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### **GEOGRAPHIC INFORMATION SYSTEMS IN HEALTH**

The selection, collection, organization, maintenance and use of data and information to describe, analyze and document the health situation of the countries of the Region of the Americas are essential functions of the Pan American Health Organization (PAHO). In this respect, PAHO collaborates with the Member States to increase the capacity for health situation analysis and to bolster the capacity to document and evaluate inequities in health and their determinants.

This knowledge assists in the formulation of health and environmental policies, the reorganization of health services, health promotion, disease prevention and control, programming and evaluation for interventions, and resource mobilization. The technical health information systems contribute to knowledge on the health and well being of the population and stimulate the use of available information and analysis.

This document describes the use of Geographic Information Systems in health (GIS-Epi) as one of the platforms of the PAHO Core Data/Country Profile initiative that is being developed. The regional technical programs, the PAHO country offices, and the regional centers have been working with the Member States to improve the Organization's ability to use new tools and technology to describe, analyze and document the situation and trends of health problems in the Region that it must address. The GIS-Epi concept involves the design, development, and utilization of Geographic Information Systems (GIS) tools for description of the health situation, epidemiological analysis, and public health management.

The GIS comprise powerful analytical support tools for decision-making that involves the integration of spatially referenced data to perform problem-solving operations. This technology is currently available for personal computing and, therefore, is accessible to the health sector. The integration of GIS and epidemiological methods and techniques in public health, including surveillance, situation analysis, and program evaluation and planning areas, facilitates the epidemiological analysis of health events and their determinants required for public health interventions and decision-making.

This document is presented to the Subcommittee on Planning and Programming to inform Members on progress to date and expected developments in this field, and to seek feedback and input from them.

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## EXECUTIVE SUMMARY

The Pan American Health Organization (PAHO) has responsibility for selecting, collecting, organizing, maintaining and using data and information to determine the profile and characteristics of health status in different population groups and geographic areas and to report on the health situation of the countries of the Region of the Americas. This knowledge is essential to determine what actions should be taken to eliminate inequity, including policy formulation, health services adequacy, disease prevention and control, health promotion, and programming and evaluation of interventions.

To strengthen the information, analysis and decision-making process, the PAHO Core Data/Country Profile platform was defined, within the context of the Strategic and Programmatic Orientations 1995-1998, and later presented to the 40th Directing Council (Document CD40/19). The Strategic and Programmatic Orientations, 1999-2002 ratified this commitment for further defining the conceptual and technical aspects related to inequities in health, including the developing of instruments for their measurement and surveillance at the national and regional levels. The initiative aims to provide updated and timely information on the health situation and trends in the Region of the Americas and for strategic policy management, priority setting for health sector action, evaluation and modification of the technical cooperation and dissemination of reports. To date, the Core Data/Country Profile platform of the initiative includes a database system with 117 indicators in five subject areas (demographic, socioeconomic, mortality, morbidity and risk factors and resources, and access and coverage of health services) for each country in the Americas, with links to specific country profiles. Access to the system is available to users of the PAHO Intranet and Internet Web pages.

There is a need for further development of the current Core Data/Country Profile platform to increase the quality and efficiency of health situation analyses, including the improved handling of geographically-referenced data, integration of databases across PAHO, epidemiological analytical tools and display of data. This platform will enable a more precise identification of the spaces, areas or groups with the largest basic unmet health needs and health inequities and the determinants related to those characteristics. Also, it will help to identify and focus interventions and evaluate their impact. To spread its use, both methods and technology will be transferred to the PAHO/WHO Country Offices when available.

The GIS are considered to be powerful computerized network tools for the current Core Data/Country Profile platform. The development of a GIS in health component (GIS-Epi) is suggested within this context. The GIS-Epi concept involves the design, development and utilization of GIS tools for description of the health situation,

epidemiological analysis, and public health management. GIS-Epi will provide the analytical tools for decision-making, integrating geo-referenced data for problem-solving operations. When GIS and epidemiological methods and techniques in public health are integrated, they facilitate the epidemiological analysis of the health events and their determinants required for public health decision-making and interventions.

## **1. Introduction**

The selection, collection, organization, maintenance and use of data and information to describe, analyze and document the health situation of the countries of the Region of the Americas are essential functions of the Pan American Health Organization (PAHO). In this respect, the Pan American Sanitary Bureau (PASB) collaborates with Member States to increase the capacity for health situation analyses and to bolster the capacity to document and evaluate inequities in health and their determinants, as indicated in the Strategic and Programmatic Orientations, 1999-2002. This knowledge assists in the formulation of health and environmental policies, the reorganization of health services, health promotion, disease prevention and control, programming and evaluation for interventions, and resource mobilization.

To strengthen the information, analysis and decision-making process at the Secretariat level, the PAHO Core Data/Country Profile initiative was launched in 1995 and presented to the Directing Council in 1997 (Document CD40/19). The Strategic and Programmatic Orientations, 1999-2002, ratified this commitment to further define the conceptual and technical aspects related to inequities in health, including developing the instruments for their measurement and surveillance at the national and regional levels. This initiative aims to provide updated and timely information on the health situation and trends in the Region of the Americas, for strategic policy management, priority setting for health sector action, evaluation and modification of the technical cooperation and dissemination of information. To achieve this objective, a computerized network platform allowing interconnection of available databanks and information throughout the Organization is being recommended.

At this stage, the Core Data/Country Profile platform of the initiative includes a database system with 117 indicators in five subject areas (demographic, socioeconomic, mortality, morbidity and risk factors and resources, access and coverage of health services) from each country in the Americas, with links to specific country profiles. Access to the system is available to date to users in the PAHO's Intranet and Internet Web pages. To improve completeness and comparability of data sets, the Secretariat is working with the Regional Advisory Committee on Health Statistics, other agencies of the UN system (such as the United Nations Population and Statistics Division, United Nations Children's Fund (UNICEF), Economic Commission for Latin America and the Caribbean (ECLAC) and others), international banks, other institutions responsible for collecting and monitoring health data, and national authorities to set standard definitions, responsibilities and other technical issues.

Notwithstanding this progress, further development of the current Core Data/Country Profile platform will increase the quality and efficiency of health situation

analyses. Within this new development is the addition of an improved management capacity of geographically referenced data, integration of different database systems, basic analytical tools, and spatial visualization of data. The improved platform will allow a more precise identification of spaces, areas or groups with the largest basic unmet health needs and health inequities, those at higher risk of death or disease and the determinants related with their higher risk. It will also help to identify and focus interventions and to evaluate their impact. While this platform is being developed, its methods and technology will continue to be transferred to the PAHO/WHO Country Offices.

The GIS comprise powerful alternative analytical tools for decision-making that involves the integration of spatially referenced data to perform problem-solving operations. The integration of GIS and epidemiological methods and techniques in public health, including surveillance, situation analysis and program evaluation and planning areas, facilitates the epidemiological analyses of health events and their determinants required for public health decision-making and interventions.

Although GIS technology is currently available for personal computing and therefore accessible to most of the health sector institutions, services and programs, there are still some issues that need to be overcome to permit its full use in the health area. Among the suggested reasons for less than full use are lack of specifically-designed tools for epidemiological analyses, limited availability of low-cost and user-friendly software, insufficient accessibility of geographic databases, fragmented health information systems, and lack of appropriate and low-cost training.

PAHO provides technical support for the re-organization and operation of epidemiological services, including strengthening of public health surveillance, modernization of records and statistical information systems and implementation and application of the Tenth International Classification of Diseases (ICD-10). It fosters basic and intermediate level training in epidemiological and biostatistical methods. The Secretariat routinely analyzes data on the health situation and trends in the Americas and disseminates this information. Within this context, the use of GIS constitutes a strategic tool.

## **2. Goal of the Geographic Information Systems in Health (GIS-Epi) Component**

The GIS-Epi concept involves the design, development and utilization of GIS tools for purposes of description of health situation, epidemiological analysis and public health management. The abilities of GIS to integrate and process data give them a great potential for application in different public health areas, and offer new opportunities to describe and analyze the relationships between environment attributes and health events in geographical settings.

The goal of the GIS-Epi component is to strengthen the analytical and decision-making capacity of PASB and national health managers and other interested parties, for more effective and efficient health information management and use. The development of this core data component will provide a platform that allows the communication and integration of the different information systems available at PAHO. In parallel to the development of the technical capacity of the Secretariat, PAHO/WHO Country Offices and national professionals will benefit from the transfer of technology, of technical and methodological capacity, and of training.

### **3. Objectives of Technical Cooperation in Health Situation Analysis Using Geographic Information Systems Technology**

#### **3.1 *General Objective***

The general purpose is to strengthen the capacity for epidemiological analysis and surveillance of the Secretariat and of the national and local health programs and services to facilitate policy formulation and priority setting in the health sector in the Region of the Americas. Additionally, it aims to strengthen the capacity of PAHO to generate knowledge needed to document and explain the health situation in the countries of the Region.

#### **3.2 *Specific Objectives***

The specific objectives are to:

- (a) develop an information platform at PAHO that provides tools for more efficient storage, handling, query, analysis, and display of health-related information;
- (b) promote the use of GIS technology as a tool for public health;
- (c) support the development of human resources to use GIS in epidemiology and public health;
- (d) support the digitizing of priority areas in the Region of the Americas that are currently not available or do not yet exist;
- (e) support the development of applications, tools and other materials on GIS in public health for end-users;
- (f) strengthen the capabilities of the current network of PAHO collaborating groups on GIS in epidemiology and to facilitate the development of others.

#### **4. Expected Results of the GIS-Epi Component**

The analytical capacity of PAHO will be increased and more information will be available in different formats to orient decision-makers. As a result of their promotion and support, there will be an increase in the number of GIS users at PAHO, and in the national health services for surveillance and planning purposes. As a result of training, more PAHO health managers and the local health services will be carrying out health situation analyses and identifying health needs for priority groups more effectively. Development of training materials and applications will help to build up PAHO's national and local capabilities of human resources for health situation analysis and surveillance and planning in public health. Finally, a digitized geographic boundary depository at PAHO for use by countries and by other PAHO programs, with the assistance of PAHO collaborating groups, may be consolidated. A collaborating network effort with participating groups in different countries of the Americas is being organized.

#### **5. Technical and Methodological Characteristics of GIS-Epi**

The GIS comprise powerful analytical support tools for decision-making that involves the integration of spatially referenced data to perform problem-solving operations. The integration of GIS and epidemiological methods and techniques in public health, including surveillance, situation analysis and program evaluation and planning areas facilitates the epidemiological analysis of health events and their determinants required for public health decision-making and interventions.

The proposed structure of the GIS-Epi/Core Data platform includes a three-tier Web-based GIS, with a basic and an advanced user-interface, to allow users to retrieve, display and analyze health-related data. While originally designed for Intranet, in the future the system will also be available on the PAHO Web site for Internet users.

#### **6. Strategies and Activities for GIS-Epi**

As mentioned earlier, in addition to the development of the platform itself, there are a series of issues that need to be addressed or advanced.

Geographic and attribute (health) data are the basic inputs of GIS. Although some geographic data and maps are either free or commercially available for most countries, detailed geographic boundaries within the country (i.e., by state/department or by county/municipality), where decisions need to be made, are usually lacking in the Americas. Therefore, there is a general need to generate these boundaries either from other maps or from visits to the field, particularly in high-priority areas.



Training costs on GIS, at the basic and intermediate levels, carried out by private companies are onerous (over US\$ 2,000 per person for a three-day workshop). Thus, PAHO is seeking efficient training strategies.

There are several alternative GIS software for use in the health services, their hardware requirements and cost varying with their capabilities: from very simple and distribution-free, to very sophisticated and expensive.

The following are the suggested strategies and activities on GIS-Epi, including the participation of PAHO Collaborating Groups:

- (a) Organizing and participating in training activities of health services personnel and in workshops and other scientific meetings for GIS in epidemiology and public health.
- (b) Developing simple computer applications that will include routines for processing data and calculation of specific epidemiological indicators and their analytical mapping. The aim is to include procedures that are useful for epidemiologists and health managers, including management of data, creating thematic maps with crude and adjusted rates, tools for identification of health-related events clustering, hypothesis testing of geographical exposures in epidemiological investigations, catchment area generators, and analysis of critical areas. This analytical capability is currently not available in any commercial GIS package. The specific analytical software would be accompanied by a manual.
- (c) Developing training materials for different levels and needs of end-users, both at the basic and intermediate training levels. Materials would include a series of modules on basic concepts of epidemiology, geography and database management and handling as they pertain to GIS—which are major areas of concern for professionals working in the field setting. In addition, two simplified manuals and examples for practical exercises for users of EpiMap<sup>1</sup> and ArcView<sup>2</sup> and MapInfo<sup>3</sup> software would be produced.
- (d) Applying GIS to specific problems and needs, including the health situation, surveillance of specific health problems (i.e., malaria) and situations (i.e., border areas), health services management, and risk assessment, among others, so that

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<sup>1</sup> EpiMap freeware is a joint development of the Center for Diseases Control of the United States Public Health Services and the World Health Organization.

<sup>2</sup> ArcView a software produced by the Environmental Systems Research Institute.

<sup>3</sup> MapInfo a software produced by MapInfo Corporation

- they may become case examples for others. Another area of work would be the development of a GIS to be coupled with the core data system, which is currently undergoing pilot testing. This GIS would be developed for use in the Intranet/Internet environments.
- (e) Disseminating information is one of the mandate/priority areas of the Program. Demonstration software showing a situation analysis of health in Central America has been developed for this purpose, and others would follow. Also, other tools that facilitate situation analysis, such as a national health atlas and the health atlas of the Americas, will be developed and will serve as models for other applications.
  - (f) Digitizing of geographic boundaries from priority areas through contracts and other agreements between institutions

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