GIS and Public Health in the Americas

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OUTLINE

• Brief History of PAHO
• Developing a GIS-Epi Model
• GIS-Epi Applications
• Challenges of Global Public Health
• Next Steps
PAHO in the Americas: Forum for Public Health
Mobilizing Ministries of Health for GIS

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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 is a central function of the Pan American Health Organization (PAHO). In this report, PAHO collaborates with the Member States to increase the capacity for health situation analysis and to broaden the capacity to document and archive information on health and their determinants.

This knowledge assists in the formulation of health and environmental policies, the organization of health services, health promotion, disease prevention and control, programming and evaluation of interventions, and resource mobilization. The traditional 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-health) 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 teams 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 nature and extent of health problems in the Region that it must address. The GIS-health 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 involve 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 decisions-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 States.
GIS-Epi Milestones

- **1993** – First PAHO GIS Workshop for Malaria Control. Chapala, México. 23 participants from the Americas
- **1993** – IACO III Iberoamerican Conference on Onchocercosis. Amazonas Venezuela (Brazil, Colombia, Ecuador, Guatemala, Mexico and Venezuela).
- **1994** – GIS Applications using Epidemiological Stratification and Focalization
- **1995** – Launching of Core Health Data initiative
- **1995** – GIS-Epi Collaborative Groups Network: Chile, Cuba, Guatemala and México
- **1995** – Organization of First International Symposium on Computer Mapping in Epidemiology and Environmental Health, Tampa FL.
- **1995** – SIGEpi development over Maplnfo using MapBasic
- **1996** – First Draft of the book “GIS in Health: Basic Concepts”
- **1996** – First Health Indicators Atlas in the PAHO Web
- **1997** – Using ArcView as standard GIS
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Geographic Information System in Public Health (GIS-PH)

- Set of interacting components that use spatial reference data and health-related information to analyze and synthesize large quantities of data and information to support, orient, and evaluate public health interventions and decision-making in a territory or defined space for a specific time period.
Geographic Information Systems (GIS) in Health

• Concept encompasses the design, development, and utilization of GIS tools for the description of health situations, epidemiological analyses and public health management.

• Some of its main applications are:
  – Spatial description/analysis of health events
  – Public health surveillance
  – Identification of environmental and occupational risks
  – Health situation analysis in a given area and population
  – Analysis of health patterns/differences at various levels
  – Identification of high risk groups and critical areas
  – Generation of operational research hypothesis
  – Planning and programming of health services
  – Evaluation of public health interventions
**GIS-Epi Project in the Americas**

- **Applications development**
  - Types of applications and examples
  - Direct support to countries
  - Support to countries through PAHO Collaborating groups
  - Support to proposals design and financing

- **Databases collection**
  - Access to cartographic data
  - Access to health data
  - Access to aerial and satellite images

- **Software development**
  - Analytical software for PC use
  - Web-based platform
  - Software based on commercial platforms
  - Beta versions and support to design

- **Training**
  - In-person Workshops
  - Courses based on electronic format
  - Applications development
  - Courses

- **Materials development**
  - Materials on concepts and uses of GIS in health
  - Materials on different types of application
  - Laboratory exercises
  - Software manuals

**Presentations in Meetings, Seminars, Symposia and Congresses**

**Collaboration with other technical groups**
Produce and disseminate guidelines
SIGEpi - Geographic Information System (GIS) is designed for applications in Epidemiology and Public Health including specific analytical procedures for equity and poverty mapping, health situation and spatial data analysis, epidemiological assessment and biostatistics. These are presented in a simplified way, in a friendly environment and in multiple languages.

SIGEpi is developed by the Area of Health Analysis and Information Systems (AIS) of the Pan American Health Organization (PAHO). This product is part of the PAHO Technical Cooperation Project "Development and Application of Geographic Information Systems in Epidemiology and Public Health".

Features:
- Creation of thematic maps utilizing measures and health indicators.
- Response to questions on the impact of spatial and geographical variables on health problems.
- Calculation, standardization, and spatial smoothing of rates and proportions.
- Descriptive statistics, correlation, and linear regression.
- Identification of Critical or Priority Areas and Populations.
- Construction of a composite index for example, index of unmet basic needs in health, poverty index, etc.
- Identification and detection of both spatial and time-space clusters.
- Measurement of the association of environmental/ecological exposure factors and health events in epidemiological studies of case-control and cohorts.
- Assessment of accessibility to health services.

It is an in-house development based on COM/DCOM technology. Using Visual Basic, third party components and powered by ESRI. Intended for Personal Computers and Windows Operating System.

http://ais.paho.org/sigepi

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PAHO/JHU Epidemiologic applications of geographic information systems course
PAHO National GIS Workshops
PAHO and Ministry of Health authorities of Brazil launching SIGEpi.
V Brazilian Congress of Epidemiology, Curitiba, Brazil
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Health Metrics using GIS-PH applications

Environmental health
Environmental risks and vulnerability
Healthy spaces
Health needs
Health Situation Analysis
Public Health Surveillance
Critical areas (groups) identification
Health services response
Health services availability and coverage
Accessibility
Public Health Programming and Planning
Intervention impact evaluation
Generic
Hypothesis generation for operational research
Health Atlases
Epidemiological Assessment of Malaria Distribution in Peten, Guatemala
Evaluation of interventions and public health programs
GUATEMALA
Monitoring Global Health Initiatives
Clusters of Severe Growth Retardation in GT, HN and ES
Hunger Reduction MDG Target

**Objective:** Study of spatial distribution of malnutrition in three countries (Guatemala, Honduras, El Salvador) of Central America.

**Methods:** Use of Severe Growth Retardation (SGR) in children of 6 years old as indicator of malnutrition. Application of the spatial cluster detection techniques: spatial autocorrelation, local indicators of spatial autocorrelation and Moran’s Scatter-plot. The study area included Guatemala, Honduras & El Salvador, and municipalities as geographic units.

**Results:** The spatial analysis shows a strong positive spatial autocorrelation ($I = 0.71, p<=0.01$) of SGR, presence of clusters. The local indicator of spatial correlation reveals three cluster of high rates of SGR, two of them at western of Guatemala and one at western of Honduras. All of them located in mountains zones and with no-agricultural land use. A cluster of low prevalence of SGR was detected in El Salvador. The identification of clusters allows to focalize the interventions and to investigate related socioeconomic and demographic factors.
Clusters of Severe Growth Retardation in GT, HN and ES

Choropleth map, quantile intervals of SGR. Moran’s I = 0.71, p<0.01

LISA Map. Local Indicator of Spatial Autocorrelation

Moran’s Scatter-Plot. SGR vs. Spatial Lag SGR.

Moran’s Scatter-Map. High significance clusters of SGR.
Objective:
To develop a GIS for Health Situation Analysis (HSA) assessment, identify problems of availability and coverage of Primary Health Care and low geographic accessibility areas in Honduras

Methods:
A multiple-dimension index was developed using a selected set of core health indicators. Correlation analysis allowed for the selection of non-collinear indicators of the model.

Results:
The results of this health situation analysis were used to identify the level of coverage of PHC in Honduras and its links with geographic accessibility.
Orient decision-making and planning
Unmet Health Needs. Morbidity Standardized Index

- Sum of normalized values of morbidity indicators (Z score)
- RATES X 100 000:
  - Pneumonia Rate among children under 5
  - Malaria Rate
  - Dengue Rate
  - Tuberculosis Rate
  - AIDS Rate
  - Diabetes Rate

Developed with SIGEpi 1.3
Low accessibility critical areas

Accessibility Index (ICA constructed with SIGEpi 1.0)
- Distances (km) and slopes to nearest facility
- Calculation of z scores
- Linear interpolation of community’s ICA Values

Selection of 2 Std Deviation values of ICA to define critical areas

RESULTS:
In Low Accessibility Critical Areas there are 807 communities with 638,856 inhabitants.
Orient decision-making and planning
Policy-making Impact

- **Resources for the Secretary of Health:**
  - On the National Congress, it was instrumental for negotiation for new medical staff positions
  - Re-allocation of budget to reorganize and open key health centers

- **The GIS application was implemented in four strategic areas of his administration:**
  - Ministry of Health PC
  - Epidemiology
  - Health Planning
  - Disasters and Emergencies

- **Simplification of the application to be coordinated by health staff**
Public Health Methods for Developing Health Metrics and Spatial Analysis

Critical Areas

HSA
- Pop. Distribution
  - Geo-referencing, Density, interpolation
  - Morbidity Std Index, 2006
  - Z score = MI

IBN
- Municipal Geo-coding

ENVIRONMENT
- Environmental risks
  - Landslides and flooding areas
  - Query and spatial selections
    - Specific Tool

Relief/ Topography
- Slope, aspect
- Spatial Analyst (GRID, TIN)

Land Use
- Spatial queries

Thiessen Polygons, Buffers
- Coverage

Z score = IAC
- Interpolation
- Accessibility Index

SERVICES
- Health Services
  - Geo-codification
- Roads
  - Classification
  - Distances
  - Slopes
  - Spatial Tools
    - Assign slope values

Hospitals
- GRID Distances
- Spider Diagrams
- Catchment's area

Cesamo
- Geo-coding
- Spider Diagrams
- Distances
- Catchment's area

Cesar

IBN
- Municipal Geo-coding

Environmental risks
- Landslides and flooding areas
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Changing Public Health Context

Global Issues

- Globalization
- Bioterrorism
- Changing environment and natural disasters
- Increase solidarity in response to health inequalities. Reducing the health gap
- Epidemiological Polarization
- Recognition of health as an essential factor for development
Gross National Product (GNP) per capita trends in The Americas by income country clusters, 1970-2005

Income country clusters

Gross national product per capita (current US$)
Inequality in Income Distribution. Region of the Américas, 2000
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Developing New Metrics for Public Health

- Equity in Health, MDG’s and Globalization represent major challenges for the public health and global health of the 21st Century
- Sound information and analyses are essential for achieving healthy people/healthy spaces goals: tracking progress; evaluating impact; attributing change to interventions; and take decisions on public health programs focus and scope
- Too many uncoordinated demands for information; too much useless data
Next Steps

• The development and use of **new basic synthetic metrics** with spatial dimensions facilitates the analytical process of public health, allows for the identification of population clusters of areas in less favorable conditions and, through this, orienting the formulation of responsible health plans and programs.

• It is recommended the promotion of the collection and use of disaggregated information at the sub-urban level within municipalities.
Needs for capacity building in GIS-PH

- Improved real-time global/regional public health surveillance
- Better targeting/focalization/stratification
- Improved response capacity
- Identification of health inequalities
- Monitoring of global health initiatives and mandates
- Orient decision-making and planning
- Evaluation of interventions and public health programs
Next Steps

- Increase the availability of consistent and reliable health data for determining population health distributions (not only national averages)
- Development of new Public Health Surveillance Systems using GIS
- Increase the efficiency of global public health cooperation building strategic collaborative networks with the academic, scientific and private sectors
Next Steps

• Moving from thematic mapping to public health analytical assessments
• Expanding regression and analytical tools such logistic regression models linked to geographically weighted models.
• Linking Multilevel Analyses with Robust GIS/Spatial Analytical tools
• Closing the Public Health Know-Do Gap
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