of facilities that offer maternal, child, and reproductive health services as well as services for specific infectious diseases, including sexually transmitted infections (STIs), tuberculosis (TB), malaria, and HIV/AIDS." The 2007 SPA for Rwanda (RSPA 2007) "provides national and provincial level representative information for hospitals, health centers and polyclinics, dispensaries, health posts and clinics offering HIV/AIDS-related services." Source: RSPA 2007.

A major obstacle to linking, visualizing, and analyzing SPA data is the need to maintain the anonymity of the health facilities involved. To meet the requirements for confidentiality of facility-level data, the facility numbers used in data collection are scrambled, geographic location and "day" variables are deleted, and facility type and managing authority variables are grouped. As a result, SPA data can only be analyzed at a high administrative level.

In Rwanda, for example, SPA data can be linked to the five provinces that constitute the first administrative level. Although SPA data are easy to link to other data sets at the province level, this high level of aggregation reduced the value of the SPA data for meaningful multi-sectoral data linking. As a result, SPA data were not used in any of the example maps provided in this document.

Performance-Based Financing (PBF) System

There is a PBF system in several countries in addition to Rwanda. The PBF system provides an incentive-based approach to increasing the availability and the quality of health services at the facility level. Data in the PBF system are recorded at the health facility level, and can be aggregated for representation at higher levels of the administrative hierarchy.

Based on the financial incentives that are tied to PBF system reporting, there are enormous sensitivities to the publication of PBF data at the facility level. As a consequence, there has never been a map created in Rwanda to show the performance of all facilities simultaneously. Such a national-level data display and feedback mechanism could provide a strong incentive for health centers to perform, as individual health centers would then be able to compare their performance to that of the other health centers in the country. Similarly, linkage of HMIS and PBF data could provide a cross-check of common indicators in order to ensure the integrity of the data in both systems. This potentially applies to any country in which these two different systems are operating simultaneously.

HIV/AIDS Data Management System

In Rwanda, the health status of individual HIV/AIDS patients is tracked in the TRACnet system. As a result, the data are considered highly confidential. To preserve confidentiality, the HMIS Unit at the MOH does not want to link to individual-level data within the TRACnet database; however, the HMIS Unit could benefit from access to data that have been rendered non-identifiable by being aggregated at higher administrative levels, such as at the level of facilities, districts, or provinces.

Establishing a link between the HIV/AIDS data management system and the HMIS would facilitate a more rapid response to questions such as “Is there an uptake of FP and HIV testing referrals associated with integration of HIV and RH/FP services?” Based on a lack of access to the TRACnet system during the development of this report, HIV data were extracted from the 2010 DHS for Rwanda.

Common Geographic Identifiers

The most critical requirement for GIS linking of multi-sectoral data is to have common geographic identifiers in the data sets being linked. The common geographic identifiers need to exist in the files containing administrative division boundaries and health facility locations, as well as in the files containing the multi-sectoral attribute data for these geographic entities. In this regard, Rwanda performed admirably, and earned its reputation as a country that possesses a mature spatial data infrastructure for GIS data linking and analysis.

Some of the indications of Rwanda’s maturity with respect to spatial data infrastructure are as follows:

- **Ready availability of standard administrative codes for the entire administrative hierarchy used within Rwanda.** The codes are publicly available as a spreadsheet via the Web site for the National Institute of Statistics of Rwanda (www.statistics.gov.rw).
- **Ready availability of current administrative divisions and health facility locations from the MOH.** In many countries, the most recent administrative division boundaries and health facility

locations can be difficult to obtain. Rwanda has set a strong precedent by making these critical base data layers publicly available on the MOH Web site (www.moh.gov.rw/).

- **Ready availability of multi-sectoral data from public sources.** Despite the lack of access to routine data from the HMIS, multi-sectoral data were easy to obtain for Rwanda by visiting the Web sites for the MEASURE DHS project (http://measuredhs.com/) and the National Institute of Statistics of Rwanda (www.statistics.gov.rw). The NISR site was particularly valuable for finding data not captured in the DHS reports, such as indicators of food insecurity and poverty. The public availability of NISR data can serve as a useful model for other countries with respect to facilitating multi-sectoral data linking.
- **Widespread use of geographic identifiers in FP/RH and multi-sectoral data.** Geographic identifiers were included in all of the data sets used for this case study. Although the data sources often used only administrative names to identify geographic areas for reporting, and there were often differences in the spelling of those administrative names, it was possible to develop a cross-reference (see Table 1) that allowed data to be linked based on administrative codes rather than names. This would not have been possible without easy access to standard administrative codes for Rwanda and their widespread adoption by data providers.

Software

All of the free and/or open source GIS software programs used in the development of this document can play a role in the decision-making process for FP/RH programs, especially in limited-resource settings. Lessons learned with respect to the use of the recommended tools can be identified as either pros or cons:

E2G

Pros:

- Excellent for creating single indicator maps for onscreen data visualization.
- Provides administrative boundaries for 40 countries.

Cons:

- Less than ideal for generating multi-indicator or publication-quality maps.

QGIS

Pros:

- Provides a full suite of GIS functionality, which can be extended even further through the use of “plug-ins” (extensions that can be downloaded from various repositories).
- Well-suited to the creation of publication-quality maps that show more than one indicator at a time.

Cons:

- The free and open source nature of the product means that it does not provide the same high level of functionality or user experience as the leading commercial GIS solutions. This can require the investigation of workarounds to achieve the desired results.
- Some learning curve is required to master it.

GeoDa

Pros:

- Excellent for visualizing and understanding data through the use of multiple, linked data views and simple but powerful statistical tools.
- Can provide valuable insights into program data to help formulate and refine vital research questions.

Cons:

- Creating publication-quality outputs requires editing the GeoDa outputs in a third-party software package, such as Microsoft PowerPoint.
- Multiple indicators can be combined in a scatter plot or a variety of other formats, but not on a single map.

Summary and Conclusions

FP/RH services help provide the foundation of a stable, healthy, and economically viable society. Use of data from sectors and sources beyond the FP/RH realm can improve provision of FP/RH services by increasing understanding of context and providing opportunities for integration of programs. Data from sectors such as food security, humanitarian relief, and poverty can provide valuable context regarding the environment in which decisions about family planning are made. Correspondingly, these sectors could also benefit from inclusion FP/RH data to contextualize their policies and programs.

Lack of information sharing can lead to information systems that are developed and maintained independently of one another. This in turn leads to datasets that are unconnected or ‘stovepiped.’ Stovepiping of data leads to their underuse. The need for informed decisions points to a definite value in overcoming this underuse of data. Through its ability to link datasets using common geographic identifiers, and to visualize and analyze the data in new and often enlightening ways, a GIS can help overcome this stovepiping of data and thus lead to more evidence-based decision making.

The development of this guidance document began with an assessment of the GIS data linking and analysis needs of key FP/RH stakeholders in Rwanda. Stakeholder interviews revealed two fundamental needs for GIS and mapping that are applicable to FP/RH programs around the world: (1) data quality checks for data reported from the field and (2) regular reporting, whether on a monthly, quarterly, or annual basis. The free and open source software programs recommended in this document (E2G, QGIS, and GeoDa), can be used by FP/RH programs to satisfy these fundamental GIS needs as well as to create new data links to enhance multi-sectoral data visualization and analysis.

In addition, the mapping and analysis examples provided in the guidance document can be used by FP/RH analysts and decision makers as templates to integrate FP/RH data with data from other sectors and to increase their capacity to use spatial tools and methods as a means to strengthen M&E efforts for FP/RH programs.

The crucial factor for success in linking datasets in order to gain a multi-sectoral perspective for program planning is to leverage the common geographic identifiers contained in those datasets. Having a central repository for standard administrative codes and multi-sectoral datasets that incorporate these codes, such as the NISR site for Rwanda, is a significant step in facilitating multi-sectoral GIS data linking and analysis to meet FP/RH program needs.

Rwanda represents a success story with respect to the development of spatial data infrastructure, and can be used as a model for other countries in applying the GIS linking principles presented in this case study.

Appendix A: Current use of GIS by FP/RH stakeholders in Rwanda

Field visit

To better understand current GIS data linking and analysis needs for FP/RH programs, MEASURE Evaluation PRH conducted a field visit to Rwanda in September 2011. A spatial analyst with the MEASURE Evaluation PRH project collaborated with the MEASURE Evaluation Country Resident Advisor for Rwanda to arrange face-to-face interviews with representatives of the Ministry of Health's (MOH's) MCH Unit and Health Management Information Systems (HMIS) Unit, as well as with representatives of the USAID Monitoring and Evaluation Management Services (MEMS) Project (www.mems.org.rw/) and the USAID | DELIVER PROJECT (deliver.jsi.com/).

The interviews focused on identifying representatives' needs for GIS, specifically:

- linking datasets using a GIS and
- GIS capacity building required to facilitate data analysis and reporting.

The results of these interviews provided the basis for identification of the essential GIS needs for FP/RH programs that are addressed in this document.

Primary Uses of GIS and Mapping

Based on the needs assessment interviews conducted with stakeholders in Rwanda, it was determined that FP/RH program staff could benefit from using GIS and mapping for two key purposes:

- performing data quality checks on data received from the field and
- reporting on a monthly, quarterly, or annual basis.

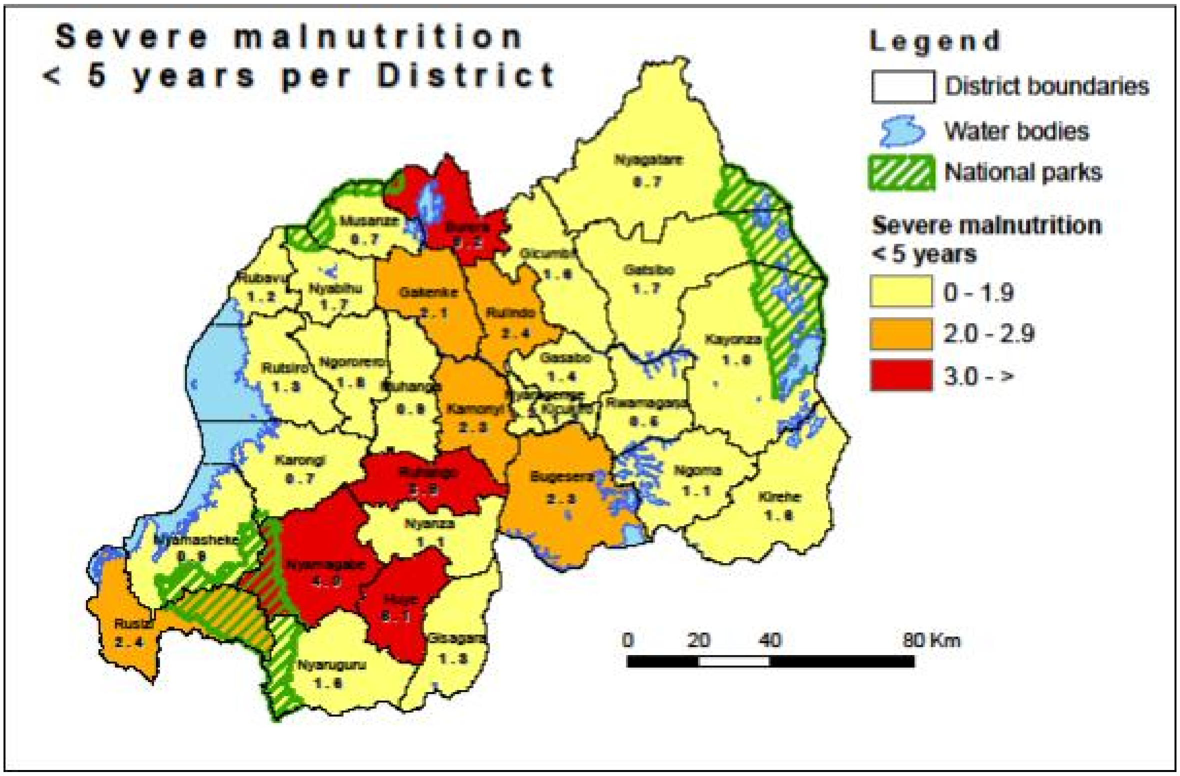
These needs are considered universal for FP/RH programs, and will be addressed in conjunction with the discussion on data linking and analysis.

GIS Data Linking and Analysis Needs

When interviewees performed GIS and mapping activities in the past, the emphasis was on mapping of single indicators to satisfy immediate program needs (see Figure 18). As a consequence, there was no urgent need identified by interviewees to link datasets from multiple sectors.

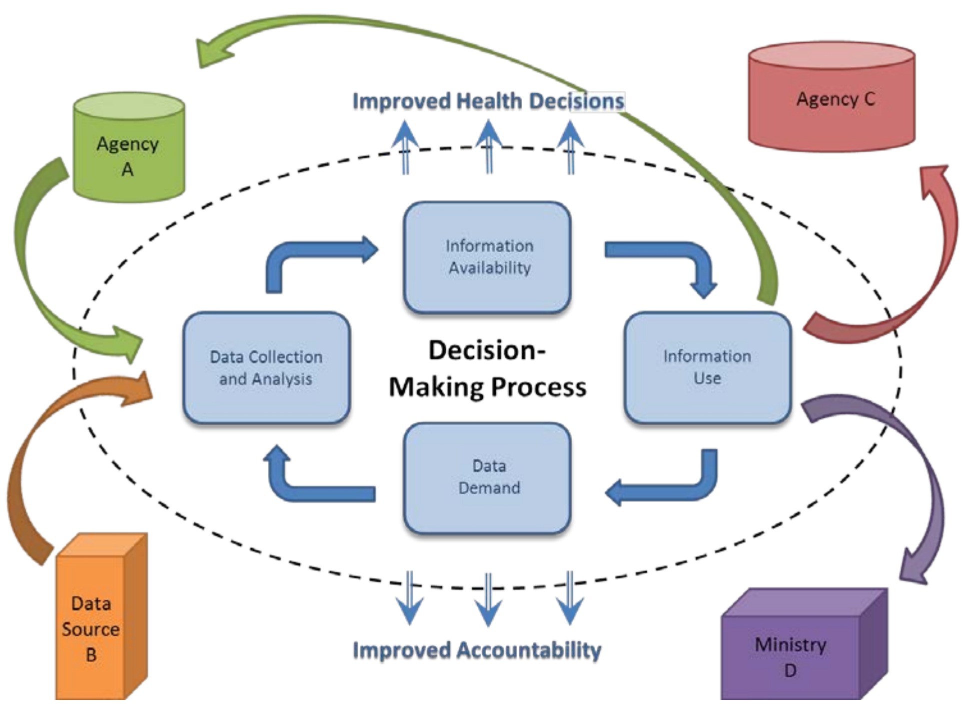
This result is indicative of a program that is in the relatively early stages of GIS implementation. As the level of GIS expertise advances and the use of multi-sectoral data links increases, however, this should fuel a greater recognition of and demand for multi-sectoral GIS links. This is consistent with the cycle of data demand and use observed in other countries in which MEASURE Evaluation PRH works (see Figure 19).

Figure 18: Example of Single Indicator Map Created by MOH Staff in Rwanda



Source: Rwanda Ministry of Health Annual Report 2009-2010, page 114.

Figure 19: Cycle of Data Demand and Use

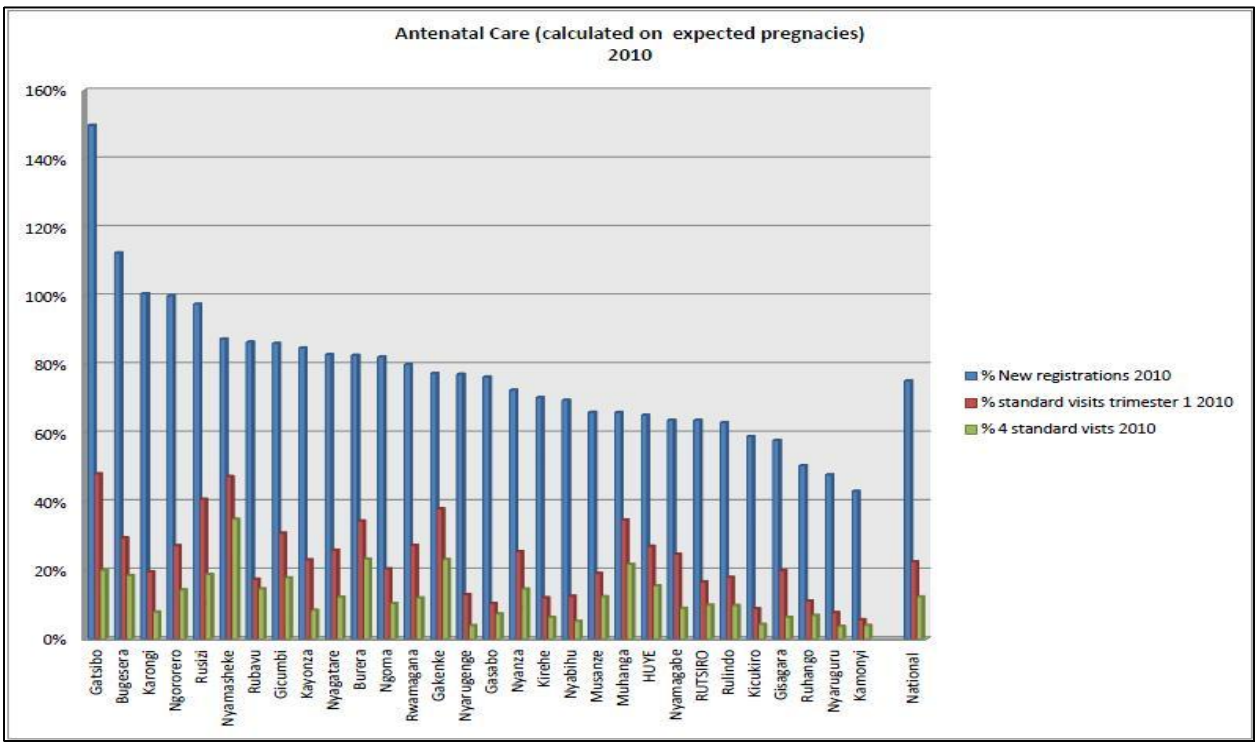


GIS Software Needs

Stakeholder interviews revealed a pattern of GIS software use in Rwanda that is similar to that of other countries in which the health sector has limited access to commercial GIS software licenses:

- Although several stakeholders had been trained by MEASURE Evaluation in the use of the free and open source GIS software known as Quantum GIS (QGIS), they did not use GIS tools and methods on a frequent enough basis to maintain a high level of expertise.
- Several of the stakeholders interviewed are not currently using GIS or mapping, primarily because they have little or no training in GIS and do not have access to GIS tools.
- In lieu of GIS and mapping, which can make data much easier to visualize, many stakeholders rely primarily on Excel pivot tables and charts (see Figure 20).
- Based on the heavy reliance on Excel spreadsheets and Access databases for the bulk of their analyses, stakeholders could immediately benefit from the introduction of basic mapping tools into their current data production environment.

Figure 20: Example of Excel Graphic Showing Antenatal Care Data for Rwanda by District



Appendix B: CYP Conversion Factors

Table 2: CYP Conversion Factors from USAID

Method	**CYP Per Unit**
Oral Contraceptives	15 cycles per CYP
Condoms	120 units per CYP
Female Condoms	120 units per CYP
Vaginal Foaming Tablets	120 units per CYP
Depo Provera Injectable	4 doses (ml) per CYP
Noristerat Injectable	6 doses per CYP
Cyclofem Monthly Injectable	13 doses per CYP
Copper-T 380-A IUD	3.5 CYP per IUD inserted
Norplant Implant	3.5 CYP per Implant
Implanon Implant	2.0 CYP per Implant
Jadelle Implant	3.5 CYP per Implant
Emergency Contraceptive Pills	20 doses per CYP
Natural Family Planning (i.e. Standard Days Method)	2 CYP per trained, confirmed adopter
Lactational Amenorrhea Method (LAM)	4 active users per CYP (or .25 CYP per user)
Sterilization (male & female)* - Asia - Latin America - Africa - Near East/North Africa	 10 CYP 10 CYP 8 CYP 8 CYP

*The CYP conversion factor for sterilization varies because it depends on when the sterilization is performed in the reproductive life of the individual. For more specific data on CYPs and sterilization, consult with national DHS and CDC reproductive health survey records which may provide a historical calculation based on a specific country's context.

Source: http://www.usaid.gov/our_work/global_health/pop/techareas/cyp.html, September 2011.