Public Health Mapping and GIS for Global Health Security

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

A WHO strategic and operational framework

World Health Organization
Acknowledgements

This strategy is a joint effort of WHO offices worldwide working the area of public health mapping and GIS. Thanks are due to colleagues in the Global Public Health Mapping network and all focal points in the Regional Offices.

Glossary of key terms and abbreviations/acronyms

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<thead>
<tr>
<th>Abbreviation</th>
<th>Full Form</th>
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<tr>
<td>CNES</td>
<td>Centre National d'Etudes Spatiales</td>
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<td>FAO</td>
<td>Food and Agriculture Organization of the United Nations</td>
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<td>GEOSS</td>
<td>Global Earth Observation System of Systems</td>
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<tr>
<td>GIS</td>
<td>Geographic Information System</td>
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<tr>
<td>GPS</td>
<td>Global Positional System</td>
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<td>PDA</td>
<td>Personal Digital Assistant</td>
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<td>SAM</td>
<td>Services Availability Mapping</td>
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<tr>
<td>SARS</td>
<td>Severe Acute Respiratory Syndrome</td>
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<tr>
<td>SEAMEO-TROPMED</td>
<td>Southeast Asian Ministers of Education Organization Regional Tropical Medicine and Public Health Network</td>
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<td>SHOC</td>
<td>Strategic Health Operations Centre</td>
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<td>UNAIDS</td>
<td>Joint United Nations Programme on HIV/AIDS</td>
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<td>UNGIWG</td>
<td>United Nations Geographic Information Working Group</td>
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<td>UNOSAT</td>
<td>United Nations initiative to provide the humanitarian community with access to satellite imagery and GIS services</td>
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<td>VCT</td>
<td>Voluntary Counseling and Testing</td>
</tr>
<tr>
<td>WFP</td>
<td>United Nations World Food Programme</td>
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Executive summary

Recent events, including the SARS and avian influenza epidemics and the recent Tsunami disaster in South East Asia last year, have highlighted an urgent need for effective information management to coordinate national and international efforts in responding to public health emergencies and priorities. These events have also underscored the unique role WHO has to play in promoting and assisting Member States in progressive and modern data collection and sharing in ways that improve the credibility and timeliness of information across geo-political boundaries.

Geographic Information Systems (GIS) and related information and mapping technologies are among the forefront of cutting edge tools that are being used to build reliable public health information and surveillance systems. Today, due to advances in technology, investment in training and in the establishment of procedures and processes at country level, GIS and mapping are being used to map global distribution of infectious diseases and related risk factors. They have also facilitated surveillance for early warning purposes and the planning and implementation of measures for disease prevention and control.

Notwithstanding this progress, several operational and technical challenges remain if the public health benefits of GIS are to be fully exploited and integrated into the routine surveillance activities in ways that benefit more broadly to health systems strengthening. First, major gaps in essential baseline data (such as the location and availability of health services and resources, schools, and populations) need to be filled. Second, mapping technologies need to be further enhanced to allow their full integration into high-speed national and international surveillance systems. Third, better international cooperation is needed to define, develop and disseminate common standards and protocols that allow the exchange of comparable data among the many partners currently using information and mapping technologies for public health.

In the current environment, there is an opportunity for WHO to leverage current efforts and play a leading role in the promotion and integration of GIS in strengthening national and global surveillance information systems.

To this end, WHO has developed a programme of work that focuses on 4 main strategic directions as follows:

1. leading global efforts in mapping baseline public health resources and risks at local levels;
2. promoting, improving and evaluating GIS tools for disease surveillance and health systems strengthening;
3. strengthening national decision-making through the use of public health mapping and GIS;
4. leveraging international cooperation for the design and implementation of GIS standards, methodologies, tools, data and technical support.

This document presents the strategic directions for WHO public health mapping and GIS. Details on services, products, activities, and timelines, as well as the staffing and budget requirements to achieve these objectives are detailed in the WHO Public health mapping and GIS plan of work.
1 | Background

Overview: the geography of diseases

Geography matters in the detection, monitoring and response to disease threats. 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 food or water, they can establish themselves far away from the original source.

Some of the diseases they cause, such as tuberculosis, malaria and pneumonia are old foes, but old foes that cause new threats. Other diseases, including HIV/AIDS, SARS and now avian influenza, pose new and unexpected challenges and the risk of global pandemics. These threats and the continuing threat of deliberate or accidental release of biologicals such as anthrax and smallpox, underline the importance of having effective geographically based information systems that can track the spread of diseases across communities and geo-political boundaries and guide effective response.

Such Geographic Information Systems are not only necessary for effective response to diseases outbreaks, but are critical in guiding respond to other health crises, such as natural disasters, and for planning and monitoring the scale up of major interventions against other public health priorities such as HIV/AIDS, tuberculosis, malaria, childhood illnesses and maternal mortality.

Geographic Information Systems (GIS)

GIS are an outgrowth of sophisticated satellite imaging technologies originally developed for military applications. Today, the systems use maps generated by earth-observing civilian satellites that remotely sense features of the earth and its atmosphere, such as topography, vegetation, and precipitation zones, and locate these features in space, using a system of latitudinal and longitudinal coordinates.

This mapping function is supported by the processing power of computers, whereby multiple layers of additional data, selected as relevant to a particular problem in a geographical area, can be superimposed on maps. Information from multiple sources is transformed into a common format that allows the user to visualize the spatial relationships and interactions of different determining factors, thus facilitating analysis and interpretation.

GIS also make use of a satellite-based navigation system, known as the Global Positioning System (GPS). Inexpensive hand-held devices are now available to receive radio signals, determine the user’s exact location, navigate movement, and calculate the distance to destinations and the time needed to reach them. As another innovation, data from a personal digital assistant can be transferred to a computer and then uploaded into a national or global information network. Public health is now benefiting from all these developments, which have made sophisticated information technologies applicable under remote field conditions, at prices affordable in developing countries, and with a simplicity that allows their use following a five-day training course.
The role of GIS in disease surveillance and public health

Geographical mapping of disease is not exactly new. Its first reported use was in London 1859 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. Since then simple health maps have been used to chart disease spread, identify sources, determine target areas and assess epidemic risk. Health maps are also being used to chart the size and profile of populations from remote rural areas to overcrowded cities. They are used to register the catchment area of a community health worker and the population served by an urban hospital.

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

Many public health applications for example derive from the close links between the behaviour of infections diseases and environmental factors, including temperature, elevation, soil conditions, land use, rainfall, and other meteorological conditions. For public health purposes, satellite-generated maps can be combined with spatial data on physical features, such as the location of health facilities, schools, roads, farms, rainforests, and water bodies, or data from other sources, such as information on population density, patterns of land use, seasonal precipitation, and the ecological behaviour of insect and animal vectors of disease. As one example, patterns of vegetation can be remotely sensed by satellite and mapped. When this information is juxtaposed with data on the habitats of vectors, meaningful conclusions can be reached about the location of populations at risk of vector-borne diseases.

Today, GIS provides a framework for managing a broad range of challenges in public health:

- assessing health services availability and accessibility;
- mapping health events and identifying disease clusters;
- real-time disease surveillance;
- stratifying risk factors and identifying populations most at risk;
- planning and targeting distribution of health interventions such as medicines, vaccines, drinking water or mosquito nets;
- tracking and analyzing global spread of disease;
- monitoring spatial/temporal trends;
- global monitoring and resource mobilization.
2 | Supporting WHO’s core areas of work

The Public Health Mapping and GIS programme at the headquarters and regional level supports many core areas of work of the Organization including:

- Epidemic alert and response
- Communicable disease prevention and control
- HIV/AIDS
- Malaria
- Tuberculosis
- Health information, evidence and research policy
- Emergency preparedness and response
- WHO's core presence in countries
- Human resources for health
- Immunization and vaccine development
- Surveillance, prevention and management of chronic noncommunicable diseases
- Child and adolescent health
- Knowledge management and information technology

**Epidemic alert and response**

GIS plays an important role in the work of epidemic alert and response. Geographic information about the location of cases and their temporal evolution in time is critical for identifying and controlling a potential disease outbreak. Health mapping technologies are an increasingly important component of WHO activities to improve outbreak awareness, preparedness, and response. They routinely support the daily activities of the WHO Strategic Health Operations Centre (SHOC), by gathering, visualizing and interpreting disease intelligence in relation to local infrastructure and health services and capacities as a support to coordinating international responses to public health emergencies. These technologies are especially well-suited to the dynamic nature of outbreaks and their management, and have significantly advanced the ability to track and visualize outbreak evolution in real time.

**Communicable disease prevention and control**

In addition to mapping the global distribution of infectious diseases and related risk factors, GIS is also being used to support the planning and implementation of measures for disease prevention and control. For example, in support of WHO's new strategic framework for action against neglected diseases (leprosy, guinea worm, lymphatic filariasis, schistosomiasis, intestinal parasites, sleeping sickness, leishmaniasis), countries and global programmes are using GIS to map the geographical overlay of different diseases in a bid to help determine if and where health interventions can be targeted to more than one disease at the same time. In the case of lymphatic filariasis, public health mapping is used to identify areas where the disease is endemic and to determine the size of the administrative unit – village or health district, for example – in which communities will be targeted for treatment, whether or not they are infected. The maps are used to target the annual distribution of drugs and monitor the number of people reached, as well as the impact over time on the incidence of the disease.

**Emergency preparedness and response**

GIS is now also been used in complex emergencies to identify where health problems exist, target those in need and prevent duplication in humanitarian efforts. In the aftermath of the Tsunami in the Indian Ocean for example, WHO used public health mapping and GIS tools to pinpoint those communities most affected and to track logistical support provided by the different agencies. Once the emergency phase was over, WHO assisted countries such as Indonesia to build national capacity for GIS to monitor the impact of the...
Tsunami relief recovery efforts and provide a direction for long-term rehabilitation and reconstruction efforts. Elsewhere, in Niger and Darfur, GIS and public health mapping have been used to assess health needs, pinpointing the location of internally displaced people disease risk and accessibility to health services.

**HIV/AIDS**

Public health mapping and GIS are today being used to monitor not only the geographic 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. In addition to tracking the dynamics of the pandemic, GIS and public health mapping tools are being used as vital tools for assessing and monitoring the availability of HIV prevention care and treatment services in relation to needs. This includes mapping of services that offer Voluntary Counseling and Testing (VCT), prevention of mother to child transmission services, antiretroviral treatment, blood transfusion and so on.

**Malaria**

WHO has been working through a network of technical expertise of public and private stakeholders to support a range of activities in malaria control. In some countries health maps are being used to give a detailed picture of where and when the disease is occurring through 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 and GIS are also used to map the coverage and accessibility of health facilities and identify areas where partner agencies are providing malaria interventions. In some countries it is being used to monitor environmental changes and weather patterns in order to anticipate likelihood of malaria epidemics.

**Health information, evidence and research policy**

Public health mapping and GIS tools, methodologies and technical support being integrated in the Services Availability Mapping (SAM) surveys that are being carried out in collaboration with the regional offices in support of health systems strengthening. The objective of SAM is to rapidly assess district and health facility level capacities and services and provide 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.

In support of improved knowledge and evidence for decision-making, the web-based Global Health Atlas is now in full operation. Multiple programmes at headquarters and regional levels are now using the system for interactive data query, mapping, reporting and dissemination. The system is serving as a common data platform across the Organization, allowing diseases, resources and other key information to be stored, viewed and disseminated essentially through one common interface. The system hosts data and maps of a wide range of infectious disease programmes, including dengue, meningitis, yellow fever, malaria, tuberculosis, HIV/AIDS, neglected diseases. It also hosts the WHO health statistics and mortality databases, the human resources for health and the child survival global monitoring system.
3 | Future challenges

Notwithstanding these activities, there remain important opportunities and challenges to support the urgent information requirements for effective national, regional and global response to pandemic influenza and to the other main health threats of the 21st century.

Firstly, there is an urgent need to invest worldwide in the development and roll out of a GIS-based system of sub-national information collection and analysis that includes mapping and monitoring of public health resources and risks, control interventions and availability and accessibility of public health services and resources.

Such information is not only necessary for effective response to disease outbreaks, but it is critical for guiding the response to other health crises, such as natural disasters, bioterrorism, exposure to chemical and radioactive agents and for planning and monitoring the scale up of major interventions against HIV/AIDS, tuberculosis, malaria, childhood illnesses and maternal mortality.

Secondly, there is a need to further enhance and expand the use of GIS and public health mapping tools and technologies that can be fully integrated into high-speed national and international surveillance systems, which form the backbone of early warning and alert systems.

To date, the public health benefits of GIS 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 disasters. The challenge is now to extend these benefits more broadly to health systems in developing countries as integral part of routine surveillance and planning activities, particularly at the district level.

Thirdly, to meet these operational challenges, international cooperation is needed to strengthen and expand partnerships for technical support, streamline surveillance activities, work towards improved data harmonization through the development of data standards and norms and information sharing networks.

In this regard, there is an opportunity for WHO to further leverage the work of Member States and the international public health community and facilitate and coordinate the promotion and integration of data standards, norms, protocols for much improved data collection and information sharing networks.
4 | Vision, objectives

Vision
The vision of the WHO Public Health Mapping and GIS programme is improved disease surveillance and public health programming through use of GIS and related information and mapping technologies.

Objectives
The objective of this strategy aims to target three main areas:

Disease surveillance and international health regulations
Promoting the integration of GIS and public health mapping as a fundamental component of national disease surveillance systems for disease detection, monitoring and response.

Key stakeholders
The strategy targets national and district surveillance officers, WHO programmes and other public health professionals.

Health systems
Contributing to strengthening country health systems through public health resource and risk mapping and monitoring based on GIS based decision-support tools.

The Organization
Strengthening the capacity of WHO to inform and guide the international community on global health situation and to support international decision making and allocation of resources.
5 | Strategic directions

The following 4 strategic directions have been elaborated in consultations with all Regional Offices and will contribute to WHO-wide expected results. These results are achieved through the development and delivery of a series of products and services at headquarters, regional and country level.

Strategic direction 1: leading global efforts in mapping public health resources and risks

Rationale

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. However, despite this progress, major gaps need to be filled.

Approach

- Providing technical assistance, tools and guidance to Member States in rapid mapping of public health resources, capacities, risks and partners.
- Mobilising and identifying in-country capacities for ongoing updating and maintenance of the data.
- Promoting and advising on the development of national spatial data infrastructures for public health.
- Working closely with other organizations of the United Nations Organizations in sector wide mapping and data sharing (health, environment, agricultural factors).
- Improving the global accessibility and maintenance of spatial databases on public health risk factors and public health resources.

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.
Strategic direction 2: promoting, improving GIS tools for disease surveillance and health systems strengthening

Rationale

The past 10 years has seen a significant increase in the development and uptake of GIS and related mapping tools and applications to support surveillance capacities and public health decision-making.

Notwithstanding this progress, there is a need for WHO to further evaluate, adapt and improve its public health mapping and GIS tools and applications to support decision-making processes at all levels of the health system.

In addition, in recognition of the multiple systems and applications that have been developed at regional and headquarters levels and by key agency partners, there is a need to standardize on a suite of complementary public health applications and tools for different target users at headquarters, country and district levels.

Approach

- Providing leadership, coordination and facilitation in the design and development of national health and disease surveillance systems based on affordable mapping and GIS technologies and related communication technologies.
- Improving existing public health mapping and GIS tools and technologies for use at local, national, regional and global levels.
- Contributing to the harmonization of data collection and tool development efforts both within WHO and with external partners.
- Developing and disseminating GIS tools and standards for health surveillance so as to assure that techniques, products, and methods are applied consistently across the world.
- Developing collaborative operational research projects based on new GIS related technologies with research institutes and private industry.
Strategic direction 3: strengthening national decision-making through the use of public health mapping and GIS systems

Rationale
A key component of the strategy is to improve decision-making of infectious disease programmes at local and national levels through the use of public health mapping and GIS systems.

Through its network of partners, the programme aims to significantly scale up capacity building activities through the expansion and progressive roll out of a trainers’ network in each WHO region. As part of this initiative, the public health mapping activities will be accelerated in a selected number of countries across the WHO regional divisions.

Consideration for geographic areas of priority will be based on the following criteria:

• areas in which priority programme partners are operating;
• areas where current pilots going on with governments;
• areas where there is a demand and political will on behalf of governments.

Approach
Through well designed capacity building programmes:

• Promoting and assisting Member States to engage in progressive and modern data collection, information gathering and sharing using GIS and related technologies and standard.
• Assisting Member States to build local capacity in using GIS and public health mapping tools and technologies to assess, prepare for and respond to a potential disease outbreak or emergency.
• Establishing national centres and networks of excellence for public health mapping and GIS best practice, coordination, technical support and capacity building.
• Leveraging the existing efforts of Member States and providing leadership and technical support in the development and provision of data standards, protocols and guidelines for using GIS in disease surveillance and public health.
Strategic direction 4: leveraging international cooperation for technical support and data sharing

Rationale

The programme will continue to actively pursue partnerships with other organizations interested in exploiting the full potential of GIS and mapping technologies.

The partnerships will be brokered through partner agreements that will aim to define the role and contribution of each partner. The primary criteria for inclusion as a partner would be willingness to share responsibility for the overall development and implementation of a more integrated GIS and mapping system for health. Depending on the situation of the individual partner, their major contribution might be financial, technical and operational, particularly with regard to the sharing and improvement of core data.

Approach

- Strengthening cooperation with other organizations of the United Nations and working towards harmonization of data collection efforts and improvement of data exchange mechanisms.
- Promoting international and multi-sectoral collaboration with a view to improving compatibility of technical solutions in the field in the area of public health information and mapping.
- Expanding the global network of public health mapping and GIS and establishing national centres and networks of excellence for public health mapping and GIS best practices, coordination and technical support and capacity building.
Public Health Mapping and GIS for Global Health Security, a WHO strategic operational framework

6 | Operational structure

First established in the 1990s to support surveillance for guinea worm disease, the Public Health Mapping and GIS programme now operates through a global partnership of WHO programmes, WHO regional offices, agency partners and research institutes.

The role of partners

At country level this includes WHO country offices, national Ministries of Health, water, planning, statistics, universities. To date, over tens of thousands of public health administrators have been trained in the use of GIS and mapping technologies in over 80 countries.

At regional level the partnership operates through the WHO Global Public Health Mapping and GIS network, comprising focal points for public health mapping and GIS from each of the WHO regions as well as from some WHO sub-regional and country offices. The role of the network is to lead the global effort in:

- assisting countries in the development of core geographic databases including the mapping of communities, health care and partner intervention areas;
- providing direct technical support to countries in the implementation of public health mapping and GIS tools, including training of trainers;
- strengthening the technical support network to countries through the identification of regional and national institutes;
- maintaining regional databases of geographic information.

At UN agency level the WHO Public Health Mapping and GIS programme will continue to build on its strategic alliances with other organizations that will further the goals and objectives of the programme, particularly with FAO, WFP, UNOSAT, UNAIDS, among others.

An important and strategic mechanism for improved collaboration with other UN agencies is the UNGWG. The overall objective of this group is to promote the use and sharing of geographic information within the United Nations system and Member States.

The global network of technical support is completed by other partners including national research and specialized institutes including the US Centers for Disease Control and Prevention, the London School of Hygiene and Tropical Medicine, the Liverpool School of Tropical Medicine, the Imperial College of London, Columbia University, the South African Medical Research Council, GEOSS, SEAMEO-TROPMED, CNES among others.

WHO programmes: within WHO, the Public Health Mapping and GIS programme works across several programmes, departments and clusters, including the department of Epidemic and Pandemic Alert and Response (alert and response operations, meningitis, influenza, yellow fever, etc); Control of Neglected Tropical Diseases, HIV/AIDS, Global Malaria and Stop TB departments, the Family and Community Health (child survival, IMCI), Health Technology and Pharmaceuticals (polio eradication, vaccines and biological), Evidence and Information for Policy (measurements and health information and human resources for health, Health Action in Crisis, Non communicable diseases, Tobacco Free Initiative Convention.
Financial support

The programme has been supported by the Bill and Melinda Gates Foundation, the governments of Ireland, Netherlands, Japan, Sweden, the United States of America, and the United Kingdom of Great Britain and Northern Ireland. The programme operates a cost recovery strategy and charges nominal fees for custom services and products. In kind contributions have been received from Environmental Systems Resource Institutes (ESRI) Inc.

WHO Public Health Mapping and GIS secretariat

The Public Health Mapping and GIS secretariat comprises a core group of staff based at WHO headquarters in Geneva. The role of the secretariat is to:

- develop and disseminate GIS tools and standards for health surveillance so as to assure that techniques, products, and methods are applied consistently across the world;
- develop and maintain a global database of geographic information including communities, health facilities, urban areas, partner intervention areas;
- establish and maintain a GIS resource website, including a communication network for all members of the partnership;
- seek opportunities and strategic alliances with other programmes and organizations that promote the goals of the programme and establish policies in letters of agreement with other organizations;
- develop collaborative operational research projects based on new GIS related technologies with research institutes and private industry;
- develop and coordinate a marketing advocacy strategy for public health mapping and GIS;
- participate in GIS assessment, technical training activities at country level aimed at testing, evaluating public health mapping applications, tools, methodologies;
- oversee the programme advocacy, product development, service delivery and finances;
- monitor and report on progress made to the goals of the programme.
**Table 1 – Core services**

<table>
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<th>Services</th>
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<tr>
<td><strong>Disease and risk mapping</strong></td>
<td>The programme provides technical assistance in the design and production of thematic maps upon request. These include production of epidemiological maps of diseases, intervention and health promotion activities, health services and health statistics as well as reference maps of countries.</td>
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<tr>
<td><strong>Design and delivery of GIS training programmes</strong></td>
<td>Services relating to technology transfer and capacity building include executive seminars, hands-on users workshops, training of trainers workshops, regional users network and on-line technical support. Expertise is provided in a range of GIS related tools and technologies including ESRI products (ArcView, ArcPad, ArcSDE, ArcIMS, ArcPad), WHO applications including the HealthMapper and the Global Health Atlas.</td>
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<tr>
<td><strong>Geographic data capture, geo-coding</strong></td>
<td>The programme provides technical assistance to WHO Member States and partner agencies in the establishment and management of geographic databases for use in public health mapping. The service includes support in identifying data sources and in data capture methodologies including digitizing and scanning paper maps, accessing and processing remote sensing data, using GPS. A geocoding service is also provided to assist in applying standard geocoding scheme to existing public health datasets. The programme provides advice to public health users on the process of establishing and maintaining geographic databases for public health decision support, including advice on establishing national spatial data infrastructures for health.</td>
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<td><strong>Field mapping surveys</strong></td>
<td>Technical assistance is provided to Member States in the design and implementation of field mapping surveys for GIS applications, including the use of GPS receivers to obtain geographic coordinates of villages, health services, schools, laboratories etc. Services also include the design and development of custom data entry forms, technical assistance and training on using hand held devices for data collection including Personal Digital Assistants (PDAs).</td>
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<tr>
<td><strong>Database design and development</strong></td>
<td>Database services include the design, automation conversion and quality assurance of public health datasets for use with GIS applications, evaluation, adaptation of standardised data exchange formats</td>
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<td><strong>GIS programming services</strong></td>
<td>Programming staff support in the design, prototyping and testing of custom applications, custom data entry forms, websites and mapping links, custom reports, dynamic on-line report generators and application interoperability.</td>
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<td><strong>GIS web services</strong></td>
<td>The programme provides expert GIS web services to public health programmes to include mapping and location services in web-enabled applications.</td>
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<td><strong>Advanced spatial analysis</strong></td>
<td>Advanced spatial techniques and analyses is provided through the programme and its network of technical expertise. This includes geospatial techniques for analysing clustering of diseases and health events, geographic distributions of vector and host populations, determining populations at risk, climate modeling and disease distribution, determining geographic accessibility to health services.</td>
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Table 2 – Core products

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<th>Products</th>
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<tr>
<td>Geospatial public health resource database</td>
<td>An on-line geospatial public health resource database that hosts digital data on national and subnational boundaries (down to 4th level), health boundaries, health services location, villages, towns, roads, rivers, airports, population density and estimates.</td>
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<tr>
<td>Technical training materials and guidelines for GIS and mapping</td>
<td>Products relating to capacity building and training include GIS technical guidelines for data collection, spatial epidemiology training manual, custom training modules for using the HealthMapper and guidelines for conducting mapping surveys, among others.</td>
</tr>
<tr>
<td>The HealthMapper application</td>
<td>An interactive data management and mapping application system designed for public health decision-makers at national and district levels who need easy access to data, reports, graphs, tables and maps.</td>
</tr>
<tr>
<td>The Global Health Atlas</td>
<td>An on-line data query and mapping application that brings together analysis and comparison standardized data and statistics for infectious diseases and health statistics at country, regional, and global levels. Features on-line data entry, data query, dynamic mapping, reports, charts, map and document library.</td>
</tr>
<tr>
<td>Thematic map library</td>
<td>An extensive on-line library of global and national thematic maps of infectious diseases, including historical and current maps of infectious diseases, health statistics, health sector, demography, emergency relief.</td>
</tr>
<tr>
<td>Disease surveillance and risk maps</td>
<td>Includes current and historical maps of spatial and temporal distribution of avian influenza, SARS, yellow fever, meningitis, cholera, HIV/AIDS, malaria, tuberculosis, lymphatic filariasis, schistosomiasis and intestinal helminths.</td>
</tr>
<tr>
<td>WHO resources</td>
<td>Includes maps charting WHO country offices, national laboratories and collaborating centres.</td>
</tr>
<tr>
<td>Health sector maps</td>
<td>Includes maps charting health service infrastructure and for some countries, includes maps of services available by district and health facility.</td>
</tr>
<tr>
<td>Emergency relief maps</td>
<td>Maps of the international disaster relief efforts in Tsunami affected countries in South East Asia. Includes maps assessing the impact of recovery efforts relating to health, infrastructure, livelihoods, shelter and education in the worst affected areas.</td>
</tr>
<tr>
<td>Reference maps</td>
<td>An extensive collection of country reference maps showing province and district boundaries, basic infrastructure (roads, towns, rivers, airports, lakes), population density and land cover.</td>
</tr>
<tr>
<td>Spatial data management system</td>
<td>An on-line system based on FAO’s Geonetwork system, that provides access to WHO’s spatial data and related metadata. Authorised users can search, edit, publish, upload and download spatial data and maps. Provides facility to perform distributed searches across spatial servers of UN agency partners.</td>
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