Geographic Information System (GIS), a Tool for Decision Making and Planning: *UNICEF Experience in the Context of the Dracunculiasis Eradication Programme in Africa*

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Background

Dracunculiasis, most commonly known as Guinea worm, a vector-borne disease transmitted through unsafe drinking water, is a string-like worm that emerges through the skin causing pain. It often cripples as a consequence of multiple co-infections. This disease, which affected more than 600,000 people in some 23,000 villages in 1990, has been reduced to 164,973 cases in 1994 in less than 10,000 villages across 19 countries: Benin, Burkina Faso, Cameroon, Chad, Cote d'Ivoire, Ethiopia, Ghana, India, Kenya, Mali, Mauritania, Niger, Nigeria, Pakistan, Senegal, Sudan, Togo, Uganda and Yemen.

That impressive achievement is the result of a number of factors among which are: a) the commitment and technical support of various organizations particularly UNICEF, WHO, Global 2000 of the Carter Center, UNDP, the United States Peace Corps, b) the financial support of several countries such as Canada, USA, Norway, and Japan, c) the political will and motivation of decision-makers in the affected countries, d) the support of the international and national private sector and e) the right combination of strategies, particularly case search for identification of affected areas and communities, provision of safe water supply, health and hygiene education for behaviour change, epidemiological surveillance, vector control and case containment.

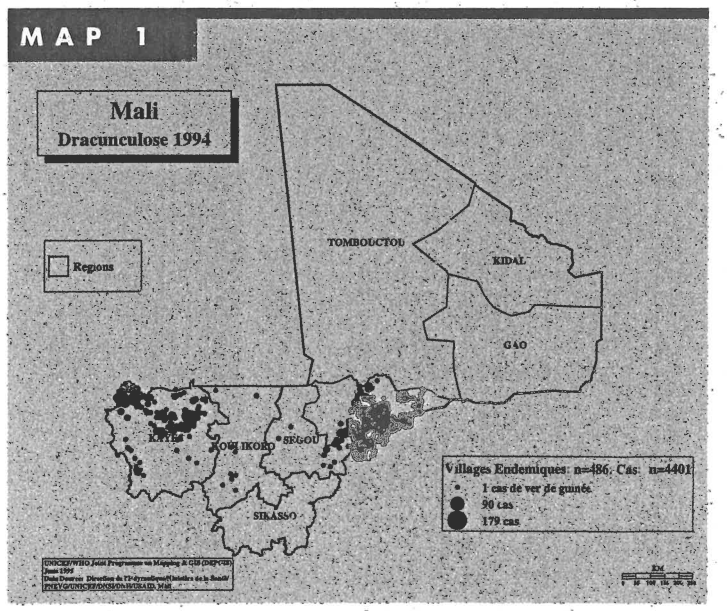
These reviews have shown that one of the major impediments to most of the programmes is data management and village-level monitoring, particularly when programmes are getting close to eradication. Indeed, as countries were reaching the case containment phase, the most crucial aspect was to identify and report in a timely manner, all new emerging cases. Therefore, the need for locating affected villages and those at risk became a real challenge, due to the fact that they were usually small, remote and difficult for programme planners to know because of their remoteness and their lack of registration on existing maps.

The large number of affected villages and hamlets made the traditional reporting format confusing for managers who did not always have the available time and the appropriate staff to go through lengthy reports and tables. Mapping of national, district and village level information and customized graphs of programme achievement appeared then to be the best alternative and the most efficient way to represent, at a glance, what they wanted to know. It enabled an effective decision-making process (see as example Map 1 of Mali showing distribution of Dracunculiasis affected villages in 1994), planned interventions such as the creation of modern water supply systems, the rehabilitation and protection of existing water points and chemical treatment of unsafe water drinking sources, good knowledge of the situation was required.

It is in that context that UNICEF and WHO have operationalized the Geographic Information System (GIS) as an effective strategy to manage information, target affected areas, plan interventions, allocate resources, improve epidemiological surveillance and monitor progress.

A Geographic Information System (GIS) is an intelligent, multi-purpose data structure and a set of geo-processing tools that manage, analyze and manipulate geographically referenced information as well as support queries and map making.

To help identify and locate human settlements, particularly the "least reached villages", not mapped and usually unknown from policy and decision-makers, Global Positioning System (GPS) revealed to be very useful. The GPS is a signal receiver and converter.



Signals received from three or four satellites are transformed and processed by the calibrated unit which gives the position of the site with fairly good accuracy (5 to 10 meters). The GPS a compact unit, light, slightly the size of a portable telephone, battery operated, reliable, easy to use, was created to be used directly in the field, at the site to be georeferenced.

Geographic Information System for improvement of water supply in Dracunculiasis Eradication Programme.

As early as December 1989 policy makers in UNICEF in light of the vast field experience acquired through UNICEF community based programme, had foreseen the difficulty ahead in identifying all the endemic villages and the villages at risk particularly in the African context. Indeed, Guinea worm appears to be a strong indicator of the lack of attention paid over the year to usually small and remote settement very often of difficult access, that could have been called "the forgotten villages".

In January 1990 a workshop was held at Hunter College on the possibilities of using a Geographic Information System to manage information related to the Dracunculiasis Eradication Programmes at country, regional and local levels, as well as to improve the monitoring and evaluation capacities of the programmes.

The objective of the Geographic Information System was to provide to decision makers a tool for the planning, management, monitoring and evaluation of all health related information, interventions or activities, with a particular emphasis on dracunculiasis in the short term.

The specifics objectives were to:

a) localize and map all endemic villages by zones, districts and regions;

b) localize and map the existing and planned physical and cross-sectoral infrastructures such as water supply system, health center, school, communication, village with health workers and community-based organizations.

c) spatially analyze desegregated information, monitor and evaluate all programmes or interventions related to Guinea worm eradication at village, district, regional, national and inter-country level.

During the 1990–1993 period, the use of GIS was introduced in UNICEF water and environmental sanitation-assisted programmes in Benin, Burkina Faso and Mali and to a lesser extent in Nigeria. The focus was to collect and map information on implementation of key water supply and health/hygiene education activities in relation to national dracunculiasis eradication programmes.

In order to make timely and rational decisions, design strategies capable of maximizing the impact of limited programme resources and implementing allowed planned interventions such as the creation of modern water supply systems, the rehabilitation and protection of existing water points and chemical treatment of unsafe drinking water sources. Good knowledge of the situation was required.

To satisfy most of the information needed at national, regional and district levels in relation to the water supply component of the Guinea worm eradication programmes, the following set of indicators was identified:

1. Location, identification, and size of infected village
2. Number of cases of Guinea worm and incidence
3. Number of infected villages having access to safe drinking water
4. Ratio of population to safe water points
5. Number and size of infected villages without access to safe drinking water
6. Villages having access to safe water supply with an organized and trained committee for operation and maintenance of water supply system
7. Infected villages with access to the health system

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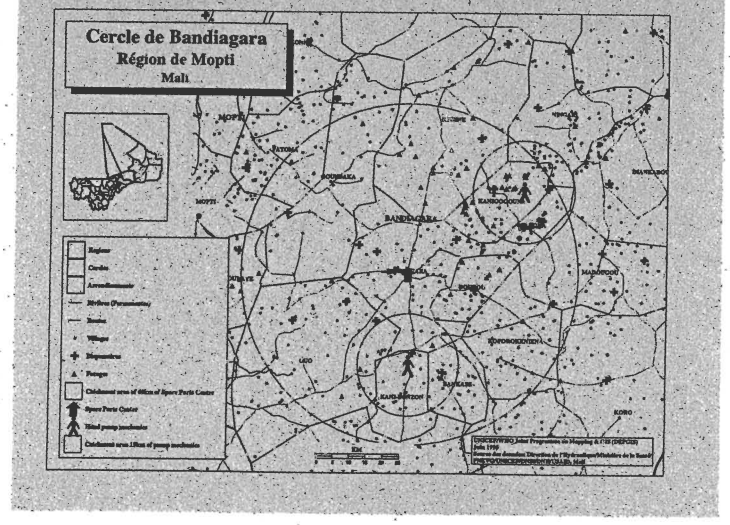
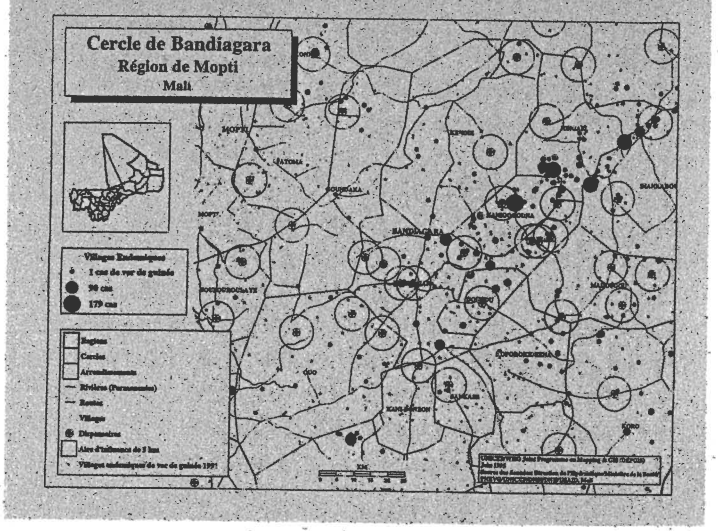
MAP 2



MAP 3



■ **Geographic Information System (GIS)**, from page 13

Those indicators, which were used as primary information for programme and strategy design as well as for baseline data for appropriate target setting in relation to programme priority and resources, later became performance or impact assessment indicators, once the strategies and intervention activities were implemented.

In Mali, Burkina Faso and Benin, based on the information from the "village by village" national survey carried out to identify endemic areas/village/settlement, the first application was in mapping all endemic villages and the existing water supply infrastructures in order to evaluate water supply needs and planned interventions in the most endemic areas.

As Guinea worm is known to be transmitted through infected water, at first the tendency was to plan for construction of water supply systems. But the use of GIS has helped refine strategies in relation to water supply. Indeed, the case of Burkina Faso was very convincing: when overlaying the baseline situation map of affected villages with the water supply infrastructure, immediately in one clear picture it was revealed that most of the endemic villages had a modern water source. The planners' task then was no longer to programme for new construction, but rather to improve consumption from the existing systems. Further investigation showed that some 40 per cent of the existing systems were not in operation due to lack of maintenance. Therefore, the focus of the water programmes changed from the construction of new schemes to rehabilitation of existing ones, the setting of an operation and maintenance system and a health/hygiene education programme to fully benefit previous investments and ensure sustainabilty. The costing of these interventions were one-sixth of what was previously estimated by the Guinea worm programme.

In the context of operation and maintenance of water supply systems, the Geographic Information System proved to be a remarkable and promising tool in the quest for efficiency and sustainability. While in the 1980's the emphasis was on service delivery, mostly focussing on construction and extension of water supply systems in order to increase coverage, the 1990's trends, benefiting wisely from lessons learned, are moving towards greater emphasis on operation and maintenance to ensure durability and sustainability.

A Geographic Information System has the capacity to assist in designing spatial and analytical envelopes that recognize regions' and districts' uniqueness and link cross-sector programme and project profiles to site selection when conceiving maintenance systems, particularly in relation to spare parts sales and distribution and training of local repair persons (see Map 2 of Bandiagara Circle in Mopti region of MALI, on page 13).

Mapping can efficiently facilitate addressing the following:

- Where would the greatest demand for spare parts by type of technology be?
- To what extent are existing distribution centers meeting the needs or the potential demand for service?
- How many competitors are located within the markets?
- Are government-subsidized centers really servicing systems not covered by the private sector or are they undermining private sector share and extension potentials?
- What is the likely demand and potential revenue from geographically creating new networks versus expending existing networks?
- Is there enough incentive for mobilizing private sector intervention?

The analytical challenge in designing a maintenance system is to depict to potential independent/private distributors the relative location of existing handpumps with pertinent information regarding the number of pumps for each technology, the demand for services, the size of the demand, and the potential growth based on planned future programmes. Highlighting where the potential exists and site selection, particularly in light of decreasing government-subsidized programmes, is key to promoting the general markets for sales of spare parts.

The Challenge

The difficulties in the implementation were:

- scarcity of information
- identification of data bank location
- several sources of data with no standardization of format
- unreliable or incomplete data
- toponym, or variation of name for the same location, or difference in orthography depending on the source of data
- age of the existing maps which were drawn in the late 1950's or in the 60's
- large numbers of institutions and agencies intervening in the provision of water and the lack of coordination among them.

The major challenge was geocoding accurately existing villages' databases using coordinates from existing maps or Gazetteers[1]; collecting with the aid of GPS, the coordinates of administratively non-registered human settlements; and creating and linking attributes' files on population and water supply.

From Water Supply to Primary Health Care planning and beyond: Geographic Information System, a tool for sector and programme linkages and integration

It was not until 1992 that the strategic role of a GIS in the eradication programme was fully realized. Indeed, as the number of cases was being reduced, it became obvious that in order to attain the goal of eradication, the exact location of every endemic village

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needed to be known in order to assure effective implementation of interventions and to allow monitoring of case containment. To achieve that latter objective, WHO and UNICEF established an operational unit to assist in Health Mapping and Geographic Information Systems for the Dracunculiasis Eradication Programme in 1993. Known as DEPGIS (Dracunculiasis Eradication Programme Geographic Information System), the programme, established within the Division of Control of Tropical Disease at WHO in Geneva, had the mission to provide technical assistance to national governments in the identification and mapping of all endemic villages.

However, the introduction of the GIS within the Guinea Worm Eradication Programme did not intend to cope only with Guinea worm, but rather to be a tool for improving countries' overall programmes by enhancing their ability to target and monitor the causes and underlying causes of deteriorating health conditions in the least-reached villages in the first stage and later, to promote good health for all.

Offering a spatial means of analysis of programme interventions across sectors, the GIS can also help policy makers to spatially relate the multiple efforts of various collaborating agencies to one another and to specific problems, action and outcome. This means information pertaining to a sector in an area can be combined with other information from other sectors in order to create a comprehensive representation of a situation in a region, a district or a community. Such a comprehensive view can be invaluable as it clearly and easily articulates sectoral parameters and issues while informing policy makers of the level of available infrastructure to face these issues.

In various African countries, within programmes assisted either by UNICEF, USAID or the World Bank, the trend is towards systematic mapping of Health Districts, analyses of site locations in relation to their catchment areas and the number of potential users necessary to make the health facilities self-sufficient or financially sustainable while ensuring their effective use. (See Map 3 of health infrastructure distribution and catchment area in relation to dracunculiasis affected villages in Mali, on page 13).

In the past, health care providers did not use spatial analysis to consider how convenient their health center location was to their patients. Particularly in rural areas, health center locations were politically motivated or often the site decision was determined by land donors' generosity.

After a long focus on the construction of infrastructures, governments are revising their approach to health care programmes in light of actual health data. Indeed, the existence of health centers did not necessarily impact the health status of the population. Accessibility and quality of services revealed to be key determinants in the effective use of health services.

More attention is being paid today to site location methodology that increases effectiveness and system efficiency, allowing health planners to see how accessible health networks are to the populations they are designed to service. Mapping also helps target better the unserved populations, particularly those of remote and difficult-to-access villages. Planners can easily visualize the limits of existing geographic "markets" and anticipate where demand for services may increase.

More and more Primary Health Care Programmes are paying closer attention to the geo-demographic market assessment approach, meaning the understanding of the demographics within the geography while taking into account regional economic disparities, growth and migration trends.

With geographic analysis, planners and decision makers can easily identify partners, see where the geographic holes in national or regional programmes exist, focus on the "right" population group to be served and reduce potential duplication of efforts and resources while looking for ways to reduce costs of service delivery and maintaining supply inventories and distribution.

Reduction of environmentally-based resources, increasing demographic pressure and the associated growth of demand in a context of stagnant or regressing economies, are putting pressure on government programmes which have to address the rising conflict among cost reduction and service availability and quality. The emerging trend towards decentralization of decisions and management of resources by local governance are raising the need for especially desegregated data, in order for development activities to adequately address vulnerable groups. Therefore, Geographic Information Systems can be an effective tool for the identification of exclusions and disparities, because of its cross-sectoral analysis potential.

The Geographic Information System is also proving to be an effective tool for emergency preparedness as in the case of the Famine Early Warning System funded by the United States Agency for International Development. It is an information system designed to identify problems in the food supply systems of some eleven Sub-Saharan African countries that could lead to famine conditions. As a result, these conditions can be pre-empted, thereby helping insure food security in these countries.

To date, the UNICEF/WHO DEPGIS, has provided support to some 19 countries and trained staff from ministries of water, health, planning, education, and the interior as well as NGOs in 17 of them. Since its establishment, the unit has assisted the governments of these countries in mapping 78,450 villages and in the collection of village-level data from remote, non-registered and sometimes unknown villages. After the large and practical experience acquired, the DEPGIS programme is looking beyond Dracunculiasis to evolve as a multi-purpose database and a public health management tool.

Bibliography

1. *Strategies and Resources: Operational strategy framework for dracunculiasis eradication.* UNICEF, July 1992
2. "UNICEF Dracunculiasis Eradication Programme Technical Support Team."

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Community-Based Health Education, from page 9

cation in the water and sanitation component have been our priority. At the operational level, the National Water and Sewer Department took over administration of rural and municipal mini-aqueducts for the first time. We are supporting their work in water quality control and in the development of the "Healthy Schools" (Escuelas Saludables) Programme. This programme aims to develop a new culture around water, hygiene practices, basic sanitation and protection of water, by strengthening the capacity of school children and involving parents and community organizations in carrying out their own activities. It consists of a diagnosis of sanitary conditions at schools, and giving top priority to urban-marginal and rural one-teacher schools. It then establishes a plan for comprehensive improvement accompanied by education processes and community participation.

The Healthy Schools project was launched in 1995. UNICEF is supporting this new initiative in 29 urban-marginal schools and 29 one-teacher schools in the rural county of Puriscal. The diagnoses were carried out as well as plans for improvement and the publishing of educational materials for these 58 schools. The process was accompanied by four investigations into sanitary conditions and one in solid waste management carried out by the Master's Programme in Public Health of the University of Costa Rica. The most important achievement in this programme is that children and parents as well as communities or organizations are at the center in carrying out the activities. In the areas of health, hygiene education and environment in schools and communities, children and adolescents are identifying problems and solutions regarding their quality of life and sustainable development. At the same time, youth clubs working in sanitation and the environment were formed in 28 communities throughout the country. These youth clubs are strengthening communication networks, and the Internet system was installed for 25 clubs. All of these projects are being carried out with the intention of systematizing the experiences and proposing changes in the curriculum. Beginning late last year, the National Water and Sewer Department and UNICEF are developing a system of indicators to measure the impact of the Healthy Schools programme involving different institutions, communities and organizations; the process was initiated as an objective of all the programmes of UNICEF Costa Rica.

Our experiences mentioned above are the consequences of the conclusions of the Mid Term Review (MTR) and compliance with the National Development Plan. The National Development Plan aims: 1) to promote sustainable development in the social, economic and environmental sense; 2) to ensure equal access to quality services for children and adolescents; 3) to promote social policies based on intersectoral approaches and the efficient use of resources; and 4) to encourage greater involvement of the community in decision-making. The Plan de Combate a la Pobreza focuses on disparity reduction and sustainability of social gains and programmes.

Considering the National Development Plan, we think that the role of UNICEF should be modified to take into account the very evolved discourse on social development in the country, the substantial advances made on progress to World Summit for Children goals and the fact that the national focus has shifted from Child Survival to Child Rights. To this end, the government has begun formulating a Children's Code to harmonize national legislation with the International Convention on the Rights of the Child (CRC). Given its limited size, we concluded that the programme should be based on demonstrably high impact activities with fewer and more focused objectives. Existing service delivery capacity in the country is such that UNICEF can focus more intensely on development, protection and participation aspects of CRC. These lessons will be incorporated into the New Country Programme, with the last two years of the current Country Programme being an important time for this transition.

Therefore, community-based health education and sanitation in the WES sector will be an important component, given that while the State is faced with a fiscal crisis the alternative is to strengthen the country's human resource potential as well as social and community participation. A by-product of the country's great social advances in the past 40 years due to farsighted policies (massive investment in health and education, and highly developed social sector institutions), is the unquestioned legitimacy of the State and consolidation of its centralized role. These policies did not foster meaningful community and social participation to increase the beneficiaries' commitment to the process. Now that the government is reducing social sector expenditures, a process for decentralization and capacity-building must take place, eventually to the empowerment of communities.

Geographic Information System (GIS), from page 25

Meeting Report TST V, Ouagadougou, Burkina Faso, 14–17 December 1992

3. "UNICEF Dracunculiasis Eradication Programme Technical Support Team." *Meeting Report TST VI,* Cotonou, Benin 26–28 March 1993.

4. "UNICEF GeoTECH, Mapping Technology Pack," Volume 1 #1, UNICEF March 1993.

5. *Countdown*, Volume 2 # 1, UNICEF Dracunculiasis Eradication Programme, March 1993.

Note

1 Gazeteers are official lists of cities, villages, places, mountains and rivers names and coordinates which are produced by the United States Board of Geographic Names for each country and published by the Defense Mapping Agency. These lists, containing official place names have been recently made available on CD-ROM as "Geoname Gazetteers" by

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