

GIS and HIV: Linking HIV Databases in Rwanda

A Case Study



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Overview

In sub-Saharan Africa, Rwanda has emerged as one of the leaders in the use of evidence to develop the most effective and cost-effective strategies for its national HIV programming. The National Strategic Plan for HIV (2009-12) articulates a comprehensive strategy for monitoring and evaluation (M&E) of activities to prevent, detect, and treat HIV and AIDS. In 2011, Rwanda added an important new tool: geographic information systems or GIS. GIS enables greater utilization of data by linking geographic mapping with data from many sources and at multiple levels. GIS-based HIV monitoring has the potential to enhance the value of data gathered vastly, by increasing the use of detailed raw data for M&E through leveraging the advantage of computer processing and software. GIS-based monitoring, widely used in many applications, also has the potential to enhance monitoring in health care, including HIV health care programs, and can improve monitoring in data-poor environments by making greater use of the limited available data, as well as making that data more accessible.

From 2010 to 2012, as part of its support for Rwanda's HIV M&E activities, the MEASURE Evaluation project planned and carried out a project on using GIS to link data from multiple sources to track the implementation and outcomes of Rwanda's HIV activities. The project, implemented with support from the U.S. President's Emergency Plan for AIDS Relief (PEPFAR) and the U.S. Agency for International Development (USAID), was designed to serve several purposes. The first was to build the capacity of Rwanda's Ministry of Health (MOH) to use GIS to map priority HIV prevention activities. The second was to enable GIS-based linkages between the health sector and other sectors in Rwanda that were already using GIS — ultimately ensuring the sustainability of GIS use in HIV monitoring.

The capacity building entailed a series of four workshops held in Kigali between June 2011 and March 2012. Participants learned to use GIS technology to link HIV data from multiple sources, and developed GIS maps to provide enhanced information about HIV across the nation. They also developed a logic framework showing how program activities and strategies were related to outcomes and impacts (including national-level goals), and learned how to apply the logic framework within the GIS maps to illustrate these outcomes and point out details or inconsistencies in the relationships between activities and outcomes.

The linkage of GIS data and logic frames yielded greater insights on programmatic results than had been possible with earlier approaches to data-gathering. These results can be used to tailor further HIV interventions to target priority populations more effectively for greater programmatic impact.

The findings from the project provided evidence on the usefulness of GIS-based M&E, and helped to convince the Rwandan government to add a GIS-qualified staff member and to incorporate GIS into its HIV M&E programming.

This case study describes the process of developing, implementing, and evaluating the GIS project in Rwanda. The document describes Rwanda's HIV epidemic; gives an overview of GIS and its relevance to Rwanda, HIV M&E, and international goals and guidance; and details the

process of implementing the GIS workshop for tracking Rwanda's HIV epidemic. The project description includes both the capacity-building process, which enabled stakeholders to create maps and share data, and the development of a logic framework to track program outcomes; and suggests lessons learned for other countries and organizations that wish to use GIS to link and monitor HIV data.

Rwanda: HIV and M&E

Of Rwanda's 11 million people, approximately 3 percent between the ages of 15 and 49 are living with HIV: a modest epidemic compared to other countries in sub-Saharan Africa (DHS, 2010). However, poverty is widespread, especially among the over 50 percent of households considered to be in poverty (National Social Protection Strategy, 2011).

Nevertheless, the Rwandan government has developed ambitious goals for national development. Beginning in 2000, the country decentralized most government services, including health care, to the district level. National objectives for economic development and improvements in the health sector are spelled out in government-issued policy reports: *Vision 2020* (Government of Rwanda, 2009), and the *Health Sector Strategic Plan* Republic of Rwanda, MOH, 2009). This last report identifies national priorities, including improving access to health services, building the quality of and demand for services, and strengthening national hospitals and research activities.

A strength of Rwanda's health sector is the government's recognition of the importance of evidence-based decision making. Commitment to research and evidence gathering has enabled significant progress toward achieving the country's efforts to meet the United Nation's Millennium Development Goals (MDG); specifically MDG 6, which calls for universal access to HIV treatment for all eligible HIV-positive Rwandans. The number of deaths from AIDS-related causes has decreased by over 50 percent between 2005 and 2011 (UNAIDS, 2012). In 2013, an estimated 94 percent of eligible individuals received antiretroviral therapy (ART), and at least 87 percent of all eligible HIV-positive pregnant women received medication for prevention mother-to-child transmission (PMTCT), (UNAIDS, 2013). Expectations are that, given current trends, universal access to ART and PMTCT services in Rwanda will be achieved by 2015.

Rwanda has made a commitment to developing a strong information infrastructure. The country has a well-developed geospatial infrastructure in which the coordinates of all health facilities are established and shared. The *National Strategic Plan for HIV and AIDS 2009-12* (Republic of Rwanda, CNLS, 2008) devotes a chapter to data gathering to support Rwanda's HIV goals (see Rwanda's HIV and M&E Goals, next page). Yet weaknesses remain. A draft health sector M&E strategy for 2009-2014 (Ssetonga MP. Unpublished) describes the state of various data-gathering tools. The report describes functions such as census and population-based surveys as "highly adequate" but characterizes other functions, such as vital statistics and health and disease records as "inadequate" or "absent". The decentralization of health services requires district-level stakeholders to make decisions that affect the availability of resources and commodities, often without adequate information. Supporting evidence-based decisions about meeting district needs requires integrating data from many sources — about staff, supplies, and funding, for example — to ensure efficient use of scarce resources.

Thus, both its commitment to evidence and its need to strengthen the evidence base made Rwanda a good candidate for an intervention to integrate HIV data within the health information system. The project sought to demonstrate the potential of GIS technology for enhancing and integrating multiple streams of data on HIV to facilitate more effective decision making.

GIS in Health and HIV Decision Making

GIS manage data using a geographic context; this geographic element makes it possible to link data sets and facilitates analysis. Though GIS is best known as a mapping platform, in fact it is the capacity to link and manage data that makes GIS valuable, even if no map is produced. Since the 1960s, when mapping and spatial analysis moved into the digital era, computer-based GIS have become invaluable research tools for epidemiologists and public health programs in higher-income nations. More recently, changes in the availability of GIS resources (software, human resources, and data) have broadened the range of environments where GIS can be used. Barriers such as cost and lack of access to data have also changed; thus it is now much easier to bring data into M&E interventions within a variety of contexts.

In GIS applications, indicator and GIS data are coded to be linked with geo-coded indicator data — for example, linking facility-level data (such as number of people tested for HIV) with GIS data of facility locations. Existing data sets can be overlaid to produce geographic profiles of a given indicator by sector, district, or facility as needed. In Rwanda, these include data sets from large-scale population-based surveys, such as the Demographic Health Survey (DHS), and routine programmatic databases managed by the Rwanda Biomedical Center, including databases formerly managed by the National AIDS Control Commission (CNLSnet) and TRAC Plus (TRACnet). Then, a logic framework can be used to define how different indicators are related to one another. The logic frameworks thus provide ways to understand and interpret the linked, location-based data sets or maps that GIS creates — linkages, for example between a given activity and a specific outcome.

GIS and Data Interpretation

The key advantage of GIS in tracking health data is that they use the full power of computers. Thus, GIS provide alternatives to the “paper paradigm” in which information is based mainly on what exists on paper or can be processed by individuals. By contrast, GIS offer the exponentially

Rwanda's HIV and M&E Goals

Rwanda's goals for HIV (2009-2012) included halving the incidence of HIV in the general population, decreasing HIV-related morbidity and mortality, and increasing opportunities for those living with or affected by HIV. The M&E strategy for HIV, developed using a participatory approach, articulates a logical framework, assigns roles and responsibilities, describes staffing and funding allocation, and describes activities to improve data-gathering from the community through national levels. The national strategy also specifies a comprehensive range of services (including counseling, antenatal care, blood screening, and community-based activities) from which data will be drawn.

Source: (Ssetonga MP. Unpublished)

greater data-processing capacity of computers, as well as a much broader range of visual input. GIS also have the capacity to link data from multiple sources and across multiple levels — from communities to governments — which facilitates a deeper understanding of local contexts that can then feed into national-level decision making. Linking from multiple sources (e.g., linking some 490 facilities in Rwanda) allows sophisticated analysis without reliance on multiple charts and tables, and can reveal underlying patterns that charts cannot show. These qualities enable GIS-based M&E to use all data, including raw data, and can provide deeper insights that would otherwise be hidden within the data or would be too time-consuming to generate.

For example, in Figure 1, GIS technology had enabled the linkage of data from various sources on HIV prevalence among young people. This map shows a concentration of HIV prevalence in Kigali. The data in figure 1 might suggest the need to intensify HIV prevention measures in Kigali. However, disaggregation of the raw, GIS-linked data shows additional details. Figure 2 shows that HIV prevalence in all districts that provided data is higher among young women. This level of data use suggests that new HIV infections among women may be driving these higher prevalence rates at the population level, identifying a need for further research or interventions to reduce the HIV risks among girls and young women.

Linking Data, Cause, and Effects

Linking data to the inputs, outputs, and outcomes of interventions using GIS systems requires development of a robust logic framework that connects each element of interventions. GIS-based data can show the impacts of interventions and provide a tangible context for demonstrating the value of a given approach. A simple example would be to increase the number of HIV test kits available; the expected outcome would be an increase in the number of people being testing. Establishing cause-and-effect relationships for more complex activities, such as interventions targeting youth, requires a more complex framework.

Introducing GIS for HIV M&E in Rwanda

Rwanda's promotion of evidence-based policy-making made the country an appropriate setting for testing a GIS-based information system. The Rwandan government was using GIS in several sectors already, and the National University of Rwanda taught GIS technology in a range of disciplines; but GIS use in the health sector was weak. The MOH and several partner organizations were interested in using the technology but lacked knowledge of how to apply it to link data.

HIV prevalence among Youth at district level 2011 (TRACnet)

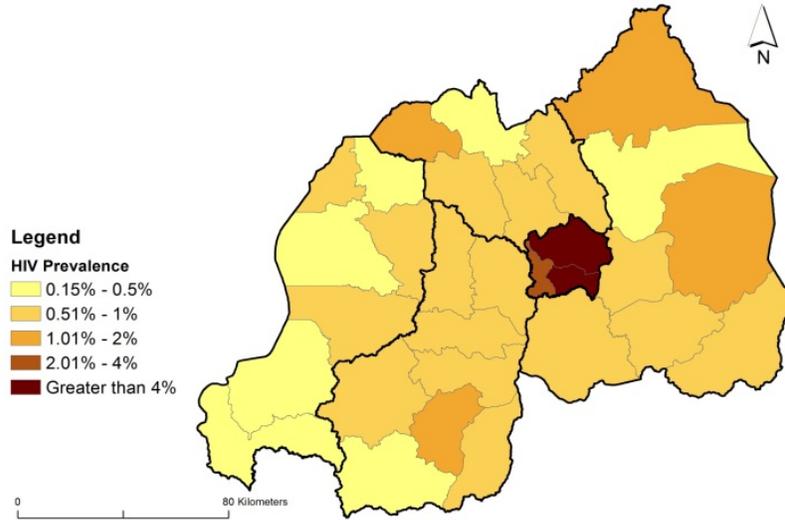


Figure 1: GIS data showing overall prevalence of HIV among youth in Rwanda.

HIV prevalence among Youth at district level 2011 (TRACnet)

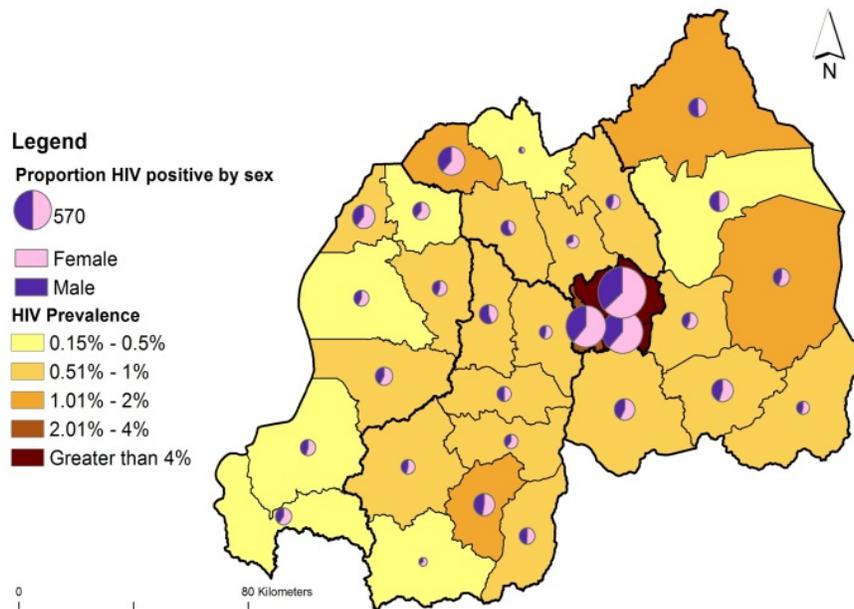


Figure 2: Disaggregated data showing HIV prevalence among youth according to sex, Rwanda.

In 2010, MEASURE Evaluation proposed the project as a way of linking HIV data using a GIS platform, using the guidance on evaluating full coverage national HIV prevention programs produced by the Joint United Nations Programme on HIV/AIDS (UNAIDS, UNICEF, WHO & USAID, 2008). The intervention was initially envisioned as a six-month, small-scale mentorship project working with a few participants to advance two teaching goals: the technical skills of linking data via geography; and the ability to use GIS data for evaluating and making decisions on HIV programs. A key objective was to show how the GIS approach builds on, and can be integrated into, existing activities. Additionally, the training was designed as a way to establish connections among the key players in Rwanda's health sector, where GIS capacity was initially weak, with well-established GIS departments in other sectors — supporting the sustainability of GIS activities in HIV.

Stakeholders' Meeting

In January 2011, MEASURE Evaluation's Rwanda field office worked with the MOH, specifically the National AIDS Control Commission (Commission Nationale de Lutte Contre le SIDA or CNLS), to put together a stakeholders' meeting. Some 20 participants, including staff from CNLS, the Rwandan Centre for Treatment and Research on AIDS, Malaria, Tuberculosis and Other Epidemics (TRACplus), USAID, the U.S. Centers for Disease Control and Prevention, and other international organizations, attended the meeting. One of the major topics was the value of using GIS to efficiently link together the country's diverse collection of data sources originating from different government health agencies, all of which use geography as a key reference. GIS were presented as having the potential to integrate these data sets in a cost-effective and timely way, thus increasing leverage and use of the data.

By the end of the meeting, participants agreed on the importance of building GIS capacity within Rwanda's public health infrastructure to obtain the maximum value from data already collected on HIV, and to enhance use of future data collection. Based on feedback from this preparatory meeting, the intervention was modified to meet participants' broader capacity-building needs. A GIS capacity-building training workshop was proposed for June 2011 that would use sample data provided by each agency involved in HIV activities, thus making the training concepts more relevant and easier to understand.

GIS Capacity-Building Workshop

The five-day June 2011 workshop on using GIS to link HIV data from multiple sources drew about 20 participants, including representatives of key Rwandan public health agencies such as CNLS, TRACplus, MOH, and the National University of Rwanda.¹ Participants, including Rwanda's leading epidemiologists, researchers, government program officers, M&E experts, and implementing partners, received in-depth, hands-on training in GIS using QGIS software and discussed the potential of GIS for strengthening the national response to Rwanda's HIV epidemic.

¹ Rwanda has since combined a number of government programs, including CNLS and TRACplus, into the Rwanda Biomedical Center.

The training took place over the first four days of the workshop and covered four technical topics: an overview of GIS; principles of data-linking and map-making; use and interpretation of data; and use of maps for decision making. Each day, participants completed related exercises, using their own data to develop maps relevant to their districts. Map-making exercises used the open-source program QGIS and focused on priority populations (serodiscordant couples, youth, and female sex workers) in accordance with national priorities, and used existing data sets (including data from DHS, CNLS' community-based program database CNLSnet, and the Youth Behavioral Surveillance Survey). MEASURE Evaluation had also met with key staff from TRACPlus and the MOH's Health Management Information System (HMIS) to ensure that the data collected would be compatible with the recently initiated District Health Information System (DHIS 2), which includes mapping functions.

On the fifth day, CNLS and MEASURE held an open forum to promote the integration of GIS within the health sector into the broader GIS sector across Rwanda, with the view of supporting the sustainability of GIS use within the MOH. Over 30 participants from more than 15 organizations participated in the forum. Presentations covered such topics as existing use of GIS in Rwanda and use or potential use of GIS and mapping in the health sector. In small group sessions, participants described how GIS might be used in HIV and health, and discussed the resources needed to develop and sustain GIS capacity, and challenges that might impede the use of GIS.

Logic Framework Workshop

In September 2011, MEASURE Evaluation and CNLS stakeholders held a three-day workshop on developing logic frameworks, which would be linked to the GIS data to track the effects of HIV prevention interventions among populations that had been prioritized for HIV prevention. Participants in this workshop decided on three priority groups identified by the MOH — female sex workers (FSWs), serodiscordant couples, and youth.

The logic framework built on the M&E staircase (figure 3) endorsed by the UNAIDS Monitoring and Evaluation Reference Group (MERG) for use in evaluating HIV prevention programs for vulnerable populations (UNAIDS, UNICEF, WHO & USAID 2008). The framework allows step-by-step examination of each element of an HIV program, from hypothesis through inputs, activities, mid-term outcomes, outcomes, and broader impacts.

During the workshop, participants developed frameworks to link HIV prevention activities with population-level impacts for the three priority groups. Impacts in the logic framework aligned with Rwanda's national HIV priorities — and the national goal of stopping the incidence of HIV in the general population by 2015 — while also with the hierarchy of questions outlined in the M&E staircase.

The frameworks developed by workshop participants is structured roughly like a pyramid. Multiple inputs and activities, at the base lead upward to a lesser number of strategies, which are linked as the pyramid “grows” to increasingly fewer outputs, intermediate outcomes, outcomes, and then, at the top of the pyramid, to the final impact. Table 1 depicts this framework and its correspondence with the M&E staircase.

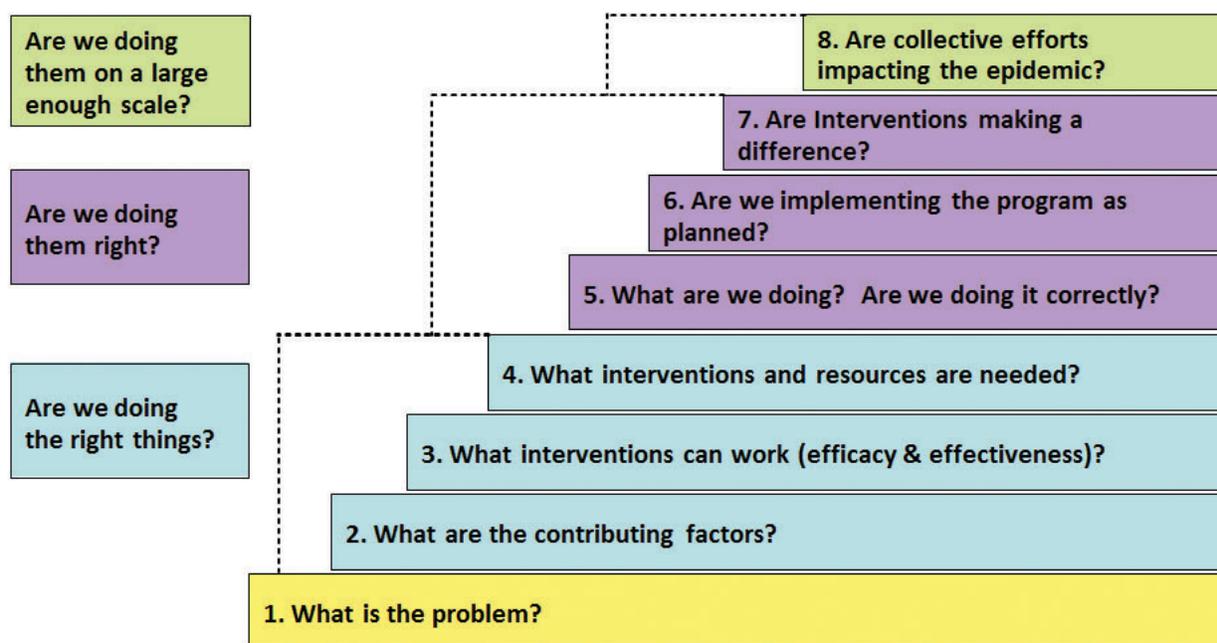


Figure 3: Logic framework endorsed by UNAIDS MERG. Source: Rugg, Peersman & Carael, 2004.

Table 1: Logic Framework for FSWs in Rwanda

M&E Staircase Steps	Logic Frame Corollary	Indicator
INPUTS TO OUTPUTS <i>Are we doing the right things?</i> (Steps 2 to 4)	<i>FSW are reached with comprehensive HIV prevention programs</i>	Proportion of most-at-risk populations (MARPs) reached with HIV prevention programs
		Number of MARPs reached by HIV prevention interventions
		Number of implementers with the minimum capacity to deliver quality HIV prevention services to MARPs.
OUTPUTS TO OUTCOMES <i>Are we doing them right?</i> (Steps 5 to 7)	<i>Risky sexual intercourse is reduced</i>	Percentage of female sex workers reporting condom use during last sex with a client
		Proportion of MARPs with comprehensive HIV knowledge
	<i>Sexual transmission is reduced</i>	Proportion of MARPs who are HIV-positive
OUTCOMES TO IMPACT <i>Are we doing them on a large enough scale to impact the epidemic?</i> (Step 8)	<i>HIV incidence in FSW = 0</i>	HIV prevalence in the population aged 15-24

In the logic framework for FSWs in Rwanda, for example, over 100 activities and inputs support the strategies, outputs, and outcomes that are linked the single final impact, which is the national goal of eliminating HIV in the general population. Thus, inputs (mobile testing, provider training) and activities (provision of health insurance, and daily testing units) are linked to strategies (extending reproductive health services to FSWs) that lead to outputs (reaching FSWs with comprehensive prevention programs), intermediate outcomes (reductions in risky intercourse), outcomes (reduction in HIV sexual transmission), and, finally, impacts (HIV incidence stops in the general population). The logic frame allows linkage of data according to the context, which then justifies the GIS linkage by location.

Using the Logic Framework to Develop Maps

In March of 2012, CNLS and MEASURE co-sponsored a half-day workshop on using a logic framework to create maps illustrating programmatic activities their outcomes. This was followed by three days of on-site training that included refresher training on GIS. Participants learned how to choose maps and data sets, and to ask questions posed in the logic frameworks to review the relationship between prevention activities and the desired outcomes in the four priority groups. This hands-on work showed participants how GIS-linked data can provide useful levels of detail that may not be easy to extract from single-sourced databases. Figure 4 shows a map of serodiscordant couples that was developed during the on-site training.

Combining data from serodiscordant couples seeking either voluntary counseling and testing (VCT) or prevention of mother-to-child transmission yielded several types of details (figure 5). PMTCT clients were more likely to be in a stable relationship, while those attending VCT services were more likely to be unmarried, and possibly considering marriage. These two types of clients suggest different types of preventive services. In the training session, this finding enabled a discussion on the differences among inputs in western and eastern Rwanda; in policy-making, it might point to additional research to pinpoint the reasons for the differences, or to refinements of activities to meet a given target.

The GIS project, planned as a six-month activity, was expanded to a projected end date of 2015, when endline results are planned to be tabulated. As of 2014, MEASURE's work in Rwanda has been phased down; it was uncertain whether endline data would become available. Nevertheless, the GIS training successfully enabled GIS-based HIV monitoring. In the months following the workshop, Rwandan health agencies responsible for HIV programming adopted GIS and were using it to enhance data collection and analysis on HIV. Also, the National University of Rwanda had added a GIS course to its public health curriculum.

The GIS project built Rwanda's capacity to use GIS for assessing HIV prevention. The project served to demonstrate how geographic data can provide an overview of HIV interventions and outcomes, providing insights on how to target or focus activities to achieve the desired results or address the needs of a specific context.

Serodiscordant Couples at district level 2011 (TRACnet)

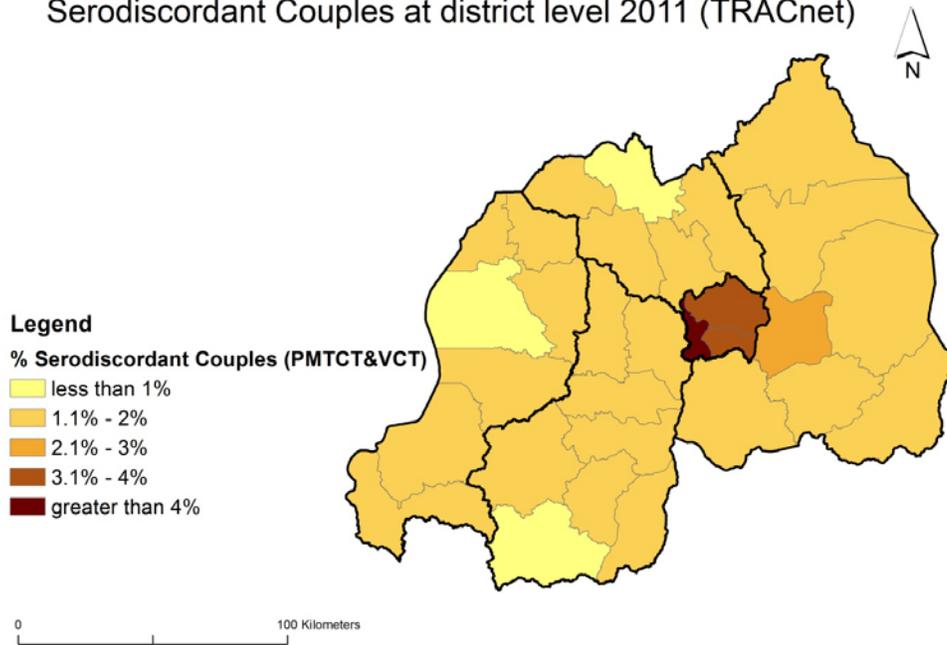


Figure 4: Prevalence of serodiscordance at the district level, Rwanda.

Serodiscordant Couples at district level 2011 (TRACnet)

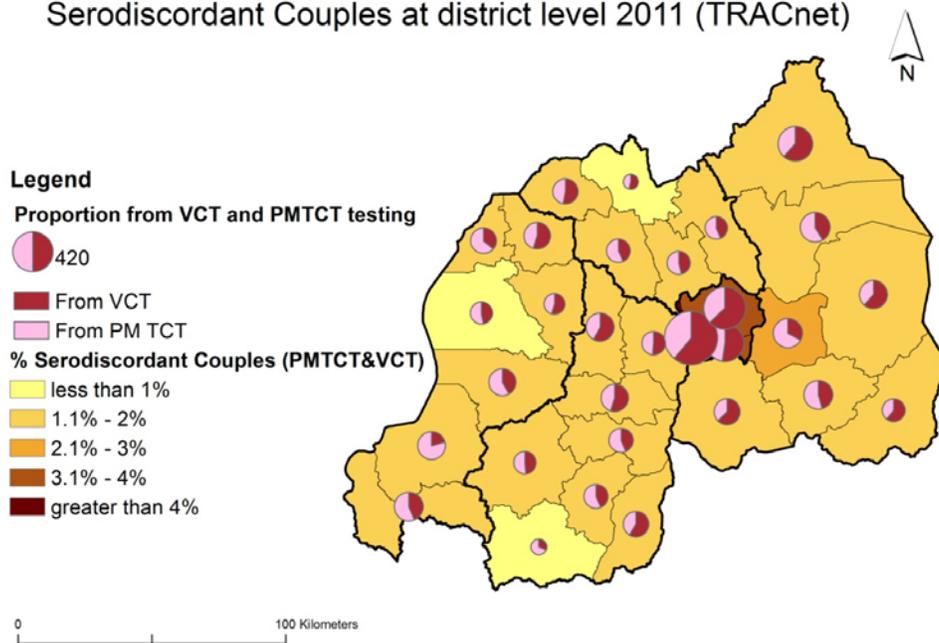


Figure 5: District-level serodiscordance identified by service provided, Rwanda.

What Worked Well

The most successful elements of Rwanda's intensive HIV strategy-building efforts are valuable for other countries to review and adapt to their own context.

Linking data from different sources using GIS: This activity demonstrated that combining data using a GIS and a sound logic frame provided nuanced insights into the relationship between inputs and outcome indicators, which would not be possible without GIS and a sound logic framework.

Government leadership on evidence-based decision making: Rwanda's commitment to evidence-based, results-based planning and its acceptance of emerging technology have positioned the country to made good progress in tracking and addressing its HIV epidemic.

Development of a GIS-based information structure within the MOH: Though MOH officials were interested in GIS for M&E, the technology had not been prioritized. However, the mapping exercises conducted during the workshop made GIS “real” and convinced participants of the potential of GIS-linked databases. Maps have now become a routine part of reporting in the Rwanda Biomedical Center (RBC) and the agency has allocated funding for GIS mapping and hired a GIS specialist.

Existing data infrastructure: Rwanda has established a number of M&E systems and tools for capturing and tracking health and HIV data. The existence of a strong geospatial infrastructure also simplified the linking and mapping processes. This infrastructure could be enhanced by links with additional types of data streams — on supply chain management, facility estimates of HIV prevalence among pregnant women, and other parameters.

Participatory project planning: By including a range of stakeholders in the planning process, and addressing their feedback and concerns, the project succeeded in modifying the workshop content to ensure maximum relevance.

Challenges

Linking data at the disaggregated level: The ability to link data from various sources depends on whether they have common elements. Location is often the common element; in public health, this includes health facilities and administrative areas. To facilitate linkage of data from multiple sources within the health sector, Rwanda has launched the Health Facility Registry project. In this project, data from each participating health facility are identified with a specific facility code. This enables the seamless linkage of data from various programs.

Timeliness of data for decision making: When data are used to make decisions, there is a need to minimize the time elapsed between data collection and the actual use of the data. For routine data, this increasingly requires agreements that allow continuous data-sharing (see the next paragraph, on appropriate data-sharing). Efficiently addressing the complexity of harmonizing multiple sources of data is important; for example, ensuring that data from the health facility

level can be used at the sectoral level, and vice versa. Having these agreements and linking structures in place ahead of time facilitates the timely integration of many streams of data.

Appropriate data-sharing: Current data-sharing agreements tend to address data that are not collected continuously, such as findings from a survey or report. However, these agreements have not kept up with the changing technology of data collection, storage, and analysis, which favors continuous or repeated data collection and sharing. Agreements for continuous data-sharing must include and acknowledge the rights and responsibilities of data ownership; the relationship resembles that of a buyer and seller, rather than that of a service provider and data user.

Confidentiality, and how to protect it, must also be part of the design of current data-sharing agreements; questions on confidentiality must be continually considered and updated (as needed) by the owners and users of shared data. This is especially important in mapped data, such as that presented in GIS applications, because displays of disaggregated data may compromise the anonymity of clients. Thus, agreements for continuously shared data must specify the roles, rights, and responsibilities of data providers and users, to minimize the risk of unintentional breaches of confidentiality. In Rwanda, the MOH has begun updating its agreements for shared data to align with the changing nature of data collection, storage, and use.

Lack of confidence in program data: GIS can provide large volumes of data, as well as layers of detail and easy access. However, if potential users lack confidence in the data or data sources, the data are less likely to be used for decision making. Showing that data are comprehensive, accurate, and comparable across data sources is essential to ensuring users' confidence.

However, the process of improving data and confidence might be viewed as a journey, with steps and benchmarks toward the ultimate goal of perfect data that are trusted and used for decision making. Initial efforts to use data can facilitate identification of gaps in data and data gathering, and point toward strategies for addressing these weaknesses. This is the case in Rwanda, where the drive for quality and reliable data is helping decision makers understand the data they have and identify the data still needed, and will lead to more reliable data and decisions based on continuously improving data.

To help build confidence in data, it is important to be transparent about problems with the data. It may be necessary, when data are not of the same quality or are not fully comparable, to add additional maps that enhance the understanding of the differences in quality of the data.

Recommendations

Build organizational capacity to use GIS first: Before asking stakeholders to share data, it is critical that they are competent to use GIS technology, and are able to do GIS analysis on their own data, within their own organizations, before requesting that they share their data with other organizations. Ensuring that the training has a practical use builds ownership and supports effective data sharing.

Develop a strong logic framework: Linking data through GIS is feasible without a logic frame. However, a robust logic frame is critical to ensure a clear linkage between program activities and the output and outcomes indicators associated with these program activities. It is essential that GIS users not only understand GIS technology, applications, and use, but also the need for a sound logic framework to justify the data linkage — as well as how to use linked data to support decision making

Continue to build the evidence base: More research and better data are needed to improve understanding of the drivers of risk for vulnerable populations. For instance, all women aged 15 to 24 are not uniformly at risk for HIV infection, and further research is needed to understand the specific characteristics and risk behaviors to target these women effectively with prevention interventions. Similarly, serodiscordant couples may need different approaches, depending on which partner is infected. In addition, more data are needed on such marginalized groups as men who have sex with men (MSM) to develop appropriate programs and activities and ensure adequate coverage of these populations.

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