World Health Organization

Putting people and health needs on the map

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GIS health mapping technologies are routinely used to support the daily activities of WHO's Strategic Health Operations Centre, which serves as a hub for gathering and interpreting disease intelligence, and coordinating international responses to public-health emergencies.

Introduction

The launch by WHO of an innovative public health mapping programme, which promotes the use of computerized Geographical Information Systems (GIS) to improve disease surveillance, is transforming the way geographically linked information can be used to monitor disease, improve health care, and save lives.

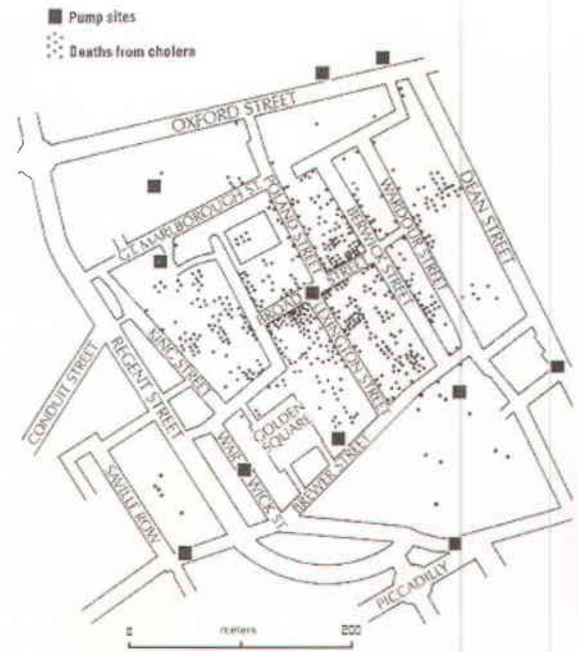
In many countries, public health mapping and GIS are already being used to locate the geographical spread of diseases and populations at risk, identify unmet health needs, and target the delivery of health interventions such as medicines, vaccines, drinking-water filters, or mosquito nets. The visualization of geographically linked information from a wide range of different sources offers fresh insights, increased responsiveness, and greater precision in efforts to improve public health.

The breakthrough follows the development by WHO of computerized mapping systems such as the HealthMapper – designed to simplify the use of GIS as a tool for public health – and the launch of a web-based public health mapping application which has been used to develop an online global health atlas.

One of the key strengths of public health mapping is the standardization of disease surveillance data from village level to global level and across diseases – strengthening disease surveillance worldwide and enabling links to be made between different diseases, health interventions, and programmes. To complete the picture, public health mapping tools can be used to analyse health-related data from a wide range of sources, providing a well informed base for decision-making.

Today health maps are being used to chart information from sectors that include education, water, population, environment, and climate, as well as health. Together, these maps offer a unique perspective of a country's health care services and of the health and vulnerability of its people. The maps include information that ranges from the location of human settlements and infrastructure (roads and rail networks, dams, irrigation schemes) to district and national boundaries, health facilities, nutrition, schools, safe water sources, and, in some countries, refugee settlements and unexploded mines. Health maps can also be used to chart the size and profile of populations from remote rural areas to overcrowded cities. They can register the catchment area of a community health worker and the population served by an urban hospital. They can also be used to map the global spread of diseases.

Each map can then be overlaid onto any of the other maps, as required, creating kaleidoscopic layers of linked information which can be analysed to support decision-making. For example, by overlaying the latest data from remote satellite sensing systems, the system can be used to map unusual weather patterns, vegetation, and mosquito breeding sites – information that can be used to anticipate unseasonal outbreaks of malaria. A composite map, combining data on populations at highest risk, health service providers, and transport networks, can then be used to help target urgently needed supplies of antimalarial medicines, mosquito nets, or insecticides in the quantities needed.



Dr John Snow

Geographical mapping of diseases is not exactly new. Its first reported use was in London in 1854 when Dr John Snow used it to trace the source of an outbreak of cholera. By mapping the location of drinking-water pumps in relation to the homes of people who died he succeeded in identifying the source of the epidemic – a single contaminated water pump.

Behind each health map lies the painstaking collection and mapping, and constant updating, of detailed information at country level. This ongoing process involves health personnel, laboratories, data collectors in the field, statisticians, and decision-makers from village level to global level. WHO's Public Health Mapping and GIS programme also draws on health-related information from a wide range of sources, including organizations involved in child health and education, migration, refugee movements, humanitarian emergencies, food security, water and sanitation, meteorology, and the environment.

First developed in the 1990s to help in the initiative to eradicate guinea-worm disease, WHO's HealthMapper is now also used in global efforts to control a range of other infectious diseases and health problems. However, it can equally well be used to monitor the global spread of noncommunicable diseases such as cardiovascular disease, diabetes, or cancer and to relate these to different risk factors. In addition, health mapping and GIS are also being developed to help improve health management systems in urban settings. Elsewhere, health mapping and GIS are being used in complex emergencies, to identify where health problems exist, target resources to those most in need, and prevent duplication in humanitarian efforts.

In the aftermath of the devastating tsunami in the Indian Ocean in December 2004, WHO used public health mapping tools to provide logistical support for the relief operation in the South-East Asia region - establishing population-based needs assessments for the worst-affected areas. During the emergency relief phase, maps were produced on a daily basis to assess the most pressing health needs - highlighting the most heavily damaged areas, including the extent of damage to villages, roads, bridges and health facilities.

Cholera outbreak in Angola: cumulative cases, 13 February - 30 July 2006

Meanwhile, the constant threat of epidemic diseases such as cholera and meningitis and the emergence of new diseases such as HIV/AIDS, Ebola, Severe Acute Respiratory Syndrome (SARS), and avian influenza and the resurgence of old foes such as yellow fever and tuberculosis (TB) – coupled with the new threat of deliberate release of biological agents such as anthrax and smallpox – have given added urgency to the need for a rapid response to outbreaks of disease in any country.

In the not-too-distant future, advances in health mapping technology are expected to offer the speed and precision needed to provide an early alert when an outbreak occurs and help to ensure a rapid response to contain the outbreak. Using GIS and hand-held mapping devices equipped with a satellite-based Global Positioning System (GPS), health workers will be able to feed health-related data from a remote area in Afghanistan, India, or Mali into a national surveillance database and, simultaneously, into an Internet-based global health information network.

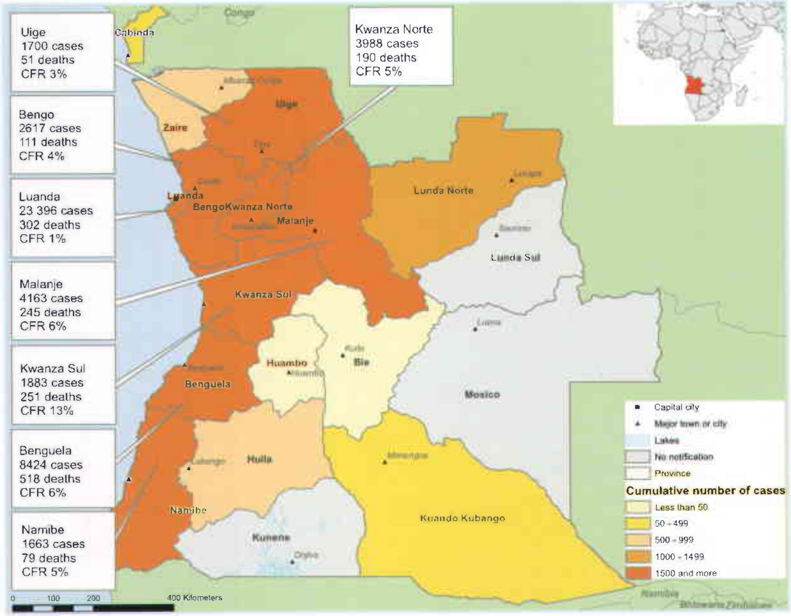
How GPS works

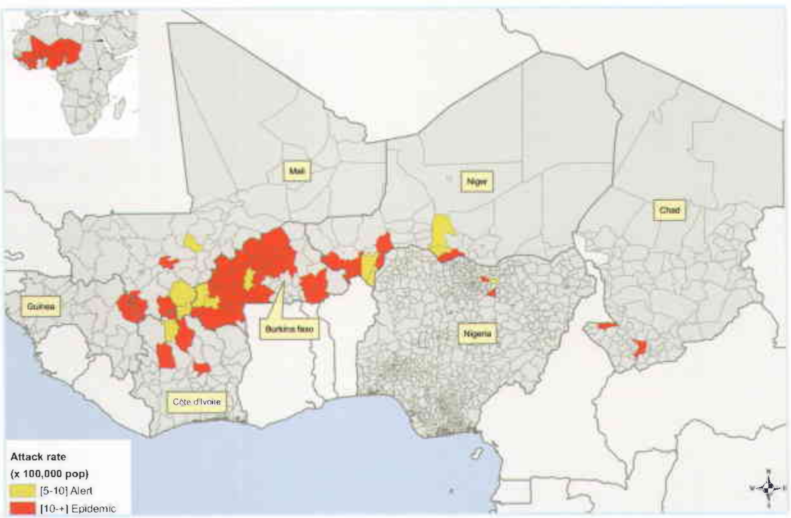
The Global Positioning System (GPS) is a satellite-based navigation system designed to locate an exact position on land, in the air or at sea – at any time of the day or night and in all kinds of weather.

The system relies on a network of 24 satellites orbiting in space 20 000 km from the earth. Each satellite transmits radio signals that allow a GPS receiver situated anywhere on earth to estimate the satellite location and measure the distance between the satellite and the receiver.

With data from at least four satellites, a GPS receiver can determine the latitude, longitude, and altitude of a position. By continuously updating the data, a GPS receiver can also log speed and direction of travel – an application used to track the movement of vehicles such as ambulances, for example, and guide them to a precise location.

Over the past decade, the price of GPS receivers has fallen substantially. Hand-held GPS units – the size of a mobile phone – are now affordable for use in low-income countries. In future, the number of GPS users is expected to increase dramatically as GPS receivers are scheduled to become an integral part of all mobile phones.





Districts crossing the alert and epidemic thresholds in African countries under enhanced surveillance during the meningitis epidemic season, 2006

Putting people and health needs on the map shows how health mapping is being used by decision-makers to:

- identify populations at risk
- assess health care coverage
- guide health sector strengthening
- highlight the geographical spread of diseases
- stratify risk factors
- assess resource allocation
- plan and target interventions
- support the monitoring and analysis of trends
- support advocacy and fundraising.

Part 1 highlights some of the ways in which health mapping and GIS are being used both in countries and at the global level to inform decision-making and improve health care.

Part 2 looks at how public health mapping and GIS are being used across the board to support global efforts to roll back malaria.

Part 3 examines how public health mapping and GIS are poised to become cutting-edge tools for disease surveillance and global health security in the 21st century.

PART 1
Making connections

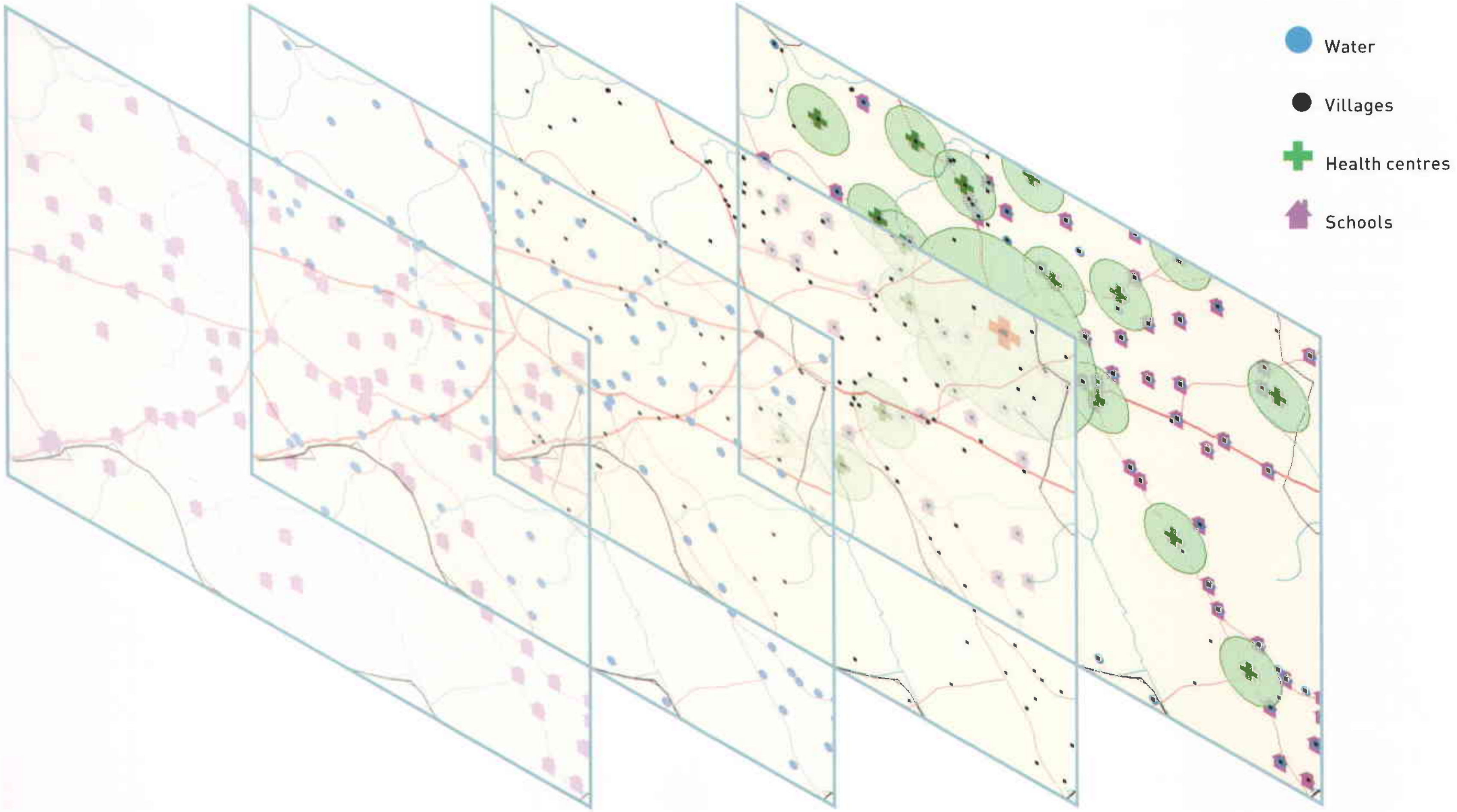
Police investigators use GIS to solve crime – mapping crime scenes and searching for possible connections between linked crimes (locations, times, dates, transport networks, and employment patterns, for example). Health planners use it in a similar way – to get a broader perspective on health and identify the missing links between diverse health-related information.

By using health maps to juxtapose information from sectors such as education, agriculture or water with health data, for example, decision-makers can make critical connections that can be used to improve health care and save lives. They can see at a glance how a disease is distributed across countries and regions and around the globe, and they can make connections between patterns of disease, the populations at risk, and the availability of food, safe drinking-water, essential medicines and vaccines, or well-functioning health facilities.

Integration of schools, water, health sectors for improved programme coordination.

It is possible to combine public health information from different sectors into a single map to help planners better understand the public health situation of individual communities. By showing the location of villages, schools, health centres and protected water sources all on the same map, it is easier for decision-makers to assess how to allocate available programme resources across sectors to achieve the most rapid development of healthy communities.

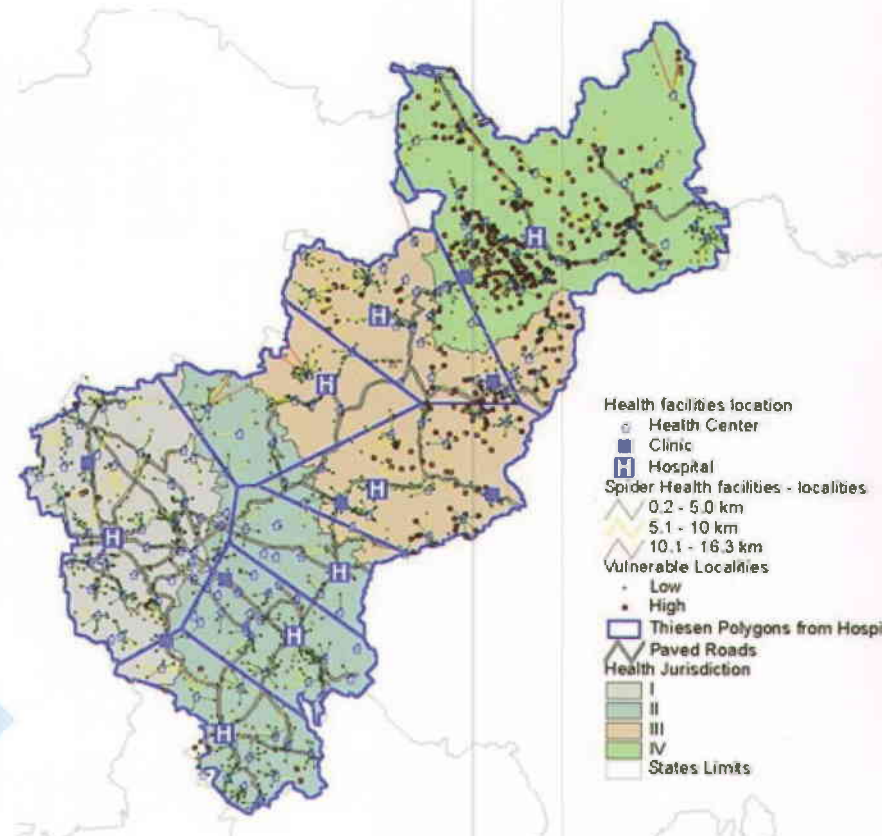
MAKING CONNECTIONS



Mapping information across sectors

For some infectious diseases – especially vector-borne diseases such as schistosomiasis and malaria – information from a range of different sectors is essential to determine where the diseases are occurring and identify the people at highest risk. Environmental and weather data are already being used in some countries in sub-Saharan Africa to track changes in rainfall and temperature patterns that may herald an increase in vector populations and outbreaks of disease. Education data are used to locate schools where children can be treated for parasitic diseases or targeted for health education programmes, and socioeconomic data are needed to ensure that scarce resources are targeted to the neediest populations.

Water engineering projects, such as dam building schemes and irrigation projects, need to be monitored and their potential impact on vector populations assessed. Similarly, mapping the exact location of new oil or mining projects, for example, could be used to prevent outbreaks of malaria among non-immune migrant workers or the spread of HIV and other sexually transmitted infections (STIs) through a possible increase in commercial sex. Public health mapping provides the ideal platform for presenting the wide range of health-related data that are needed for this kind of analysis and decision-making.

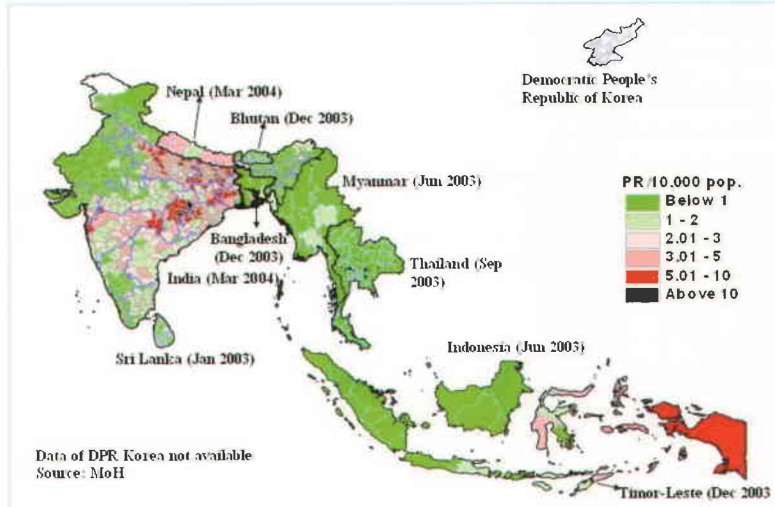


Mapping risk assessment in Mexico
In the Mexican state of Querétaro, the Pan American Health Organization (PAHO) has used its own GIS-based public health mapping tool - SIGEpi - to identify the populations at highest risk of environmental disasters (including earthquakes, floods, land subsidence, and other hazards such as oil and gas pipelines). The risk assessment helped identify the highest concentration of vulnerable communities – poor, marginalized populations in 242 settlements in the north-east of the state with low levels of health coverage and the highest exposure to environmental hazards. ©PAHO.

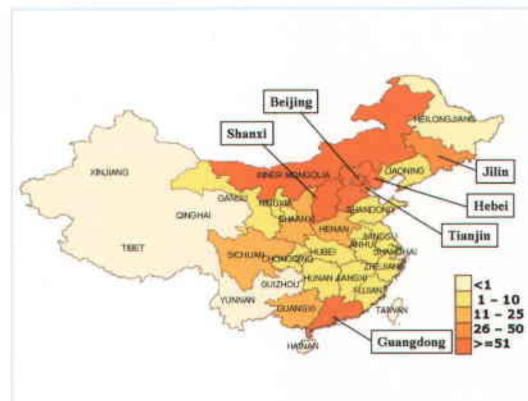
A regional perspective on health

In WHO's South-East Asia Region, public health mapping and GIS are proving to be invaluable for monitoring trends, analysing and presenting data, and supporting decision-making. For example, public health mapping is used to monitor progress in efforts to control or eradicate diseases such as polio, leprosy, and malaria, and to support planning, advocacy, and the targeting of resources. In addition, it is a key support tool for monitoring the spread of antimicrobial resistance (resistance to antimalarial drugs, for example) and the incidence of diseases linked to environmental factors such as chemicals, food, soil, the workplace, and the quality of air or water. A recent development is the creation of a web-based Integrated Data Analysis System, which can be used to establish a regional database that includes reports, graphs, charts, and maps. This is expected to become a key tool for statistical analysis and decision-making throughout the region.

In 2003, WHO's Regional Office for the Western Pacific outbreak response and preparedness team used GIS to map the cumulative number of cases and deaths of Severe Acute Respiratory Syndrome (SARS) globally and locally.



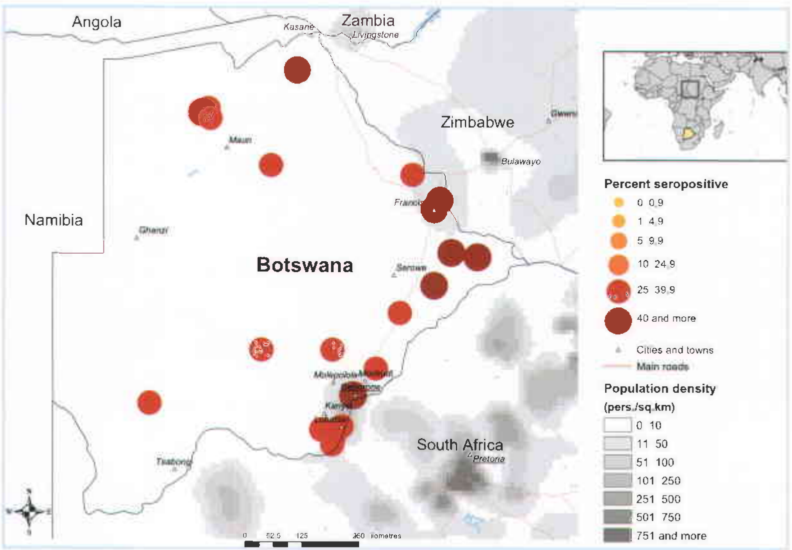
Leprosy: prevalence Rate in South-East Asia Region for year 2003 / 2004



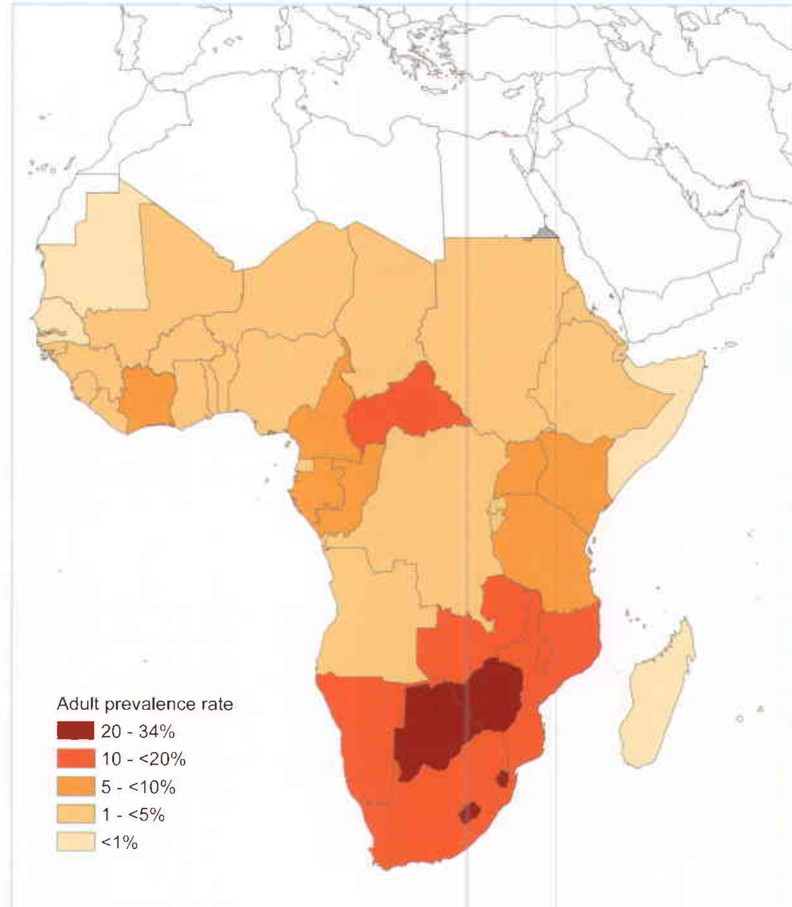
Cumulative number of Severe Acute Respiratory Syndrome (SARS) in China mainland, 15 May 2003

From local level to global level

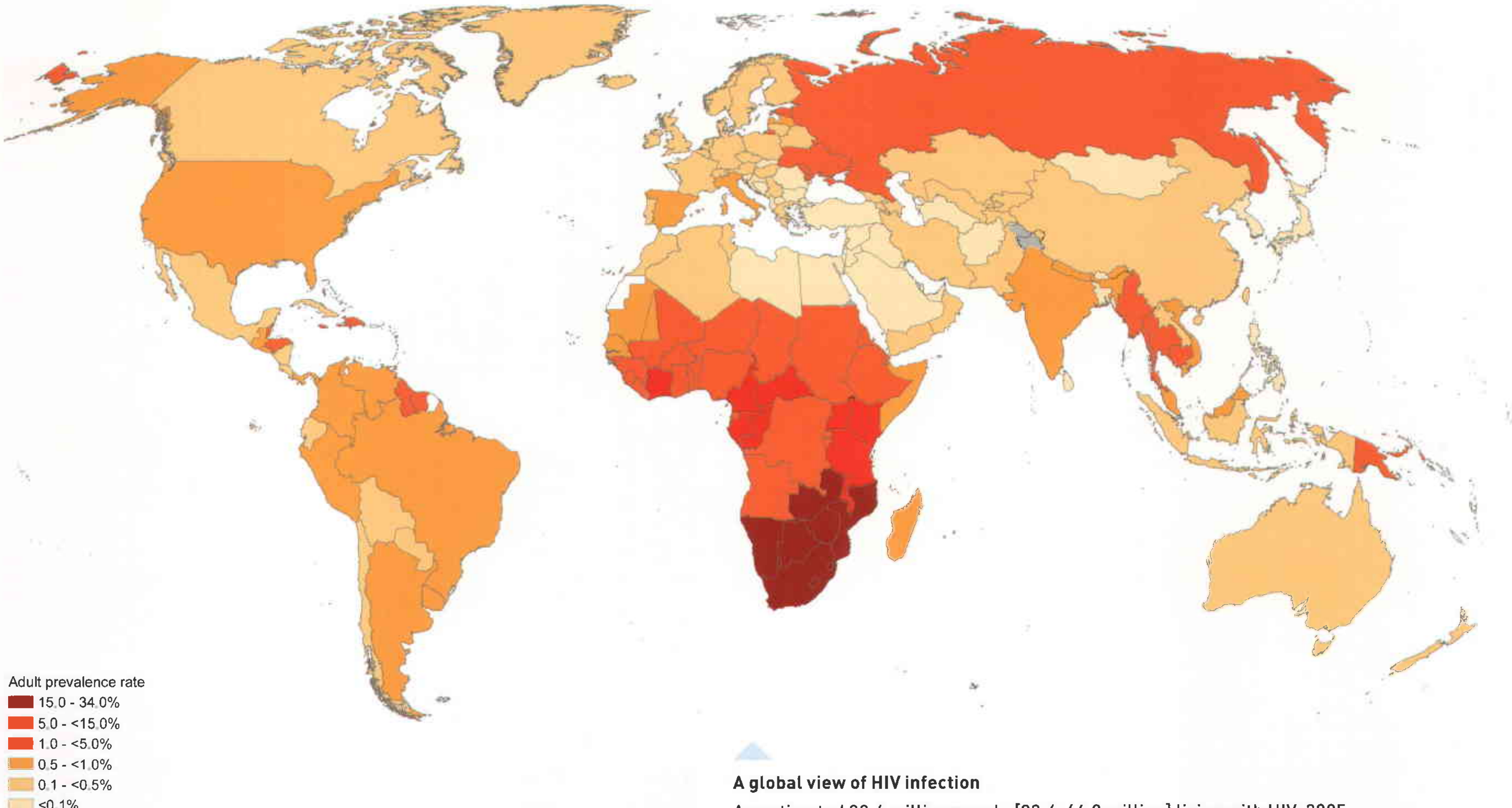
Public health mapping can provide a perspective on health extending all the way from village or community level right up to global level. It can be used to show the global distribution of a disease, its regional spread, and the areas where it is occurring, from country level down to the number of cases reported at community level in an individual hospital or health centre. It can chart river systems across continents but also pinpoint safe drinking-water sources for local communities.



HIV sentinel surveillance in pregnant women in Botswana, latest available year, 2002-2005



HIV prevalence (%) in adults in Africa, 2005



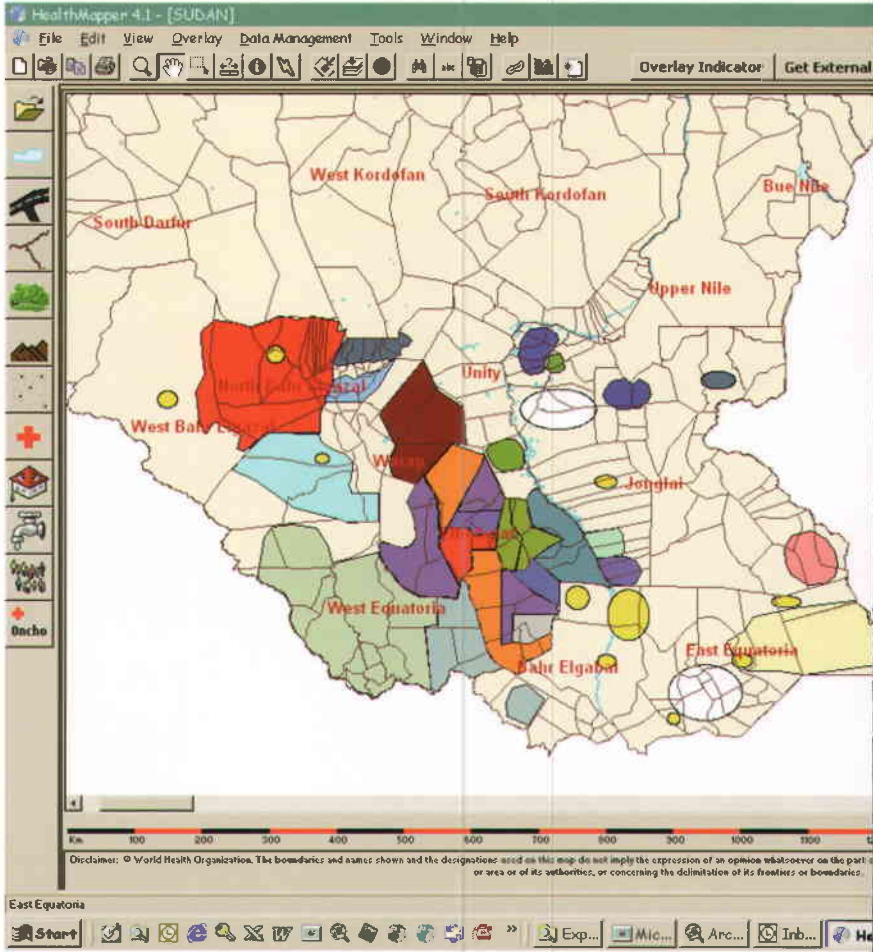
A global view of HIV infection

An estimated 38.6 million people [33.4-46.0 million] living with HIV, 2005

Input from partner agencies

Health mapping is also used to draw on health-related information from a wide range of sources. Foremost among these are WHO's partner agencies. These include United Nations agencies involved in child health and education, migration, refugee settlements, humanitarian emergencies, food security, water and sanitation, meteorology, and the environment. They also include international organizations such as the International Federation of Red Cross and Red Crescent Societies, the medical charity Médecins Sans Frontières, as well as a raft of national and international nongovernmental organizations (NGOs).

Public health mapping can also be used to ensure that partner agencies are operating in areas where the health needs are greatest – and not duplicating work already being carried out by other agencies. In Sudan, for example, health mapping was used to locate the health-related programmes of partner agencies to identify areas where they overlapped and areas with unmet needs.



NGOs working in Sudan, 2002
GIS is an important tool in mapping who is doing what and where. This map shows those areas where NGOs were working in Sudan in 2002.

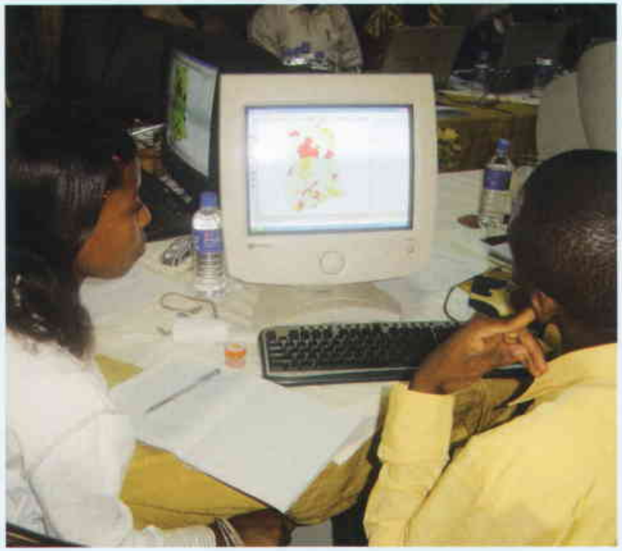
HealthMapper training

Over the past five years, the WHO Public Health Mapping and GIS team have organized more than 60 training workshops on health mapping - providing hands-on training for thousands of people across the globe. Those who have been trained include health workers from ministries of health as well as personnel from universities, health research institutes, partner agencies and WHO country and regional offices.

The HealthMapper technology currently operates to support a range of infectious disease activities in more than 100 countries in all WHO regions. As some examples, the technology facilitates the operation of all the large eradication and elimination campaigns in ways ranging from the identification of treatment populations for lymphatic filariasis to the monitoring of ivermectin distribution for onchocerciasis and global surveillance for the remaining pockets of poliomyelitis, dracunculiasis, and leprosy. As one of many examples for malaria, these technologies are being used to monitor the number of children who sleep under insecticide-treated nets and to identify areas where the use of nets has successfully lowered the incidence of infection. As one of many examples for HIV/AIDS, mapping prevalence in risk groups together with data on service facilities allows planners to immediately determine where prevention and treatment activities can be intensified.

Tashkent, Uzbekistan, November 2005

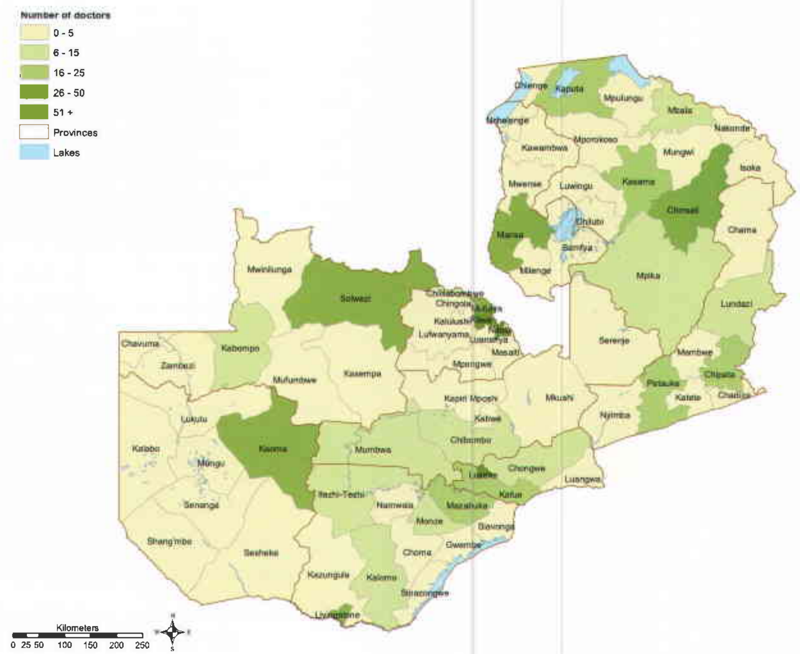
Dodoa, Ghana, July 2005



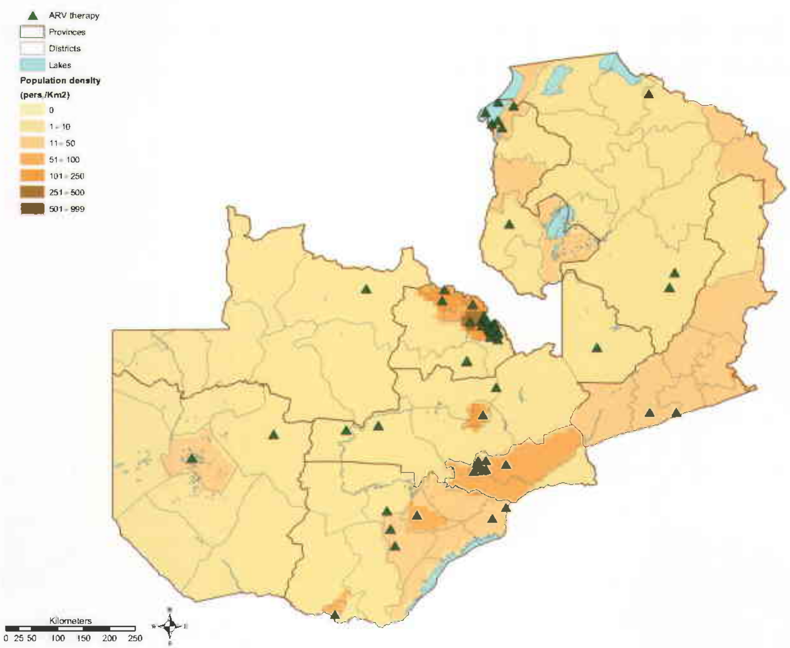
Assessing health care coverage: Services Availability Mapping (SAM)

In many developing countries, health care is provided by a range of different health service providers, including the government, the private sector, local partners, and NGOs. All too often, however, there is a lack of up-to-date information on the adequacy of health service coverage nationwide and on the level of care available in each health facility.

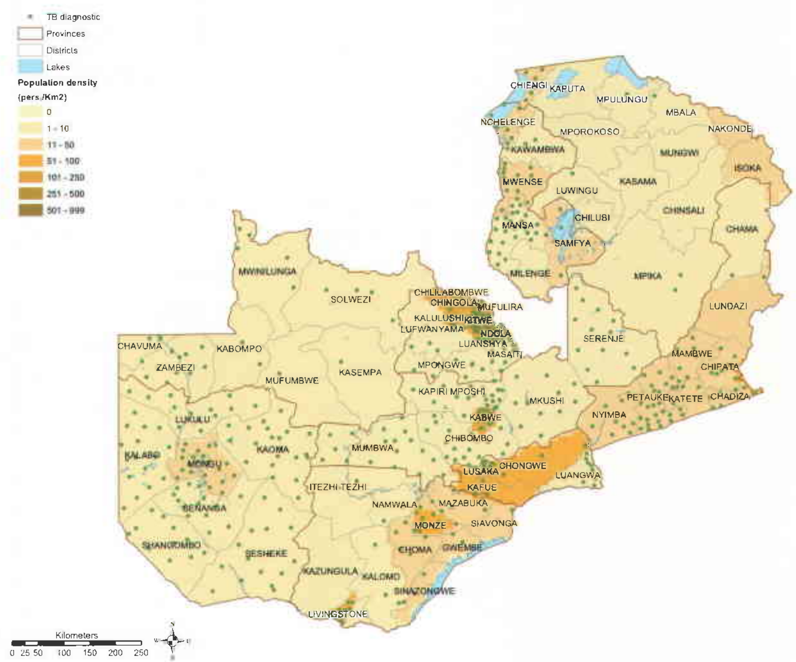
Public health mapping can fill that gap – providing health planners with a detailed picture that can be used to show where health services are adequate, where they are thin on the ground or non-existent, and where they are heavily concentrated in a few urban areas. This information is critical in efforts to strengthen health service delivery systems, in planning disease control programmes, and in efforts to ensure that essential health services are equally accessible to all people – including those who are difficult-to-reach. It is also a vital tool for use in scaling up programmes. For example, in efforts by WHO and other partners to scale up access to antiretroviral therapy for people living with HIV in low- and middle-income countries public health mapping is being used to assess and monitor the availability of HIV prevention, care and treatment services in relation to needs.



Number of doctors per 100,000 people – Service Availability Mapping, Zambia, 2004



Location of antiretroviral therapy (ARV) sites – Service Availability Mapping, Zambia, 2004



Location of sites providing tuberculosis (TB) diagnosis – Service Availability Mapping, Zambia, 2004

Services Availability Mapping (SAM) was developed to meet the increasing need for a rapid assessment of health care coverage and services availability at district and health facility level. The aim is to support decision-making by providing national and district planners with the skills and tools required to assess, map and monitor service and resource availability on a regular basis.

SAM is based on the use of standard survey methodology in conjunction with public health mapping tools and applications. The survey involves a questionnaire with over 50 questions relating to the availability of specific health care resources and priority health care interventions. The questionnaires are administered to health management teams during rapid field surveys of every district or health facility. The results are then transferred from a hand-held personal digital assistant (PDA) to a computer and uploaded into WHO's HealthMapper system for immediate feedback, analysis and decision-making.

Baseline SAM can be used to establish what health services or resources are available – and where – at a given point in time. Alternatively, the tool can be used as a follow-up to previous facility-based surveys – producing user-friendly maps illustrating the distribution of health services or commodities. These can then be overlaid with other maps showing the prevalence of specific diseases or population density. The power of these outputs is their ability to support decision-making by providing a rapid and easy-to-understand visual display of the distribution of specific services within a defined geographical area.

1.

Data collected using questionnaires on PDAs by district health teams.

2.

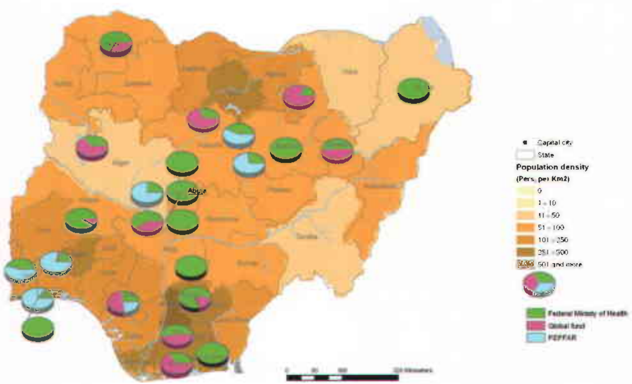
PDA is synchronize transfer.

About Service Availability Mapping surveys

C for data

3.

Data is analysed and maps and charts produced using WHO's HealthMapper

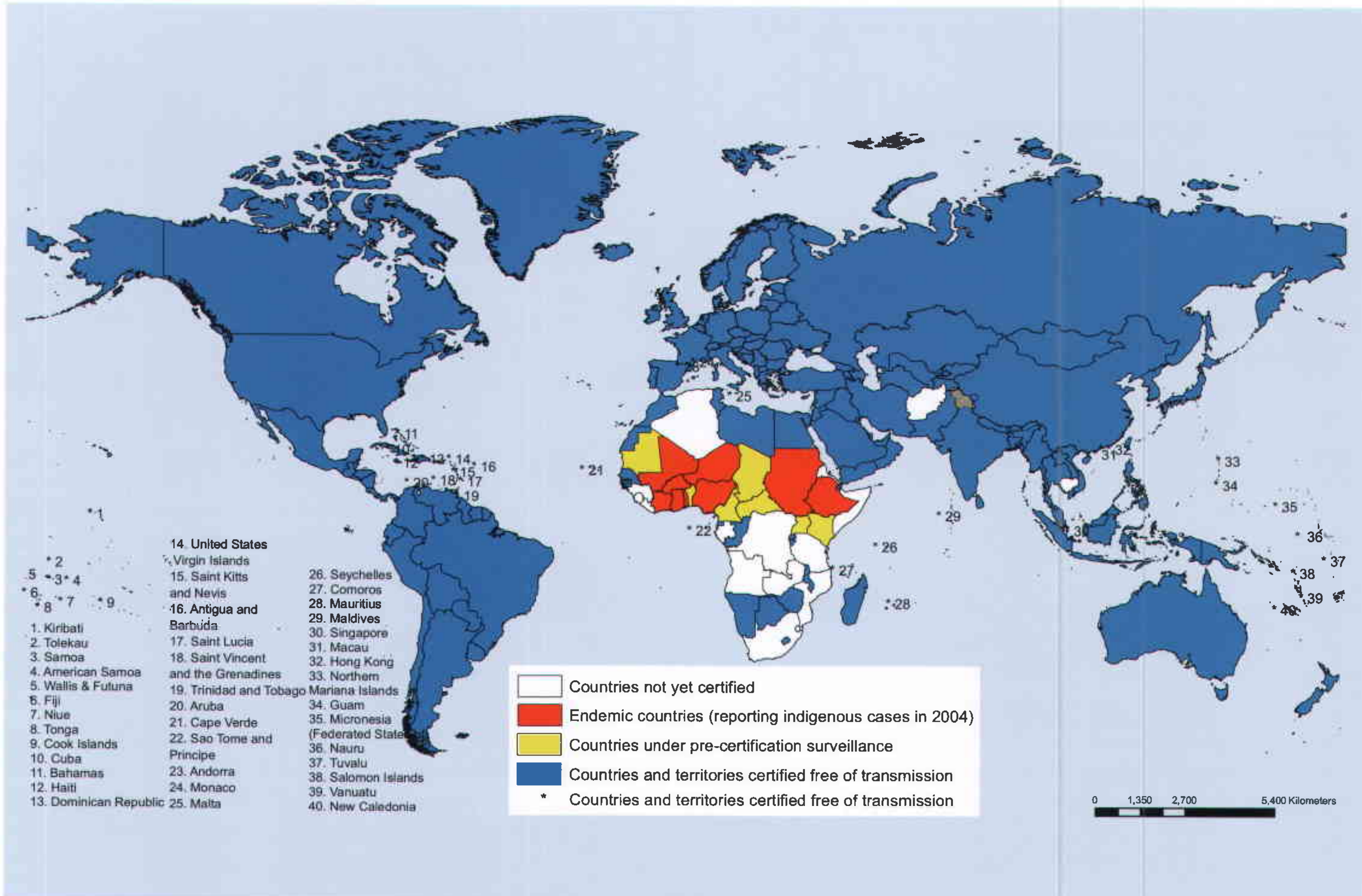


The SAM may reveal that in one district, for example, the availability of antenatal services is high in relation to the number and age distribution of the female population. Elsewhere, it may highlight that facilities for HIV voluntary counselling and testing are not available in areas where HIV prevalence is very high.

The value added of SAM is that it is rapid, cost-effective, and provides an easy and simple way of presenting data that is immediately relevant at national, district and sub-district levels. In addition, it provides the necessary link between scale-up and efforts to strengthen health systems – not only providing information on existing coverage and scale-up potential but also monitoring how services grow and expand geographically over time and laying the foundation for future evaluation of progress.

WHO is now adapting its public health mapping tools for use in densely populated urban areas. Urban mapping requires a massive amount of detailed information for a relatively small area – a shift of focus from mapping villages in a rural setting to pinpointing and profiling individual housing units, apartments, hospitals and other kinds of health and social care facilities. The urban mapping tool is being piloted in the city of Lyon, in France, where it is being used initially to help improve the allocation of health care facilities for people discharged from hospital after undergoing cancer treatment. The system uses information on individual medical and social needs and their housing situation, for example, to match patient needs to the appropriate health facility – ensuring that the system is managed more efficiently and that patient needs are met.

Certification of dracunculiasis eradication, status as of March 2006



Reaching people in need

First used in global efforts to eradicate guinea-worm disease, WHO's public health mapping system is today proving to be a critical tool not only in locating the remaining cases of this disabling disease but also in mapping the accessibility of health care and safe drinking-water for the people at risk.

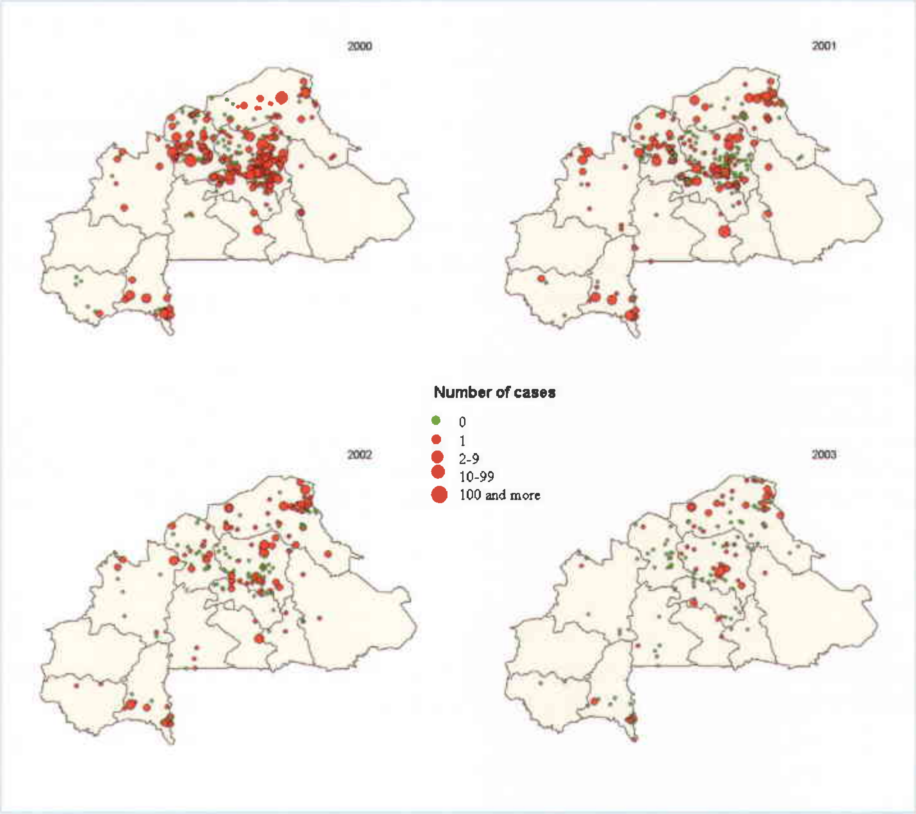
Guinea-worm disease occurs mainly in impoverished rural areas where people have no access to safe drinking-water. It is caused by parasites transmitted by tiny water fleas (Cyclops). Once inside the body, the parasites develop into worms, which work their way through the body and gradually emerge through the skin on the lower legs and feet – causing excruciating pain, infections, and disability.

Although there is no treatment for the disease, it can be prevented by providing access to safe drinking-water, and by ensuring that unsafe water is filtered and that infected individuals do not contaminate drinking-water. The problem lies in pinpointing the villages where the disease is occurring and then reaching people in what are often remote, inaccessible rural areas.

This is where public health mapping comes in.

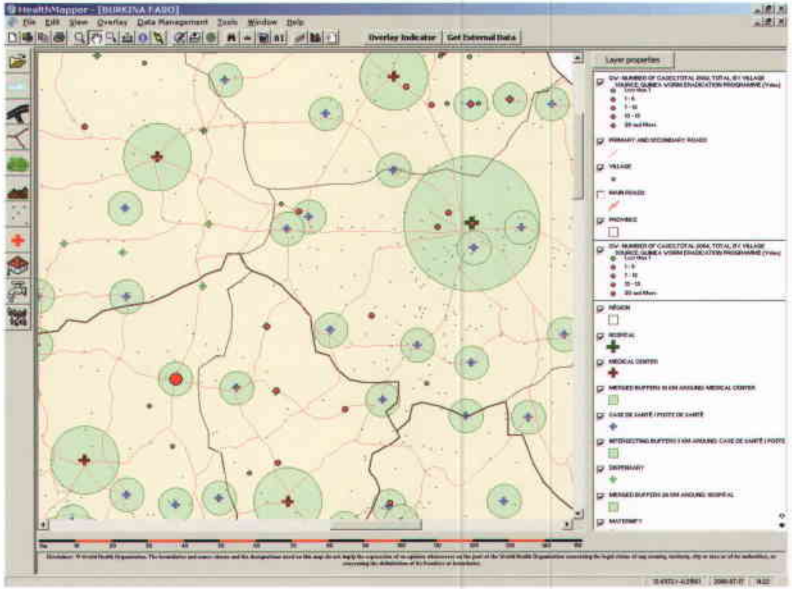
As new cases of guinea-worm disease are notified, health workers are able to pinpoint each affected village on a map and chart the number of cases involved. They can also map out the location of safe drinking-water sources and measure the distance from these to the nearest villages. By highlighting areas with no access to safe drinking-water, the maps can be used to encourage investment in improved water facilities.

Monitoring progress towards dracunculiasis eradication in Burkina Faso, 2000-2003



The next step is to ensure that water filters are distributed to people with no access to safe drinking-water and that those who are infected are given health care (to prevent secondary infection and ease the pain) and warned against the risk of contaminating drinking-water by immersing an affected limb to ease the pain. In some cases, water may also be treated with chemicals to kill the water fleas. In order to plan and target these measures, it is essential to know the location of health facilities in relation to the villages affected by guinea-worm disease – and public health mapping is the ideal tool for this.

A valuable spin-off is the collection of village-level data for some of the most remote, uncharted areas in Africa – information that can now be used for other disease control programmes or by other sectors such as water, education, transport, and environment.



Guinea-worm endemic villages, Burkina Faso, 2002
The map showing the endemic villages can be overlaid with a second map charting the availability of health facilities and the limits of their catchment areas. This is vital information which can be used to identify those affected villages that are beyond the reach of health facilities and therefore in need of outreach workers to ensure that every case of the disease is contained. A programme manager can use this information to plan and target interventions, ensuring the most efficient use of resources.

Eradicating guinea-worm disease

In 1982, when WHO launched the initiative to eradicate guinea-worm disease, there were about 10–15 million cases a year. By 2005, the number had been reduced to about 10 674 cases – a 33 % reduction in the number of reported cases over the previous year. Today, guinea-worm disease is endemic in only 9 countries in the African region, with Ghana and Sudan together accounting for about 90 per cent of the remaining cases.

The use of public health mapping in the eradication initiative has helped to strengthen surveillance by establishing a standardized system for reporting on guinea-worm disease across 16 countries in sub-Saharan Africa. Data can be collected from a range of different sources (population, water, health) and presented in a way that supports analysis and decision-making. Health mapping is also being used to monitor progress in eradicating the disease, to pinpoint the remaining cases, and to prevent its reimportation into disease-free areas.

Mapping public health resources and risks

Effective response to health events, disease outbreaks and epidemics requires accurate and up-to-date information on the local demographic and disease transmission dynamics, the availability and effectiveness of existing health and social services, as well as knowledge of basic infrastructure including roads, ports, airports. An understanding of public health risks such as water sources, industrial risk zones, commercial farms, wetlands, workplaces etc is also critical.

Over the past 10 years, WHO has been assisting national ministries of health in the development of geospatial databases for public health. Through a global partnership involving WHO regional and country offices, agency partners, and NGOS, a vast storehouse of baseline data has been established, particularly for Africa.

Building a spatial database for public health: core data elements

Public health resources, including:

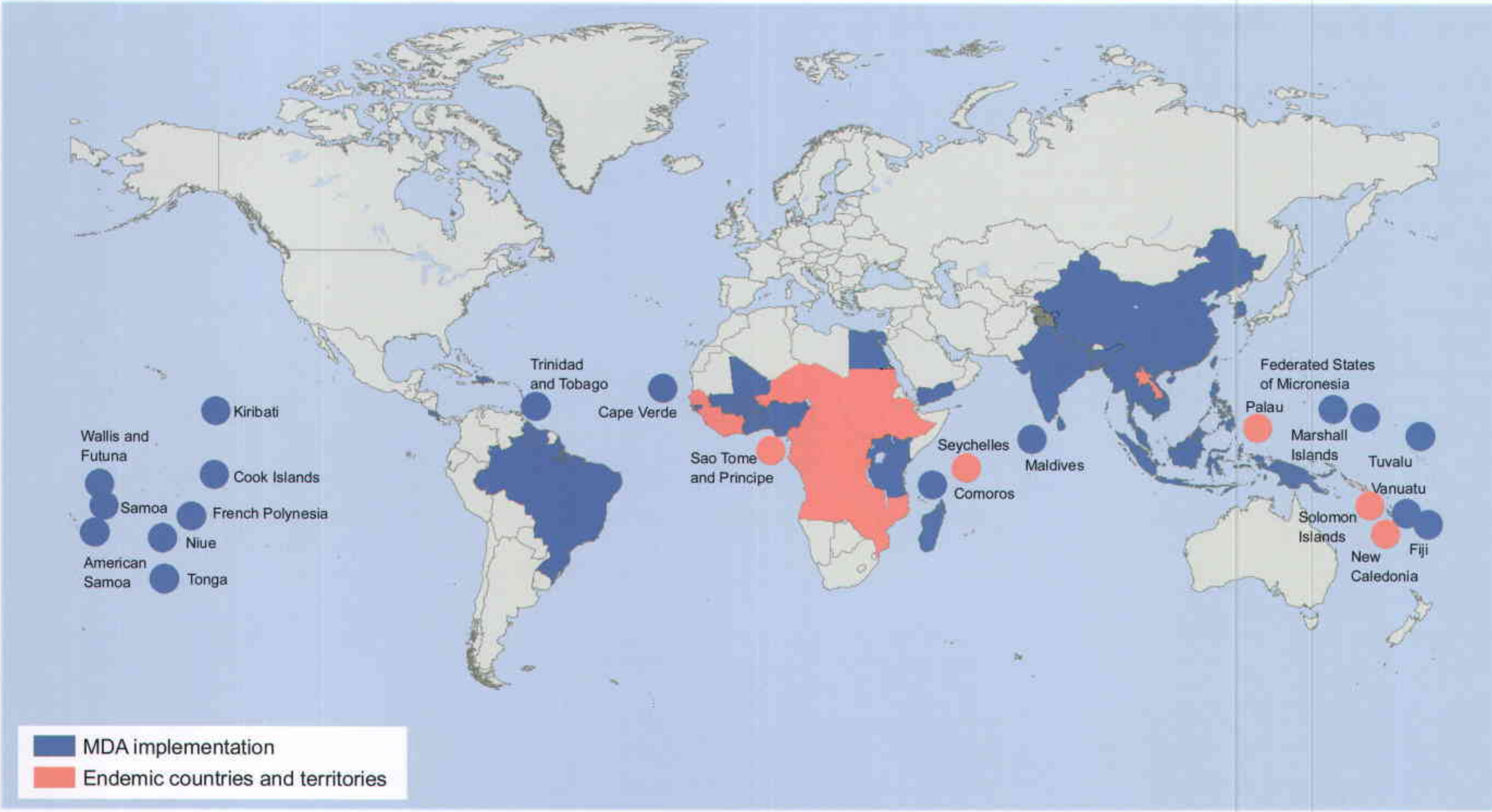
- health facilities – public and private including hospitals, health centres, dispensaries
- special facilities including laboratories, blood banks
- partner intervention areas and activities – UN agencies, non-governmental and faith-based organizations.

Public health risks, including:

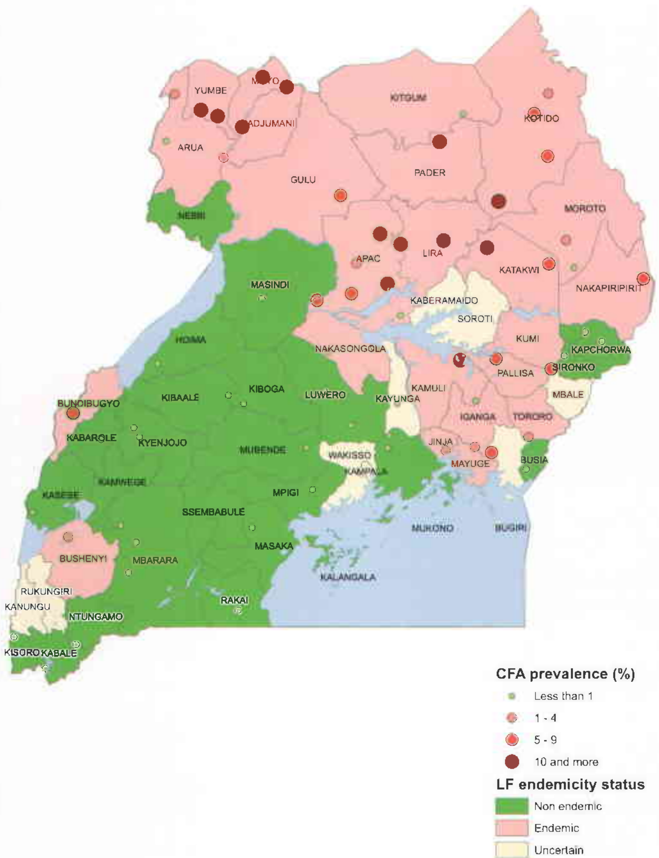
- Contaminated water sources, swamps, wetlands, air quality, commercial farms (e.g poultry), forests and game parks, migratory birds routes.

Local infrastructure, including:

- Population settlements, urban areas, roads, airports, ports, large workplaces, water supply, schools.



Lymphatic filariasis endemic countries and territories covered by Mass Drug Administration (MDA), 2006



Lymphatic filariasis endemicity and Circulating Filarial Antigen (CFA) prevalence in Uganda, 2004

Targeting the distribution of medicines

In countries where lymphatic filariasis occurs, public health mapping and GIS are being used to underpin global efforts to eliminate the disabling parasitic disease. The aim is to map out areas where the disease is endemic, target the distribution of medicines, and monitor progress in the elimination programme over time.

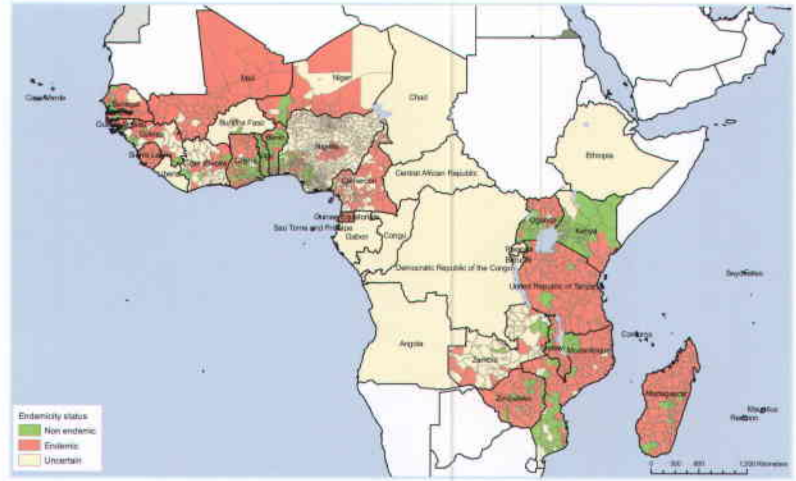
The mapping tool has been customized for use in the global initiative – ensuring that each country uses standardized indicators for disease surveillance and programme monitoring from the outset. The use of a standardized reporting system throughout the elimination initiative will ensure that data can be analysed and compared at the regional and global level and will eventually help certify that the disease has been eliminated worldwide.

Public health mapping is used initially at country level to map out areas where the disease is endemic. Preliminary surveys are carried out to map areas where people have physical signs of the disease (e.g. swollen limbs), indicating that the disease is endemic. In areas where the evidence of disease is less clear-cut, follow-up sample surveys are carried out involving the use of diagnostic blood tests. Accurate estimates of the disease burden are essential to enable ministries of health to plan their elimination programme and to budget for the resources needed.

By the end of 2005, most countries had completed the initial mapping phase. In those countries that had already done so, the health maps have produced a few surprises.

In Burkina Faso, for example, the number of people at risk of lymphatic filariasis turned out to be almost double the previous estimates. The surveys revealed that the disease was endemic in all 53 health districts in the country, placing the entire population – about 12 million people – at risk.

Once the prevalence of the disease has been established and mapped, public health maps are used to determine the size of the administrative unit – village or health district, for example – in which everyone will be targeted for treatment, whether or not they are infected. When these areas have been mapped out, the maps can be used to target the annual distribution of medicines and monitor the number of people reached, as well as the impact over time on the incidence of the disease. The elimination strategy involves annual mass treatment with two medicines delivered at the same time or the use of cooking salt fortified with the medicine diethylcarbamazine (DEC). To interrupt transmission of the disease in endemic areas, mass treatment will have to be carried out for 4–6 years – the lifespan of the parasitic filarial worms inside the body.

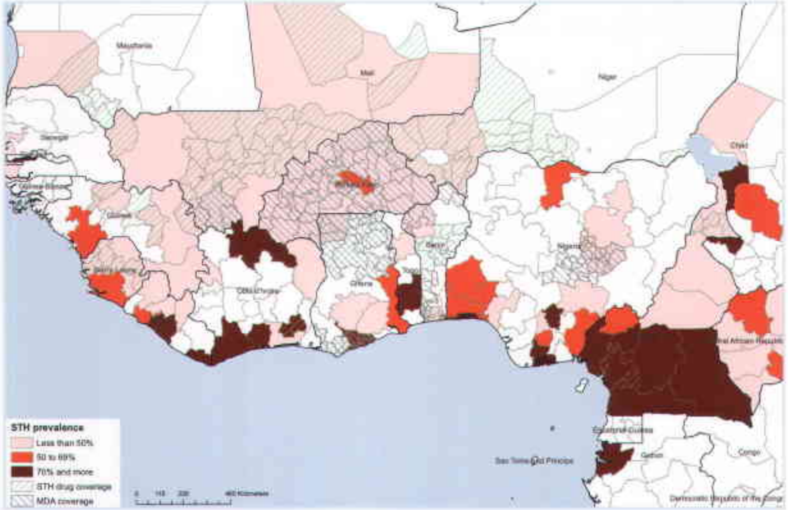


Lymphatic filariasis endemicity status in the countries of the African programme review group, latest available, 2006

Lymphatic filariasis

Lymphatic filariasis is a severely disabling mosquito-borne parasitic disease that causes extreme swelling of the limbs and genitals as well as damage to internal organs. An estimated 120 million people are infected and more than one billion people are at risk. The disease is endemic in 80 countries, including 32 of the world's 38 least developed countries. In 1997, the World Health Assembly called on WHO Member States and partner agencies to eliminate the disease as a public health problem.

Lymphatic filariasis endemicity status in the countries of the African programme review group, latest available, 2006



Lymphatic filariasis endemicity status and mass drug coverage (MDA) in the countries of the African programme review group, 2004-2005

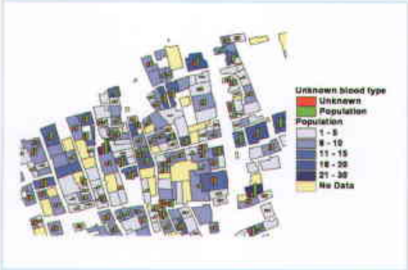
Mapping links between diseases

A further use for health mapping is to show links between diseases. In some countries, they have been used to help determine where health interventions can be targeted to more than one disease at the same time, thereby increasing cost-effectiveness, and where this would be more difficult.

Efforts to control lymphatic filariasis and soil-transmitted helminthiasis (STH) – debilitating parasitic diseases that affect 2 billion people worldwide – are now being carried out in tandem in developing countries. Health mapping is being used to map out the prevalence of both diseases at country level.

WHO is advocating the use of a coordinated approach using large-scale preventive chemotherapy to tackle tropical parasitic diseases like lymphatic filariasis, onchocerciasis, soil transmitted helminthiases, schistosomiasis, which are now recognized to be a significant public health problem as well as a major impediment to poverty reduction in certain endemic countries. As in many areas more than one of these infections are present and the recommended interventions use similar drugs and frequency of administration, their co-coordinated administration is considered cost-effective. While the recommended treatment against lymphatic filariasis is to administer the entire population of an implementation unit (a designated administrative level, usually the district, which if found endemic the entire eligible population is treated) at risk of lymphatic filariasis with either ivermectin and albendazole or diethylcarbamazine and albendazole once a year, the treatment against soil transmitted helminthiases is targeted at the pre-school age and school age children of the endemic districts with albendazole, once or twice a year depending on endemicity levels. Thus the annual round of DEC or ivermectin in combination with albendazole takes care of both filariasis and onchocerciasis as well as soil transmitted helminthiases. A second round of albendazole after six months targeted at school-age and pre-school age children may be required in areas with a higher prevalence of soil transmitted helminthiases.

IKONOS satellite image, multi-spectral, 1 m resolution, 1:5000 scale, Aba-Masoud, Egypt



Analysis of blood type information availability, Aba-Masoud, Egypt

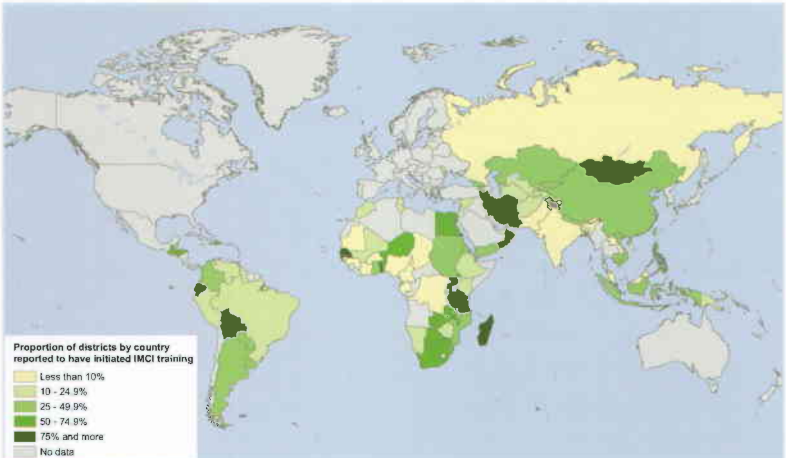
Targeted population for vaccination, Aba-Masoud, Egypt

A regional perspective on health

In 2003 and 2004, WHO's Regional Office for the Eastern Mediterranean (EMRO) conducted a household pilot project in Aba-Masoud village, Egypt, to support multi-sectoral planning and monitoring.

Satellite remotely sensed multi-spectral images (1 m resolution, 1:5000 scale) from IKONOS satellite plus local maps were integrated in WHO's HealthMapper application to create a detailed electronic map of the village, showing houses, roads, canals, power lines, among others. Survey data on household and individual information (gender, education, etc.) were overlaid on the map, together with health data from the Ministry of Health family health record database.

The maps produced, in addition to planning vaccination visits, assisted the local authorities in analysing the link between the disease patterns spreading in the village with different factors like available water sources, existing types of animals in each house, and even with local patterns of behaviours and social activities.



Estimated coverage of IMCI training, as of December 2005

Integrated Management of Childhood Illnesses (IMCI)

(IMCI) aims to reduce the high death toll among children under five through a combination of preventive and curative interventions addressing the major life-threatening conditions: diarrhoea, malnutrition, measles, malaria, and pneumonia. It is based on the recognition that a sick child may be suffering from more than one condition at the same time.

Monitoring child care

While public health mapping and GIS can be used to support individual disease control programmes, they are also used for much broader applications such as monitoring key health and development strategies in developing countries.

This approach is being developed to help monitor the use of the strategy for integrated management of childhood illnesses – one of the evidence-based strategies for improving child survival in developing countries. In the near future, the use of health mapping will be expanded to map global, regional, and country progress in child survival, and track progress in achieving the child health-related Millennium Development Goals.

To help chart progress in the global implementation of IMCI, health mapping has been used to show the implementation phases of those countries that have adopted this strategy to improve child health outcomes.

To get a more detailed picture, a health planner can first zoom in on Africa and then click on Uganda, for example – one of the first countries on this continent to introduce IMCI.

At the country level, health mapping can provide a more detailed profile of individual health facilities and the children they serve. Planners are now able to map on a district-by-district basis not only the individual health facilities that are implementing IMCI but also the percentage of IMCI-trained health workers employed there and whether they receive regular supervision, as well as the availability of essential medicines.

Health planners in a ministry of health can also use health maps to chart a range of child health indicators, such as nutritional status, disease prevalence, immunization coverage, and birth and death rates, to help identify and target the children at highest risk and monitor progress over time.

Taking stock

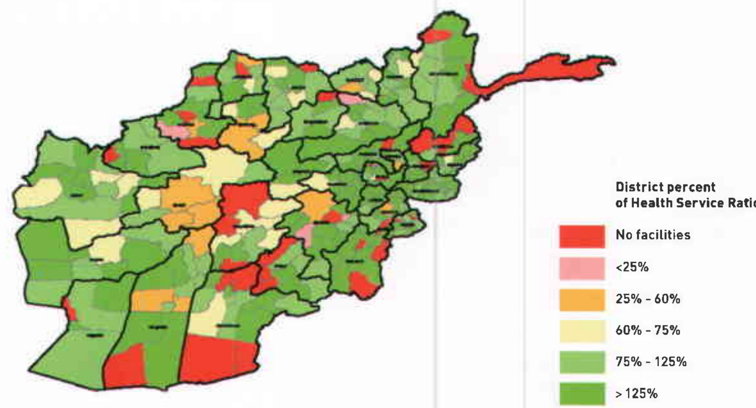
In the aftermath of the conflict in Afghanistan in late 2001, the task of reconstructing the battered health system was one of the top priorities. The needs were immense. The country's health status was among the worst in the world. Malnutrition and infectious diseases took a heavy toll. An estimated one in four children died before their fifth birthday. Life expectancy at birth was 42.

Health care was delivered by a range of health care providers, including the government, the private sector, and NGOs. Health care facilities were scattered unevenly throughout the country. Many were in remote, inaccessible areas or had been abandoned, and as many as one-third of health facilities still in operation had been damaged by war or earthquakes. In addition, the country was littered with unexploded landmines, more than one million people were internally displaced, and the millions of Afghan refugees sheltering in neighbouring countries were impatient to return home.

There was an urgent need to take stock of the country's health resources, strengthen disease monitoring systems, and identify the most pressing needs. In response, WHO's public health mapping team worked with the Ministry of Public Health, in collaboration with a range of other partner agencies, to develop a dynamic health atlas for Afghanistan. The atlas is a compilation of maps from the village level up. Together, these maps offer an astonishingly

The maps locate more than 900 functioning health facilities, recording their current state of repair, the health service provider responsible, and the level of services provided – whether they have a laboratory, for example, or offer childbirth facilities. The map on distribution of Basic Health Centers (BHC) also indicates the size of the population served by the health facilities, which can vary dramatically from one district to another. This information can be used to highlight populations not reached by existing health services and to help redirect resources to these areas. When the health maps revealed that the city of Herat lacked adequate health facilities, for example, Médecins Sans Frontières moved to step in and fill the gap.

District health care service ratio in Afghanistan, October 2002

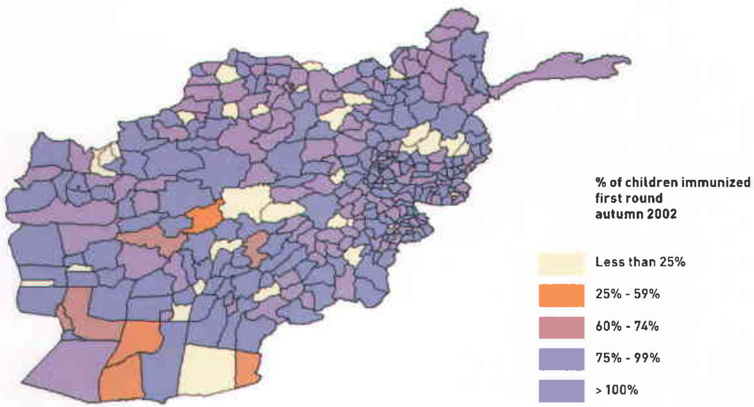


detailed picture not only of health resources and patterns of disease but also of the country's geography, ecology, climate, infrastructure, and population density – all of which can have a critical bearing on health.

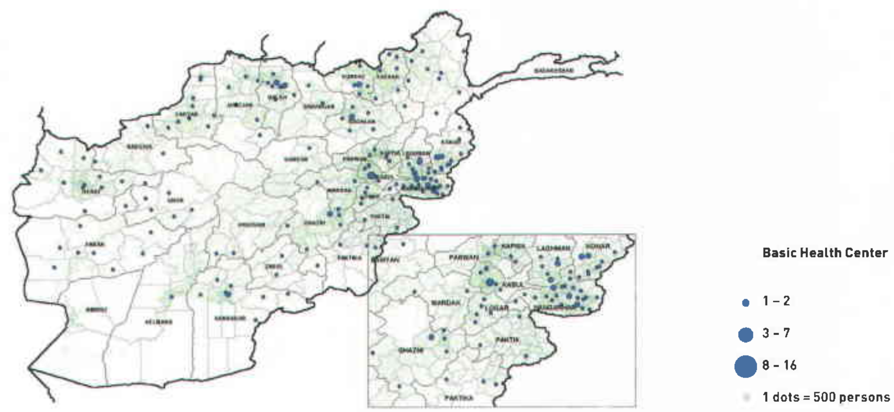
Many of the data for the atlas were obtained from an interagency assessment of health resources in Afghanistan carried out for the Ministry of Public Health during 2002. The inventory was conducted by survey teams equipped with cameras and hand-held mapping devices to photograph and pinpoint the infrastructure and facilities. WHO has used these and other data to develop a public health mapping system for Afghanistan and has trained public health workers to use the system to strengthen disease surveillance, identify unmet needs, and plan public health programmes.

The Afghanistan mapping activities were made possible through a wide collaboration between many in-country partners including the Ministry of Public Health, Afghanistan, the Afghanistan Research and Evaluation Unit (AREU), the Afghanistan Information Management Services (AIMS), the WHO Afghanistan Office, the WHO Regional Office for the Eastern Mediterranean (EMRO), Health Net International (HNI) and Management Sciences for Health (MSH). Other partners contributing data and resources include the Food and Agriculture Organization of the United Nations (FAO), UNHCR, the United Nations Children's Fund (UNICEF), WFP, the International Committee of the Red Cross, MACA/PAPA, and the Swedish Committee for Afghanistan.

National immunization days in Afghanistan: coverage rate for the first round, autumn 2002

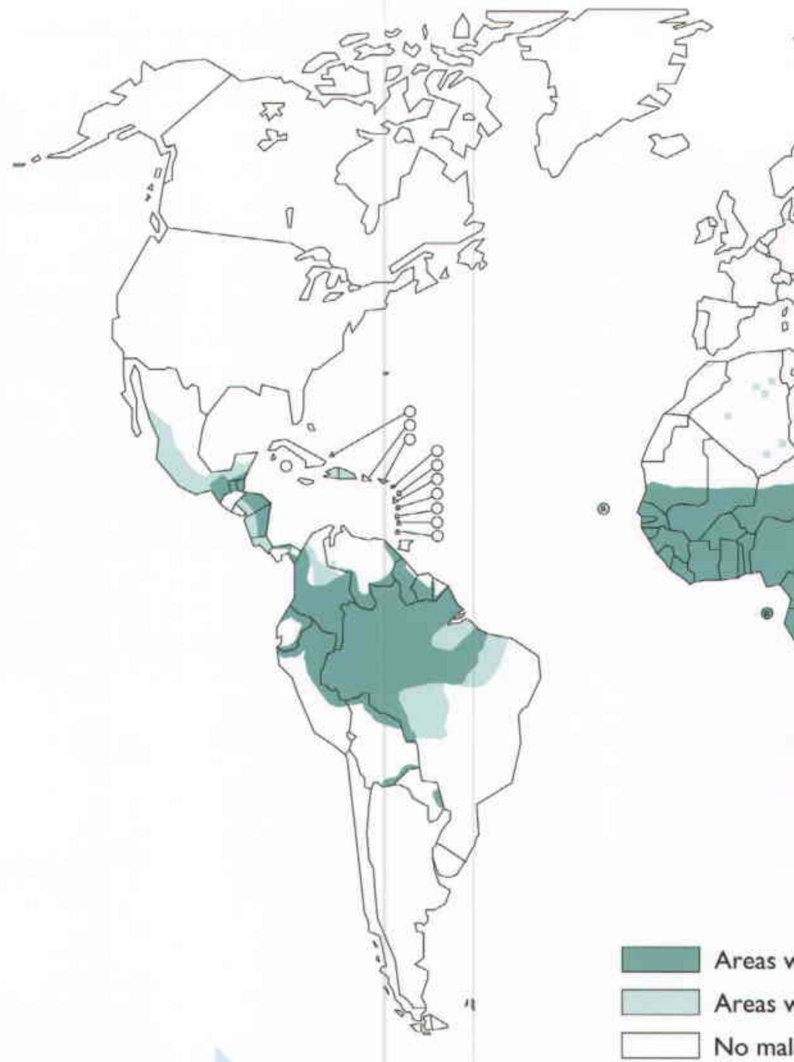


Distribution of basic health centers in Afghanistan, 2001



PART 2
A window on malaria

Malaria risk areas, 2005



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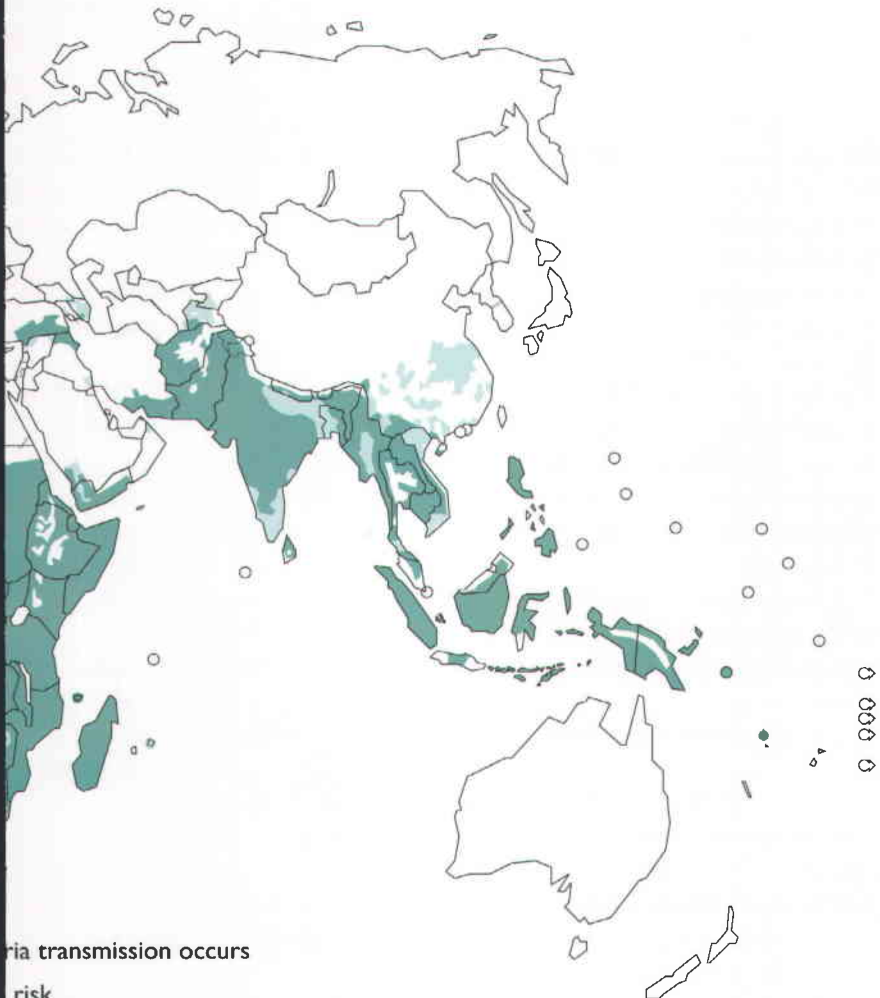


ria transmission occurs

risk

nitive source of information about malaria endemicity

Public health mapping could have been tailor-made for use in malaria control programmes. In countries where it is being exploited to the full, it offers a geographically linked disease intelligence network, providing a comprehensive picture of the malaria burden and of nationwide efforts to control the disease and contain epidemics.

Health maps are being used to give a detailed picture of where and when the disease is occurring throughout a country and to identify the groups worst affected. The maps can be used to help target the distribution of antimalarial medicines, bednets, or insecticides, and to monitor their impact. They can also pinpoint areas where malaria parasites have developed resistance to first-line antimalarials.

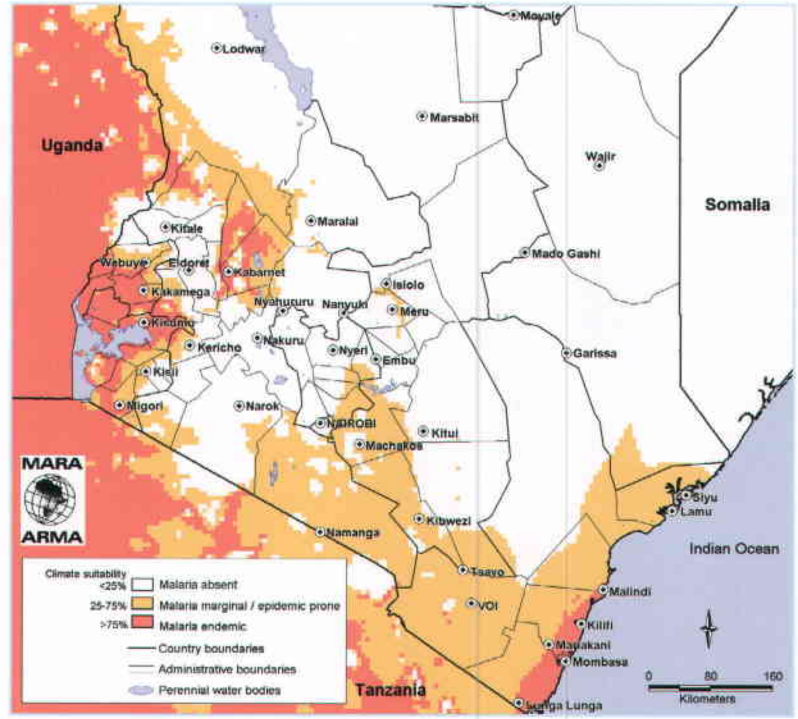
Public health mapping is also used to map the coverage and accessibility of health facilities and identify areas where partner agencies are providing malaria interventions. In some countries, health maps are now being used to monitor environmental changes and weather patterns in order to anticipate life-threatening epidemics of malaria.

Showing patterns of disease

In areas where malaria is endemic, the disease usually occurs in a fairly stable and predictable seasonal pattern. Elsewhere, the disease may occur sporadically or at a low level, leaving non-immune populations vulnerable to explosive epidemics of the disease. Health mapping is used to differentiate between areas with different patterns of disease and to help ensure an appropriate response.

In epidemic-prone areas, weekly monitoring of cases is essential to chart any sudden increase in cases that may signal the start of an epidemic.

The malaria distribution model was used to mask out all potentially unstable transmission areas at country level.



Distribution of Endemic Malaria in Kenya

This map is a product of the MARA/ARMA collaboration (http://www.mara.org.za). July 2005, Medical Research Council, PO Box 70380, Overport, 4067, Durban, South AfricaSwiss Tropical Institute, Multilateral Initiative on Malaria (MIM) / Special Programme for Research & Training in Tropical Diseases (TDR), Roll Back Malaria (RBM).CORE FUNDERS of MARA/ARMA: International Development Research Centre, Canada (IDRC); The Wellcome Trust UK; South African Medical Research Council (MRC); Malaria distribution model: Craig, M.H. et al. 1999. Parasitology Today 15: 105-111.Topographical data: African Data Sampler, WRI, http://www.igc.org/wri/sdis/maps/ads/ads_idx.htm.

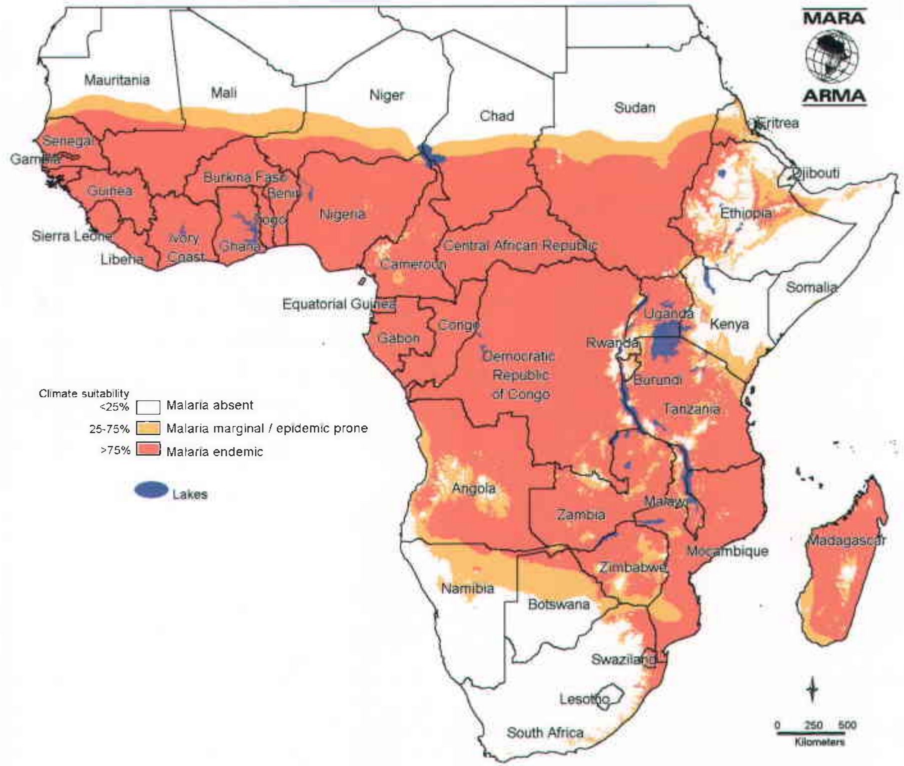
Mapping the disease

Malaria programme managers can use health maps to chart where malaria transmission occurs locally and globally.

Health mapping and GIS are also used to keep track of the number of children who sleep under insecticide-impregnated bednets at night and to highlight areas where the use of bednets has successfully lowered the incidence of malaria.

Once the burden of malaria has been mapped at the district level – showing the number of cases reported each year – a programme manager can overlay this map with another map charting the health facilities. This helps identify high-risk areas that are poorly served by health facilities and may need to be targeted for coverage with community health workers.

This map is a theoretical model based on available long-term climate data. Although it is reasonably accurate, it is not based on actual malaria data and may not reflect the real malaria status. It shows the theoretical suitability of local climatic, and therefore the potential distribution of stable malaria transmission in the average year.



Distribution of Endemic Malaria in Africa

This map is a product of the MARA/ARMA collaboration (http://www.mara.org.za). July 2001, Medical Research Council, PO Box 17120, Congella, 4013, Durban, South AfricaSwiss Tropical Institute, Multilateral Initiative on Malaria (MIM) / Special Programme for Research & Training in Tropical Diseases (TDR), Roll Back Malaria (RBM).CORE FUNDERS of MARA/ARMA: International Development Research Centre, Canada (IDRC); The Wellcome Trust UK; South African Medical Research Council (MRC); Malaria distribution model: Craig, M.H. et al. 1999. Parasitology Today 15: 105-111.Topographical data: African Data Sampler, WRI, http://www.igc.org/wri/sdis/maps/ads/ads_idx.htm.

Working with partners

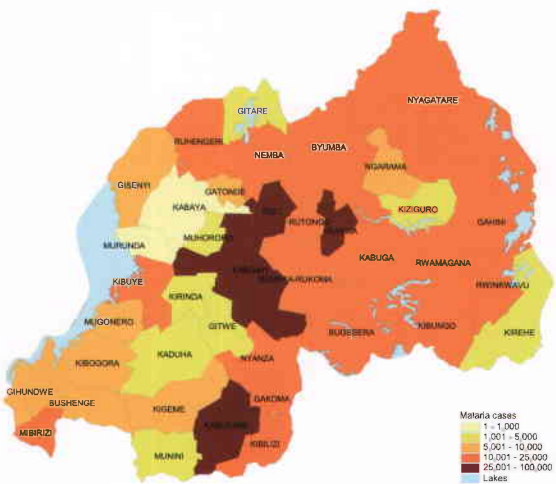
In some countries, public health mapping is being used to track the services provided by partner agencies involved in malaria control, to ensure that they are targeted where they are needed most and that service provision does not overlap. In Rwanda, for example, health maps have been used to locate the partner organizations involved in providing insecticide-treated bednets at district level. The maps are designed to locate service provision in relation to the prevalence of disease. This information can be used both to help monitor the impact of the bednets over time and to identify areas where malaria rates are high and service provision low.

Efforts to roll back malaria

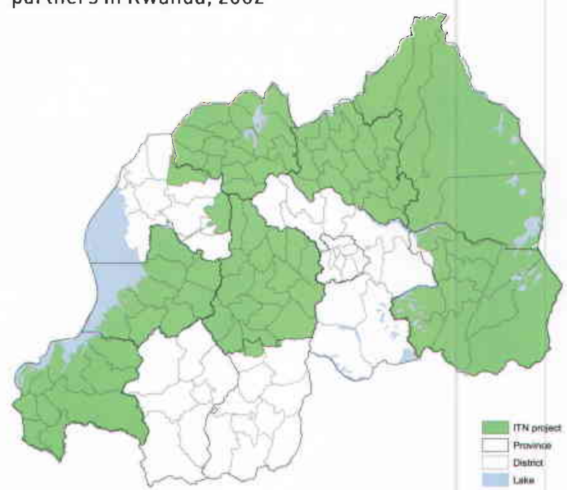
Malaria kills more than one million people a year, most of them young children. In sub-Saharan Africa, where almost 90% of all malaria deaths occur, the disease accounts for more than one in five of all deaths among children under five years old. Malaria strikes the poorest populations and contributes to poverty through lost earnings and high treatment costs.

The Roll Back Malaria Partnership (RBM), spearheaded by WHO, is committed to halving the global burden of malaria by 2010. Its strategy includes: access to rapid diagnosis; prompt treatment in the home; preventive treatment for pregnant women; use of insecticide-treated bednets and vector control; research to develop new medicines, vaccines, and other tools; improved surveillance to improve epidemic forecasting; and response and use of the IMCI strategy to reduce malaria deaths among children.

Confirmed malaria cases in Rwanda, 2003



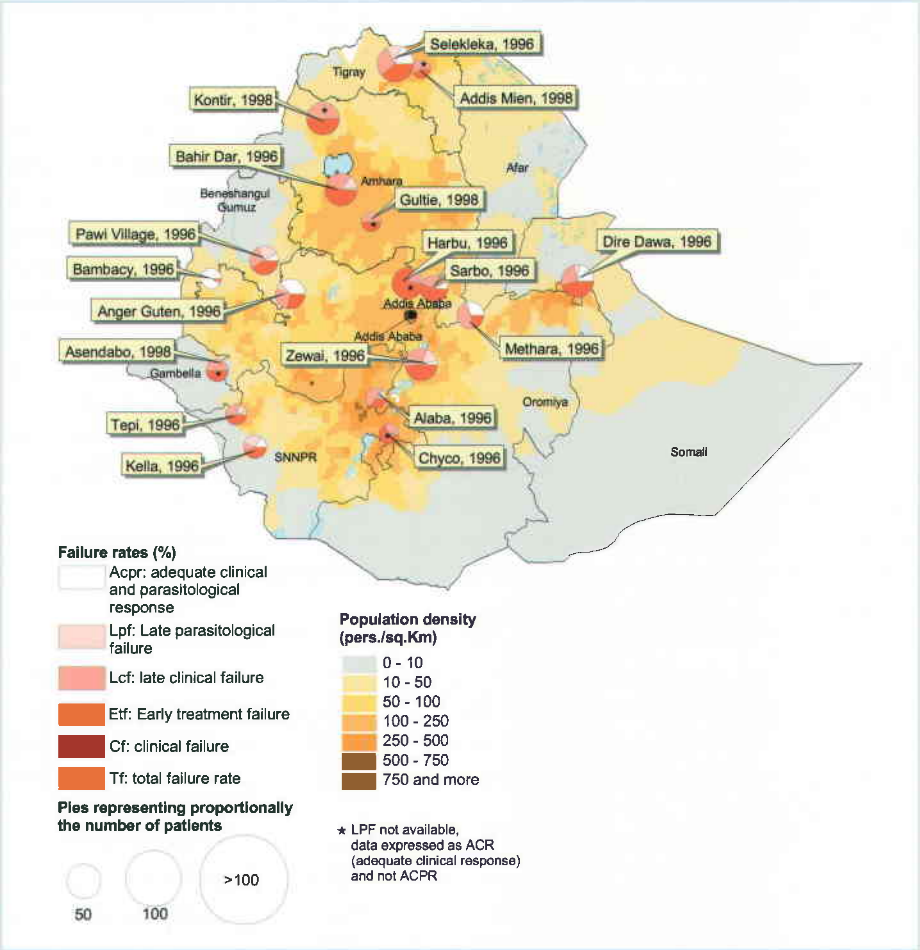
Areas covered by ITN projects by partners in Rwanda, 2002



Monitoring drug resistance

One of the greatest threats to malaria control today is the increasing resistance to first-line antimalarials – due mainly to the overuse and misuse of these once powerful medicines. The least expensive and most widely available antimalarial medicine, chloroquine, is no longer effective in most of the countries where malaria is a major public health problem, and resistance to the most affordable alternatives – sulfadoxine – pyrimethamine and mefloquine – is an emerging problem in many countries today.

In malaria-endemic countries, sentinel surveillance sites have been established to monitor the effectiveness of antimalarials, closely following treatment progress in selected patients by regularly testing the level of parasites in the blood. Public health mapping is used to chart the data obtained from these surveillance sites and show the failure rates for the currently used antimalarials. Once the failure rate reaches a threshold of 25%, the medicine needs to be replaced.

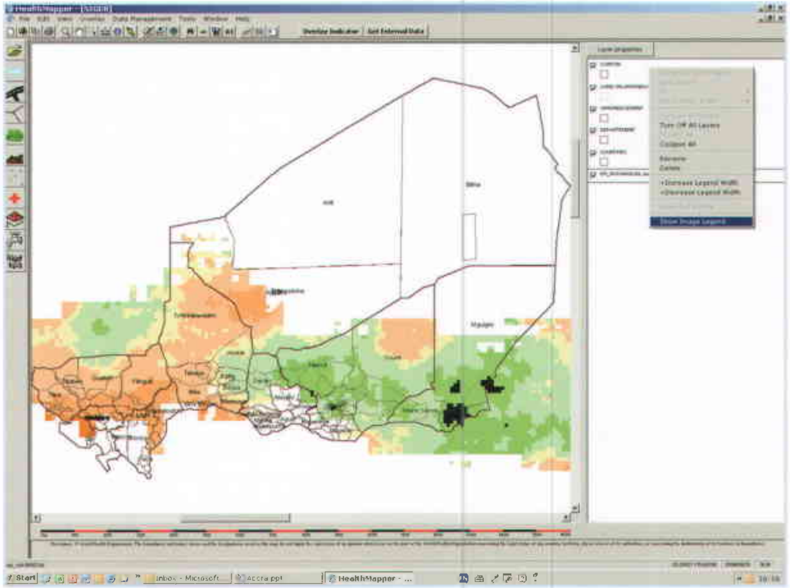


Malaria drug resistance: chloroquine failure rates in Ethiopia, 1996-1998

Malaria early warning systems

Many countries in Africa experience frequent severe epidemics of malaria with heavy loss of life, often triggered by changes in rainfall and temperature patterns that encourage an increase in mosquito populations. Among those at highest risk are people living in semi-arid and desert-fringe areas of Africa, where epidemics frequently follow excessive rains.

To help anticipate epidemics of malaria, some countries now make use of satellite weather data to monitor seasonal climate forecasts and track rainfall and temperature patterns at the district level. By integrating these satellite data with health maps identifying epidemic-prone areas, a programme manager can anticipate and plan for a possible epidemic. This involves closely monitoring surveillance data to check for any sudden increase in cases over a period of a few weeks, ensuring that vector control is stepped up, where appropriate, and that adequate supplies of antimalarials are available.



Using rainfall anomaly maps for malaria monitoring
Malaria programme managers can upload rainfall anomaly maps and use them in their local mapping systems to identify those districts that should be monitored closely in case of a malaria epidemic.

The HealthMapper

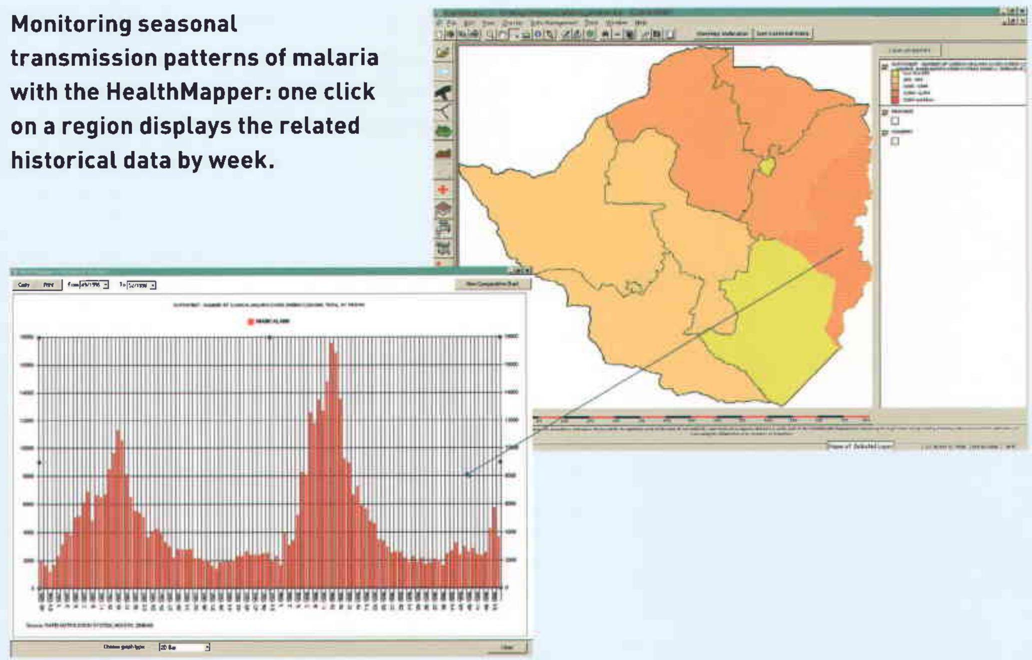
WHO's HealthMapper is an interactive information and mapping system designed for public health managers and decision-makers who need easy access to a database, reports, graphs, tables, spreadsheets, and maps. It was developed to simplify the use of GIS and mapping for public health and to help organize the collection, storage, retrieval, management, and analysis of public health data.

The mapping and information "package" consists of:

- a geographically-referenced database (containing information from village level to global level)
- a data management facility (for the storage and retrieval of reports, spreadsheets, tables, and graphs)
- a mapping interface (to create interactive thematic maps).

Available for use in public health settings worldwide, the HealthMapper is supplied free of charge to countries as a CD-ROM.

Monitoring seasonal transmission patterns of malaria with the HealthMapper: one click on a region displays the related historical data by week.



PART 3
A 21st century tool

Public health mapping for disaster relief efforts

In response to the devastating tsunami in the Indian ocean in December 2004, WHO's public health mapping and GIS team worked with its regional and national counterparts along with a range of other partner agencies to provide rapid mapping and GIS support to the relief operation in the South-East Asia Region.

As soon as information started coming in from the field, maps were used to pinpoint the exact location of internally displaced people in relation to functioning health facilities – highlighting the populations with no access to health services. These maps were used to help redirect and track resources such as emergency health supplies, including surgical and diarrhoeal kits. Maps were used to chart the areas where humanitarian relief agencies were operating, in order to identify areas that were underserved, to avoid any duplication of efforts, and to serve as a coordination mechanism.

On the ground in Banda Aceh, Indonesia - the area worst affected by the tsunami - a WHO public health mapping and GIS expert was deployed along with WHO epidemiologists and experts from the Global Outbreak Alert and Response Network (GOARN) to rapidly establish early warning system for epidemics and to train provincial health staff on how to enter, manage and map data for disease surveillance. WHO's HealthMapper system linked the disease surveillance and early warning system and generated epidemiological data and maps that were regularly shared with health partners in the field.

Mapping Indonesia Tsunami recovery indicators: health infrastructure, December 2005

Health facilities destroyed and rehabilitated or newly constructed

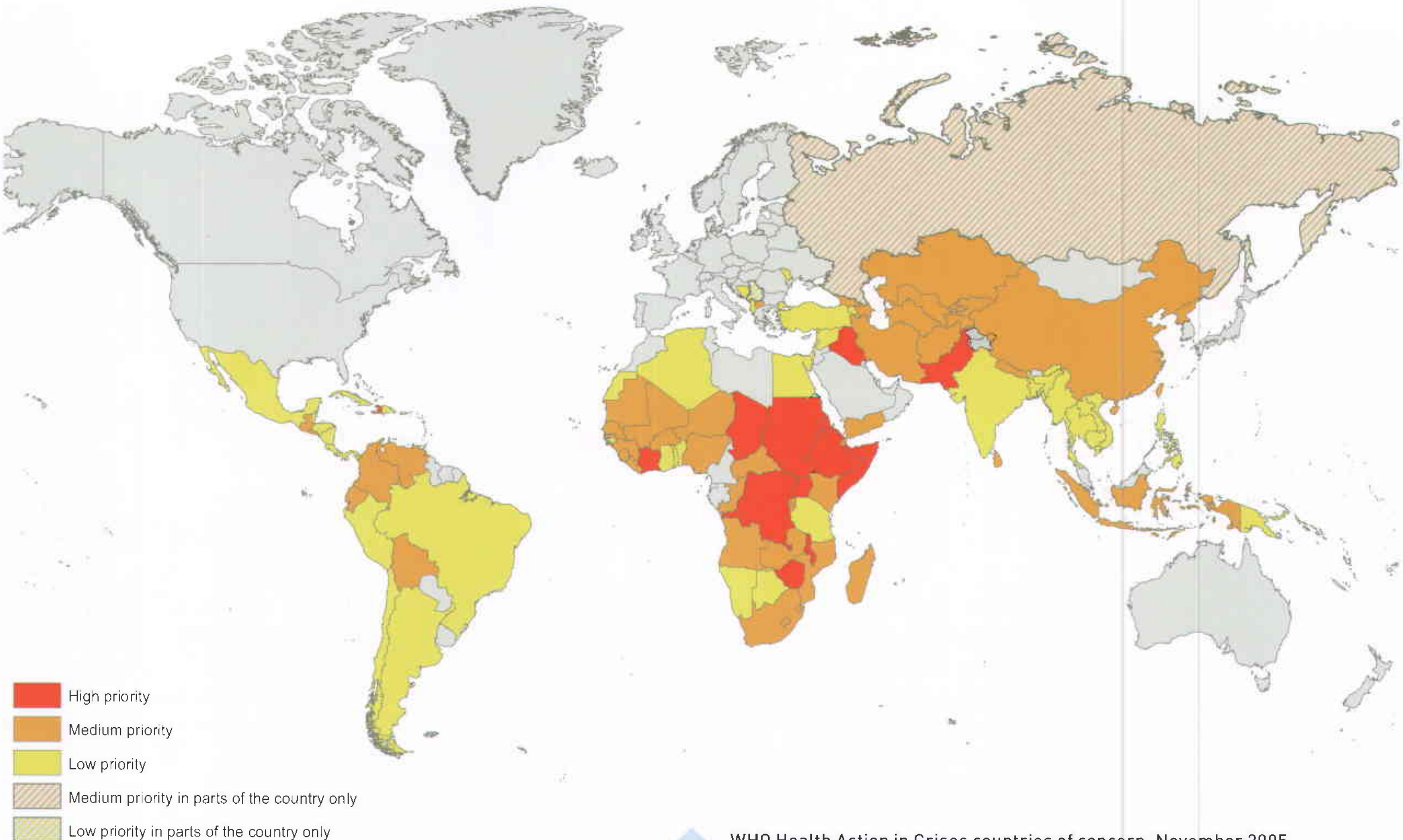
Number of health centres

Average distance to general hospitals

Number of child facilities rehabilitated or newly reconstructed

Many of the data were obtained from government and UN interagency health assessments carried out in conjunction with local WHO offices. In Banda Aceh province, the inventory was conducted by military helicopter-assisted survey teams equipped with hand-held mapping devices (global positioning systems) to pinpoint the location of displaced populations and basic infrastructure. The information was simultaneously dispatched to WHO regional and headquarter levels and integrated in the main GIS data repository at WHO's Strategic Health Operations Centre for analysis and dissemination.

Once the emergency phase was over, WHO provided support to countries such as Indonesia to build national capacity for GIS and public health mapping. Indonesia is now planning a household mapping survey in Aceh and North Sumatra in an effort to assess the impact of the tsunami on population health, and provide a direction for long-term rehabilitation and reconstruction efforts in the health-related sector. WHO's public health mapping and GIS team is supporting this survey by providing technical expertise in field mapping using PDAs for remote data collection in conjunction with the HealthMapper.



WHO Health Action in Crises countries of concern, November 2005

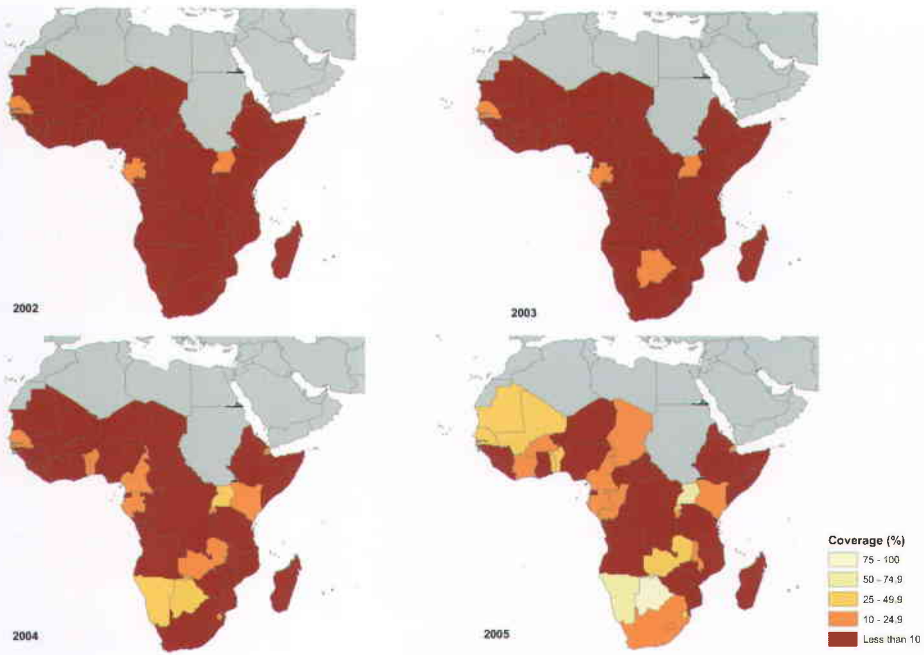
Lebanon humanitarian crisis, 2006

Functional status of hospitals in Lebanon, as of 7 August 2006

WHO Regional Office for the Eastern Mediterranean, in close collaboration with the Ministry of Health, conducted assessments of the damages to health facilities and the impact of the crisis on the delivery of health services in the country.

Humanitarian intervention in Lebanon: health, as of 28 July 2006

In collaboration with other UN agencies and partners, WHO Regional Office for the Eastern Mediterranean tracked down the activities of the international community on the ground. Maps produced included international agencies providing assistance with food, health, medical supplies, water and non food items and services.



People in sub-Saharan Africa on antiretroviral treatment as percentage of those in need, 2002-2005

Mapping the changing dynamics of a global epidemic

Public health mapping and GIS are today being used in efforts to monitor not only the geographical spread of HIV/AIDS but also the changing dynamics of the pandemic. Health maps are able to highlight on a country-by-country basis the prevalence of the disease, differentiate between the various groups affected, identify key high-risk areas, and monitor trends over time.

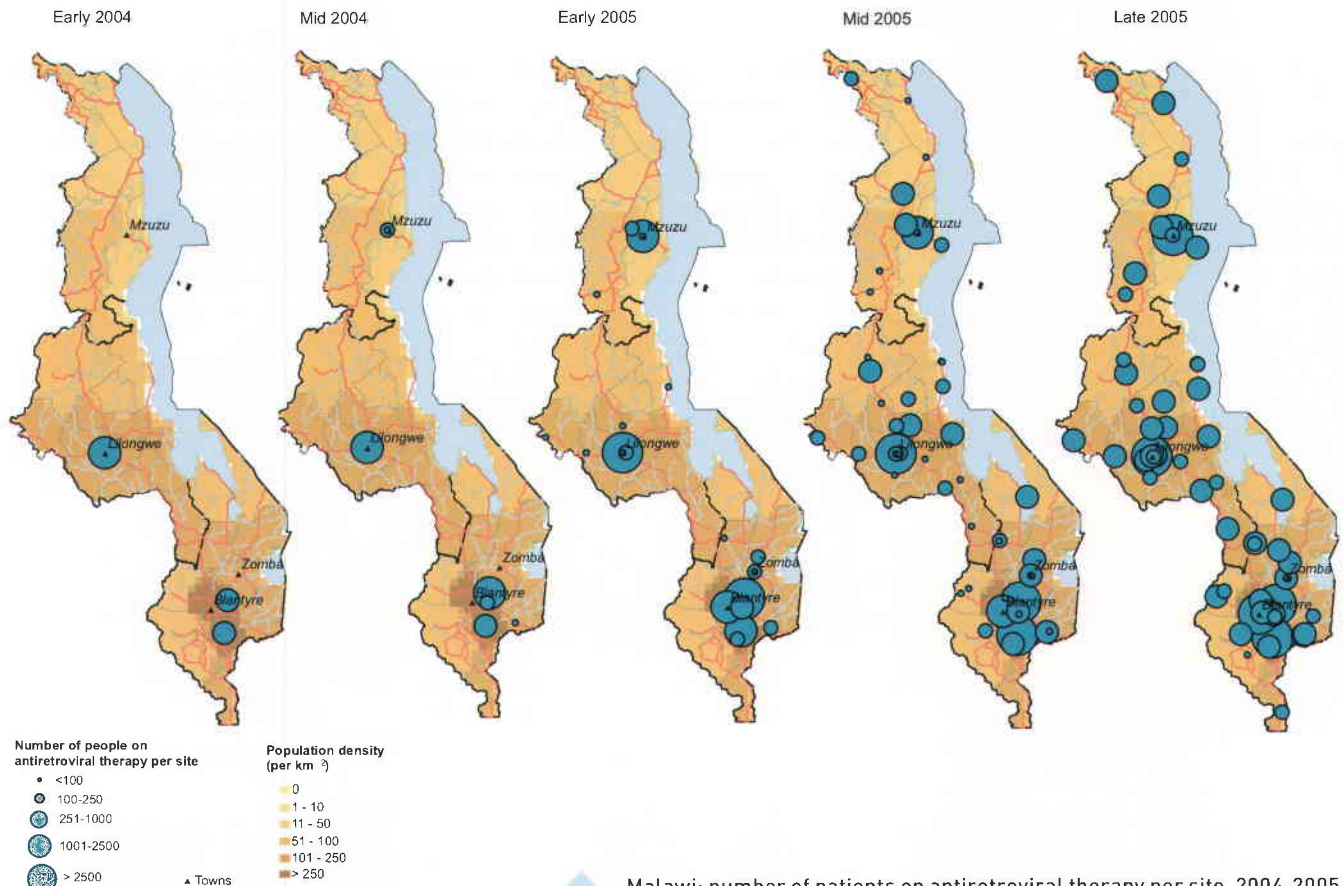
Most people living with HIV/AIDS do not know that they are infected and have never been tested. Estimates of the prevalence of the disease in each country are therefore derived from the results of routine anonymous testing at sentinel surveillance sites such as antenatal clinics.

If this map is then overlaid onto a base map that includes the main towns and cities, it is possible to see at a glance whether prevalence among pregnant women is greater in urban or rural areas. Similarly, a map showing major trading routes or mines, for example, can be used to show where rising prevalence may be linked to an increase in commercial sex at truck stops along the trading route or in mining areas. This kind of information can be used at country level to target health education messages and the distribution of condoms to encourage safe sex.

Add another map layer showing population density countrywide, and a government health planner can see at a glance whether the sentinel sites are well situated throughout the country. Are they widely scattered or heavily clustered in one region? Do they serve a representative, well populated catchment area?

A recent innovation is the use of health mapping and GIS to help in targeting efforts to prevent and treat the disease – by pinpointing the health facilities where blood safety needs to be stepped up, for example, or mapping where medicines are needed to treat the disease or to prevent mother-to-child transmission. As access to antiretroviral therapy is being scaled up in developing countries, public health mapping and GIS are already being used to keep track of the number of people with or without access to treatment in countries throughout the world.

It is also envisaged that health mapping will be used to highlight areas where an increase in risk behaviour – injecting drug use, for example – could herald a wave of new infections. In areas where the epidemic is still at an early stage, such as some countries in Asia, the graphic visualization of where and how the disease is spreading, and at what pace, can be a powerful tool for advocacy and decision-making.



Malawi: number of patients on antiretroviral therapy per site, 2004-2005

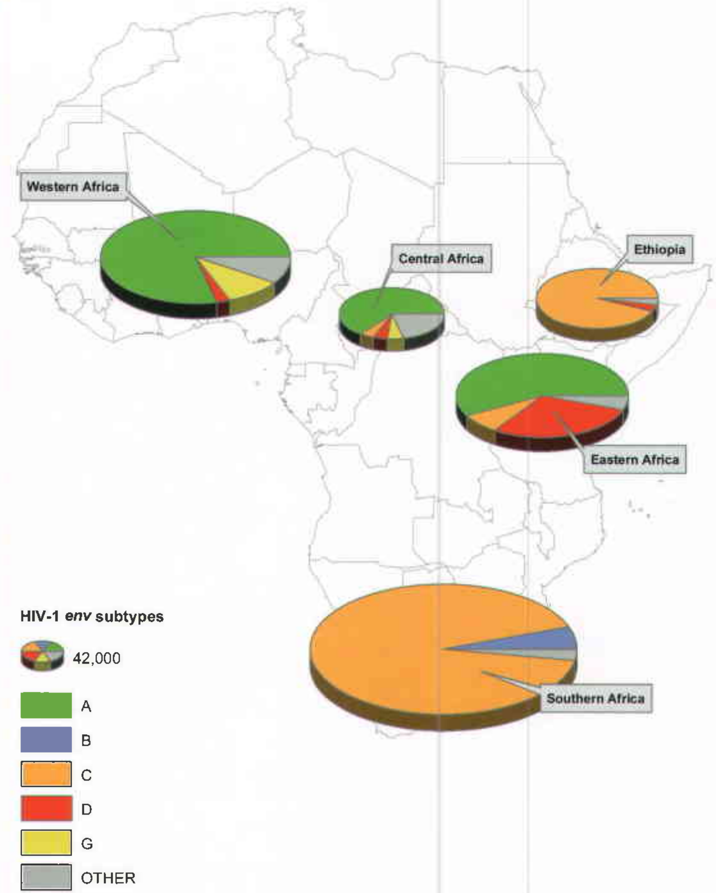
HIV/AIDS

By December 2004, an estimated 40 million people worldwide were living with HIV/AIDS. During 2004, an estimated 5 million people were newly infected with HIV and an estimated 3 million people died from AIDS.

In late 2003, WHO, UNAIDS and partners launched the "3 by 5" initiative – an emergency effort to ensure that 3 million people living with HIV in developing countries have access to antiretroviral therapy by the end of 2005.

Health maps are also being used to show where the different subtypes of the virus are occurring. Over time, they will be used increasingly to demonstrate the geographical spread of resistance to antiretroviral medicines and thus help to ensure that alternative medicines are made available to prevent treatment failure.

Distribution[a] of HIV-1 *env* subtypes in the WHO African Region, 2000
[a] size of circles is proportional to the number of infected people



A global investigative tool

As polio edges closer to eradication, public health mapping is being used as a key investigative support tool to chart where and why cases are still occurring and to help plan the appropriate response. Health maps are also used to identify where cases may be going unnoticed because of weak links in the surveillance system.

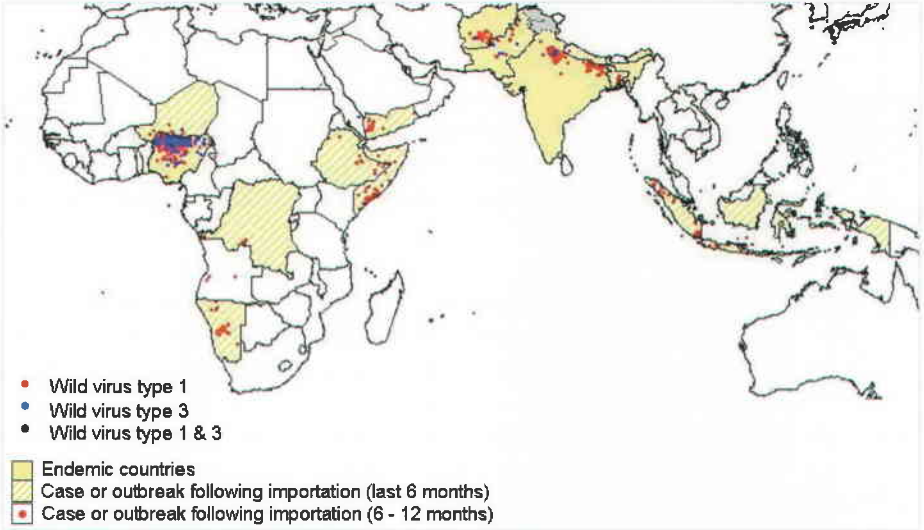
Good surveillance is the lynchpin of the polio eradication initiative. Without this it is impossible to pinpoint where the virus is still circulating or to verify where it has been eradicated.

Countries are required to report all cases of Acute Flaccid Paralysis (AFP) involving children under 15 years of age, which may or may not include polio-related cases of AFP. A national surveillance system should be sensitive enough to detect at least one AFP case a year for every 100 000 children under 15, even in countries where polio has been eradicated. This AFP case-detection rate is a measure of a country's ability to detect any case of polio that might occur.

Countries are also required to send stool samples for each AFP case for laboratory analysis, to ascertain whether poliovirus or other viruses are present. If poliovirus is found, follow-up tests are carried out to determine whether it is wild or vaccine-related poliovirus and whether the case is indigenous or imported. This classification is needed to determine the appropriate response.

In regions where polio is still occurring, health mapping can be used to chart all AFP cases and to show how many of those were subsequently diagnosed as wild poliovirus cases – showing their geographical distribution at district, country, and regional level. When these data are overlaid onto a map of population distribution, it is possible to see at a glance whether the distribution of AFP cases is consistent with the density of the population.

Public health mapping is also being used to map the standard of AFP surveillance in countries throughout the region and over time, showing to what extent countries are meeting the criteria for AFP case detection and laboratory diagnosis. These data are essential to indicate where surveillance systems need to be strengthened.



Officially reported wild polio virus cases, 2 August 2005-1 August 2006

Global health alert and response

In today's interconnected world, microbes, like people, are constantly on the move. Ferried around the world by airline passengers or carried across borders into neighbouring countries by people, animals, insects, or other vectors, and sometimes in food or water, they can establish themselves far away from the original source.

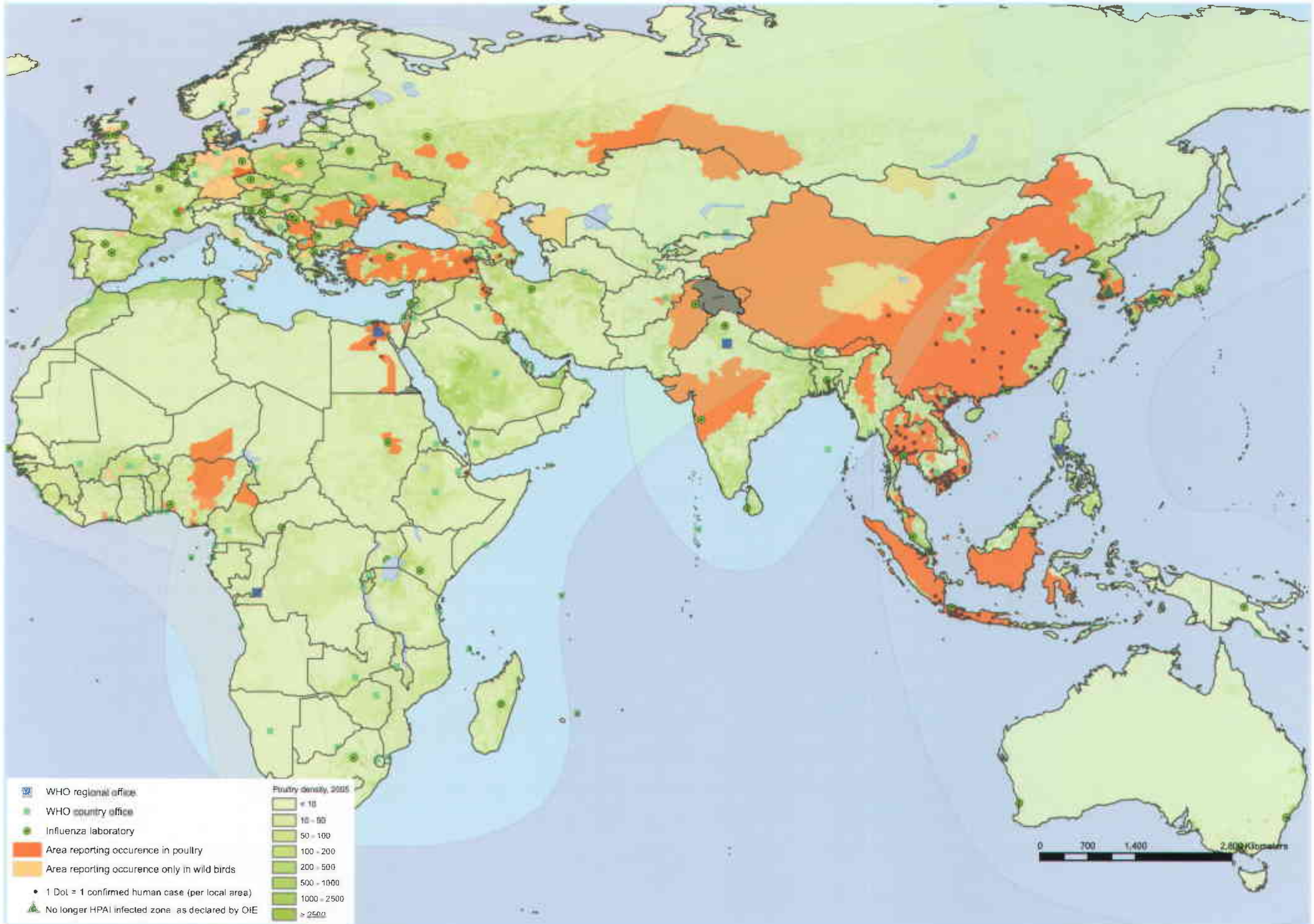
Some of the diseases they cause, such as TB, malaria, and pneumonia, are old foes –but old foes that now pose a new threat. Today, the arsenal of medicines available to treat these diseases is becoming rapidly depleted as microbes develop resistance to first- and second-line treatments. Other diseases, including HIV/AIDS, SARS, and avian influenza, pose new and unexpected challenges and the risk of global pandemics. In addition to the often formidable health problems they pose, some epidemic-prone diseases also have severe social and economic consequences for the countries and regions worst affected.

Meanwhile, the continuing threat of the deliberate or accidental release of biological agents such as anthrax and smallpox underlines the importance of having an effective global disease intelligence network in place to ensure both routine surveillance and an early warning of unusual outbreaks of disease.

Geographical Information Systems and mapping technologies are now directly linked to the WHO event management system for public health emergencies of international concern. This electronically-managed system guides decisions pertaining to outbreak alert and response by uniting information from early warning systems, risk assessment and the operational response. As one example of this link, conditions related to geography that have been associated with past outbreaks can be superimposed on maps to generate a picture of areas at greatest risk and the time of the year when the risk is expected to peak. Moreover, because satellite-generated maps and their associated data are transnational in nature, they can help identify factors that favour the spread of an infectious disease from one locality to neighbouring countries. In so doing, they also help compensate for the inability of many national surveillance systems to detect diseases with a potential to spread internationally.

Like many other infectious diseases, highly pathogenic H5N1 avian influenza is influenced by multiple environmental factors. Experience over the past two years has revealed seasonal peaks in animal outbreaks and associated human cases. Survival of the virus in the environment is influenced by conditions of temperature and humidity. Risk factors for human infection are also better understood, and are known to be associated with human proximity to poultry in rural and periurban areas. Most recently, migratory birds have been implicated in spread of the virus to new areas. Mapping technologies thus have functions that can be used immediately to assess the further spread of avian influenza in birds and identify human populations at greatest risk of exposure. Examples include the mapping of poultry outbreaks and poultry densities in affected countries to identify human populations at risk, determine their access to health care, and pinpoint areas where surveillance should be intensified. The mapping of wetlands and the flight routes of migratory birds can identify countries at risk of importation of the virus and indicate times of the year when veterinary surveillance, possibly with international assistance, should increase. In this regard, the HealthMapper can make these maps meaningful for health planners by plotting population densities and showing health capacities in areas at risk, particularly for Africa.

Baseline health and demographic data, already collected for a large number of countries, can provide the foundation for rapidly adapting health systems to cope with an emergency on the scale of a pandemic. For example, HealthMapper can be used to identify schools and other facilities that can be converted to handle abrupt surges in the number of people seeking health care. Logistic arrangements during a pandemic can likewise be expedited. HealthMapper's considerable use in directing the delivery of population-wide interventions has direct applicability during a pandemic. As further assistance to pandemic preparedness and response, mapping technologies can aid the prediction, in real time, of pandemic spread globally, within a country, or within a community.



Confirmed human cases and occurrence of avian influenza in poultry and wild birds since 2003, status as of August 2006

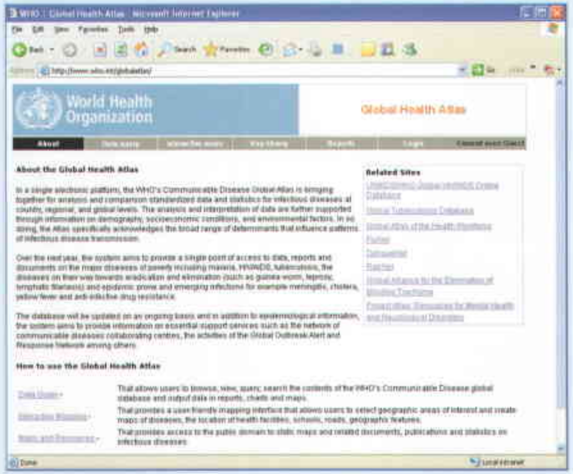
The Global Health Atlas

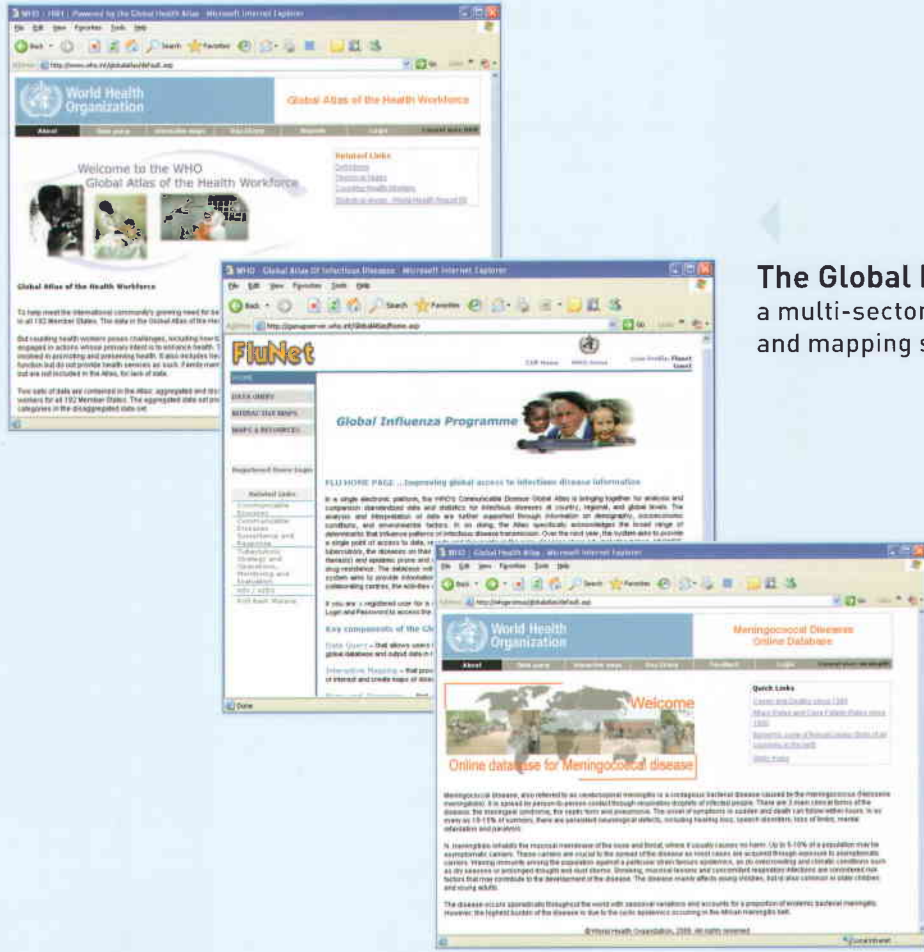
To ensure that national governments and global decision-makers have ready access to a wide range of information on infectious diseases and other health-related issues, WHO has established an innovative online global atlas of infectious diseases based on public health mapping technology. The Global Atlas of Infectious Diseases – a vast storehouse of data and interactive health maps – allows users to compare and analyse geographically linked information based on surveillance and survey data, reports, graphs, and other documents from countries and regions throughout the world. The system is intended to be a "one-stop shop" for information on infectious diseases for use by WHO programmes and partners.

The Atlas is designed to be readily accessible and user-friendly, with interactive maps offering a powerful overview of health needs, available resources, and the global status of disease control programmes. When fully operational, the Atlas will also offer access to real-time information on outbreaks of infectious diseases, providing an early alert that can be used to help contain the outbreaks more rapidly.

The Atlas also provides access to vital web-based geographical information systems designed to enhance global disease surveillance by providing an early warning system for outbreaks of life-threatening diseases with epidemic potential. These systems include FluNet, established in 1997 to provide real-time access to global information on the strains of influenza virus currently in circulation and on the latest outbreaks of the disease. FluNet is based on information supplied by a network of more than 100 national influenza centres in over 80 countries and by four WHO collaborating centres. The network supplies the data needed to formulate the annual influenza vaccine – based on the strains of the virus currently in circulation – and provides a critical early warning of the emergence of any new strains, such as avian influenza, with the potential to cause pandemics. The stakes are high. While annual epidemics of influenza are estimated to kill 0.5–1 million people worldwide, the worst pandemic in the twentieth century – the so-called "Spanish flu" of 1918 – claimed between 40 and 50 million lives.

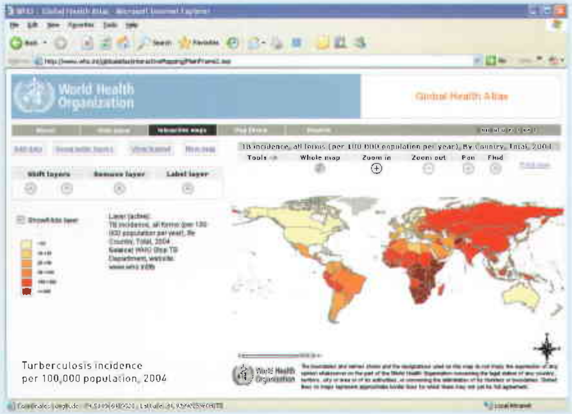
The Global Atlas also provides online access to similar electronic databases established to improve global surveillance of dengue fever (DengueNet) and of rabies (RabNet) in both animals and humans. All three electronic networks allow the remote entry and sharing of up-to-the-minute data by authorized health officials and laboratories and thus help to improve epidemic preparedness and response.

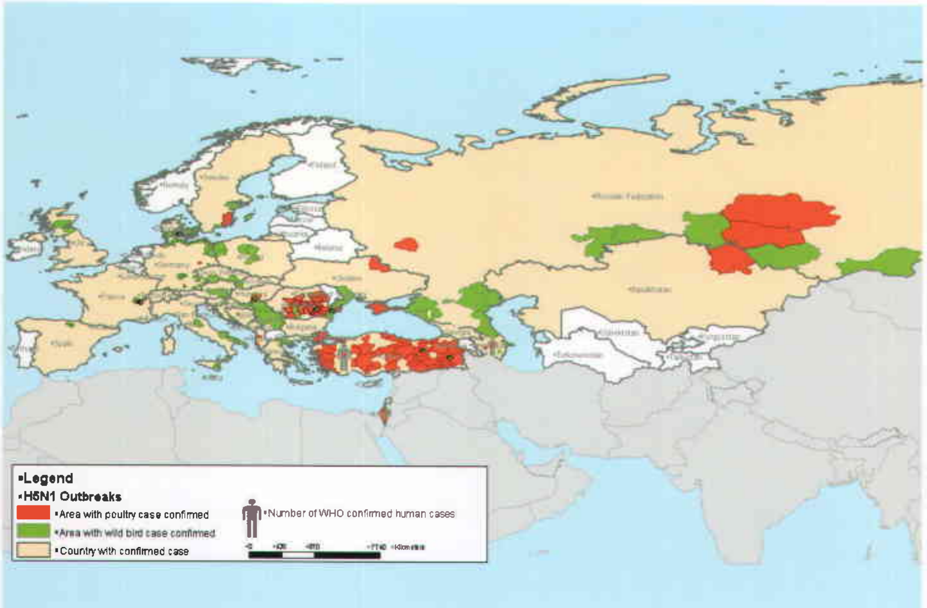




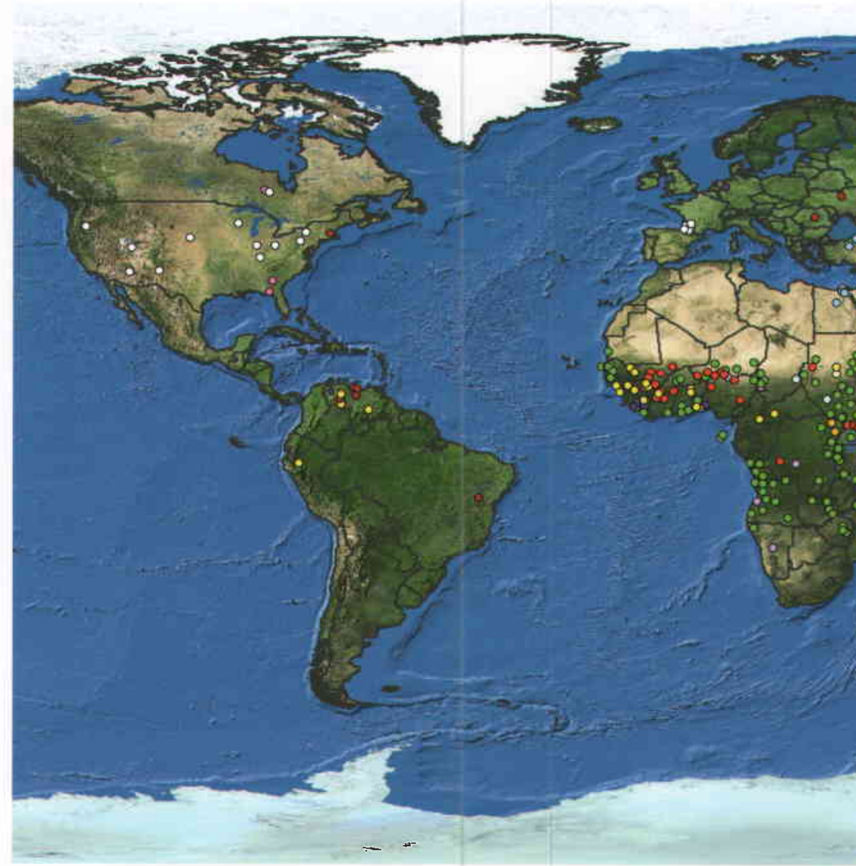
The Global Health Atlas:

a multi-sectoral interactive information and mapping system.





WHO Regional Office for Europe is using GIS to track avian influenza outbreaks in the Region: Areas affected since 1 July 2005, status as of August 2006



Selected communicable disease outbreaks, June 2005-December 2006

Public health mapping for the 21st century

An effective disease reporting system ensures that governments are able to pinpoint where health problems exist, to estimate the size of the problems, and to monitor trends. Good surveillance is also essential to target interventions and measure their impact, monitor drug resistance, and provide an early warning system for outbreaks of known diseases and the emergence of new ones.

At the same time, governments need the capacity to anticipate and monitor the impact of other sectors on health. Many of the key determinants of health, as well as the solutions, lie outside the direct control of the health sector. They include household income, access to sanitation and safe drinking-water, environmental factors, climate change, demographic trends, education, agriculture, trade, tourism, housing, and labour markets.

In addition, countries need to have information systems in place that can profile health facilities and health service provision nationwide and identify and target underserved populations. They also need to be able to keep track of the services provided by public and private sector partners and by the private sector.

However, in countries where national health systems are weak and underfunded, surveillance and information activities are often inconsistent and uncoordinated. In response, WHO is coordinating efforts to strengthen national surveillance systems through training in epidemiology and laboratory practices – an approach that is being pioneered in Africa. The aim is to help countries to establish integrated disease surveillance systems with streamlined activities and good reporting systems in which information is shared – and used – at national, regional, and global levels.

Public health mapping is at the forefront of these efforts to strengthen national surveillance capacity and global health security. GIS and public health mapping technologies provide an ideal platform for integrating data from a wide range of health-related sources. These technologies encourage the standardization of data collection and provide a common currency across data, diseases, health programmes, and sectors to support analysis and decision-making.

Nevertheless, a number of technical and operational challenges remain before public health mapping can realize its full potential for global disease surveillance and other public health applications. Up till now, the development of GIS and mapping applications has been driven mainly by a few individual disease programmes in a limited range of countries. As a result, the existing functions are tailored to the needs of specific disease control programmes. The mapping tools now need to be more broadly developed and applied in all countries. They should also be extended beyond infectious diseases to include applications for noncommunicable diseases and health systems development, for example.

There is also a need to intensify and expand public health mapping and GIS activities worldwide to build up a more detailed and wide-ranging geographical database, with a particular emphasis on mapping health problems and access to health care in rapidly expanding urban settings, a hitherto neglected area. To achieve this, training in public health mapping and GIS is being stepped up and training networks are being established in each WHO region.

Meanwhile, further technological advances are also essential. The existing tools and applications need to be fully integrated into a high-speed global public health mapping system that also serves as an effective early alert system to support the detection, verification, and response to outbreaks of diseases, especially those that are new or unexpected.

At present, a time lag exists between the discovery by a health worker in the field of a potential outbreak of a disease and the reporting of this at the national, regional and global level – and this delay is costing lives. To ensure real-time reporting of outbreaks with epidemic potential, the field worker needs to be equipped not only with a satellite-based global positioning system (GPS) but also with a hand-held internet-linked computer device that can immediately feed the information directly to the relevant decision-makers at the national, regional, and global level.

To help meet these operational challenges, international cooperation is needed to strengthen and expand partnerships for technical support and data sharing. Once these key building blocks are in place, public health mapping is poised to become a powerful cutting-edge tool for global disease surveillance in the 21st century.

To date, the public health benefits of geographical information systems and mapping technologies have been most extensively utilized during large health campaigns and international responses to public health emergencies, including those caused by outbreaks and natural disasters. The challenge now is to extend these benefits more broadly to health systems in developing countries in ways that make the multiple powers of these technologies an integral part of routine surveillance and planning activities, particularly at the district level. WHO has developed a programme of work for doing so, and this is being pursued in collaboration with a large number of international partners.

Public Health Mapping and GIS for Global Health Security a WHO strategic and operational framework

Through its global partnership, The WHO public health mapping and GIS programme is playing a leading role in the promotion and integration of GIS in strengthening national and global information systems.

Vision

Improved disease surveillance and national public health systems through the use of GIS and related information and mapping technologies.

Strategic directions

- Disease surveillance and international health regulations: promoting the use of GIS as an integral component of national disease surveillance and response systems.
- Health systems: strengthening country health information systems through mapping and monitoring of public health risks and resources.
- The Organization: strengthen capacity of WHO to inform and guide on global health situation and decision-making through enterprise-based GIS systems

Core functions

- Lead global efforts in mapping baseline public health resources and risks at local levels;
- Promote, improve and evaluate GIS tools for disease surveillance and health systems strengthening;
- Strengthen national decision-making through the use of public health mapping and GIS;
- Leverage international cooperation for the design and implementation of GIS standards, methodologies, tools, data and technical support.

Public health mapping partnership

The WHO public health mapping programme operates through a global partnership involving national governments, universities and research institutes, other United Nations agencies, NGOs, bilateral agencies, and foundations, including:

Technical partners
Centers for Disease Control, USA
Centre National d'Etudes Spatiales (CNES), France
European Space Agency (ESA), France
Geneva International Academic Network, Switzerland
Hospices Civils de Lyon, France
Imperial College London, England
Liverpool School of Tropical Medicine, England
London School of Hygiene and Tropical Medicine, England
Macro International Inc., USA
Medical Research Council, South Africa
Population Services International (PSI), USA
Southeast Asian Ministers of Education Organization, Regional Tropical Medicine and Public Health Network (SEAMEO-TROPMED), Thailand
The Carter Center, USA
University of Colombia, USA
United States Agency for International Development (USAID)

United Nations agency partners
Food and Agriculture Organization (FAO)
Geographic Information Support Team (GIST)
Joint United Nations Programme on HIV/AIDS (UNAIDS)
United Nations Environment Programme (UNEP)
United Nations Geographic Information Working Group (UNGIWG)
United Nations High Commissioner for Refugees (UNHCR)
World Food Programme (WFP)

Private sector partners
Environmental Systems Research Institute (ESRI) Inc., USA
Michelin, France

With support from
Bill and Melinda Gates Foundation
Governments of Republic of Ireland, Japan, Netherlands and United States of America

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Maps, illustrations and photographs

Page 3 Photograph. WHO.

Page 4 Illustrations. Wikipedia, the free encyclopedia (www.wikipedia.org).

Page 5 Banda Aceh and Aceh Besar sub-districts, displaced people and health facilities as of 24 January 2005. Bakosurtanal (National Coordinating Agency for Surveys and Mapping in Indonesia), Central Bureau of Statistics in Indonesia.

Page 6 Photograph. WHO.

Page 7 Cholera outbreak in Angola: cumulative cases, 13 February-30 July 2006. WHO Country Office, Angola.

Page 7 Districts crossing the alert and epidemic thresholds in African countries under enhanced surveillance during the meningitis epidemic season, 2006. Multi Disease Surveillance Centre, WHO.

Page 9 Illustration. Public Health Mapping and GIS, WHO.

Page 10 Mapping risk assessment in Mexico. WHO Regional Office for the Americas.

Page 11 Leprosy: prevalence rate in South-East Asia Region for year 2003/2004. Ministry of Health, in collaboration with WHO Regional Office for the Western Pacific.

Page 11 Cumulative number of Severe Acute Respiratory Syndrome (SARS) in China mainland, 15 May 2003. WHO Regional Office for the Western Pacific.

Page 12 HIV sentinel surveillance in pregnant women in Botswana, latest available year, 2002-2005. WHO/UNAIDS.

Page 12 HIV prevalence (%) in adults in Africa, 2005. WHO/UNAIDS.

Page 13 A global view of HIV infection: an estimated 38.6 million people [33.4-46.0 million] living with HIV, 2005. A report on the Global AIDS epidemic 2006 UNAIDS.

Page 14 NGOs working in Sudan, 2002. Public Health Mapping and GIS, WHO.

Page 15 Photographs. WHO Regional Office for Europe and WHO Regional Office for Africa.

Page 16 Number of doctors per 100,000 people - Service Availability Mapping, Zambia, 2004. Ministry of Health, Zambia, in collaboration with Measurement and Health Information Systems/Public Health Mapping and GIS, WHO.

Page 17 Location of antiretroviral therapy (ARV) sites - Service Availability Mapping, Zambia, 2004. Ministry of Health, Zambia, in collaboration with Measurement and Health Information Systems/Public Health Mapping and GIS, WHO.

Page 17 Location of sites providing tuberculosis (TB) diagnosis - Service Availability Mapping, Zambia, 2004. Ministry of Health, Zambia, in collaboration with Measurement and Health Information Systems/Public Health Mapping and GIS, WHO.

Pages 18-19 Illustration. Public Health Mapping and GIS, WHO.

Page 20 Certification of dracunculiasis eradication, status as of January 2005. Global Programme to Eradicate Dracunculiasis, WHO.

Page 41 Health facilities destroyed and rehabilitated or newly constructed. Aceh Provincial Health Office, United Nations Population Fund, Central Bureau of Statistics in Indonesia, December 2005.

Page 41 Number of health centres. Aceh Provincial Health Office, United Nations Population Fund, Central Bureau of Statistics in Indonesia, December 2005.

Page 41 Average distance to general hospitals. Aceh Provincial Health Office, United Nations Population Fund, Central Bureau of Statistics in Indonesia, December 2005.

Page 41 Number of child facilities rehabilitated or newly reconstructed. Aceh Provincial Health Office, United Nations Population Fund, Central Bureau of Statistics in Indonesia, December 2005.

Page 42 WHO Health Action in Crises countries of concern, November 2005. Health Action in Crises, WHO.

Page 43 Functional status of hospitals in Lebanon, as of 7 August 2006. Ministry of Health in Lebanon in collaboration with National government of Lebanon, World Health Organizational Regional Office for the Eastern Mediterranean, Office of U.S. Foreign Disaster Assistance, Vietnam Veterans of America Foundation, World Food Programme, United Nations Office for the Coordination of Humanitarian Affairs.

Page 43 Humanitarian intervention in Lebanon: health, as of 28 July 2006. Ministry of Health in Lebanon, in collaboration with National government of Lebanon, World Health Organizational Regional Office for the Eastern Mediterranean, Office of U.S. Foreign Disaster Assistance, Vietnam Veterans of America Foundation, World Food Programme, United Nations Office for the Coordination of Humanitarian Affairs.

Page 44 People in sub-Saharan Africa on antiretroviral treatment as percentage of those in need, 2002-2005. Progress on Global Access to HIV Antiretroviral Therapy A report on " 3by 5" and Beyond March 2006 , WHO.

Page 45 Malawi: number of patients on antiretroviral therapy per site, 2004-2005. Ministry of Health, Malawi, in collaboration with HIV/AIDS programme, Progress on Global Access to HIV Antiretroviral Therapy A report on " 3by 5" and Beyond March 2006 , WHO.

Page 46 Distribution of HIV-1 env subtypes in the WHO African Region, HIV/AIDS Epidemiological Surveillance report for the WHO African region 2005 update WHO.

Page 47 Officially reported wild polio virus cases, 2 August 2005-1 August 2006. Global Polio Eradication Initiative, WHO.

Page 49 Confirmed human cases and occurrence of avian influenza in poultry and wild birds since 2003, status as of August 2006. World Organisation for Animal Health (OIE), national governments and Epidemic and Pandemic Alert and Response, WHO.

Page 51 Illustrations. Public Health Mapping and GIS/Stop TB Partnership/Human Resources for Health/Global Influenza Programme/Epidemic Readiness and Intervention, WHO.

Page 52 WHO Regional Office for Europe is using GIS to track avian influenza outbreaks in the Region: Areas affected since 1 July 2005, status as of August 2006. WHO Regional Office for Europe.

Page 52 Verified communicable disease outbreaks, 2001-2006. Epidemic and Pandemic Alert and Response, WHO.

Page 55 Illustration. Public Health Mapping and GIS, WHO.

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