THE HOUSEHOLD REGISTRATION SYSTEM

A Point-and-Click Revolution in Health and Demographic Research

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Contents

Acknowledgments

The Household Registration System (HRS) is a collaborative venture of the Navrongo Health Research Centre (NHRC) in Ghana, the Population Council, and the University of Southern Maine. The Population Council and The Rockefeller Foundation (Health Sciences Division) supported HRS planning and initial development activities. The Thrasher Research Fund supported the HRS with two grants to the Population Council: the first grant funded initial development of the HRS, system documentation, and dissemination workshops; the second enabled the Council to expand its Web site to include a section dedicated to the HRS, where researchers can access the program and obtain remote technical assistance for HRS use. The Thrasher Research Fund also funded the HRS team to develop a Microsoft Windows-based version of the system, HRS2®, and to conduct additional dissemination workshops.

All stages of HRS development have involved large-scale field implementation, testing, and system documentation by the NHRC. The Rockefeller Foundation (Population Sciences Division) is funding demographic surveillance research by the NHRC. The Finnish International Development Agency and the United Nations Population Fund supported scientific exchanges between researchers at the NHRC and at the International Centre for Diarrhoeal Disease Research, Bangladesh. The Finnish International Development Agency, The Mellon Foundation, and The Rockefeller Foundation funded scientific support for development of demographic surveillance operations at the NHRC.

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Introduction

After a half-century of progress in public health and population research, scientists still lack a critical mass of basic demographic and health data in developing countries. In shortest supply are longitudinal population-based data—the output of a demographic surveillance system (DSS) that tracks every member of a population over time. These systems yield unparalleled insights into demographic and health dynamics; yet there have been few DSS sites in developing regions. This has impeded efforts to analyze and respond effectively to health and population issues in these regions.

An international, interdisciplinary team of scientists has been working for nearly a decade to remove this obstacle to improving people's wellbeing in the developing world. Their work has spawned a set of initiatives that harness the power of computer technology to increase research capacity in developing countries—notably the capacity to carry out longitudinal population-based surveillance and related studies. The nerve center of these initiatives is a novel computer program called the Household Registration System (HRS).

The HRS is the first software system designed to function as a template for generating DSS computer programs—i.e., programs that facilitate the collection, management, and analysis of DSS data. A compact program-that-writes-programs (an "automated software generator"), the HRS can be adapted to different settings and study designs and can be operated by users who are not computer specialists. This is the only DSS-related software that is available at no cost and can be obtained via the Internet. Researchers can download the newest version of the system, HRS2® for Windows, from the Web site of the Population Council: www.popcouncil.org. To date, a dozen HRS sites have been established in developing countries.

The HRS was field tested in northern Ghana, where it serves as the electronic engine of the Navrongo Demographic Surveillance System (NDSS). Run by the Navrongo Health Research Centre (an outpost of Ghana's Ministry of Health), the NDSS has helped to make the Navrongo Centre one of Africa's most productive research stations. The NDSS supports several scientific undertakings at the

Centre, including the pioneering Navrongo Community Health and Family Planning Project—the first project to measure the demographic impact of a large-scale family planning program in Africa. Regarded as a model demographic surveillance system, the HRS-based NDSS has been replicated at several research sites in Africa and Asia. Data from these sites have yielded important public health findings—such as a correlation between HIV prevalence and adult mortality from malaria, a disease that is usually fatal only to children.

The Navrongo Centre is a flagship member of a growing, global network of DSS sites linked primarily through electronic channels. Called INDEPTH—an acronym for International Network of field sites with continuous Demographic Evaluation of Populations and Their Health in developing countries—this nongovernmental organization represents 19 DSS sites in developing regions, including the 12 using HRS-based systems. The network allows investigators at otherwise isolated sites to exchange information and ideas, pursue collaborative research agendas, and set universal standards for DSS research. The organization's Web site (www.indepth-network.org) is the first Web site dedicated exclusively to longitudinal demographic and health research.

Efforts are underway to widen the network of DSS sites around the world and to expand the corps of developing-country researchers trained in DSS operations. In sub-Saharan Africa, the HRS team is helping to build a network of longitudinal community health research centers similar to the Navrongo Centre. These sites would use HRS-based or comparable surveillance systems to undertake a range of field studies, from vaccine trials to family planning experiments. African researchers have received Population Council funding to train at the Navrongo Centre, preparing them to carry out longitudinal research in their own countries.

The HRS team is also working to increase remote technical assistance services to HRS users in the field. These services (provided by e-mail, Internet, and nonelectronic means of communication) reduce the need for on-site foreign consultants, thereby increasing the independence of developing-country researchers and cutting the cost of their work. One Indonesian team got an HRS-based system up and running with remote assistance only; their first on-site visit from a foreign HRS expert came a year after the system was installed.

A key feature of the HRS is that it permits cross-country comparisons of DSS data. The system is designed to generate a "reference data set"—a core set of demographic data, presented in a standard format, that can be compared among HRS sites. This powerful and previously unavailable scientific asset allows researchers to conduct empirically rigorous, multi-site trials of vaccines and other medical technologies. Such studies are weakened when data from various DSS sites are not comparable (because, for example, systems have defined "risk" in different ways). To increase the supply of standardized DSS data, the HRS team attained a consensus among African researchers on a Reference Data Model compatible with the HRS. This model (which INDEPTH is helping to disseminate) can be built into the design of non-HRS-based systems to facilitate data exchange among, and technical assistance to, DSS sites.

The HRS was conceived by Population Council researcher James Phillips and designed by computer scientist Bruce MacLeod, an expert in software engineering at the University of Southern Maine who specializes in making complex computer systems accessible to nonspecialists. Two Ghanaian scientists played key roles in developing and field testing the HRS: Fred Binka (chair of INDEPTH and former director of the Navrongo Centre) oversaw Navrongo research operations from 1992 to 1998, and Frank Indome (a Population Council consultant in Navrongo from 1992 to 1994) adapted MacLeod's HRS prototype to the Navrongo setting. Senegalese demographer and Population Council fellow Pierre Ngom was the technical leader of the Navrongo Demographic Surveillance System team from 1994 to 1998.

The value of the HRS cannot be appreciated fully unless one first understands the significance of longitudinal population-based surveillance. What exactly is a demographic surveillance system? How does it work? Why do we need DSS data in developing countries—and need these data now more than ever? Why have there been so few DSS sites in these countries? These questions are answered in the next section of this report. The third section discusses the HRS in more detail, and the fourth describes its applications in the field.

Longitudinal Population-Based Surveillance: What, How, and Why

Longitudinal population-based surveillance involves tracking the members of a geographically defined population over time, collecting data on the core components of demographic change—births, deaths, and migrations in and out—and often other information relevant to demographic and health outcomes. A demographic surveillance system comprises all the data collection and management operations involved in this process. An advanced DSS (like the Navrongo Demographic Surveillance System) is not a stand-alone surveillance operation, however; rather, it serves as a platform for a range of research projects and experimental interventions that make use of the DSS sampling frame (see box, page 7).

Longitudinal population-based surveillance is a uniquely powerful research tool because it chronicles the life course of every individual in a population and simultaneously illuminates large-scale population dynamics, such as morbidity patterns and fertility/mortality/migration rates and trends. It is the only type of study that is both longitudinal and population-based, and it overcomes biases inherent in other study designs frequently used in population research.[1] Solid DSS data permit analyses that would not otherwise be possible: for example, researchers can use these data to identify causal determinants of fertility, morbidity, and mortality; to map the distribution of risk in a population; and to measure the population-level impact of

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[1] For example, periodic population surveys (such as the Demographic and Health Surveys) are population-based but not longitudinal. These surveys require respondents to recall past events and behaviors, and such retrospective data are often unreliable. In DSS studies, participants are queried on a regular basis about recent events and behaviors, an approach that reduces retrospective bias. Longitudinal cohort studies (which follow a subset of individuals over time) are obviously longitudinal but not population-based. These studies are limited in focus and highly sensitive to sample loss (e.g., through out-migration). A DSS tracks an entire population; thus, it excludes biases resulting from small sample size.

Anatomy of a DSS

A demographic surveillance system (DSS) is a longitudinal population-based surveillance system that may collect health as well as demographic data. A DSS must include two basic operations: 1) a baseline census that defines the study population and records (at minimum) the age and sex of population members; and 2) mechanisms for monitoring births, deaths, and migrations on an ongoing basis. Most systems also include mechanisms to identify members' household/familial relationships and marital status, cause of death, and covariates of (i.e., factors affecting) demographic rates (such as individuals' educational, economic, and health status). Some surveillance systems monitor births and deaths only, but these systems are restrictive: "risk accumulating to individuals cannot be monitored unless all components of demographic dynamics are observed" (Phillips and MacLeod forthcoming).

The most advanced surveillance systems serve as platforms for a range of scientific undertakings. Research projects linked to a DSS may focus on diverse subjects (e.g., behavioral, social, economic, or epidemiological issues); may be quantitative, qualitative, or both; and may represent a range of study designs (e.g., panel surveys, cohort studies, randomized trials, and factorial experiments). Experimental interventions may be therapeutic (e.g., trials of new vaccines or reproductive health technologies); behavioral (e.g., pilot projects promoting healthy sexual and reproductive behaviors); or supply-side-oriented (e.g., experimental service-delivery strategies).

health and family planning interventions. This information allows policymakers and program planners to make decisions based on sound scientific evidence.

That a good DSS is a remarkable engine for research has been demonstrated beyond doubt by the Matlab DSS in Bangladesh. This 33-year-old system has spawned nearly 2,000 scientific publications on demographic and health dynamics in a rural South Asian population. It was the first developing-country DSS to collect longitudinal population-based surveillance data on events, risks, and relationships and to manage these data by computer so rigorously that their causal connections could be established empirically—for example, Matlab data proved that mothers' educational attainment affects child survival. This system has shown that a good DSS can—and should—directly benefit the study population: "The lives of Matlab residents have been improving due, in part, to the many interventions in that locality" (Phillips 1998b, 6).

Matlab also demonstrated the feasibility and scientific value of situating a DSS in an isolated, impoverished developing-country setting. This arrangement concentrates research and programmatic attention where it is needed most; it may also yield insights relevant to populations in similarly disadvantaged environments.

Headquartering a DSS in a field station located in such a setting has economic and logistical advantages as well as scientific ones. The field station can function as a nexus for funding and research infrastructures (including computers), along with data and scientific/technical expertise. The station's DSS can serve as a central data-management system for diverse research projects that "piggyback" on the surveillance operation. This allows researchers to share and compare data among studies and obviates the need to build separate data-management systems for each study (a considerable cost savings). The field station can also serve as a professional training ground and as a magnet for researchers who might otherwise choose to work in a developed country; thus, it can help to build research capacity in the DSS locale. The Matlab and Navrongo stations, along with a few others, have demonstrated the tremendous research potential of these "population laboratories."[2] Indeed, "most population laboratory–based research has been produced by a few generously funded, rigorously managed, and well-equipped research stations" (Phillips and MacLeod forthcoming).

Outside of these scientific oases, however, DSS data are in short supply in the developing world; thus, they are missing where they

[2] "In some settings this has occurred despite economic and political turbulence and institutional weakness in local universities and ministries of health" (Phillips 1998a, 1).

are needed most: in places where health and population-related problems are at their worst. “For one billion people living in the world’s poorest countries, where the burden of disease is highest, those who are born or who die are still not counted” (INDEPTH 1998, 1). Longitudinal population-based surveillance data are absent even in countries where a good deal of population research has been carried out over the years.[3] These data are so scarce in sub-Saharan Africa that model life tables for this region must be based on survival data from other regions.[4]

This dearth of DSS data slows progress in public health and family planning on many levels. Program planners cannot target services to those at greatest risk of unwanted pregnancy, disease, and death without DSS data to identify who and where these people are. “Most of [those at greatest risk] die without any contact with the health system” (INDEPTH 1998, 1). Researchers cannot empirically assess the efficacy of interventions if they lack data providing clear “before and after” pictures of a population’s health and demographic status. This means they cannot conduct field trials of promising new health technologies, such as vaccines, that now sit in laboratories waiting to be tested (see box, page 10). Policymakers and program planners are left to make decisions affecting millions of people’s lives in an empirical vacuum.

The need for DSS data in developing countries is now greater than ever. Long-standing health and population-related concerns (unwanted pregnancy, maternal and child mortality, and endemic disease, to name a few) are being compounded by new threats to people’s wellbeing, including the spread of virulent and newly resistant infectious pathogens (such as those responsible for AIDS, tuberculosis, and malaria) and consequences of implosive urban population growth (such as rising mortality rates in many African cities). Furthermore, the sheer number of people with health and family

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[3] “Ironically, there is a surprising amount of information-generation, research activity, and capacity in data-poor countries” (INDEPTH 1998, 2).

[4] These tables (the equivalent of life insurance charts) allow researchers to predict demographic outcomes, such as infant mortality and life expectancy; thus, they are critical instruments for research and program planning.

So many vaccines, so few places to test them

Scientists have developed scores of experimental vaccines against diseases that are major causes of death in developing countries. Yet few of these vaccines are undergoing human trials—largely because of the dearth of field sites where these tests can be conducted with scientific rigor.

There are now more than 50 malaria antigens in existence, but only one vaccine is in trials, and one other is slated for trials. Japanese researchers have developed a new measles vaccine that does not need to be kept cold or administered only to four-month-olds—two major drawbacks of the vaccine now in use (given that refrigeration and birth records are scarce or nonexistent in many developing-country settings). This promising vaccine is also stuck in the research pipeline.

Vaccines are best tested at field sites with longitudinal population-based surveillance capabilities—i.e., DSS sites—located where the targeted disease is endemic. Scientists can then determine whether a vaccine has had a demographic impact by analyzing DSS data on cause-specific mortality rates before and after a vaccine trial. (The same applies to field trials of other health technologies.) Multi-site trials, in which an intervention is tested at several sites with comparable DSS data, yield the most rigorous scientific results. The growing network of developing-country DSS sites using HRS-based systems is making it possible, for the first time, to conduct reliable multi-site trials of experimental vaccines.

planning needs is increasing exponentially as developing-country populations continue to expand.

Finding solutions to these problems requires stepping up longitudinal population-based surveillance and related field research. This need comes just when governments have cut back on foreign aid and health budgets, meaning that more research must be squeezed out of fewer funds. At the same time, researchers are better prepared than ever to undertake this work and to do so in a cost-efficient way. In sum, “health problems requiring surveillance-based clarification have never been greater; technological solutions requiring surveillance-based trials have never been more promising; and scientific readiness for low-cost, replicable, and high-quality surveillance studies has never been so advanced" (Phillips 1998b, 7).

So, given these conditions, why have there been so few DSS sites in developing countries? The answer boils down to two words: complexity and cost.

Longitudinal population-based surveillance requires interviewing tens or hundreds of thousands of people in their homes, on a regular basis, over the course of years—a logistical challenge that increases in those developing-country settings where populations are isolated, dispersed, and/or highly mobile (as in many parts of rural Africa). The large quantities of data gathered in the field must then be entered into a computer, managed, and analyzed appropriately. Money, staff, computer systems, field station facilities, scientific/technical expertise, management skills—all of these resources are needed to undertake and coordinate field and computer operations in a DSS.

To complicate matters, the entire surveillance process is highly error-prone. Inaccurate reporting by respondents, incorrect entries into data-collection books, data-entry mistakes on the computer, and insufficient mechanisms to catch and correct errors all threaten to contaminate the database. In a longitudinal system, small errors compound over time, handicapping if not destroying the system. This situation represents the major data-management challenge facing DSS researchers; yet there has been little systematic research on this computing problem.

Computer-related constraints have largely limited longitudinal population-based surveillance in developing countries. Every DSS program not based on the HRS has been custom-built from the ground up for a specific research site by computer experts. These programs are typically large and complicated, take lots of time and money to develop and maintain, and require expensive, high-powered computers and computer specialists to run them. For example, millions of dollars have been invested in the Matlab program, which consists of nearly 5,000 lines of computer code, runs on a mainframe computer system in Dhaka (far from the field site), and is operated by a large team of computer professionals and support staff. Making even minor modifications in the program's code is a time-consuming job that must be done by an expert programmer. Not only is this set-up costly, it also creates a dependency on off-site, often foreign, specialists, and it limits to an elite corps those able to operate a computerized DSS. Moreover, the separation of field and computer operations makes it difficult to synchronize these operations and complicates the process of correcting data errors, adding to the expense of the system. Altogether, Matlab operations cost several thousand dollars a year to maintain.

Places with sufficient resources to invest in a Matlab-like system may nevertheless be stymied by computer-related constraints. Attracting computer scientists to a developing-country DSS project is not easy: "Technical assistance for [the computer] program can require posting a computer specialist to a remote location—an arrangement that technicians in the computer field typically reject—where their efforts generate technology that no one else can understand, change, or manage" (Phillips 1999, 2).

These factors largely explain why a good DSS is so hard to find: the financial, technical, and logistical requirements of setting up and running these systems have been prohibitive in most developing-country locales. But this is beginning to change—thanks in large part to the Household Registration System.

The Household Registration System

The Household Registration System is a product unprecedented in the population field: a DSS computer program *template*. This software system can generate any number of site-specific DSS programs, according to user specifications, and can be customized to the needs of almost any demographic/health surveillance operation. It is the only DSS-related software to make use of two recent innovations in software engineering: automated software generation and object-oriented programming (a methodology that simplifies the handling of large, complex programs). The HRS was designed to overcome the limitations of custom-built DSS computer programs, making it possible for more developing-country researchers to run a computerized DSS.

No advanced computer knowledge is needed to operate the HRS. Program modifications require only a minimal knowledge of FoxPro, the computer language in which the HRS is programmed. The newest version of the HRS—HRS2® for Windows—is an even more user-friendly upgrade of the system.[5]

The heart of the HRS is a "core system" that serves as the foundation for every DSS program generated by the HRS. The core is based on the principle that certain "characteristics of households, household members, relationships, and demographic events…are common to most studies of human populations. The logic for these characteristics is embedded in the core system" (Phillips and MacLeod forthcoming). The HRS uses the household as the basic unit of analysis because this is known to be a fruitful approach to demographic and health research.[6]

The core system is a foundation on which many different structures can be built. Programs generated by the HRS can be tailored in any number of ways to suit different study requirements. For example, the HRS can be adapted to studies of social structures other than (or in addition to) households, such as extended families and kinship networks; and it can be adapted to accommodate additional information, such as data on specific events or household/individual characteristics. Users can extend the basic program by adding to it small units, or modules, of computer code that correspond to specified functions. Code modules can be constructed by computer specialists at remote locales, then transferred electronically to field

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[5] HRS2® (released in January 1999) is compatible with Windows 95 and all subsequent versions of this operating system. It is programmed in Visual FoxPro version 5.0 (Microsoft Corporation).

[6] "Strong observed correlations between social and economic status and health status attest to the value of information on household member relationships, customs, and behaviors in research on the determinants of survival. The household unit of analysis is also critical to research evaluating health interventions, since health service effectiveness is determined as much by household social and behavioral factors as by the efficacy of medical technology" (Phillips and MacLeod forthcoming).

sites. For example, if a research team using an HRS-based DSS wants to track episodes of malarial fever in children under age five, a module corresponding to this function can be sent to the DSS site, where it can be dropped into the program.

The HRS generates DSS programs that perform three basic functions:

1) maintain a consistent record of baseline and longitudinal data on households and household members in a geographically defined population;
2) generate all printed documentation for field and computer operations—instruction manuals, data-collection books (called field registers or household/compound registration books), interviewing guidelines, error reports, and other materials;
3) produce a standard package of statistics—including demographic rates (fertility, mortality, migration) for the overall population, for subsets of the population, and for different time intervals; population distributions by sex, age, and geographic area; and life tables.

The interactive, visual, menu-driven format of the HRS allows users to define study parameters, enter and edit data, and generate reports with the click of a mouse. Easy-to-read prompts and other messages guide users through the steps that must be taken to perform any function.

The HRS largely dictates how data collection/entry/management/analysis are undertaken in an HRS-based DSS. The system specifies procedures to be followed in the field and on the computer; it coordinates field and computer operations; and it synchronizes these operations within a fixed work cycle.[7]

Ensuring data accuracy and consistency is a top priority of the HRS. Rigorous field and computer protocols are built into the system

[7] The standard cycle is 90 days. This interval is considered optimal because it is "short enough to ensure that all pregnancies can be seen within a round [of interviews], but long enough to ensure that all data can be entered, checked, processed, and reported in the work cycle" (Phillips and MacLeod forthcoming). However, the HRS can be adjusted to accommodate a work cycle of any specified duration.

to maintain a “clean” database. Interviewing procedures are standardized and detailed; field registers are designed to minimize data errors (see footnote 8); and field supervisors routinely visit a sample of households to check the quality of data-collection work. Data entered into the computer must pass through a gauntlet of error-trapping procedures, which check the logic of events, dates, relationships, and so forth. Data failing any of these tests *cannot* be inserted into the database; this is one of the most powerful features of the program. If a data inconsistency is detected—for instance, if a birth is reported in a household where no mother is registered—a message identifying the problem appears on the computer screen. The information is re-entered to rule out a data-entry error; if the problem persists, the system generates an error report, which is used to determine the steps that must be taken to correct the error.

An HRS-based surveillance operation takes shape as follows: At the outset, researchers enter basic study parameters into the program, which then generates the requisite computer code for the specified study. In the first round of interviews, field workers collect baseline census information about every household and household member in the study population. This information is entered into the computer. The system then generates field registers that contain the baseline data and are formatted to facilitate data collection, entry, and management.[8] At the start of the next work cycle (e.g., 90 days after the baseline census), workers take these registers into the field to conduct a new round of interviews in every household, marking answers to questions and other relevant information in the books. Completed registers are submitted to data-entry clerks, who transfer new information into the computer. Data-checking procedures (described above) are followed to ensure that new data entries are

[8] For example, households are listed in registers in the order in which they are visited, and each household has its own register page on which the name of the head-of-household and characteristics of the household and its members are printed. Pages have separate rows for each household member, columns in which to record events that have occurred since the previous interview, and space to note new information about the household and its members. This layout ensures that event data and data on individuals-at-risk are recorded together; and this, in turn, helps to ensure that linked database records are consistent with each other.

consistent with the database. All these steps must be completed before the next work cycle begins.

As data accumulate through repeated work cycles, the database deepens and statistical patterns emerge. These are the raw materials that researchers use to analyze demographic/health dynamics and to answer questions that could not be answered in the absence of DSS data. For example: Is a vaccine or family planning program having a demographic impact? What are the primary causes of child mortality and the key determinants of child survival in a study population? HRS-based surveillance systems allow researchers to identify the determinants of demographic/health outcomes because these systems account for risk at the individual level. In addition, DSS programs derived from the HRS have “relational” databases—a design that facilitates correlating events with individual or household characteristics/relationships and that makes it easier to maintain a consistent database.

The HRS significantly reduces the cost and complexity of longitudinal population-based surveillance. The program can run on moderately priced microcomputers housed in a field station and can be operated by computer nonspecialists with remote technical assistance; therefore, it eliminates the need for expensive computer hardware, off-site computer facilities, and specialists to run DSS programs. Field and computer operations are proximate to each other in an HRS-based DSS; therefore, these operations can be coordinated easily, data can be transferred from the field to the computer quickly, and data can be checked and corrected efficiently. This eliminates logistical complexities, inefficiencies, and data-management costs of systems in which field and computer operations are far apart. But the biggest cost savings of the HRS is up front: the program is free—in other words, it eliminates the $2 million cost of a custom-built DSS program.

The Household Registration System remains a work in progress. The HRS team aims to:

1) expand its program of remote technical assistance to HRS users;

2) launch a training program (in workshop format) to increase the capacity of developing-country researchers to set up and run HRS-based systems, particularly in sub-Saharan Africa;
3) develop the next version of the system: HRS3® for Windows. This version will be more than a standard upgrade of HRS2®; it will improve upon the current version by enabling users to access a new set of software tools that will make it easier to adapt the HRS to any longitudinal study.

The HRS in Action: Navrongo and Beyond

Field workers on bicycles and motor bikes are a common sight in the remote Kassena-Nankana District of northern Ghana. These are the data collectors of the HRS-based Navrongo Demographic Surveillance System, which tracks the 137,000 inhabitants of this poor, rural district. Kassena-Nankana is fast becoming the Matlab of sub-Saharan Africa—a center for state-of-the-art DSS operations, rigorous health and family planning research, and culturally appropriate experimental interventions in an area characterized by high rates of fertility, morbidity, and mortality.

In 1991 James Phillips and Bruce MacLeod were invited to field test the HRS in Navrongo, where Ghanaian health scientist Fred Binka was conducting malaria research. Previously a British scientific team had undertaken a Vitamin A study in the area, for which they had developed a DSS; however, the system's computer program could not be adapted easily to the malaria study. Binka needed a DSS for his research; Phillips and MacLeod needed a research site to test and develop their DSS software. The men wasted no time joining forces in the field.

The HRS was pilot tested in Navrongo in 1992; the full-scale HRS-based Navrongo Demographic Surveillance System was launched in 1993. Since then, the NDSS has served as a platform for six research undertakings, the largest of which is the Navrongo Community Health and Family Planning Project. This multifaceted project tests health and family planning interventions tailored to local needs and cultural/social institutions; it also uses national Ministry of Health resources in novel ways to bring services to the local population. “Preliminary results indicate that the project is having an impact on reproductive motives, contraceptive behavior, and fertility,” reports the Navrongo Centre, now under the directorship of Ghanaian health scientist Alex Nazzar (Navrongo Health Research Centre 1999, viii). For example, local fertility rates have declined since the inception of the Navrongo Project.

The five other NDSS-based studies have focused on diseases endemic to Kassena-Nankana, notably malaria, the number one cause of death in the region:

1) an insecticide (perethritin)-impregnated bed net trial (testing a malaria intervention);
2) an epidemiological study in advance of a malaria vaccine trial;
3) an etaquine trial (testing a malaria prophylaxis);
4) an epidemiological study of human rotavirus (a virus that causes watery diarrhea in infants, who often die from this condition in the absence of medical intervention) in advance of a human rotavirus vaccine trial;
5) a study of long-term health effects of cerebral spinal meningitis.

The NDSS is regarded as a model DSS because it is dedicated to humanitarian goals, scientific excellence, policy/program-relevant research, and sustainability. The Navrongo team works to upgrade NDSS operations, sharpen study designs, and expand communications with a variety of groups: policymakers, program planners, researchers outside Navrongo, members of the public, and other interested audiences.

Beyond Navrongo, the HRS is in full-scale use at 11 sites: three in Tanzania, two in Kenya, and one each in Burkina Faso, The Gambia, Indonesia, Mali, Mozambique, and Uganda. A wide range of scientific projects are underway or are planned at these sites (see box, page 19). Data from surveillance operations and vaccine trials at HRS sites will be comparable, since these data will be standardized

HRS sites and research agendas

SITE	AREAS OF RESEARCH
Burkina Faso	acute respiratory infection, child survival
The Gambia	malaria and other diseases, nutrition, reproductive health
Ghana	community health, epidemiological studies in advance of malaria and human rotavirus vaccine trials, other malaria studies, reproductive health and family planning
Indonesia	health system reforms
Kenya (2 sites)	malaria vaccine trial, urban health research
Mali	child survival, reproductive health
Mozambique	malaria vaccine trial
Tanzania (3 sites)	malaria vaccine trial, health system reforms, tropical disease research
Uganda	reproductive health

Source: Phillips 1999, Table 1

according to HRS reference data protocols. Life tables derived from data at these sites also will be comparable.

In 1999 a research team from Matlab visited Navrongo to see what it could learn from its scientific progeny. Longitudinal population-based surveillance had come full circle.

Now it is time for that circle to expand.

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