

## Decision Support Systems for Improving the Analytic Capacity of Decentralized Routine Health Information Systems in Developing Countries

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### 1. Introduction and background

Routine health information systems in most third world countries are woefully inadequate to provide the information support necessary for planning and management of the health services. According to Neame and Boelen, "The health care environment is bursting with information, but the sector lacks the capacity to find, communicate or use it effectively".<sup>1</sup> One of the main reasons for this situation is that routine health information systems in most countries are centrally planned and managed.<sup>2</sup> Indicators, data collection instruments, and reporting forms usually have been designed by centrally located epidemiologists, statisticians, and administrators (called *data people*), with minimal involvement of lower-level line managers and providers of the health services (called *action people*). The cultural differences between the two groups are often so huge that Dunn speaks of the "two communities metaphor".<sup>3</sup> Data processing and analysis are mainly the responsibility of a centrally located office. Complex data transmission and compiling systems slow down the production of feedback in such a way that, by the time a feedback report is received at lower levels, the information is frequently obsolete for decision making. Planners and managers face deadlines and time constraints in their daily decision making. Outdated information, even of high quality, is of low value to them. The main result of this centralization is that information use is weakest at the district

level, where the main public health interventions are planned, implemented, and monitored, and at the health unit level, where individual health decisions are made.

Fortunately, many national policymakers in developing countries have decided to attack the information problem at the roots. Bolivia, Cameroon, Eritrea, Morocco, Niger, Pakistan, Philippines, and South Africa are examples where comprehensive HIS restructuring efforts have taken place recently or are still underway. One of the more consistent findings of these experiences is that *decentralization of information management toward the district level is an effective strategy to improve routine information systems.*

Decentralized Routine Health Information Systems in developing countries allow health program managers at both peripheral (district and regional) and central (national) levels to better monitor and evaluate the health programs by making available at all levels the data necessary for decision making. Since information technology became increasingly affordable for developing countries, computerization of data processing and analysis has further contributed to the availability of quality and timely data.

Routine information systems include a wide array of data collection subsystems, such as health center service statistics and disease surveillance systems, financial/budgetary systems, personnel management systems, population/vital registrations, and commodity logistics

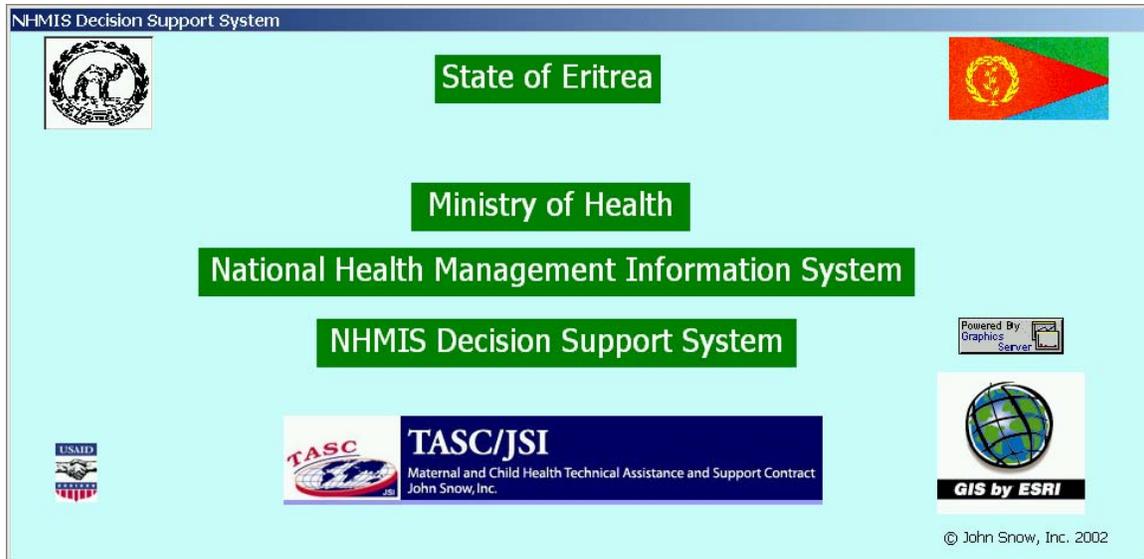
systems. When these systems first became computerized, automated data processing and analysis was done only at the central level, while manual data collection and processing procedures continued to exist at facility and district levels. Reports were manually processed and data were manually aggregated by district workers, and sent to the national level. Often this resulted in the loss of facility level information because only district summaries were submitted to the national level. Feedback reports sent to the data producers and district managers often lacked relevance (did not permit facility level analysis), were unreliable (data errors went undetected) and were out dated and untimely.

As computers became more affordable and ubiquitous, efforts have been made to decentralize the processing of information to the lowest level possible, which for many developing countries is the district or regional level. Thus feedback from the district to the data suppliers (facilities) can be more timely, relevant and reliable. Health facility level data are collected manually in the form of a monthly or quarterly report at the health facility and sent to the district level, where they are entered into the computer. After data processing occurs at the district level, the data are then passed to the regional and national health managers (via modem or diskette). One major advantage of such a decentralized system is that the district managers no longer have to wait for a feedback report to be sent from the central level in order to monitor their health programs. The data exists locally, where local processing is more apt to result in reliable data, since errors can be checked with the actual facility level reports. Feedback to the data producers can also be done in a timely manner.

Even with decentralized data processing systems, routine health information is often not fully exploited for numerous reasons, including analytic and data management skills of the health program managers. Because of the hierarchical and relational format of the raw data, the program managers have to spend too much time preparing these data in a presentable format for analysis (aggregating, processing, copying to spreadsheet and graphics software, etc.). Insufficient time is spent on the analysis itself, and on interpretation of the information for health services planning and management. Decision support systems have thus been developed to enable decision makers to more rapidly prepare their data for analysis, so that more time can be spent actually analyzing the data and using the information for decision making. This paper presents recent experience of John Snow, Inc. (JSI) staff in the development and use of these decision support systems.

## **2. Development of decision support systems**

The decision support system (DSS) is a module added to an existing routine health information system that allows decision-makers to visualize health indicators and data elements collected by the system in graphical and geographical presentations. Recent applications developed with the help of JSI include The Moroccan National Health Information System for Maternal and Child Health (2000), the Eritrean Health Management Information System (2002) and the Haitian Health Information System (2003). The user, after accessing the module, chooses a series of options to determine the specific analysis desired.



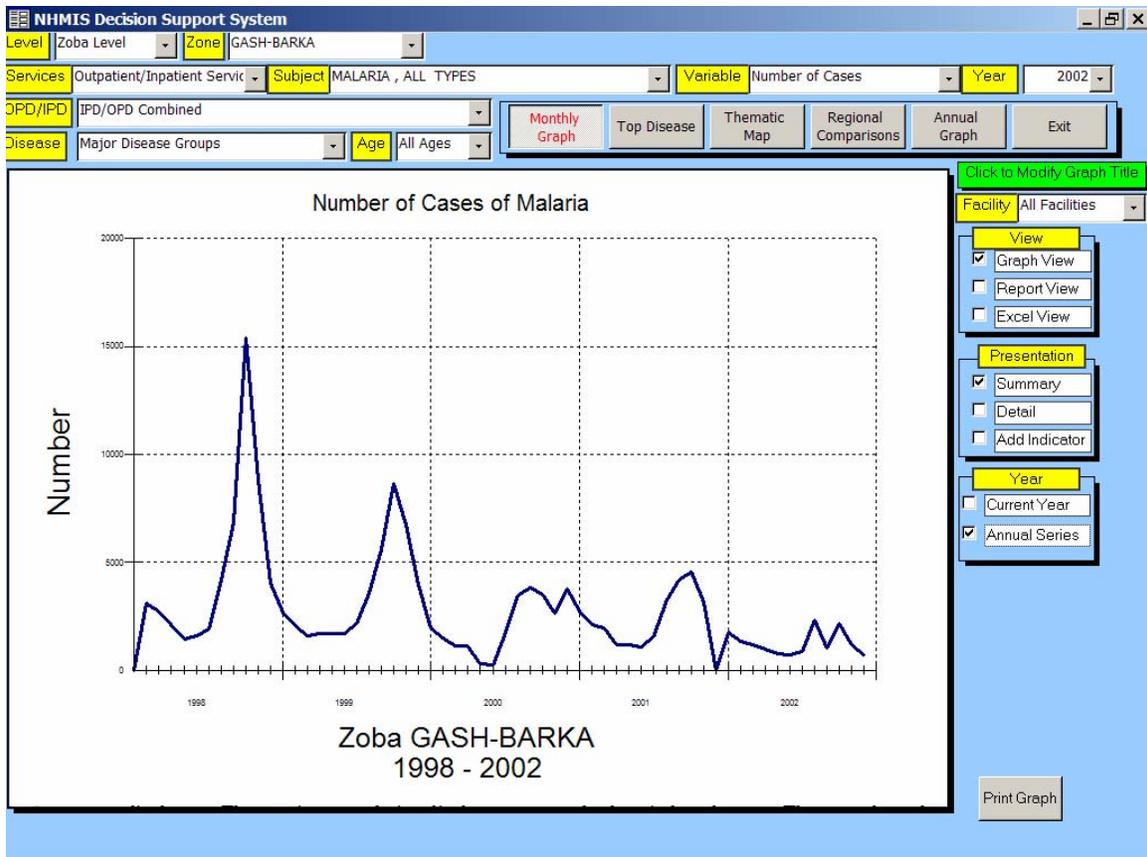
**Figure 1. Eritrean Decision Support System**

Here is the process:

First the user chooses a level of analysis, national, regional, district, or health center. If the regional level is chosen, the system then displays a list of regions, so that the user can then choose the desired region. If the district level is chosen, the system presents a list of regions, as above, then a list of districts in the chosen region. If health center level is chosen, the system presents a list of regions, then the districts in the chosen region, then the health centers in the chosen district.

Next, a health program is chosen. The user can choose from a country specific list of health programs and services. Examples include curative care services, family planning, prenatal and postnatal services, obstetric care, integrated management of childhood illness (vaccinations, nutrition, diarrhea diseases and respiratory diseases), epidemiologic surveillance, laboratory

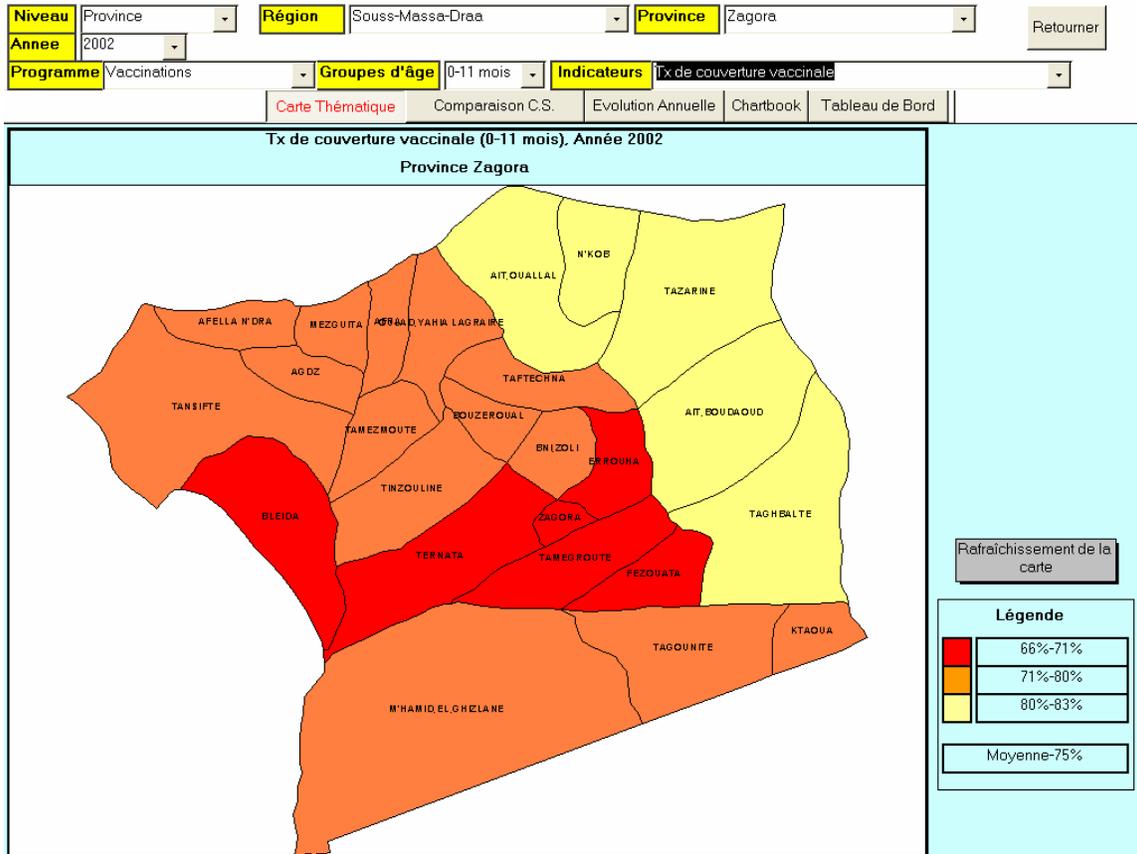
services, emergency services, essential drugs and target populations. When a specific health program or service is selected from the drop down list, the user is presented with a list of the program/service indicators and data elements specific for that program/service. Indicators/data elements can include population based rates, percentages, averages, or numbers. For instance, for obstetric services, the indicators include the coverage rate of births in the health facilities (percentage of births in the health facility out of the number of expected births), percentage of complications taken under care, death rate due to complications, percent of cesarean births, % low birth weight infants. The data elements include the number of: live births, still births, infant deaths within 24 hours, complications seen, complications taken under care, cesarean births, referrals, maternal deaths and low weight births.



**Figure 2. Example of Monthly trend graph of Malaria cases in Gash Barka Zone, Eritrean Decision Support System**

Finally the user chooses the desired analytic display. The various analytic displays offered include time trends (monthly and annual), geographic comparisons (histograms and GIS thematic maps) and pie charts. Each analytic display also includes various options, which the user can choose to modify the analysis. For instance, the monthly timeline displays the chosen indicator/data element for the current year by month, or for the previous 5 years by month. The user can select all the data,

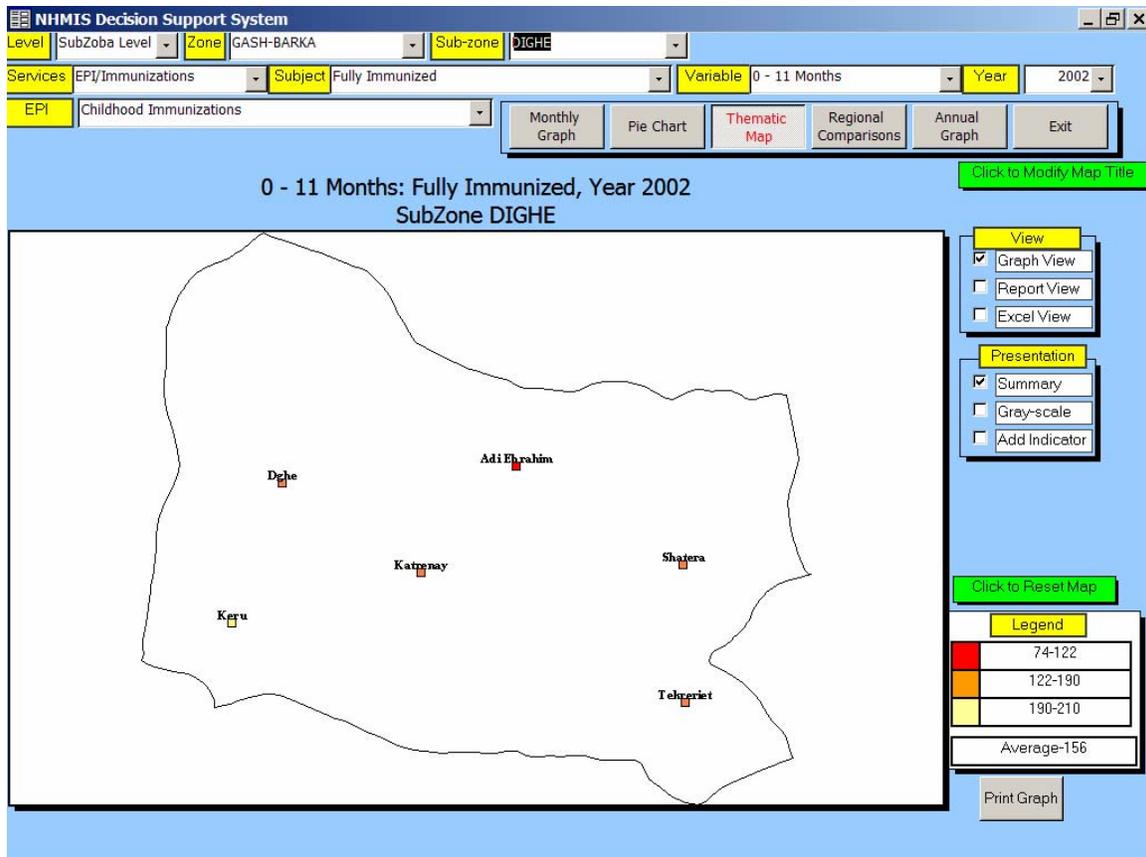
or choose a subset of data, such as rural clinics only, hospitals only, etc. The annual graph displays the indicator calculated annually, such as the annual coverage rate for vaccinations. The user can choose to display the chosen indicator in the form of line or bar graphs. The regional comparison displays a histogram by region at the national level, by district at the regional level and by health center at the district level.



**Figure 3. Example of Thematic Map of Vaccination Coverage, Zagora Province, Moroccan Decision Support System**

The thematic map displays the indicator using GIS mapping technology. For instance, at the national level, the indicator is displayed by region or by district. If a region is chosen, the regional map by district is displayed, and if a district is chosen, the district map by health center coverage area or health center location is displayed. Other mapping features include selection of a zoom to enlarge a portion of the map, pre-defined cut-points can be changed to user-defined cut-points, and the map regions are clickable, to display the indicator values (numerators and denominators) for the selected region. One problem encountered with the mapping was the availability of

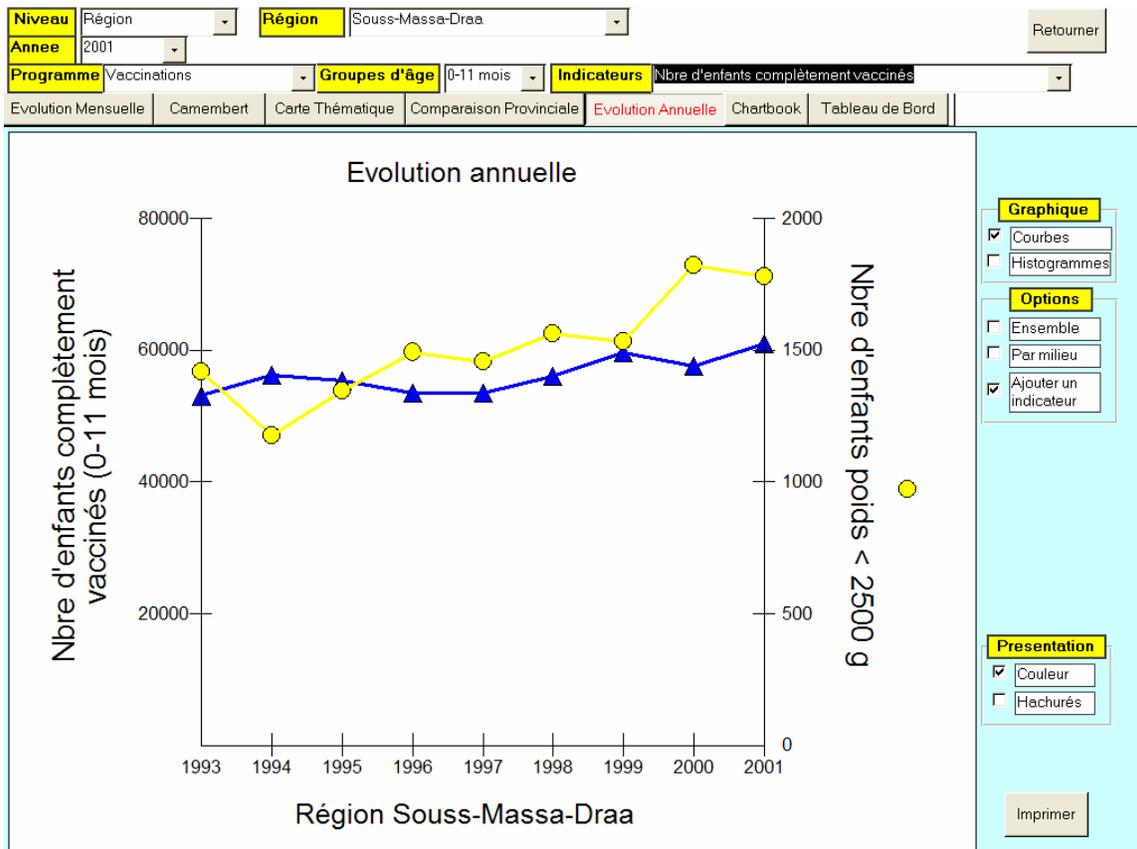
appropriate map layers. Maps with regional and district boundaries were readily available, but none of the countries had developed map layers for the health center catchment area. In Morocco, maps with communal boundaries were available, but these were not always the same as the health center catchment area. The solution used was to use the communal boundaries, and then let the users at the district level define which health center was allocated to which commune. In Eritrea, maps were developed which showed the location (latitude, longitudinal) of the health center. Thus the user can click on a facility, and display the value for the chosen indicator.



**Figure 4. Example of Thematic Map of Fully Vaccinated Children 0-11 months, Eritrean Decision Support System**

Other decision support features include the preparation of a chart book, in which the system generates a series of graph images that are linked to a Microsoft Word document or PowerPoint presentation, in which a series of graphs can be generated and printed with little effort. There is also a summary table format, in which 2-3 indicators for each health program are calculated and compared with the national,

regional or district average. The systems also allow for viewing the data (numerators and denominators) for each graph element, exporting the data to Microsoft Excel, printing the graphs and maps, and creation of image files (JPEG format) for inserting or linking with documents and presentations. It is also possible, for certain graph types to add a second indicator to the graph, for comparative analysis.



**Figure 5. Example of comparative analysis of annual trends of low birth-weight babies with completely vaccinated children, 0-11 months, Souss-Massa Draa Region, Moroccan Decision Support System**

In each of the countries in which JSI has assisted the Ministry of Health in decentralizing the computerized data processing system as well as developing decision support systems to improve their analytic capability, it has been necessary to develop new software to meet their changed needs in terms of data collection and processing. Since earlier (centralized) systems were developed before the introduction of the Windows operating system, these countries had developed systems using a variety of DOS-based software, such as dBASE, Foxpro and Clipper. For the revised decentralized systems, new computers with Windows operating systems had been purchased for the districts, and the Ministries of Health requested that these new applications be developed using Windows-based application development tools. Microsoft Access was

selected in Morocco, Haiti and Niger, while Eritrea developed a Visual Basic user interface, with Access tables for data storage. For the decision support systems, Active-X Object development tools were incorporated into the Access systems which provided the graphic and geographic functions that were lacking in Access. To calculate and display the graphic analyses, a Graphics Server (Pinnacle WebWorkz, Inc.) Active-X object was added to the Access user interface form. The mapping and geographic analysis were achieved using MapObjects LT (ESRI, Inc.). These development tools were chosen because they were state of the art, and offered “royalty free distribution”. In other words, only development copies of the software needed to be purchased, and then the developed applications could be distributed without having to pay a licensing fee for each

installation. This was important, since the system was decentralized, and copies were distributed to each district, as well as numerous copies within the central Ministries of Health.

### 3. Results

Early results (primarily from Morocco) show that the DSS has been widely appreciated by district health managers as a planning and programming tool for health activities in their districts. The district managers have “ownership” of the data, and have higher motivation to insure the data is of good quality. However, even when quality data are available and well presented, managers and care providers tend to make little use of information for decision making. More emphasis is needed on the development of an “information culture”, in which there is more motivation and incentives for managers to use data for decision-making. Data Users Workshops were an important element in the process of enabling district health managers to better understand how to use information for improving service delivery and improved staff performance through supervision. The workshops also permitted better coordination and communication between district, regional and central levels. Finally, they helped district managers understand how information for the routine reporting system can be complemented by more in depth and qualitative studies and surveys.

The Eritrean DSS was also greatly appreciated, but implementation at the District level has been slower than anticipated, due primarily to delays in obtaining adequate computer resources at that level. At the National level, the system has gained wide usage as a tool for decision-making among both the Ministerial Health Program managers and International donor agencies.

The implementation of the DSS in Eritrea, Niger, and Haiti are still in an early stage, so that results have not yet been analyzed. Since the system was developed first in Morocco, the recommendations of

the Moroccan system users as well as the resulting DSS programming modifications were incorporated into the system subsequently developed for Eritrea. Again, recommendations from the users in Eritrea were incorporated into the DSS in Haiti and Niger, so that the system developed more functionality and flexibility with subsequent versions.

One impediment to the development and sustainability of decentralized routine health information systems is the current process of project funding. Technical assistance efforts for routine information systems are different than for other non-routine data collection efforts, such as surveys or special studies. Surveys and other special studies can be planned, implemented, data entered and analyzed, in a fixed time period. Capacity building for strengthening routine health information systems requires a multi year effort. Data collection and processing revisions and refinements are more frequent and time consuming. Information users need to be trained on a continuing basis to analyze and share their understanding of the information. Yet, most health information system projects are funded only for short time periods.

### 4. Next steps

One category of information users which needs to be more involved in capacity building for information use are the health facility managers and care providers. The DSS allows for presentation of the information by health facility. District managers need to be trained to organize information use workshops for the health facility staff, using printed outputs from the DSS. Better use of information by health facility managers and care providers not only will directly improve service delivery, but also have a long lasting effect on the quality of the data generated.

More research is needed to explore the importance on data use of other determinants such as the organizational

environment as well as individual behavioral factors. Many developing countries are struggling with the decentralization of management functions. District managers are called upon to adopt new behaviors in terms of how to use information as the basis for decision making related to these new management functions.

Keywords: Routine Health Information Systems, Developing Countries, Decision Support System

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I do not have any significant financial interest/arrangement or affiliation with any organization/institution whose products or services are being discussed in this session.

The authors are employed by John Snow, Inc.

<sup>[1]</sup> Neame R. and Boelen C. *Information Management for Improving Relevance and Efficiency in the Health Sector: A Framework for the Development of Health Information Systems*. Geneva: World Health Organization, 1993.

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<sup>[3]</sup> Dunn W.N. The Two-Communities Metaphor and Models of Knowledge Use: an Exploratory Case Study. *Knowledge 1*, 1980.