



PAHO's GIS in Public Health Project: The Honduras Case

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International Geographic Information Systems (IGIS)
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Health Situation Analysis (ASIS), Assessment of coverage and access to Health Services in Honduras.

Objective: Assessment of Health Situation using Health Indicators.

Methods:

Thematic mapping and exploratory data analysis was applied to Morbidity Indicators. A method of construction of a compound index was applied using a selected set of indicators. A correlation analysis allows to identify the indicators for the model.

Results:

Was identified the critical municipalities by indicators and the morbidity index.

The results of this exploratory and health situation analysis is used to assess the regional coverage and access to first level health services in Honduras and correlating with geographic accessibility.

Background



- **Problem definition**

- Take decisions about which Primary Health Care centers open or close
 - Health needs
 - Geographic availability and coverage
 - Accessibility and road infrastructure
- Low Budget
 - Need to focus interventions

- **Decision to ask technical cooperation to PAHO**

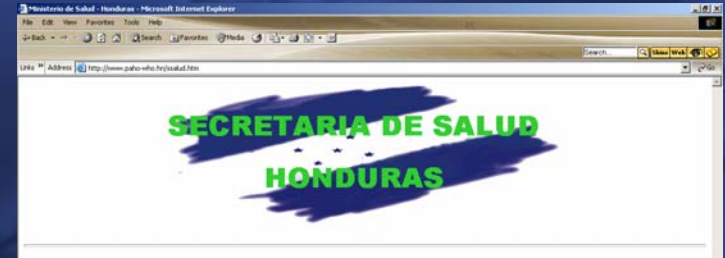
- Design a first proposal to develop the proof of concept for a GIS model
- Mission to Honduras to:
 - discuss the proposal
 - identify different sources of digital geographic information
 - identify other collaborating groups





General Objective

- To develop a GIS for the Health Situation Analysis (HSA) assessment, identify problems in the availability and regional coverage Primary Health Care and low accessibility areas in Honduras



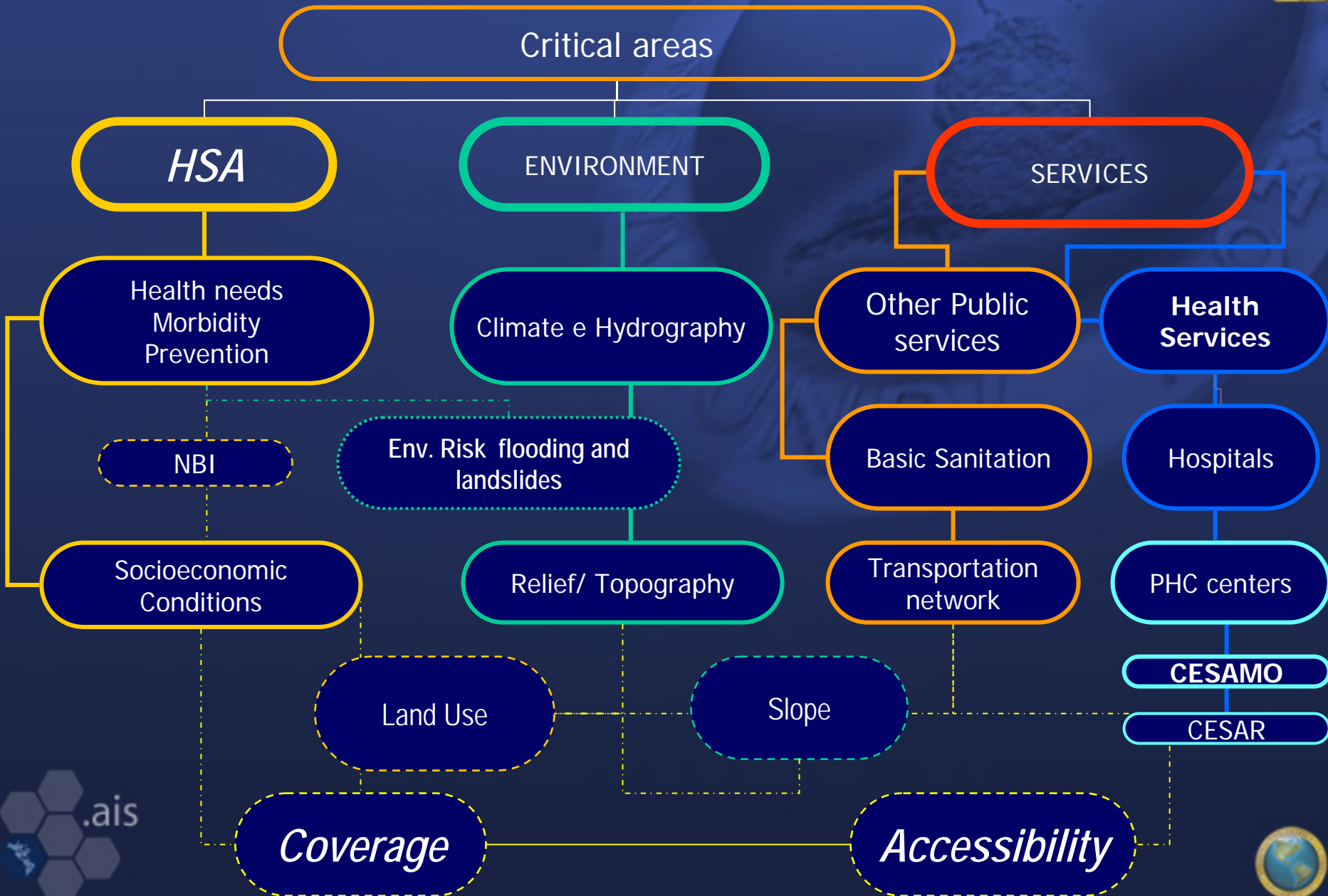


Development of the GIS application

- Conceptual model development
- Identification of the operational design of the accessibility measures and factors that modify it
- Data preparation, geo-processing and projection (Geographic-UTM16)
- Application of public health methods to select GIS and spatial analysis techniques
- Identification of low accessibility and high health needs critical areas
- Definition of "What-if scenarios" (in process)



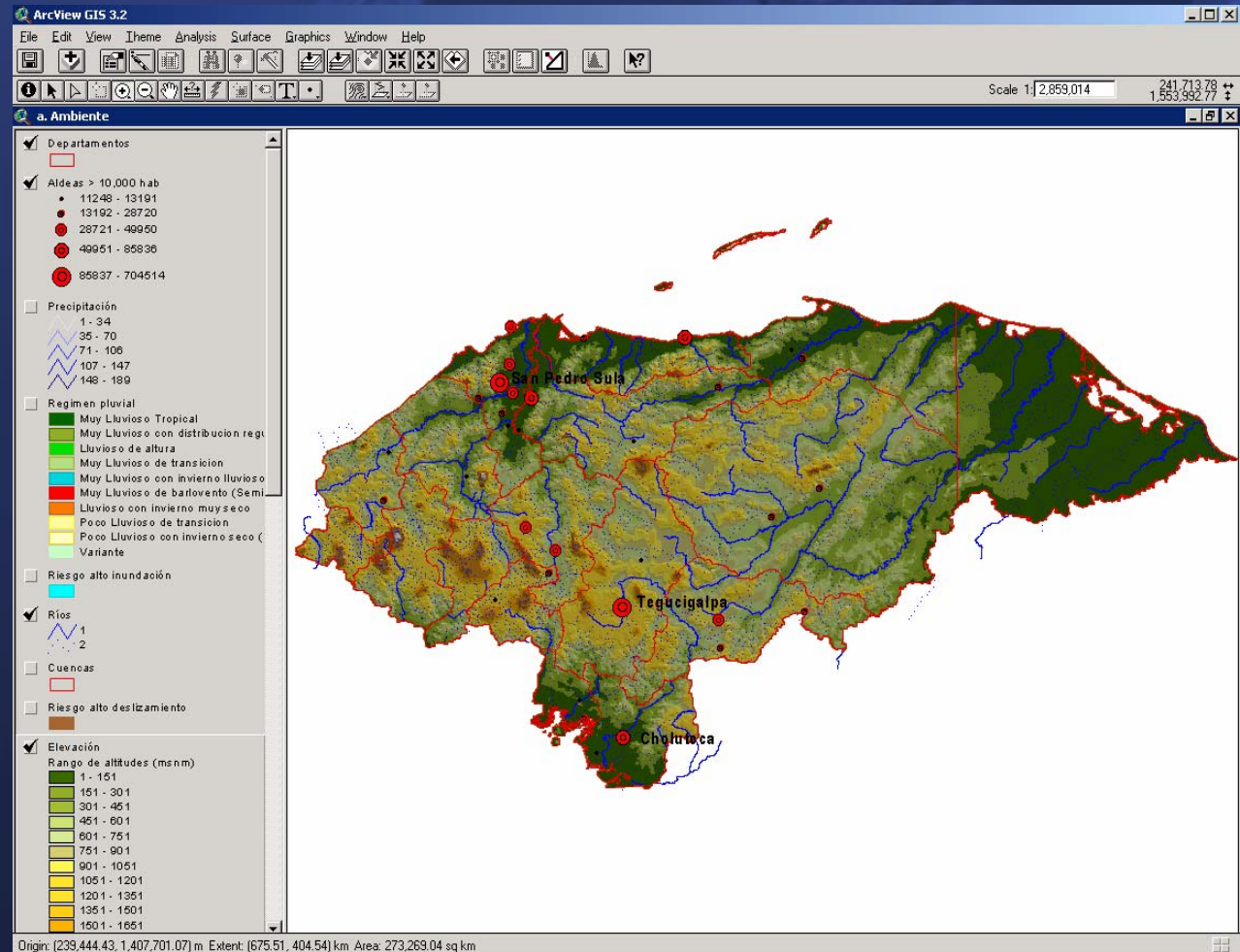
Conceptual model and operational design



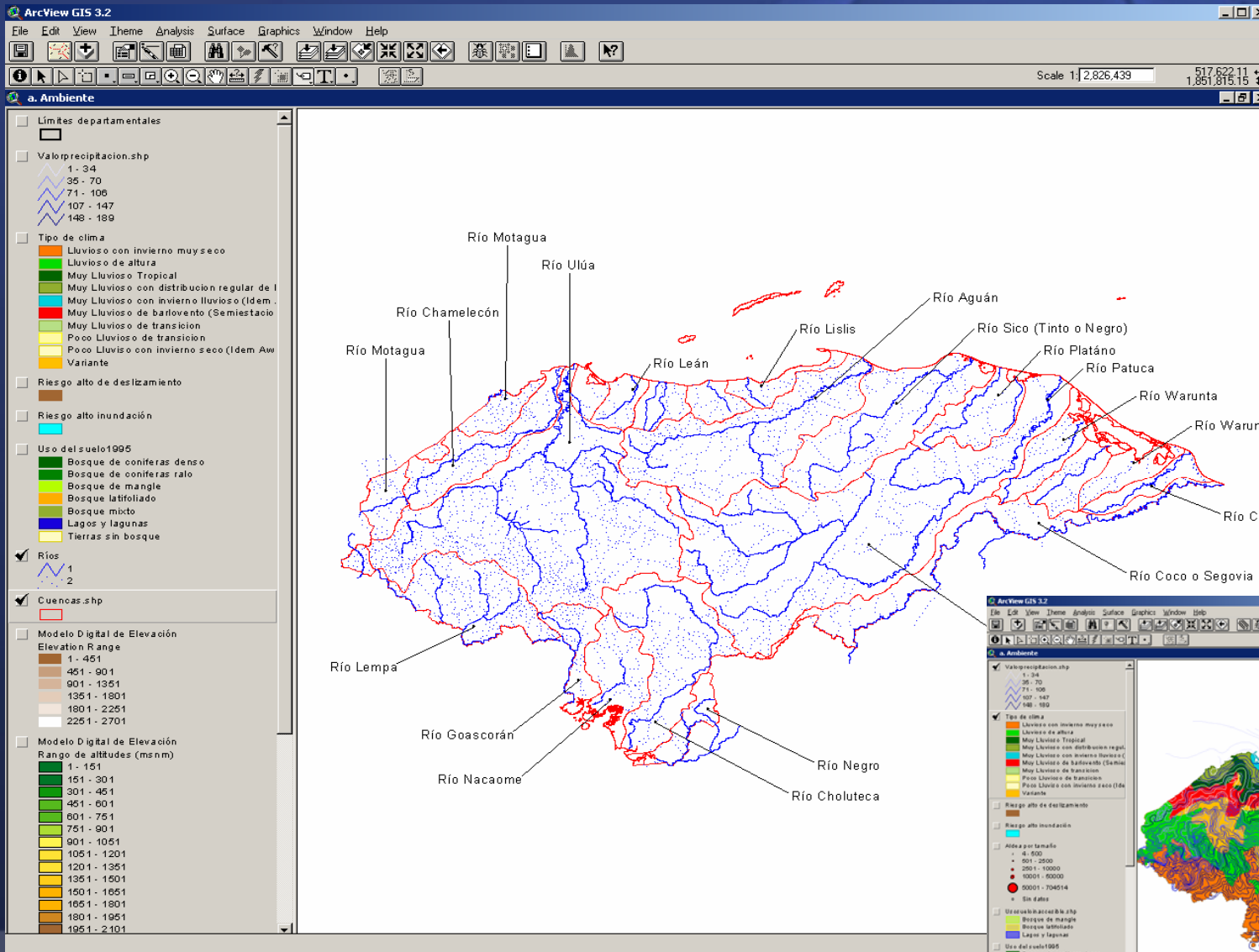


Data preparation: compilation, geo-processing and projection

- Standardize projections and Datum
- Geo-processing of administrative limits and localities
- Geo-coding health statistical data
- Management and overlapping of maps about natural features
- Transformation of DEM (Digital Elevation Model) to ArcView formats (GRID, TIN)



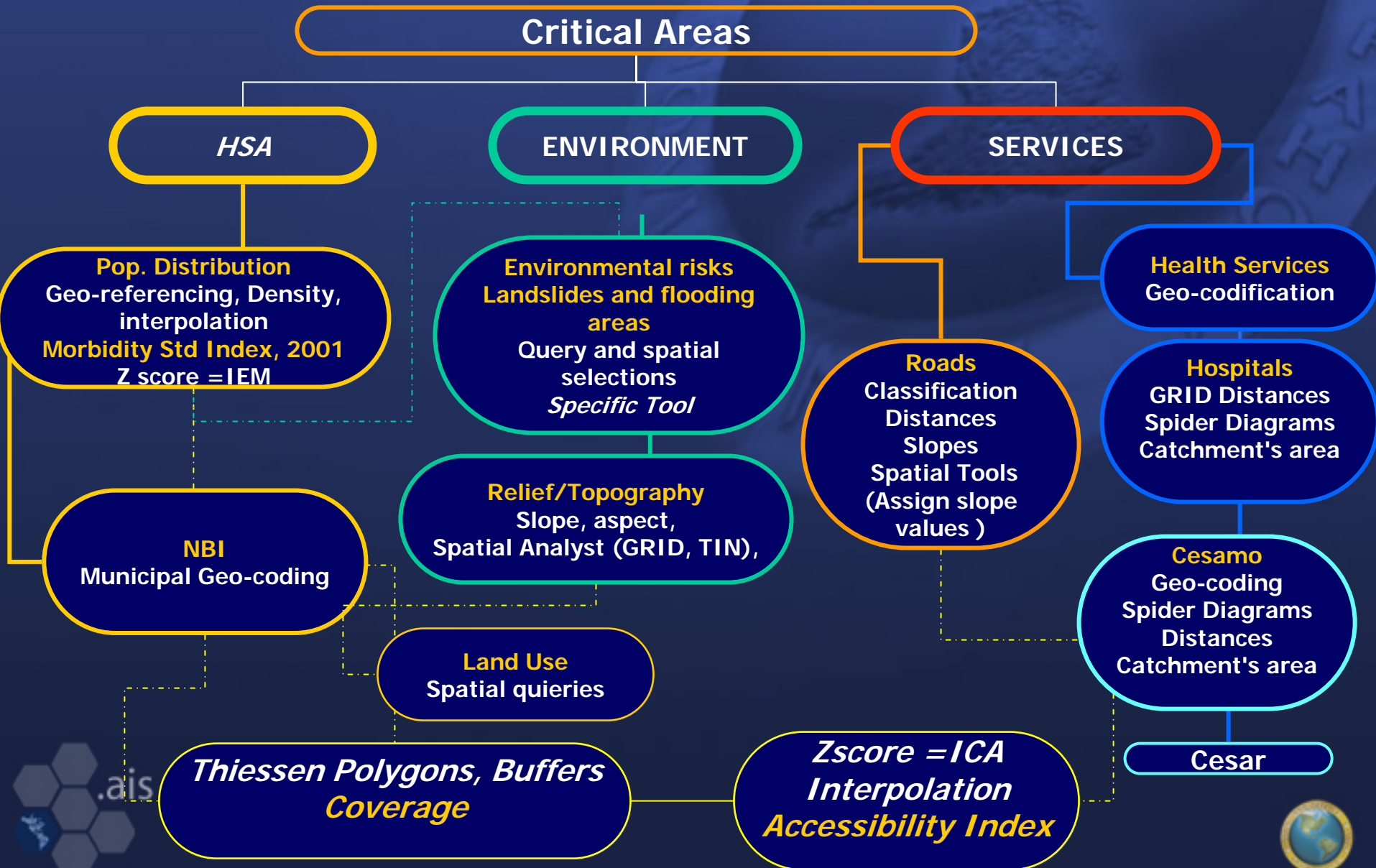
Environmental digital data



Climate

Hydrography

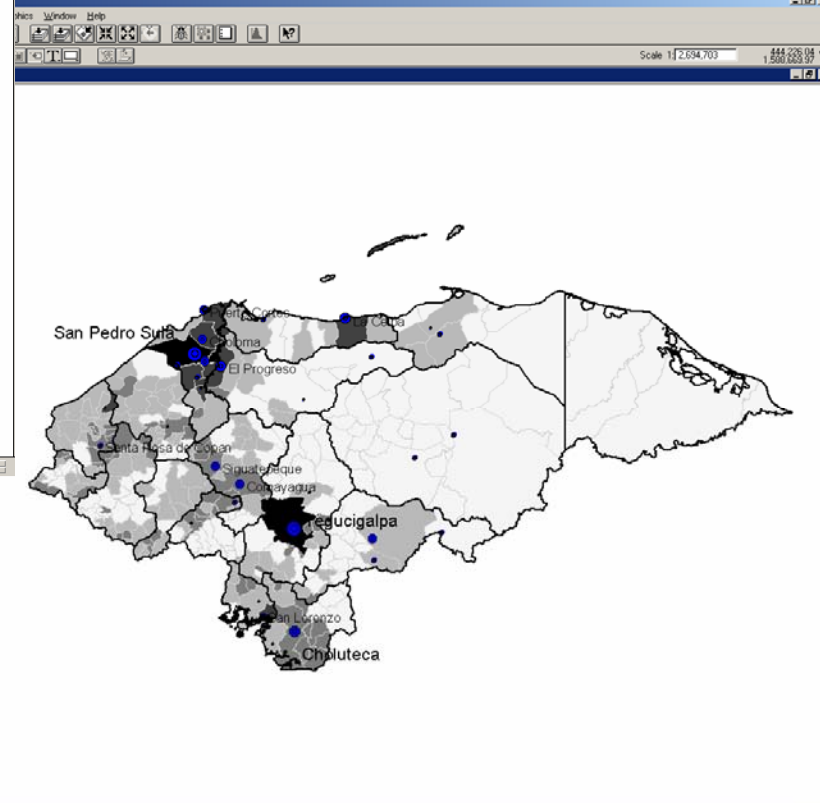
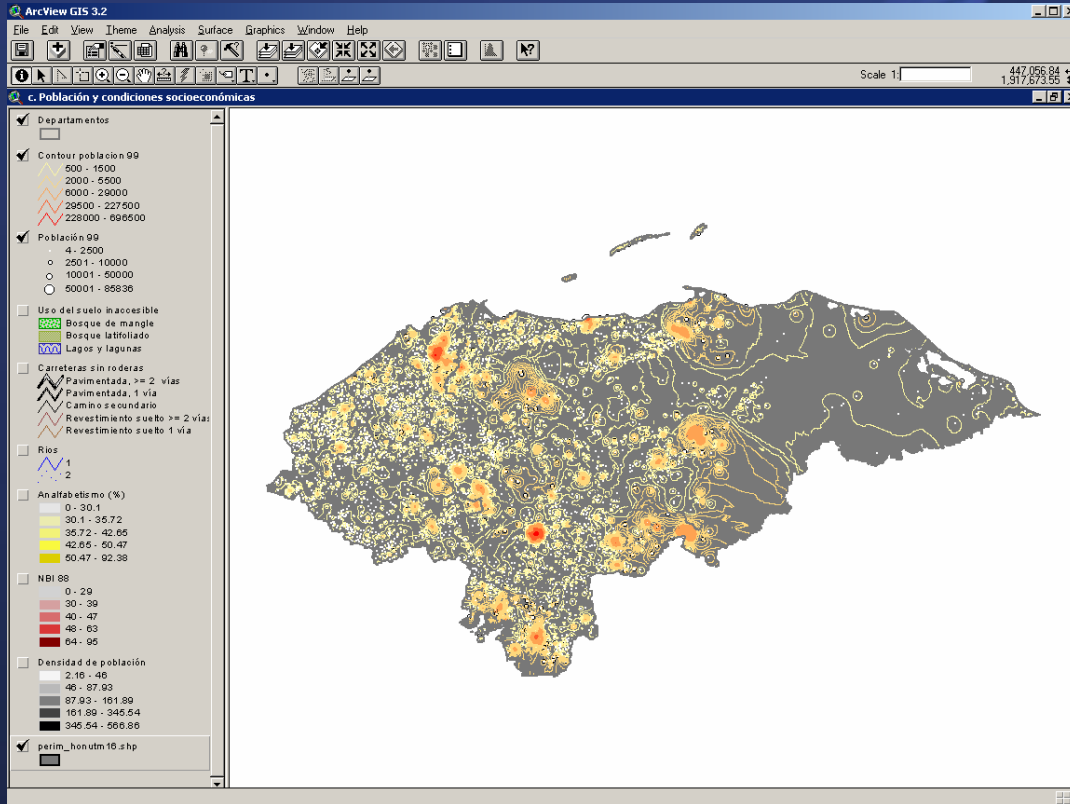
Public Health Methods for GIS and Spatial Analysis





Population Distribution

Municipal density

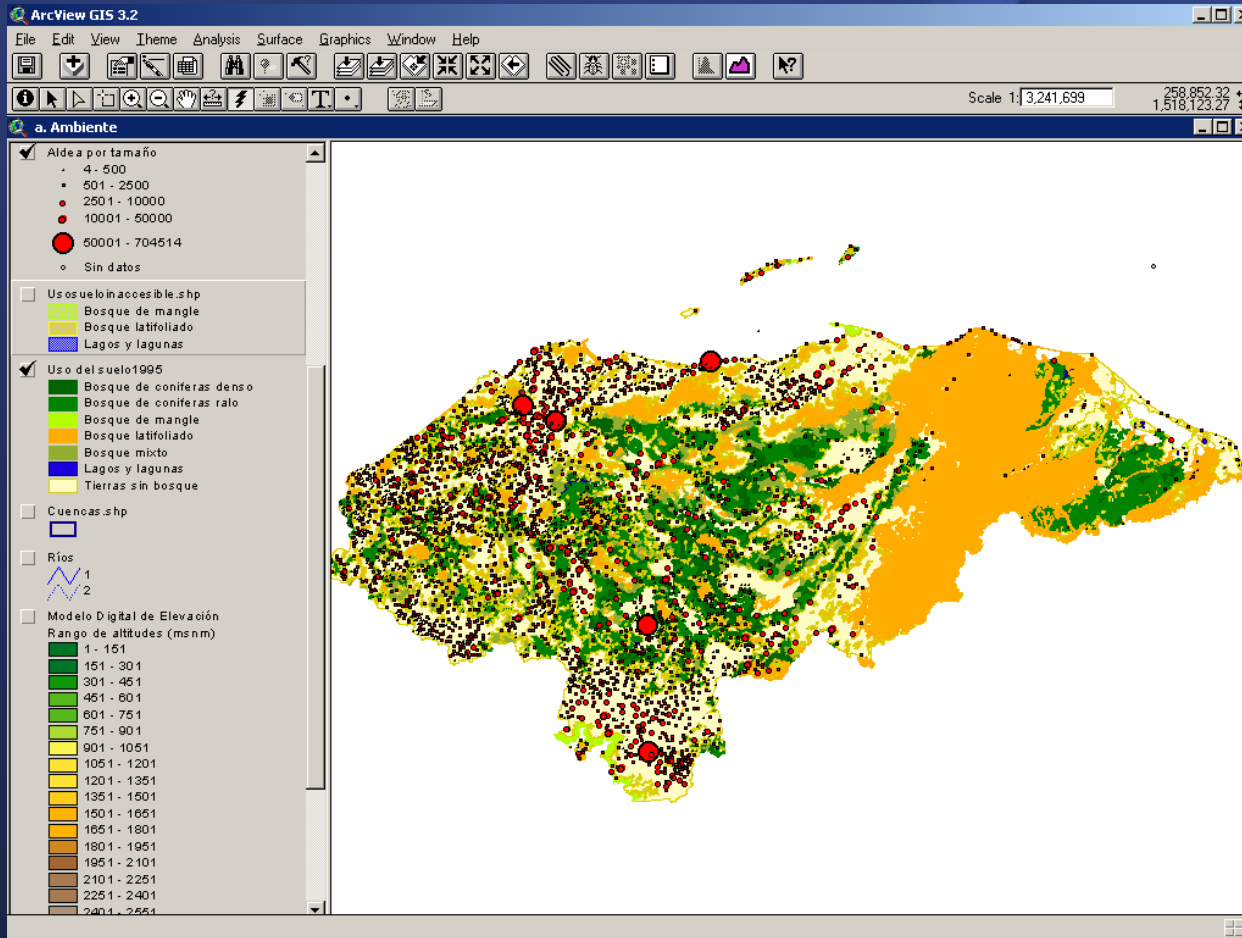


Community

Population size interpolation

.ais

Land Use and Communities Distribution Overlapping

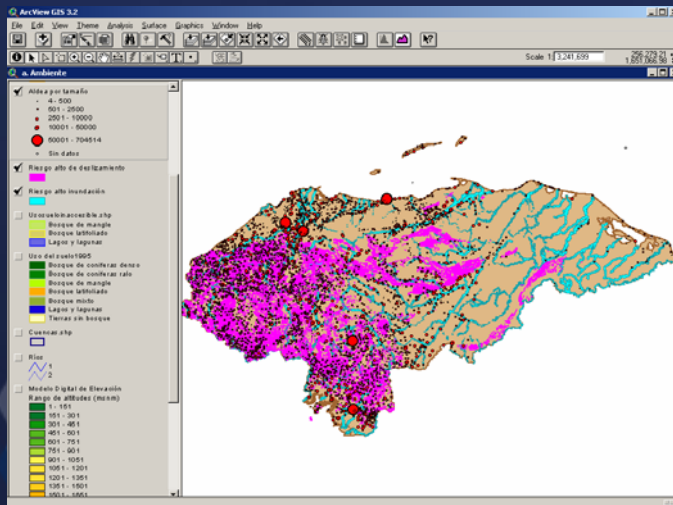
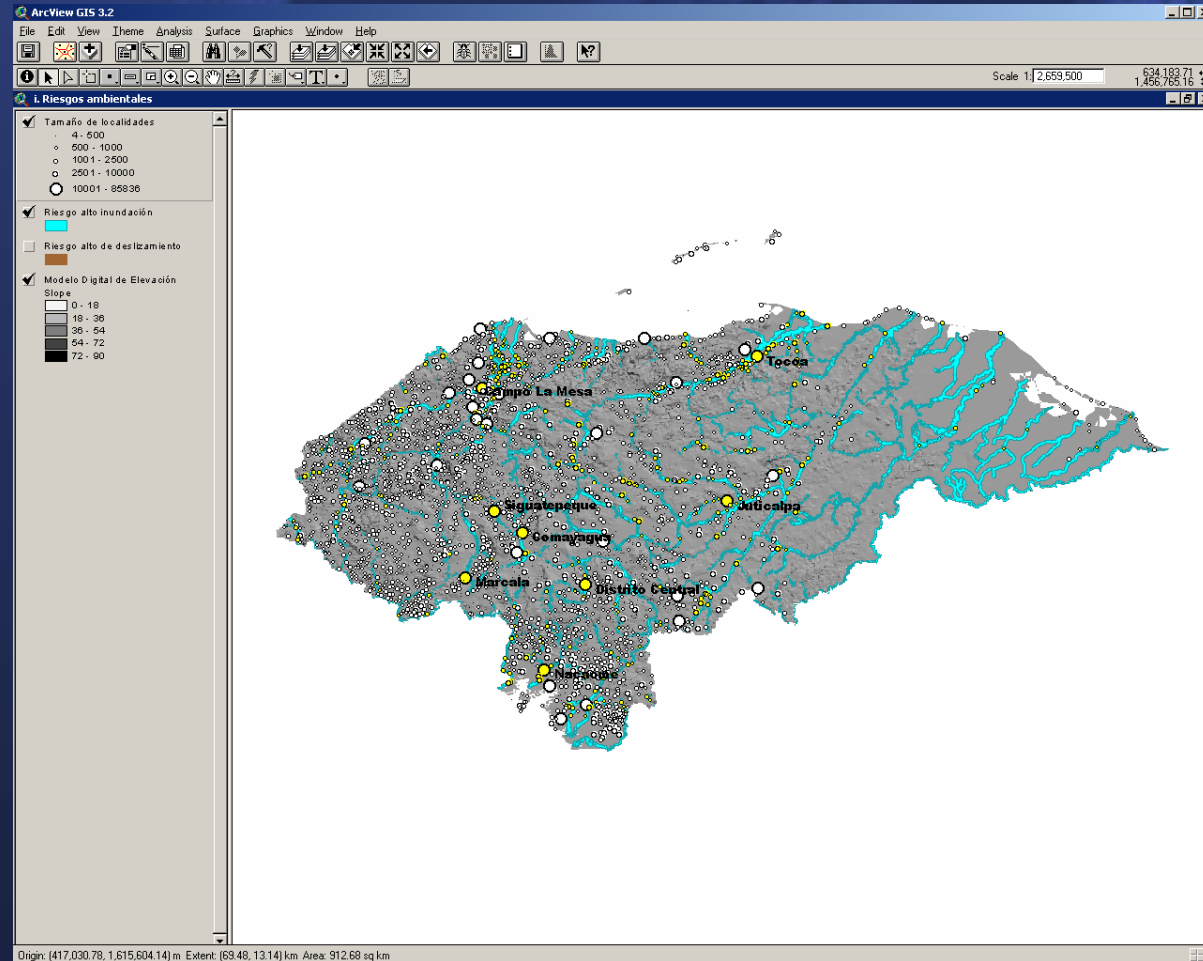


Evergreen broadleaf forest, mangrove swamps and inner water masses delineate places with difficult access.



Overlapping Environmental Risks and Population

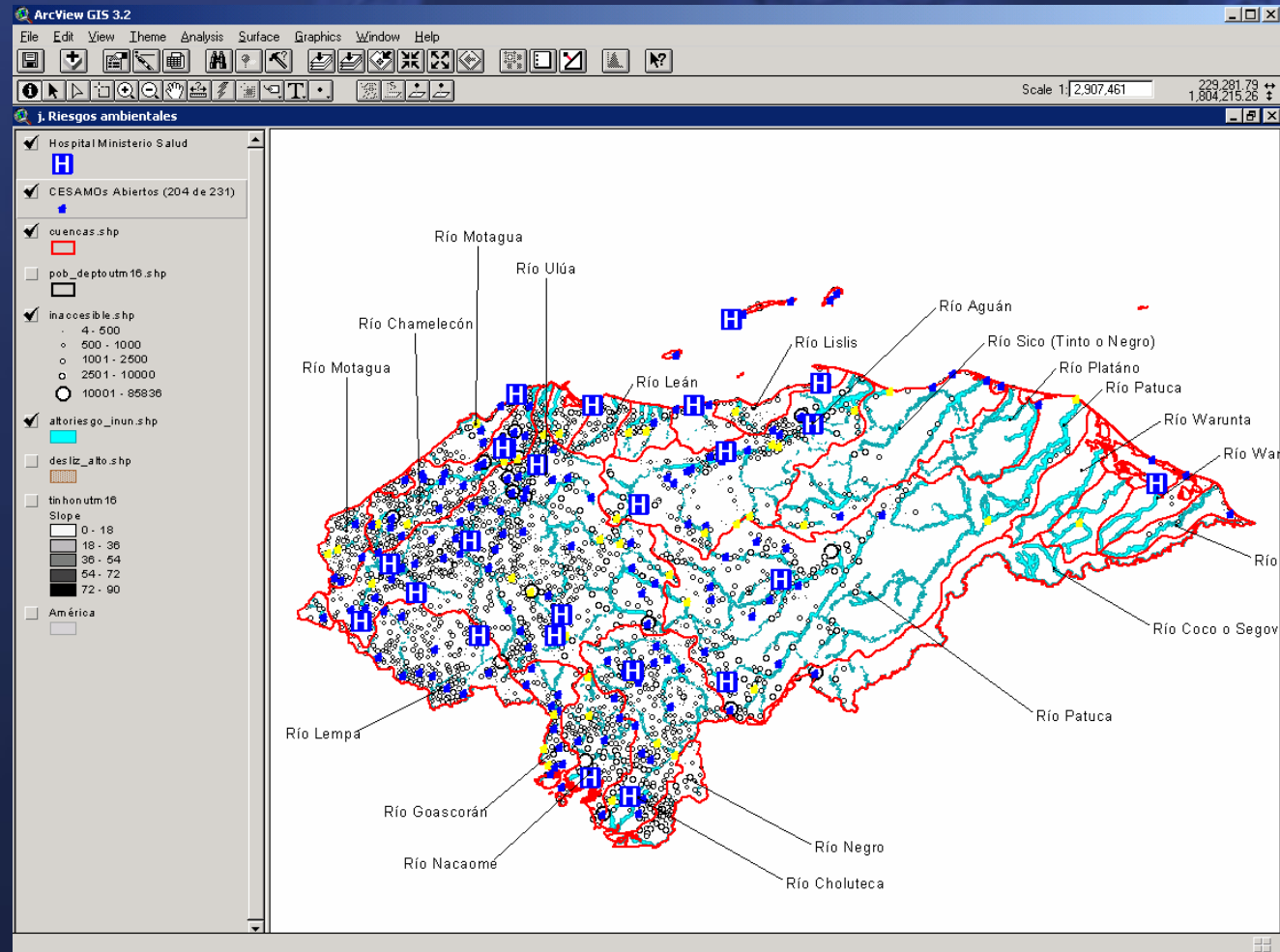
- **Flooding High Risk** (around 1 km from rivers)
 - 458 communities
 - and 824 889 people
- **High Risk of Landslides**
 - 90 Communities
 - and 53 501 people.





Differential emergency response of PHC

- 45 out of the 204 geo-referred PHC (22%) are located inside high risk flooding areas.

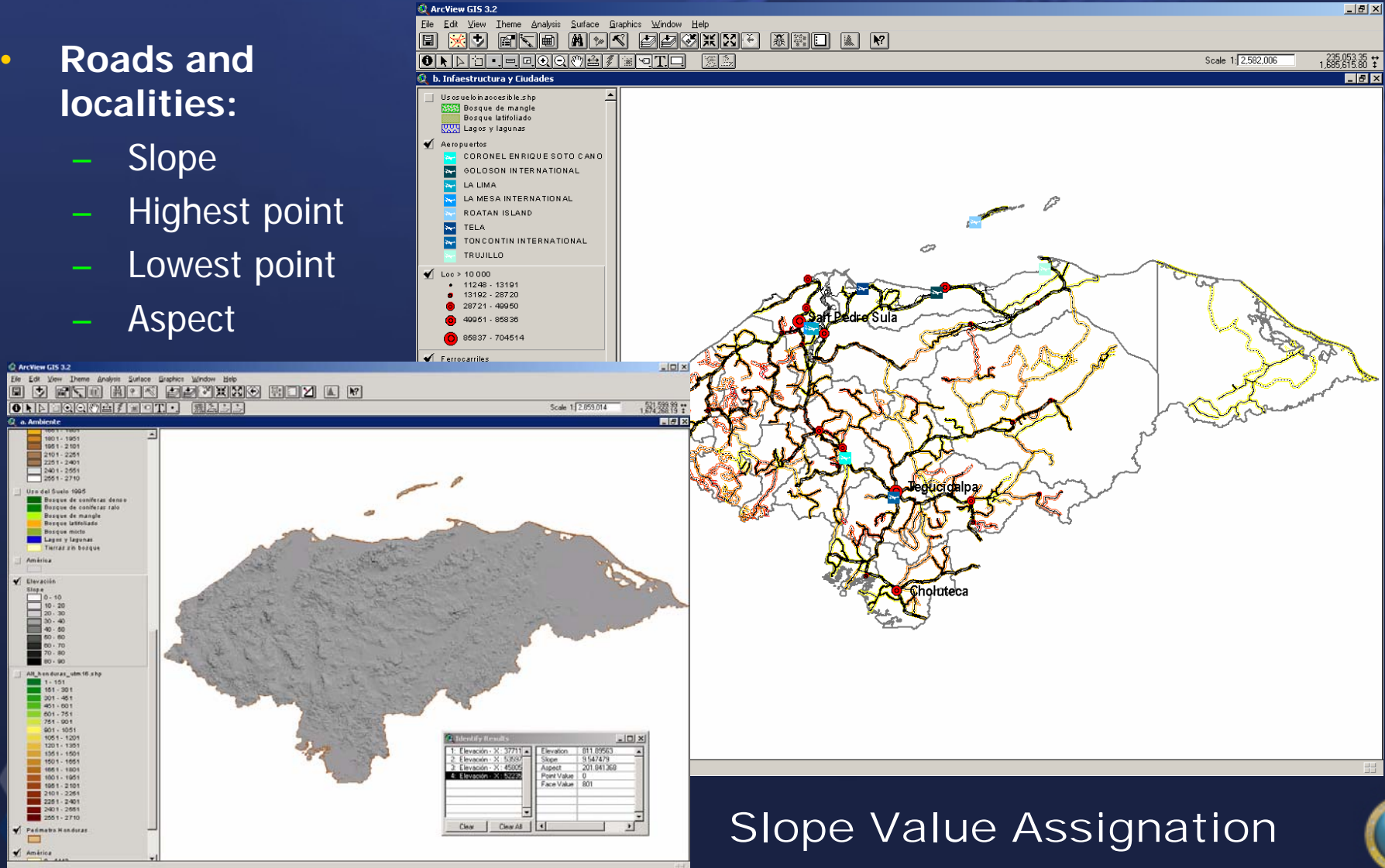




Slope measurement and assign values to points and lines (from TIN)

Roads and localities:

- Slope
- Highest point
- Lowest point
- Aspect



Slope Value Assignment



Morbidity Indicators

National Magnitud, 1999 [3].



Main Causes

	Number	Rate x 100,000
Acute Infectious Diseases	455914	7538.00
Diarrheas	247142	4086.00
Malaria	51911	858.00
Dengue	18068	298.00
Classic Dengue	17999	297.50
Diabetes mellitus	12014	199.00
Tuberculosis	4392	73.00
AIDS	983	16.00



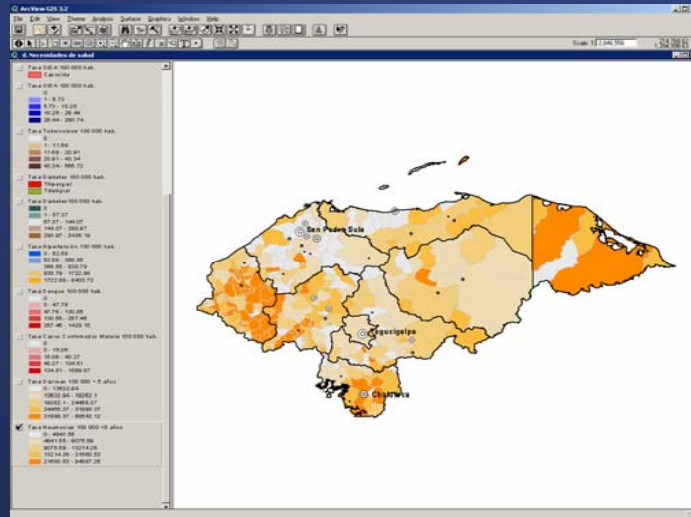
[3] <http://www.secsalud.hn/boletines/epidemiologico/asis.htm#IV>



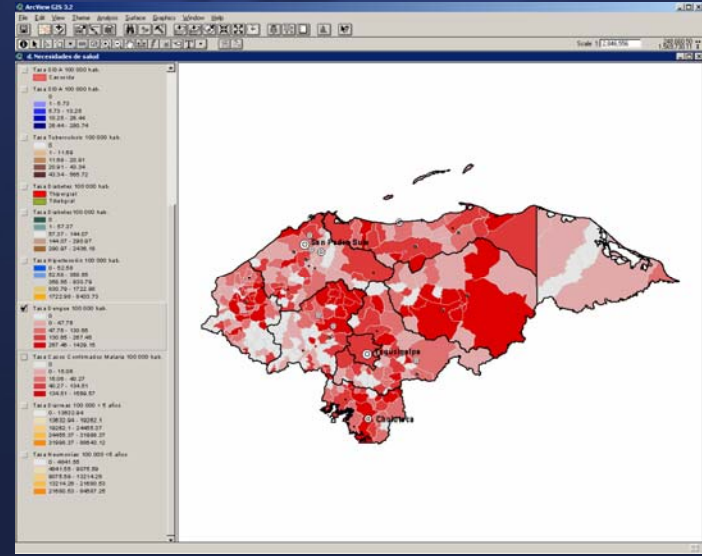
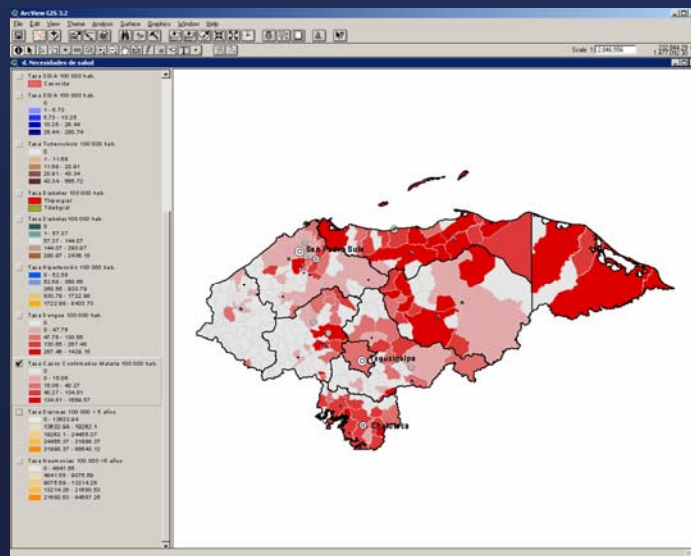
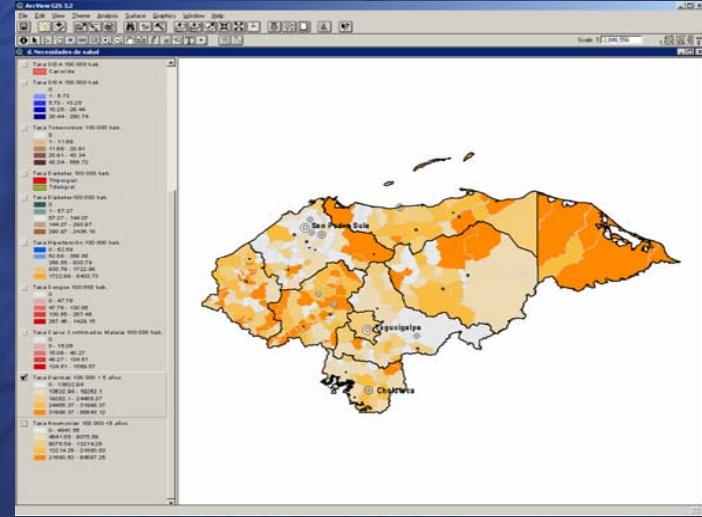
Municipal Infectious Diseases, 2001



Pneumonias



Diarrheas

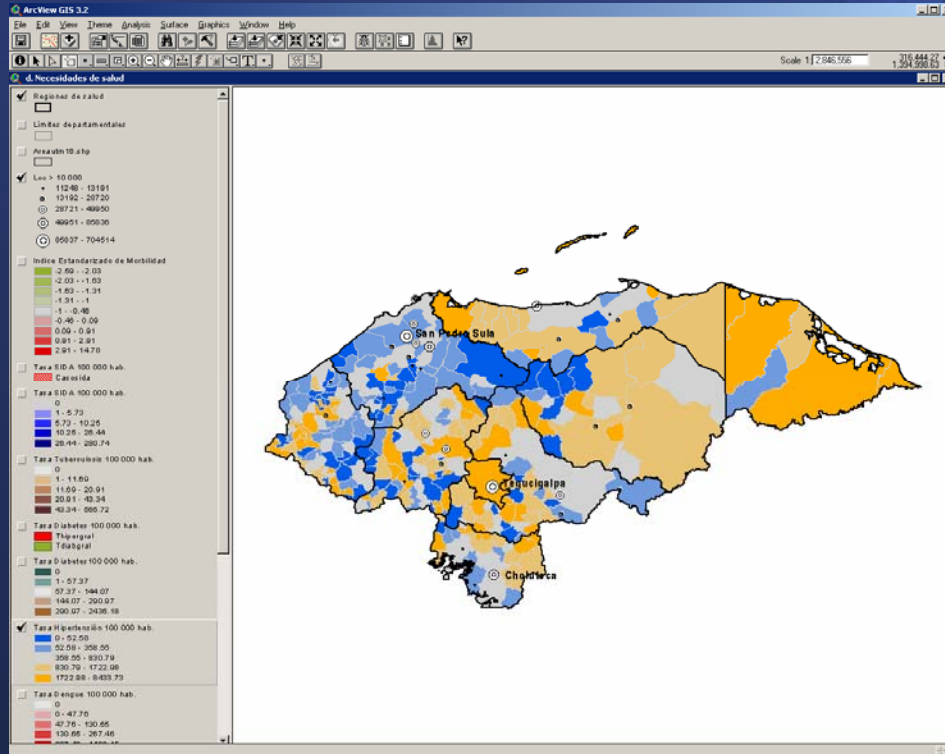


Malaria

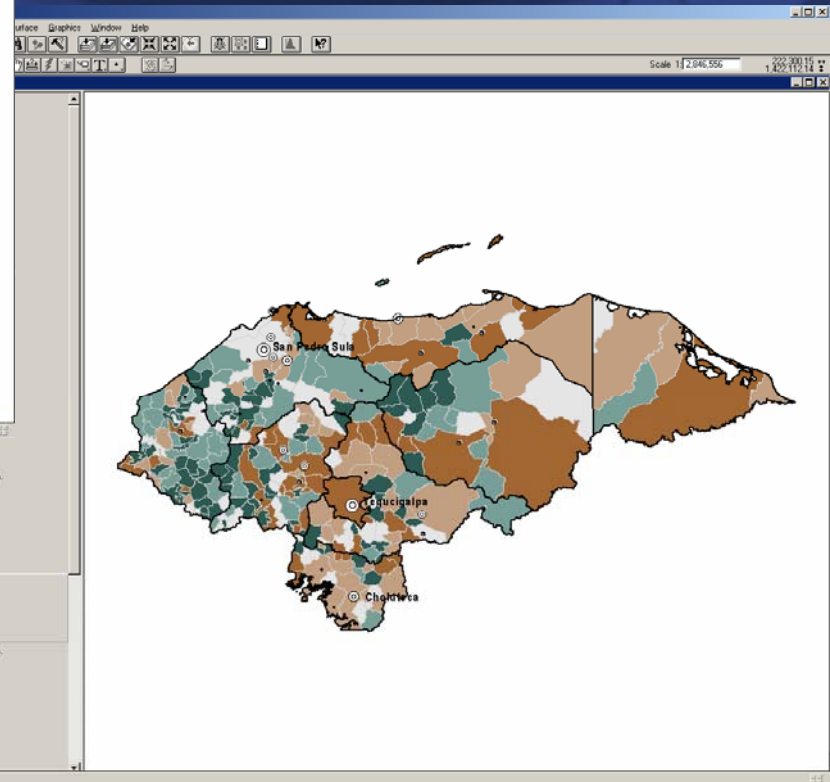
Dengue



Municipal distribution of chronic diseases, 2001



Diabetes



Hypertension

.ais

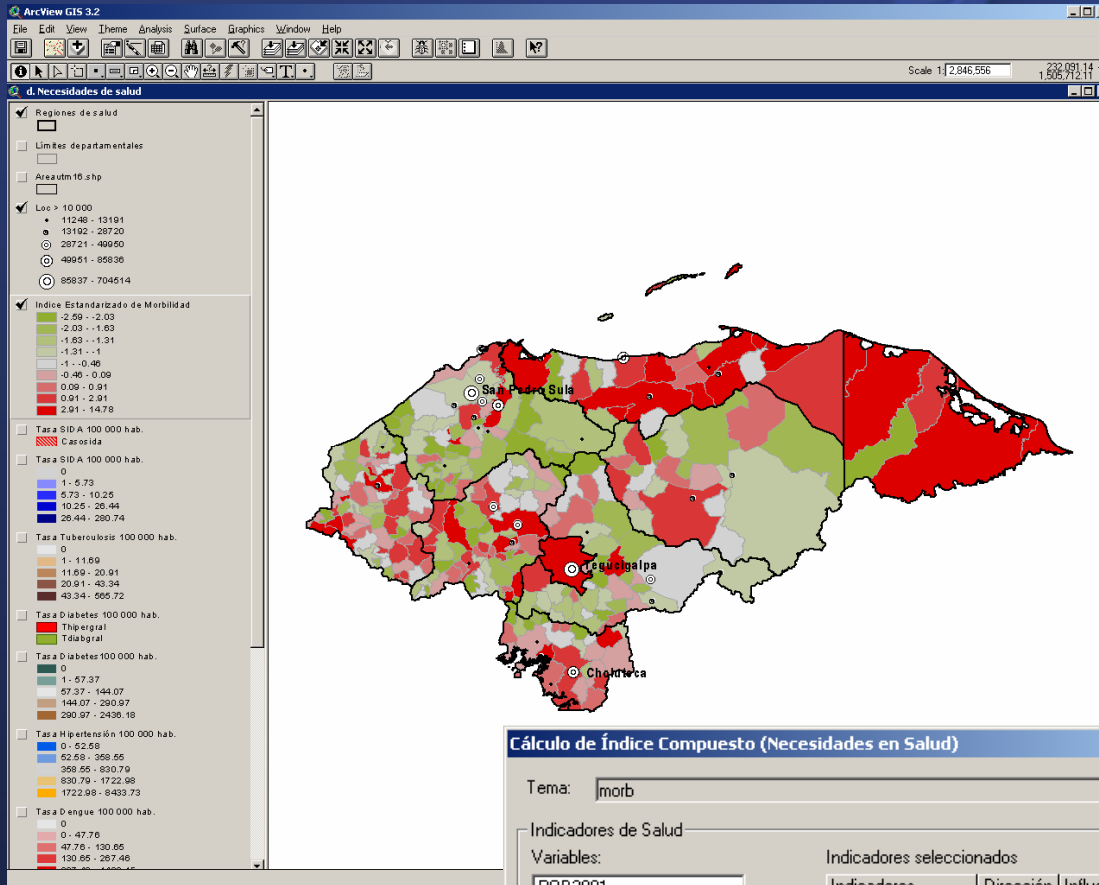
Morbidity Indicators Correlation



Variables	TNEUMOM5X1	TDIARRE5X1	TMALARIAX1	TDENGUEX10	THIPERGRAL	TDIABGRAL	TTBX100	TAIDSX100
TNEUMON 5X1 00	1.00 (1.00,1.00) N = 298	0.47 (0.38,0.55) N = 298	-0.01 (-0.12,0.11) N = 298	0.06 (-0.05,0.17) N = 298	0.05 (-0.06,0.17) N = 298	-0.04 (-0.15,0.08) N = 298	0.05 (-0.06,0.17) N = 298	-0.02 (-0.13,0.10) N = 298
TDIARRE5 X10 0	0.47 (0.38,0.55) N = 298	1.00 (1.00,1.00) N = 298	0.16 (0.05,0.27) N = 298	0.14 (0.02,0.25) N = 298	0.29 (0.18,0.39) N = 298	0.21 (0.10,0.32) N = 298	0.35 (0.24,0.44) N = 298	0.08 (-0.03,0.19) N = 298
TMALARIA X10 0	-0.01 (-0.12,0.11) N = 298	0.16 (0.05,0.27) N = 298	1.00 (1.00,1.00) N = 298	0.04 (-0.07,0.16) N = 298	0.08 (-0.03,0.19) N = 298	0.28 (0.17,0.38) N = 298	0.16 (0.05,0.27) N = 298	0.10 (-0.01,0.21) N = 298
TDENGUE X10 0	0.06 (-0.05,0.17) N = 298	0.14 (0.02,0.25) N = 298	0.04 (-0.07,0.16) N = 298	1.00 (1.00,1.00) N = 298	0.13 (0.02,0.24) N = 298	0.06 (-0.05,0.18) N = 298	-0.02 (-0.13,0.10) N = 298	0.03 (-0.09,0.14) N = 298
THIPERGR AL X 100	0.05 (-0.06,0.17) N = 298	0.29 (0.18,0.39) N = 298	0.08 (-0.03,0.19) N = 298	0.13 (0.02,0.24) N = 298	1.00 (1.00,1.00) N = 298	0.55 (0.47,0.63) N = 298	0.18 (0.07,0.29) N = 298	0.08 (-0.04,0.19) N = 298
TDIABGRA L X 100	-0.04 (-0.15,0.08) N = 298	0.21 (0.10,0.32) N = 298	0.28 (0.17,0.38) N = 298	0.06 (-0.05,0.18) N = 298	0.55 (0.47,0.63) N = 298	1.00 (1.00,1.00) N = 298	0.18 (0.07,0.29) N = 298	0.17 (0.06,0.28) N = 298
TTB X 100	0.05 (-0.06,0.17) N = 298	0.35 (0.24,0.44) N = 298	0.16 (0.05,0.27) N = 298	-0.02 (-0.13,0.10) N = 298	0.18 (0.07,0.29) N = 298	0.18 (0.07,0.29) N = 298	1.00 (1.00,1.00) N = 298	0.08 (-0.03,0.20) N = 298
TAIDS X 1000000	-0.02 (-0.13,0.10) N = 298	0.08 (-0.03,0.19) N = 298	0.10 (-0.01,0.21) N = 298	0.03 (-0.09,0.14) N = 298	0.08 (-0.04,0.19) N = 298	0.17 (0.06,0.28) N = 298	0.08 (-0.03,0.20) N = 298	1.00 (1.00,1.00) N = 298



Morbidity Standardized Index



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

Cálculo de Índice Compuesto (Necesidades en Salud)

Tema: morb

Indicadores de Salud

Variables:

Indicadores	Dirección	Influencia (%)
TNEUMOM5X1	+	20.0
TMALARIAX1	+	20.0
TDIABGRAL	+	20.0
THIPERGRAL	+	20.0
TTBX100	+	20.0
TSIDAX100	+	20.0

La suma del % de influencia tiene que ser igual a 100 %

Influencia total: 100

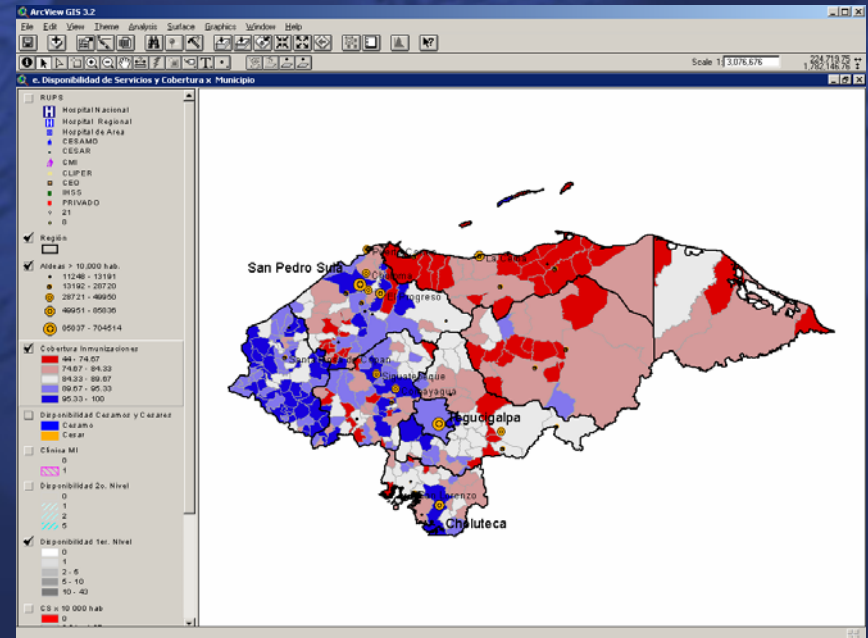
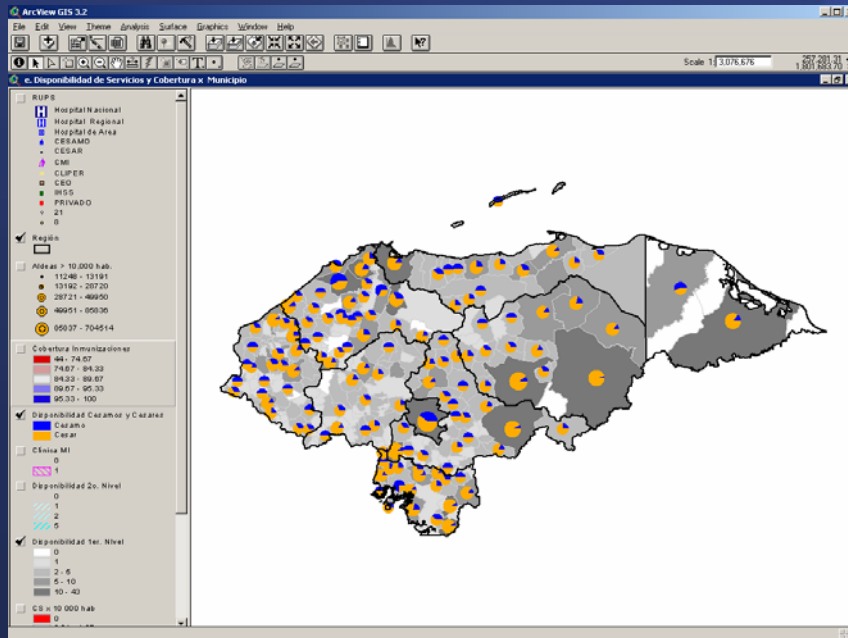
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• Developed with SIGEpi 1.0





Municipal Distribution of Health Services, 2001

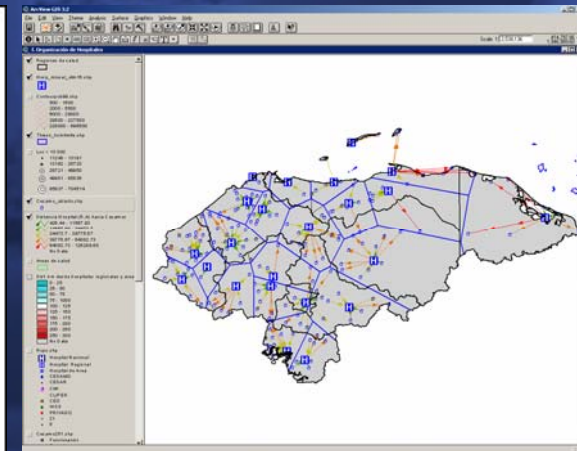
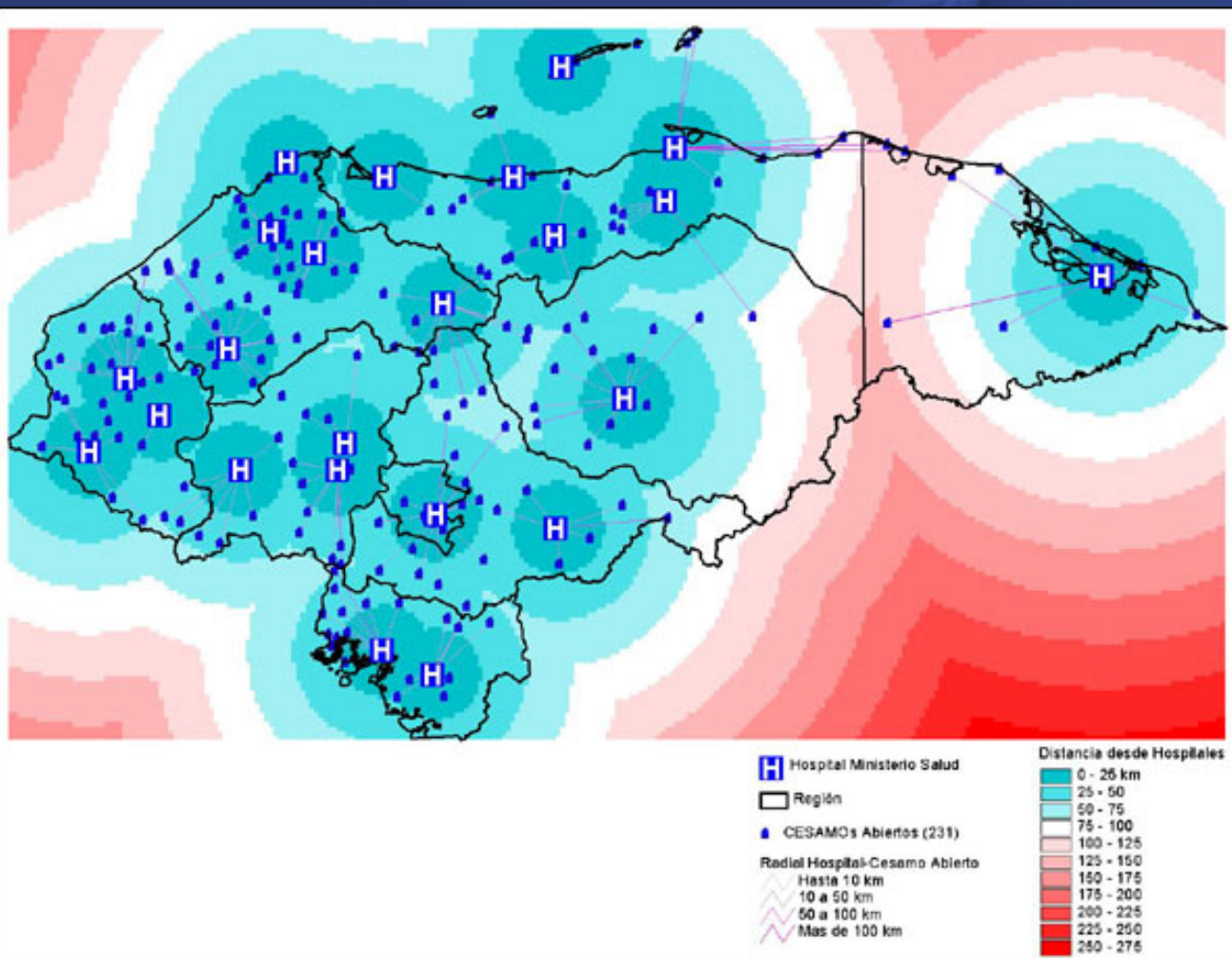


- Primary Health Services
 - Total
 - CESAMO/CESAR

- Immunization coverage



Hospitals Spatial Organization, 2001



- GRID distances
- Thiessen Polygons
- Spider Diagrams
- Relationship with PHC centers in the administrative area



Identification of low coverage, accessibility and high health needs critical areas



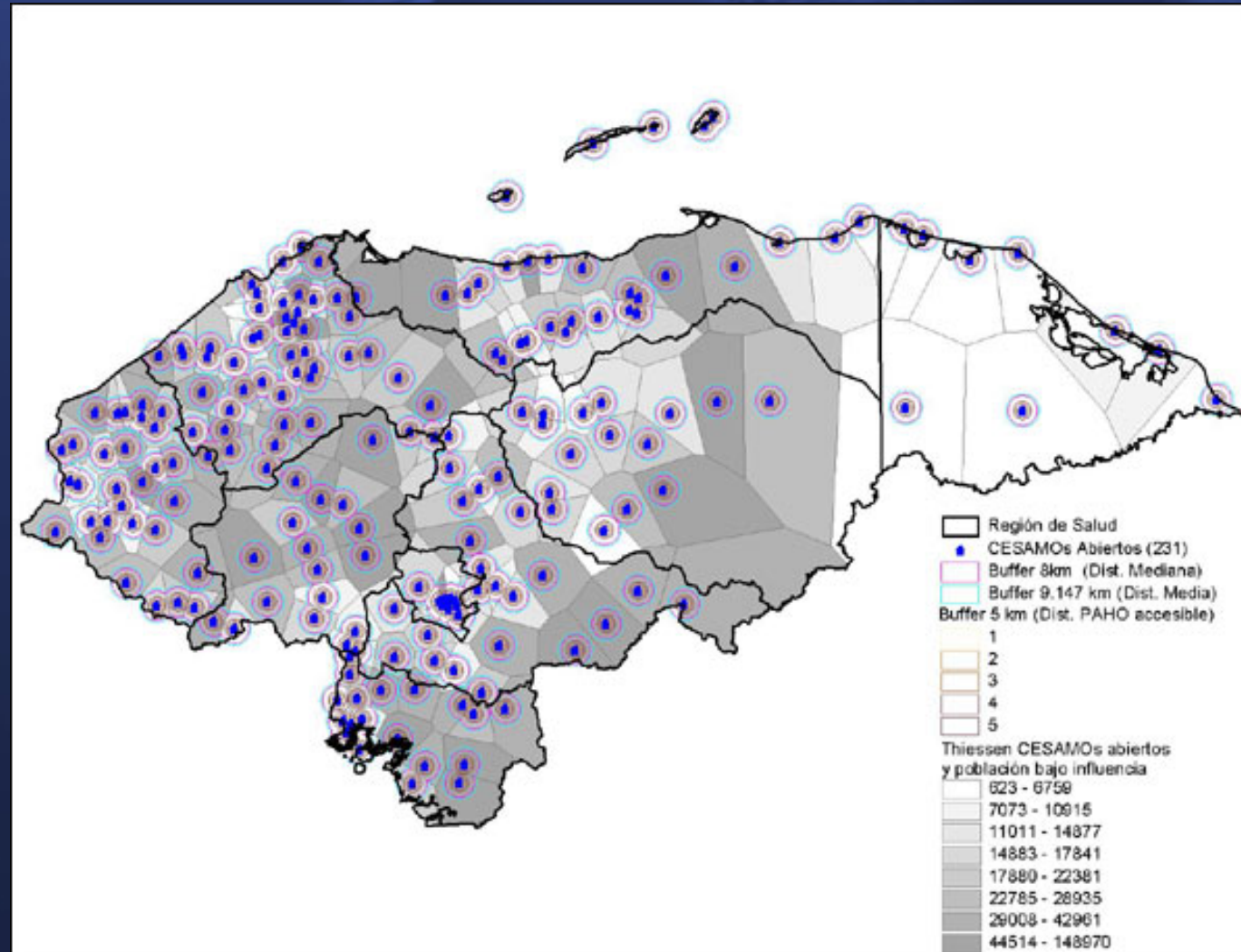
- Measurement of the interaction between Health Services and Population in terms of:
 - Geographic Potential Coverage:
 - Thiessen Polygons
 - Buffers
 - Differences
 - Geographic Accessibility:
 - Distances and slopes to nearest PHC facility
 - Distances to nearest paved roads
 - Average slope of the nearest paved road
 - Locality surrounding slopes
 - Distances in km
 - Slope in % where 100% = 45 degrees





Geographic potential coverage of PHC centers "CESAMOS"

- Thiessen Polygons:
 - 545 km²
- Concentric ring buffers
 - 5 km PAHO
 - 8 km median
 - 9.1 km mean distances



Communities in geographic catchment's area

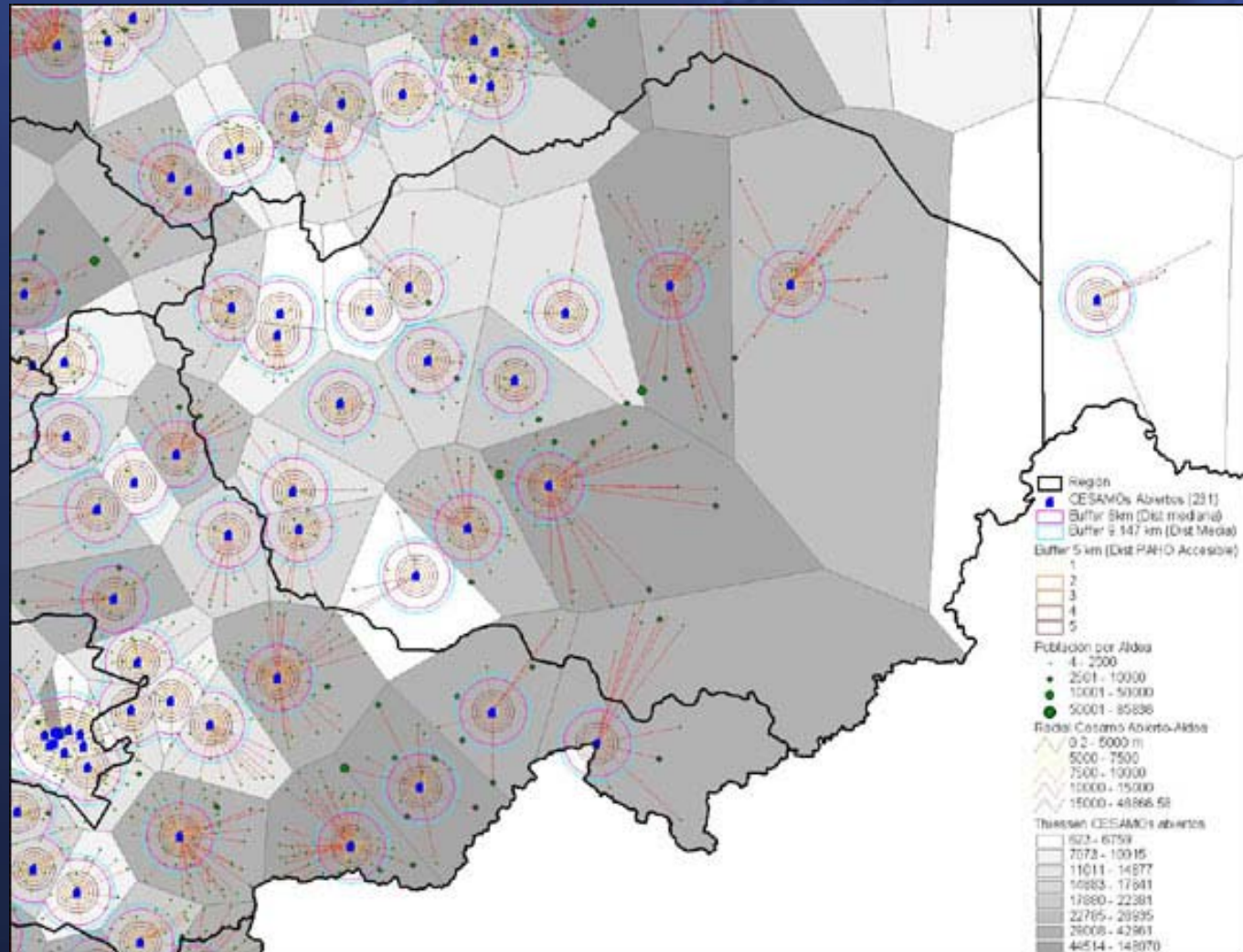


Thiessen Polygons catchment's area cover:

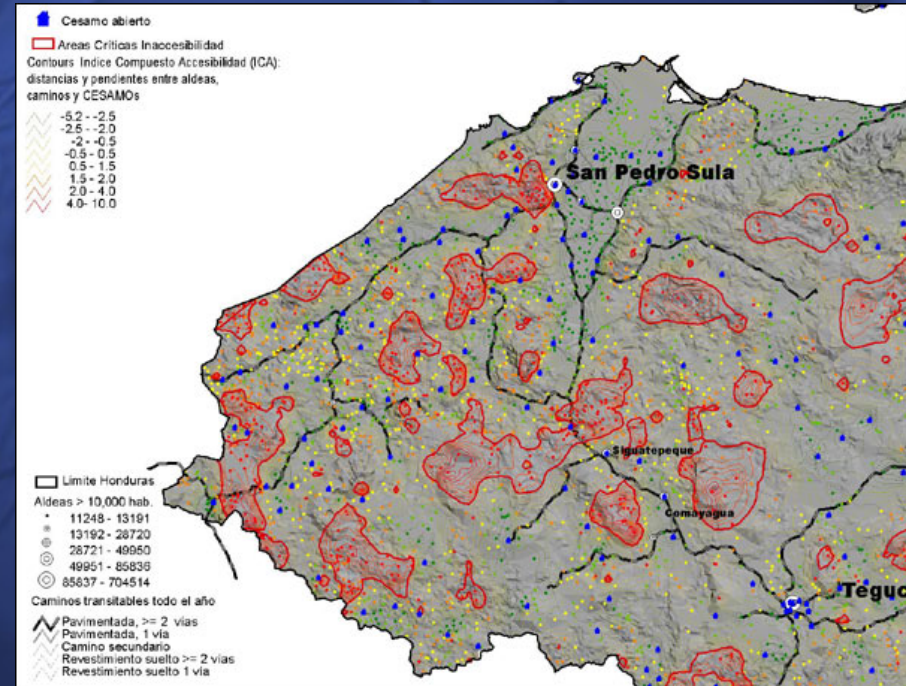
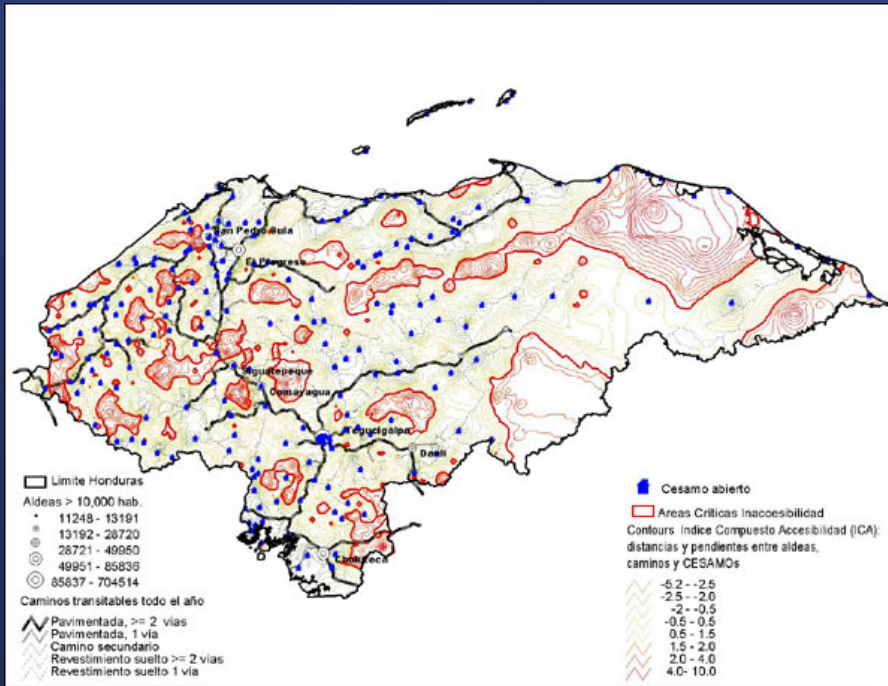
- 19 communities and 148 979 people
- $148\,979 / 5 = 29\,794$ families

Beyond 8 km Buffer of CESAMOS are:

- 1 883 communities
- 2 085 862 people



Low accessibility critical areas



Accessibility Index (ICA constructed with SIGEpi 1.0)

- Distances (km) and slopes to nearest facility
- Slopes Calculation of z scores
- Linear interpolation of community's ICA Values Selection of 2 Std Deviation values of ICA to define critical areas

RESULT:

In Low Accessibility Critical Areas there are **807** communities with en **638, 856** inhabitants.





Further analysis and What-if scenarios

- **Complete de definition of critical areas:**
 - with highest health needs indicators
 - include land use indicators
 - rural-urban
- **Over critical areas**
 - opening nearest closed facility CESAMO with a physician
 - opening nearest alternative services CESARES (rural centers) located al least at 5 km away from paved roads





Impact

- **Resources for the Secretary of Health:**
 - On the Congress, was possible negotiate new posts for physicians
 - Re-allocation of budget to open or close health centers
- **The GIS application has been installed in four strategic areas of his administration:**
 - Ministry of Health PC
 - Epidemiology
 - Health Planning
 - Disasters and emergencies
- **The Presidency Social Commission has asked advisory from PAHO to design a Situation Room based on GIS**



Team Work



Main collaborators in this project:

- **Geog. Patricia Najera Aguilar**, *Short Term Professional in GIS, AIS/DD/PAHO*
- **Dr. Carlos Castillo Salgado**, *Area manager of Health Analysis and Information Systems in AIS/DD/PAHO*
- **MCC. Manuel Vidaurre Arenas**, *Information Systems Specialist AIS/DD/PAHO*
- **Ing. Ramón Martínez Piedra**, *Short Term Professional in GIS, AIS/DD/PAHO*
- **Dr. Enrique Loyola Elizondo**, *Regional advisor AIS/DD/PAHO*

Ministry of Health, Honduras

- **Lic. Elias Lizardo Zelaya**, *Secretary of Health in Honduras*
- **Dr. Humberto Cosenza**, *External Coop.*
Dr. Marco Tulio Carranza, *Epidemiologist*
Dra. María del Socorro Iteriano, *UPEG*
- **Dr. Godofredo Andino**, *Disasters and national emergencies*
- **Dr. Orlando Solórzano**, *Epidemiology*
- **Ing. César Rodríguez**, *Epidemiology*
- **Dra. Doris Rodríguez**, *Statistics*
- **Dra. Marza Montes**, *- UPEG*
- **Dra. Ana Lucia Estrada**, *- UPEG*
- **Ing. Javier Garcia**, *PRIESS/BID*

PWR Honduras

- **Dr. Carlos Samayoa Castillo**, *Representative PAHO in Honduras*
- **Dr. Luis Miguel Amendola**, *National Professional*
- **Ing. Edwin Cruz**, *GIS Consultant*
- **Ing. Carlos Riedel**, *Network Administrator PWR/Honduras*
- **Dr. Guillermo Guibovich**, *Epidemiologist AIS, PWR/Honduras*

CIGEO/UNITEC:

- **Lic Ramón Sarmiento**, *Vicerrector - UNITEC*
- **Ing. Heidi Mendoza**, *Coordinator CIGEO/UNITEC*
- **Ing. José Luis Portillo**, *Cartography CIGEO/UNITEC*





Data Sources

Ministry of Health

- Morbidity
 - HAS Rates 2000 municipal
 - Epi-municipal 2001
- Unmet Basic Needs (NBI)
- Health Centers Attributes

Other institutions in Honduras

- SINIA Environment, Land Use
- UNITEC Flooding, Landslides
- IGN/INE 2001 Census communities

PAHO PWR

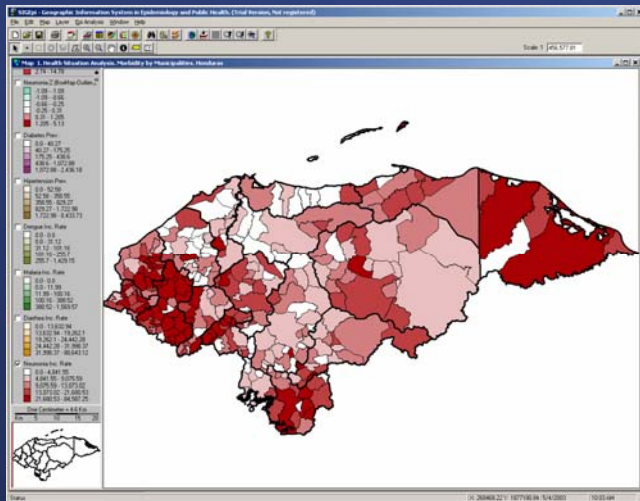
- SIG-OPS GIS project
- Health indicators in "Shapefile"
- Data base documentation

AIS / PAHO HQ

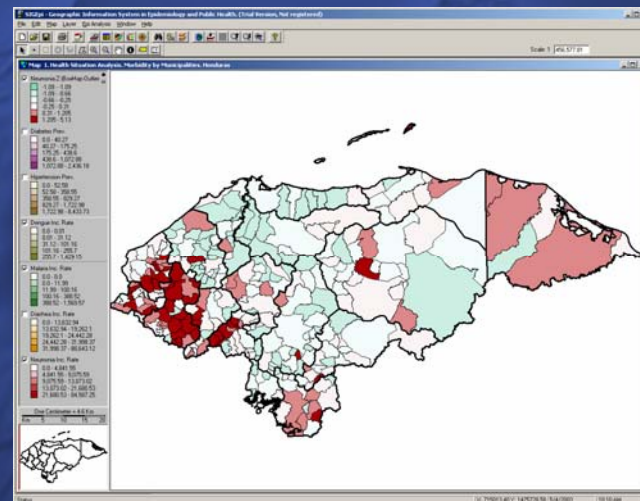
- Conceptual and operational model
- USGS DEM transformation
- INCAP data malnutrition indicators
- Projections
- Geo-coding
- Statistical Analysis
- Spatial Analysis
- GIS application



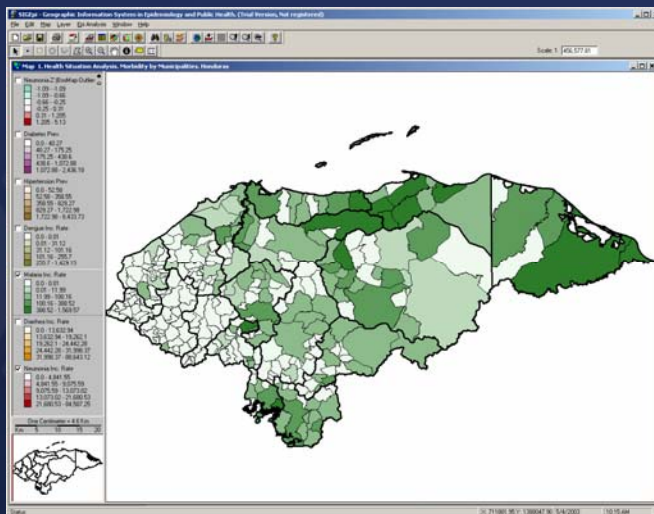
Exploratory Analysis of Morbidity Indicators



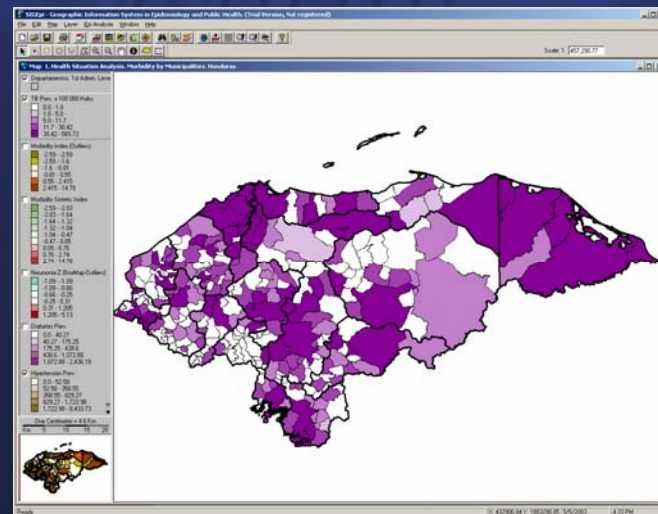
Pneumonia



Pneumonia (Outliers, Box-plot map)

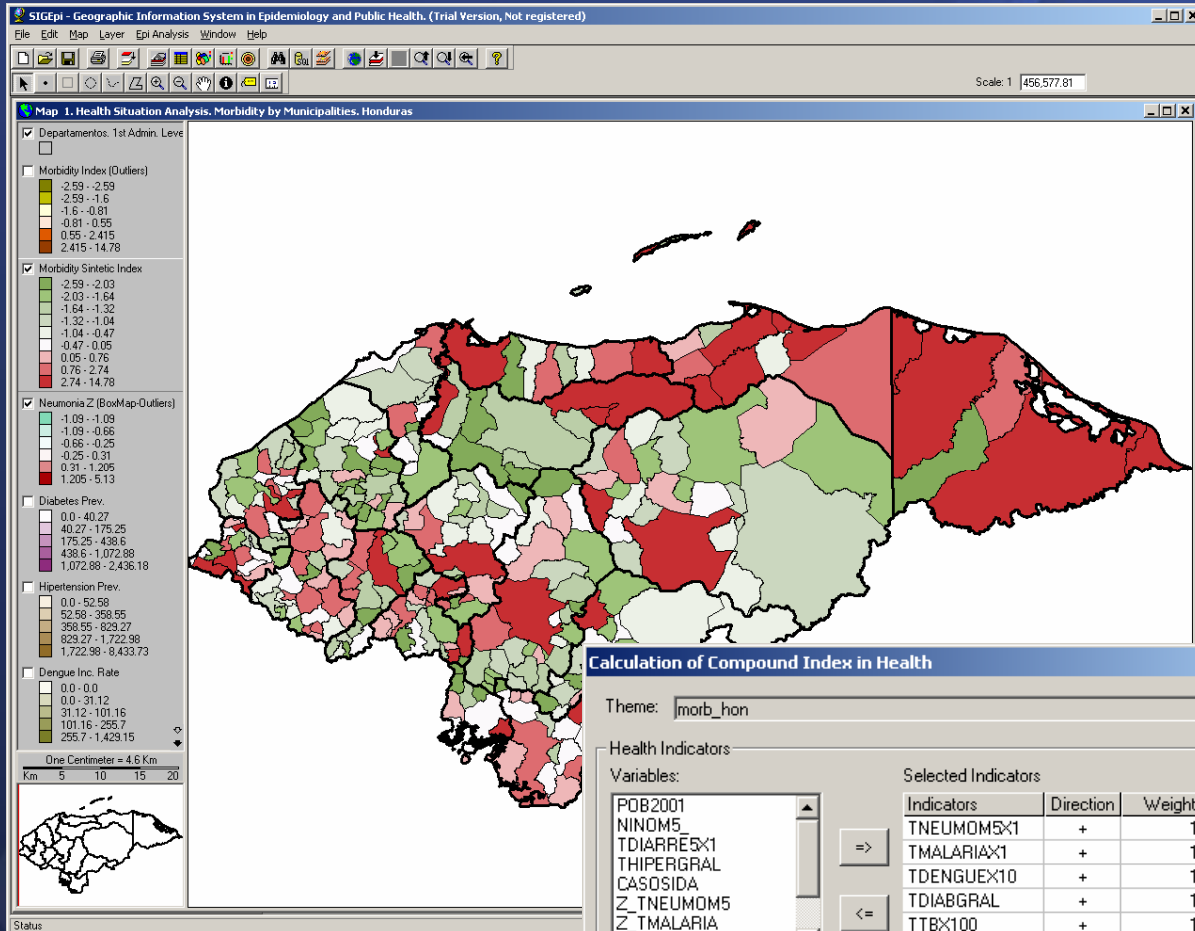


Malaria



Tuberculosis

Index of Morbidity



SIGEpi procedures

- Thematic mapping of health indicators.
- Correlation analysis.
- Box-plot maps (outlier detection)
- Construction of a composite index of morbidity Zscore:
 - Pneumonia rate in children less that 5 yrs X 100,000
 - Malaria x 100 000,
 - Dengue x 100 000,
 - Tuberculosis x 100,000,
 - AIDS x 100,000,
 - Diabetes x 100,000).

Calculation of Compound Index in Health

Theme:

Health Indicators

Variables:

Selected Indicators

Indicators	Direction	Weight (%)
TNEUMOM5X1	+	16.7
TMALARIAx1	+	16.7
TDENGUEX10	+	16.7
TDIABGRAL	+	16.7
TTBX100	+	16.7
TSIDAX100	+	16.7

Sum of % of weights must be equal to 100 % Total weight:

Type of Thematic Map: Categories Ranges

Classification Method: Terciles Quintiles

Compound Health Index dialogue box. SIGEpi



How SIGEpi is improving Health and Equity in the Americas?

- Specific design of analytical procedures to identify and locate inequalities integrated in a GIS
- Distribution strategy focused on priority countries and sub-regions:
 - Training
 - Software
 - Technical cooperation
 - Materials
- Technical support in the development of applications to ID sub national and frontier problems



PAHO/JHU Epidemiologic applications of geographic information systems course (1)

The Graduate Summer Institute of Epidemiology and Biostatistics

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The Summer Institute provides an opportunity for graduate study to degree candidates as well as individuals taking selected courses for professional development. The courses we offer are intended to develop an understanding of basic and advanced principles of epidemiological research, and will present epidemiologic methods and their application to the study of the natural history and etiology of disease.

After completing the methods used to investigate the epidemiologic link between collecting, interpreting

Course Descriptions - Microsoft Internet Explorer

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Address <http://www.jhsph.edu/summerepi/coursedescript.htm#340.889.11> Go Links

340.889.11 Epidemiologic Applications of GIS M T W Th F

Instructor(s): Carlos Castillo-Salgado and Enrique Loyola-Elizondo

This course will present the methods and uses of epidemiology towards the development and application of Geographic Information Systems (GIS) in public health. Emphasis is made on the potential of GIS as an epidemiological analysis tool for describing the magnitude of priority health problems, identifying health determinants and supporting health decision-making. Specific topics will include epidemiological risk assessment and GIS, thematic mapping of unmet health needs, malaria risk assessment and GIS application for evaluation of public health programs. The course includes hands-on experience and laboratory exercises using different public domain and ESRI software. **Should not be taken by student who have completed 223.842 in Winter Intersession 00-01.** (15 CME credits, 1.5 CEU's, 2.5 CM, 2 Acad. credits).*

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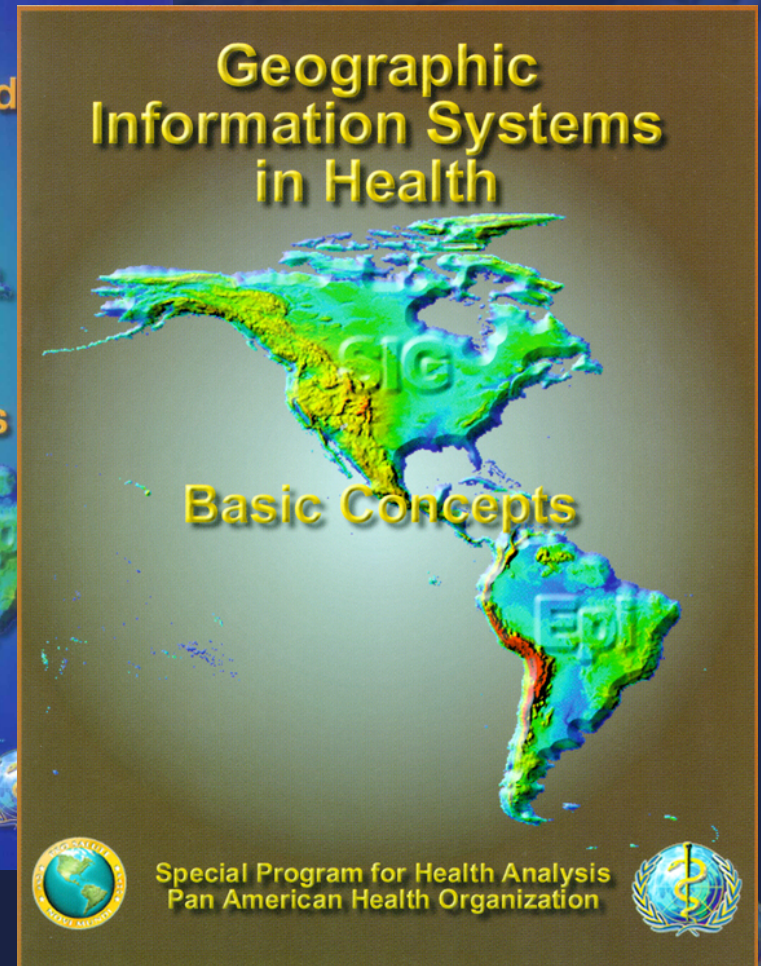
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PAHO/JHU Epidemiologic applications of geographic information systems course (2)



Geographic Information Systems in Health: Basic Concepts



SIGEpi – GIS for Epidemiology and PH

The screenshot displays the SIGEpi software interface, which is a Geographic Information System (GIS) for epidemiology and public health. The main window shows a map of South America with various layers and analysis tools. A menu is open, showing options like 'Estadísticas Descriptivas...', 'Distribución de Frecuencias...', 'Análisis de Correlación...', 'Análisis de Regresión...', 'Cálculo de Tasas...', 'Estandarización de Tasas', 'Suavizador Espacial de Tasas', 'Suavizador de Razón Estandarizada de Mortalidad...', 'Identificación de Áreas Críticas...', 'Índice Compuesto en Salud...', 'Análisis Espacial', 'Asociación de Casos en [Tiempo/Espacio (Knox)...]', 'Asociación Exposición-Efecto...', and 'Análisis de Accesibilidad...'. A smaller window shows a map of the Americas with a legend for 'Tasa de Mortalidad Infantil. Las Américas' and a regression analysis window with a table of coefficients.

Regresión

Se presenta el resultado de la regresión e y la variable dependiente seleccionada.

Modelo de Regresión

Coefficientes

Variable	Coefficiente	Error Estándar

Map 1

BRASIL_2 (SILVCO)	BRASIL_2 (INBI)	BRASIL_2 (TMI)	BRASIL_2
18.06 - 25.6	0.37 - 3.47	18.06 - 25.6	18.06 - 25.6
25.6 - 28.94	3.47 - 1.25	25.6 - 28.94	25.6 - 28.94
28.94 - 36.22	1.25 - 0.61	36.22 - 36.26	36.22 - 36.26
36.22 - 36.26	0.61 - 2.73	36.26 - 74.67	36.26 - 74.67
36.26 - 74.67	2.73 - 4.43		

Map 2

BRASIL_2 (SILVCO)	BRASIL_2 (INBI)	BRASIL_2 (TMI)	BRASIL_2
18.06 - 25.6	0.37 - 3.47	18.06 - 25.6	18.06 - 25.6
25.6 - 28.94	3.47 - 1.25	25.6 - 28.94	25.6 - 28.94
28.94 - 36.22	1.25 - 0.61	36.22 - 36.26	36.22 - 36.26
36.22 - 36.26	0.61 - 2.73	36.26 - 74.67	36.26 - 74.67
36.26 - 74.67	2.73 - 4.43		

Organización Panamericana de la Salud
Programa Especial de Análisis de Salud

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Variables

Variable	Valor
OB_FEM	...
OB_MASC	...
OB_TOTAL	...
OBTOT	...
UPERF	...

Estrato - Casos

Caso	Valor
CAS_15	...
CAS_15_39	...
CAS_40_64	...
CAS_65	...

Crear Mapa Temático de la Tasa Ajustada

OK Cancelar

Case Studies for SIGEpi

Adobe Acrobat - [Casos_de_Estudio.pdf]

File Edit Document Tools View Window Help

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Bookmark

- Tabla de contenido
- Introducción
- Tabla cruzada de Funciones/Procedimientos vs. C
- Caso No. 1. Descripción de la distribución de In
 - Archivos necesarios
 - Pasos que se deben seguir para realizar este
- Caso No. 2. Identificación de países críticos e
 - Archivos necesarios
 - Pasos a seguir para realizar la identificación d
- Caso No. 3. Evaluación de la calidad ambiental:
 - Archivos necesarios y su descripción
 - Pasos que se deben seguir para desarrollar es

ÁREA DE ANÁLISIS DE SALUD Y SISTEMAS DE INFORMACIÓN (AIS)
ORGANIZACIÓN PANAMERICANA DE LA SALUD (OPS)

Sistema de Información Geográfica en Epidemiología y Salud Pública



Sistema de Información Geográfica en Epidemiología y Salud Pública



SIGEpi - Geographic Information System in Epidemiology and Public Health.

File Edit Map Layer Epi Analysis Window Help

Scale: 1 6,291,566.11

Project

- Project
- Maps
 - Map 1
- Database
 - Tables
 - Queries
 - Graphs
 - Results
 - Layouts

Map 1

- Literacy
 - 4.0 - 5.9
 - 5.9 - 8.7
 - 8.7 - 11.6
 - 11.6 - 14.0
 - 14.0 - 16.7
 - 16.7 - 20.0
 - 20.0 - 24.5
 - 24.5 - 45.5
- Malnutrition
 - 32.01 - 36.12
 - 36.12 - 40.27
 - 40.27 - 41.42
 - 41.42 - 42.82
 - 42.82 - 44.38
 - 44.38 - 53.25
 - 53.25 - 63.5
 - 63.5 - 70.32
- AMRO_EDD_REGION
- WORLD_SID (Raster)

One Centimeter = 63 Km
Km 100 200

Adobe Acrobat - [Casos_de_Estudio.pdf]

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ORGANIZACIÓN PANAMERICANA DE LA SALUD (OPS)

Note que durante el proceso de relación de la tabla de datos con la tabla cierta la ventana de la tabla de datos Ind_box. Si se revisa las columnas de capa cartográfica AMERICA se encontrará que se han añadido las var Ind_box.

8.- Construya un mapa temático con la tasa de mortalidad infantil por país seguir los siguientes pasos.

1. Active la capa temática AMERICA haciendo clic sobre su nombre. La capa está seleccionada cuando su leyenda aparece ombrineada.
2. Seleccione la opción **Crear mapa temático...** del menú **Capa**, o la **Mapa Temático de la Barra de Herramientas**, o simplemente **nombre de la capa en la leyenda**.

Aparece el diálogo de selección del **Tipo de Mapa Temático**.
Seleccione el mapa temático de intervalos y haga clic sobre el botón **OK**.

Aparece el diálogo **Mapa Temático de Intervalos**.

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New PAHO/AIS Web Site in GIS-Epi

The image shows two overlapping browser windows displaying the SIG-EPI website. The background window shows the home page, and the foreground window shows a detailed page about applications and technical aspects.

SIG-EPI - Home - Microsoft Internet Explorer

File Edit View Favorites Tools Help

Address www.sig.web

SIG-EPI
SIG-EPI PROJECT IN THE AMERICAS

español

Applications
Databases
Software
Training
Diffusion
Contact

Geographic Information Systems in Health (GIS-EPI)

Objective

The Health Analysis and Information Systems Area's (AIS) project on Geographic Information Systems in Health (GIS-EPI) was created with the objective to contribute to the strengthening of health workers' capacity for epidemiological analysis by providing efficient tools with GIS-Epi to facilitate such tasks. These computerized tools permit the health situation analysis, monitoring, and evaluation of an interventions effectiveness that are required for decision-making and planning in health.

In order to achieve the above objective, examples of GIS-Epi applications were developed in various areas of the health, training materials were prepared, courses and workshops were offered, and the network of users was strengthened.

What is GIS-EPI?

This concept involves the design, development, and use of GIS tools and applied to the different needs for the description of the health situation, for epidemiological analysis, and for public health management .

SIG-EPI Project > Aplicaciones

Applications and technical c

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Regional patterns in Health Situation Analysis (ASIS)

- Public health surveillance and
- Identification of critical areas
- Determination of environmental
- Recognition and location of healthy spaces and of factors that promote and protect health
- Health atlas
- Impact Assessment of population-based interventions
- Hypothesis generation for operational research in new areas of study

Diagram: GIS-EPI Process Flow

Entrada	Almacenamiento	Proceso	Salida
<ul style="list-style-type: none"> Tablas Digitales GPS Software Hardware 	<ul style="list-style-type: none"> Database GIS-ROOM Client Data 	<ul style="list-style-type: none"> Mapas de Salud Mapas de Riesgo Mapas de Vigilancia Mapas de Diagnóstico Mapas de Planificación 	<ul style="list-style-type: none"> Digital Impresión

Done Local intranet

PAHO acknowledges ESRI's generous donation of MapObjects to be integrated in SIGEpi

