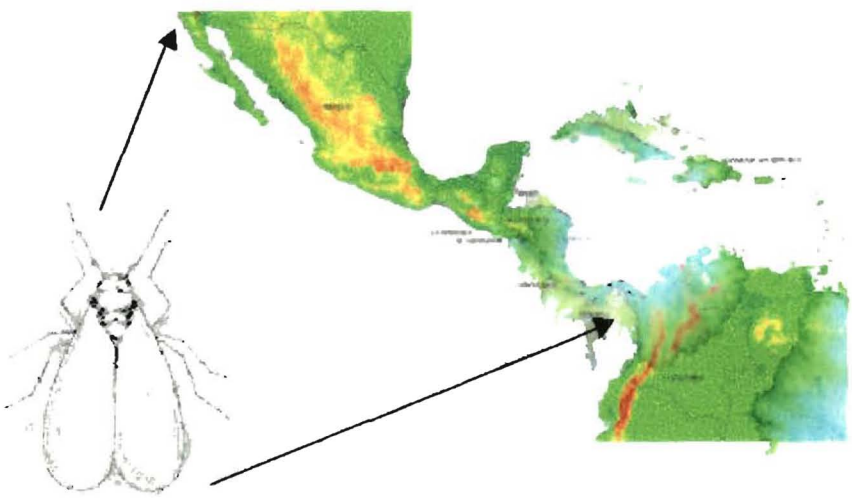
Integrated Pest Management and GIS:

Spatial Analysis of the Whitefly problem in Central America, Mexico and the Caribbean

The GIS component:
user and technical documentation
Whitefly V 2



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International Center for Tropical Agriculture

Introduction

As part of the on-going project "Sustainable Integrated Management of Whiteflies as Pests and Vectors of Plant Viruses in the Tropics", one of the main outputs for Phase 1 included the building of a spatial database using a geographical information system (GIS).

The study area includes Central America, Mexico and the Caribbean.

The purpose of this was to develop a digital database that integrates the information collected by the whitefly project and to enable end-users to view the information available in a spatial context. Some of the spatial information available, include:

- Areas affected by whitefly-transmitted viruses for different years (1970's, 1990's, 1994, 1998)
- Base information, such as, rivers, roads, towns, land-use cover, Digital Elevation Model(DEM), Holdridge life zones
- Climate: rainfall, mean minimum temperature, mean maximum temperature, evaporation and the number of dry months at 3-km pixel size
- Economic loss
- Crop production by municipality (where information is available). Crops include tomato, tobacco, cotton, peppers, beans, cucumber, squash, brocoli
- Whitefly occurrence.

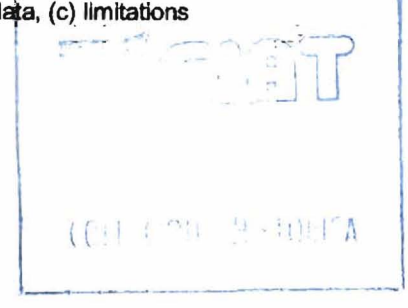
The whitefly v2.0 package contains a variety of tools that allows for the generation of analysis information. Some of the analysis capabilities include:

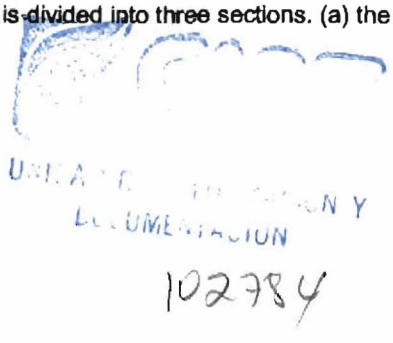
- Site characterization under the cursor
- Site characterization of an area unit (ie a polygon)
- Location of similar climatic areas, within a percent range, for the site characterization returned for a point.
- Location of similar climatic areas, as is found occurring in an area unit.
- Dynamic link of Excel tab-delimited text files containing information at any administrative level to an existing administrative boundary coverage to enable real time visualization of external tabular data. Edition of the file is done through Excel.
- Generation of point coverages from an Excel file.
- Creation of whitefly occurrence information based upon the physical factors required for a whitefly to exist.

The information can be viewed using Arcview3.0a+ and layouts can be created and printed with the results to queries made.

One of the main objectives of this interface has been to enable the end-user the flexibility to generate additional themes, from new information as it is gathered from the field. This can be accomplished by generating point, line or polygon themes from data collected by a GPS or to create themes based upon the varying administrative levels available for each country.

This document was produced to aid the end-user and is divided into three sections. (a) the interface, (b) the data, (c) limitations





(a) The Interface

The interface was developed using Arcview3.0b on a UNIX platform but also adapted for use on a PC environment. To run the application successfully the user requires at least ArcView3.0b with the spatial analysis and dialog designer extensions. All the functionalities were developed using Avenue.

Features included from the standard ArcView3.0a

FILE: General file opening and managing grids
EDIT: Editing the themes
VIEW: Adding themes to views
ANALYSIS: Analysis features included with spatial analysis
GRAPHICS: Graphic adding capabilities
HELP: On-line Arcview help

Extensions required:

Spatial Analysis (standard ESRI)
Network Analysis (standard ESRI)
Database Themes (standard ESRI)
Dialog Designer (standard ESRI)
Grid clip (created by J Klass, 1999)

Summary of the features included in the interface

The interface contains the following additional options:

GRID EDITS: This enables the user to combine, merge, mosaic, aggregate or clip grids.

VIRUS: This contains the virus information for a limited number of crops. (Beans mid1990's, Tomatoes mid1970's and mid1990's, Hotspots 1998, BGMV 1994[1])

WHITEFLY: Areas where whiteflies are likely to occur based on critical and optimum climate and environmental factors. Whitefly biotype and species information is not available at the present time.

CROPS: Includes the production information for the following crops: beans, tomatoes, melon, watermelon, peppers, cotton, squash, chiles, soya, tobacco and cucumber. This is not complete for all countries.

ENVIRONMENT: Includes the base information such as, the different administrative level boundaries (country, department and municipio), roads, towns, holdridge lifezones, digital elevation model, slope, aspect)

CLIMATE: Rainfall, minimum temperature, maximum temperature, evaporation and number of dry months. (monthly and annual)

SPATIAL CHARACTERIZATION: Query point and area of interest, perform site characterization as well as obtain areas with a similar climate as that queried.

UPDATE: Enables users to update existing tab-delimited files and create view the new information. This can only be applied to administrative boundary level information (municipio, department or country). In addition, users can import point information provided the file contains latitude and longitude information.

HELP: Online html help that is easliy displayed using an internet browser.

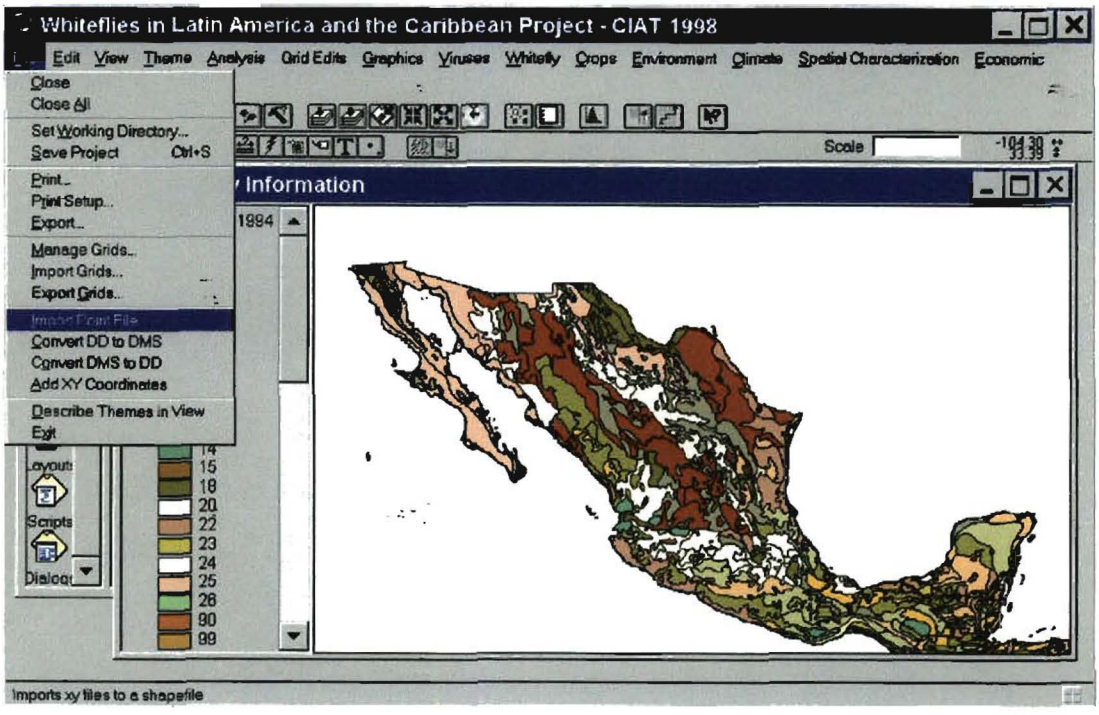
NOTE: The new information that can be created is dependent upon the administrative level information available for each country and on the GPS points provided. If new regions or information that cannot be created by the features provided the user will need to have the data digitized.

[1] BGMV – bean golden mosaic virus

(b) User's Guide

Additional features included in the project

- **FILE**



Import Point File
Convert DD to DMS
Convert DMS to DD
Add XY Coordinates (only works on point and polygon themes)

Describe Themes in View

Import Point File

Enables the user to import a *xy-coordinate* file containing information on point, polygons or lines. This can be collected by a GPS and imported directly into the present project.

NOTE: The xy-coordinate file must be in comma delimited format in the following order

Stn_id, x_coordinate, y_coordinate

Example of file containing coordinates:

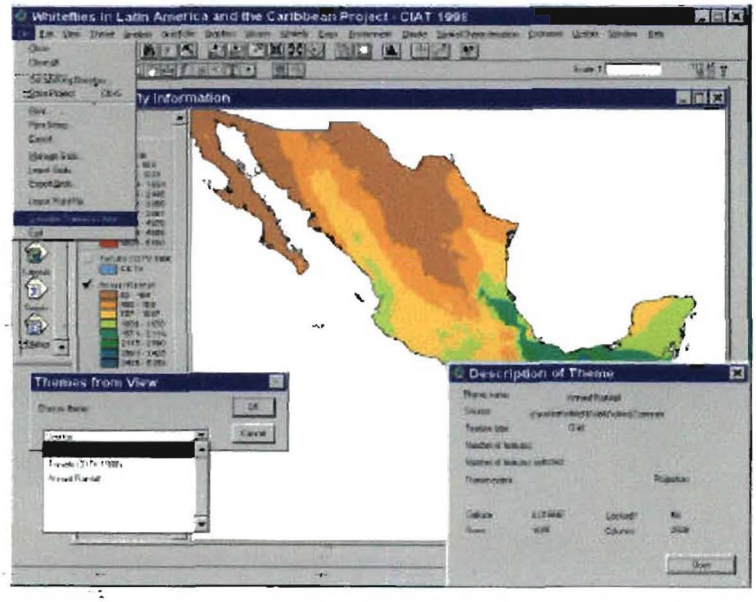
ID,x,y
3,-72.1,10.2
4,-73.2,11.2
5,-75.6,11.2
6,-78.35,12.1

To link additional information to the new shapefile (point, polygon or line), the user will need to import the attribute table and join this to the table associated with the new shapefile.

Convert DD to DMS
Enables the user to convert coordinates from decimal degrees to degrees-minutes-seconds. The results will be added to a table within the project.

Convert DMS to DD
Enables the user to convert coordinates from degrees-minutes-seconds to decimal degrees. The results will be added to a table within the project.

Describe Themes in View
This option enables the viewer to obtain information about an active theme (cover or shapefile) or a grid that is in the view.

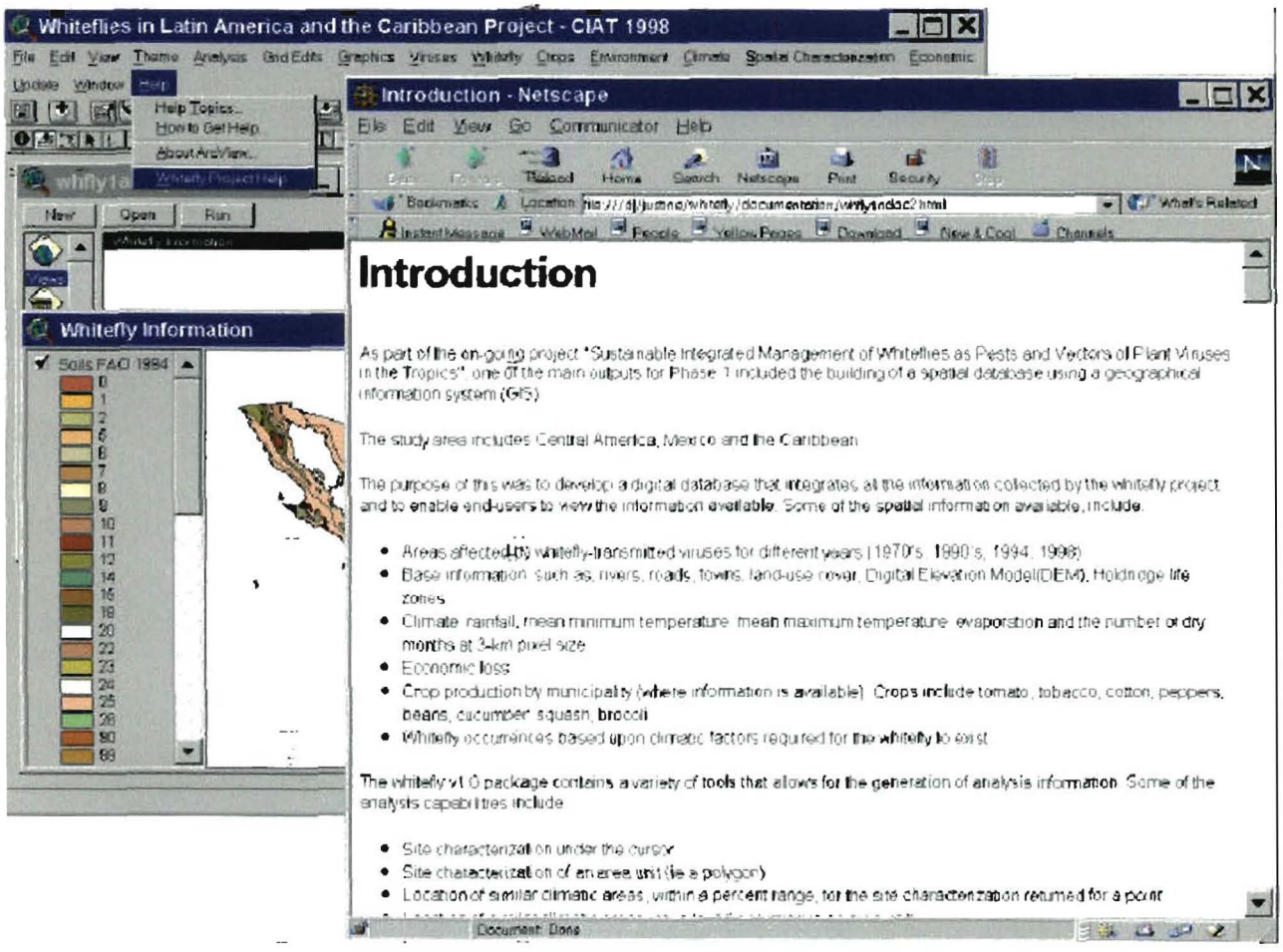


- **HELP**

Whitefly On-line Help

On-line help is available through the Netscape Browser.

The help files are in adobe acrobat pdf format and can be read using the netscape Browser provided your computer has adobe acrobat reader. If not you will have to download it from the web (http://www.adobe.com).



New features included in the project

- **GRID EDITS**

Grid Clip
Merge Grids
Combine Grids
Aggregate
Mosaic

Grid Clip

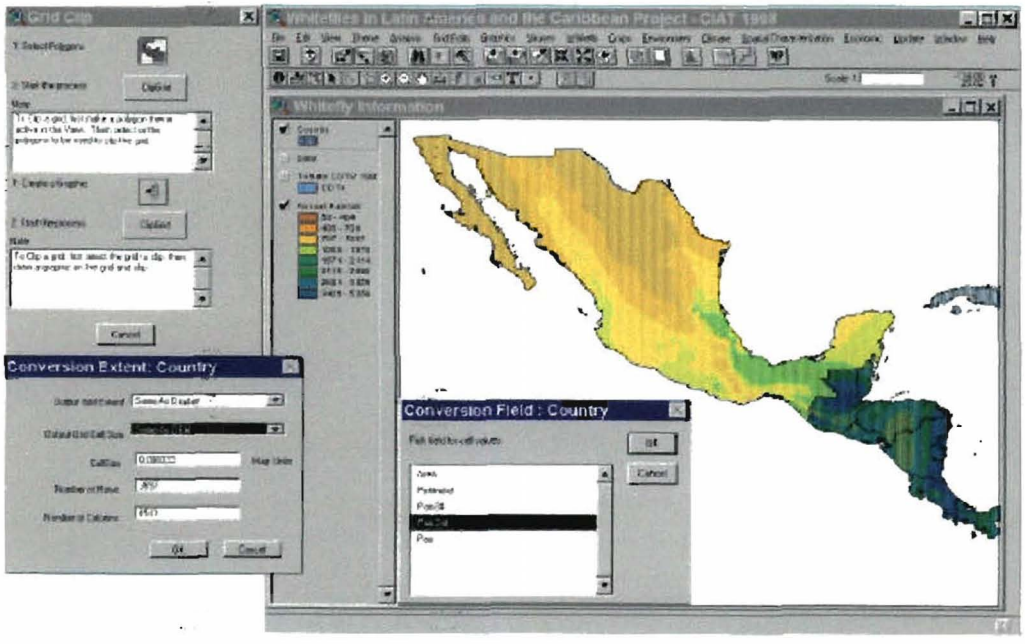
Enables the user to clip a grid. The user has two options: a) to clip an area using a polygon or b) to clip an area based upon a box.

a) to clip an area using a polygon

This enables the user to perform a country by country analysis without incorporating the entire region.

1- Select a polygon (as illustrated in yellow)
2- Click the button ***ClipGrid***.

The user will be prompted for additional information, this includes the extent and cell size for the new grid, the field to use for the conversion, the grid to clip and a new filename.



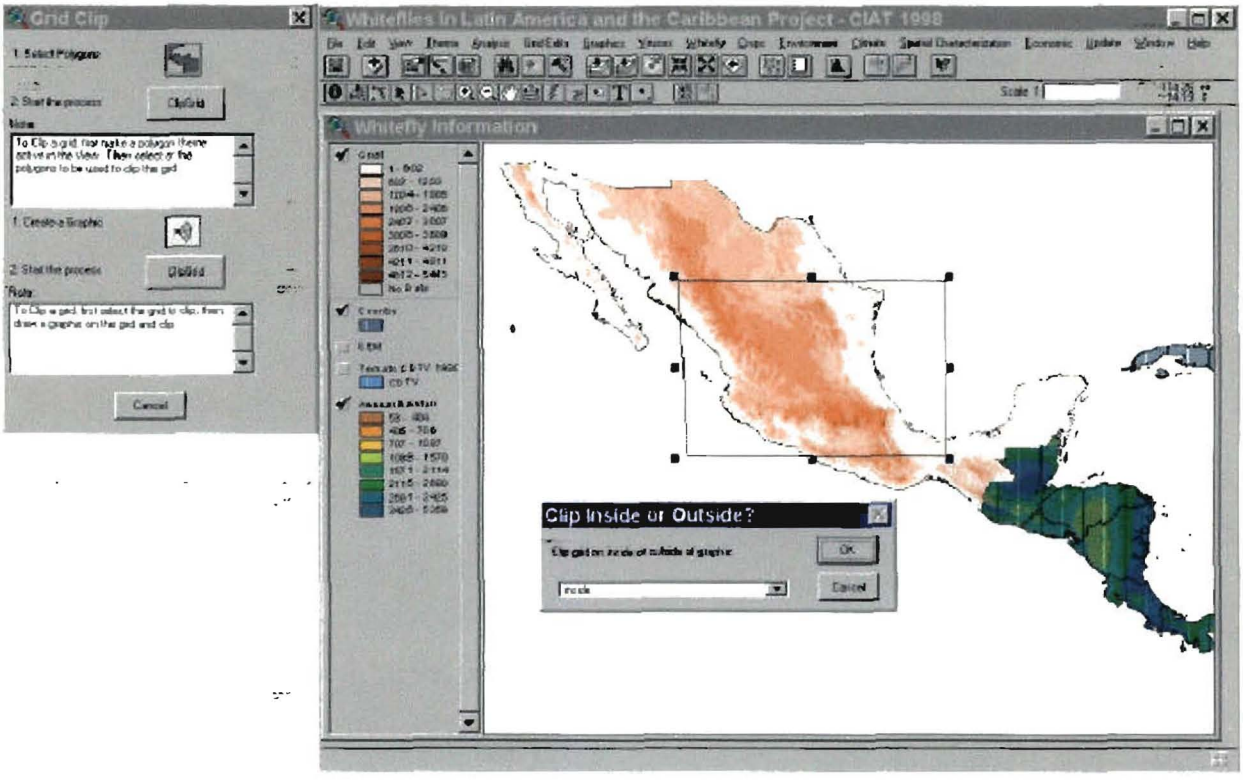
Once the process is finished the new grid will be added to the display, as illustrated below.

J Klass: CIAT, GIS Lab 1999

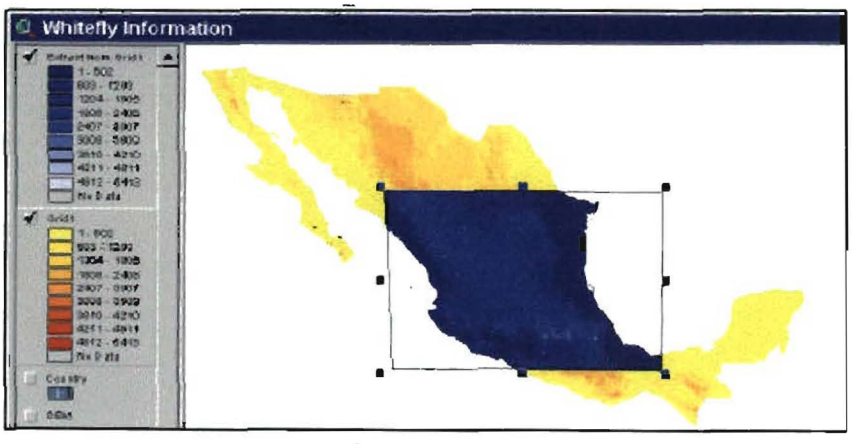
b) to clip an area using a box

1- Create a graphic in the view
2- Activate the grid theme to be clipped. (In this example Grid1 is active)
3- Click ***ClipGrid*** button

The user will be prompted whether to include the area inside or outside the graphic area.



Once the process is finished the new grid will be added to the display, as illustrated below. The area in blue is the newly clipped grid.



Merge Grids
Enables the user to merge a list of Grids together.

Combine Grids
Enables the user to combine a list of Grids together. This will compute the numerous combinations available with the combined grids.

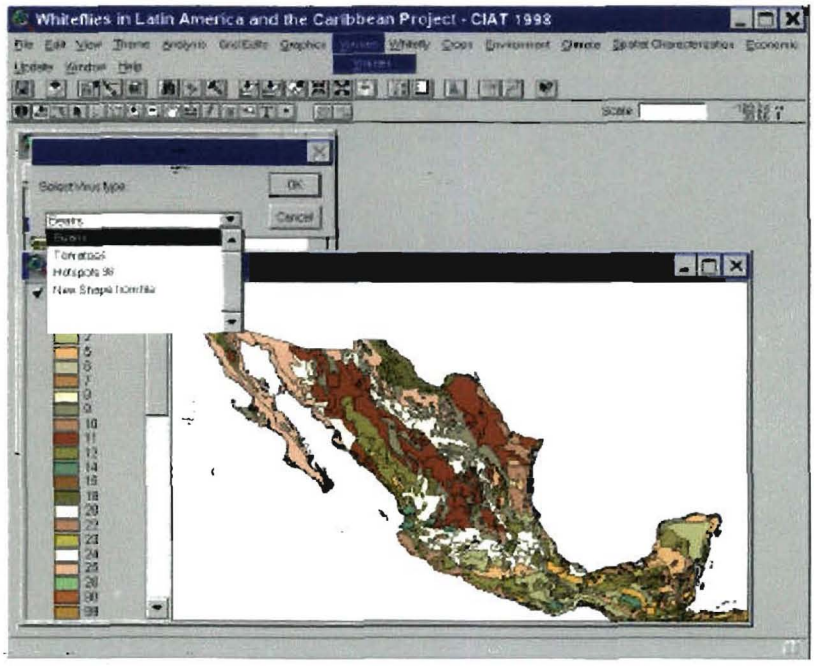
Aggregate
Enables the user to aggregate a grid.

Mosaic
Enables the user to mosaic grids together.

VIRUSES

Viruses transmitted by the whitefly

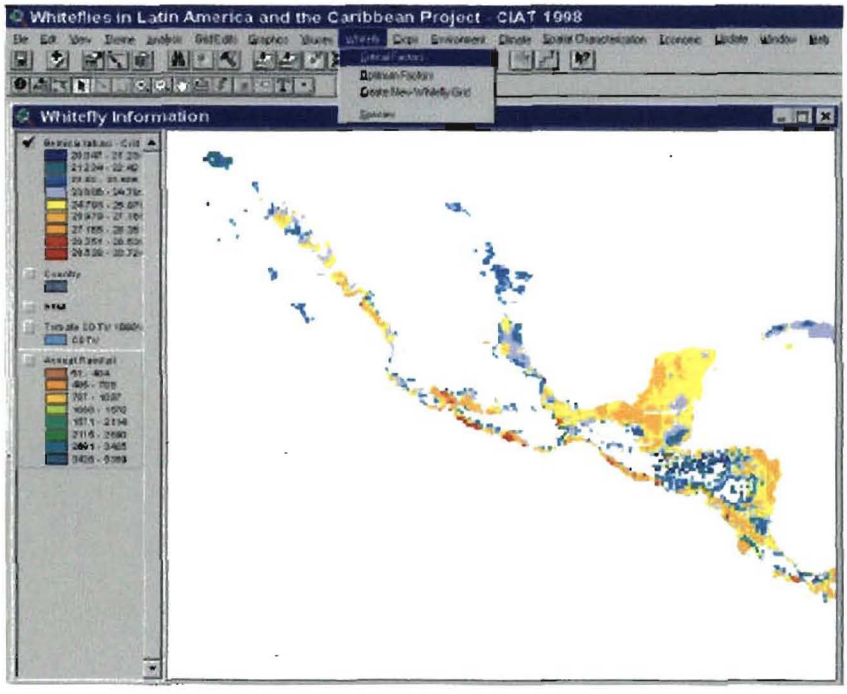
The user can select the existing data (ie beans, tomatoes or identified hotspots for 1998) .



WHITEFLY

Whitefly Information

a) Critical Factors
b) Optimum Factors
c) Create New Whitefly Grid
d) Species (not available at this time)



a) + b) Critical Factors and Optimum Factors

The critical and optimum factor information for the existance of whiteflies was based on information provided within CIAT (F Morales, P Anderson).

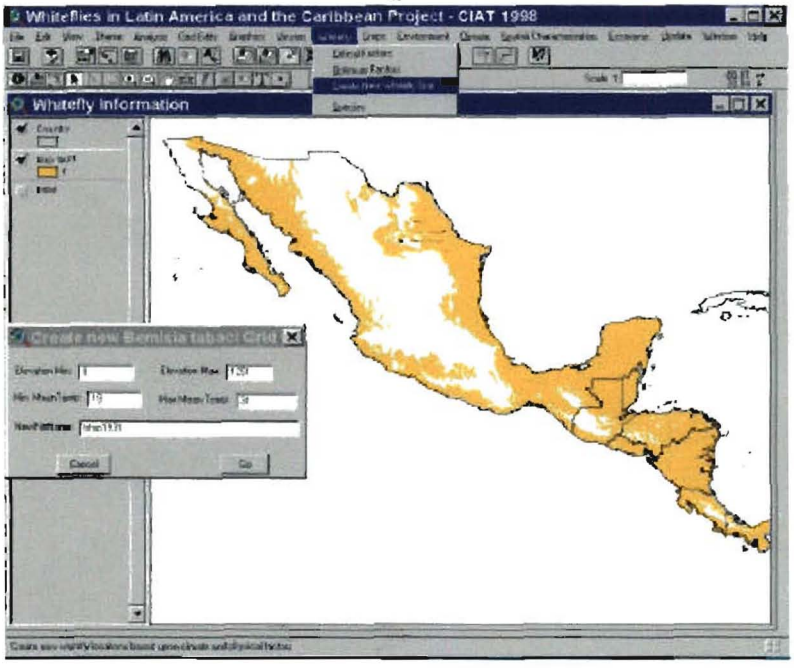
Description	Geog Locn	Cover name	Feature	Projection	Source	Scale
Bemisia tabaci optimum factors (elev: 0-1250, Temp: 20-30)[2]	LAC	Btopt	grid	DD(wgs84)	Climate: P Jones (CIAT) Factors: F Morales, P Anderson	.167
Bemisia tabaci critical factors (elev: 0-1250,Temp: 15-32)[1]	LAC	Btcrit	grid	DD(wgs84)	Climate: P Jones (CIAT) Factors: F Morales, P Anderson	.167

[2] Mean temperature was calculated as follows: $(\Sigma tmin_i + \Sigma tmax_i) / 2$
Where tmin is the mean annual minimum temperature and tmax is the mean annual maximum temperature and $i_1 \ldots i_{12}$ represent the month (Jan to Dec)

J Klass: CIAT, GIS Lab 1999

c) Create New Whitefly Grid

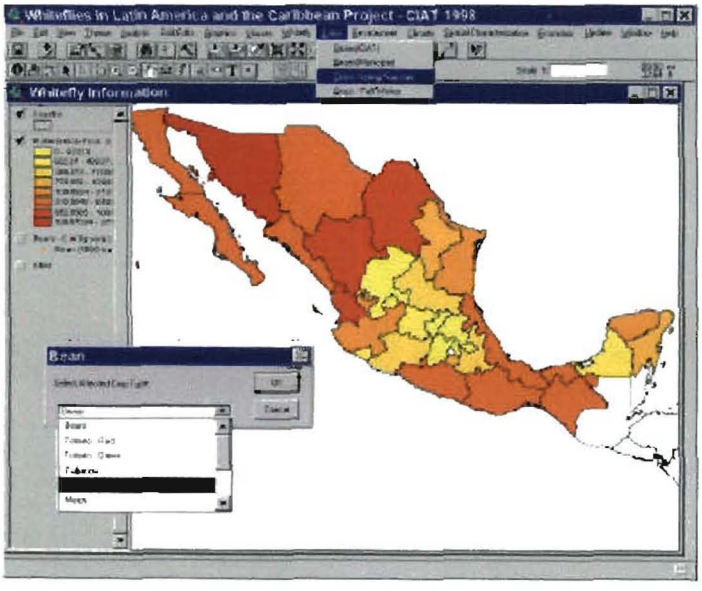
This enables the user to create a new grid based upon elevation and temperature ranges.



- **CROP**

Crop Information

This includes the location of specific crops at administrative level 2, as points and by season at administrative level 2.



The crop information, at the present time is quite limited due to its availability. The information available includes:

- beans (points, where 1 dot = 1000 ha)
- bean production by municipio
- crops for Mexico, by season
- Guatemala (location of growing areas with specific crops)
- El Salvador (cotton)

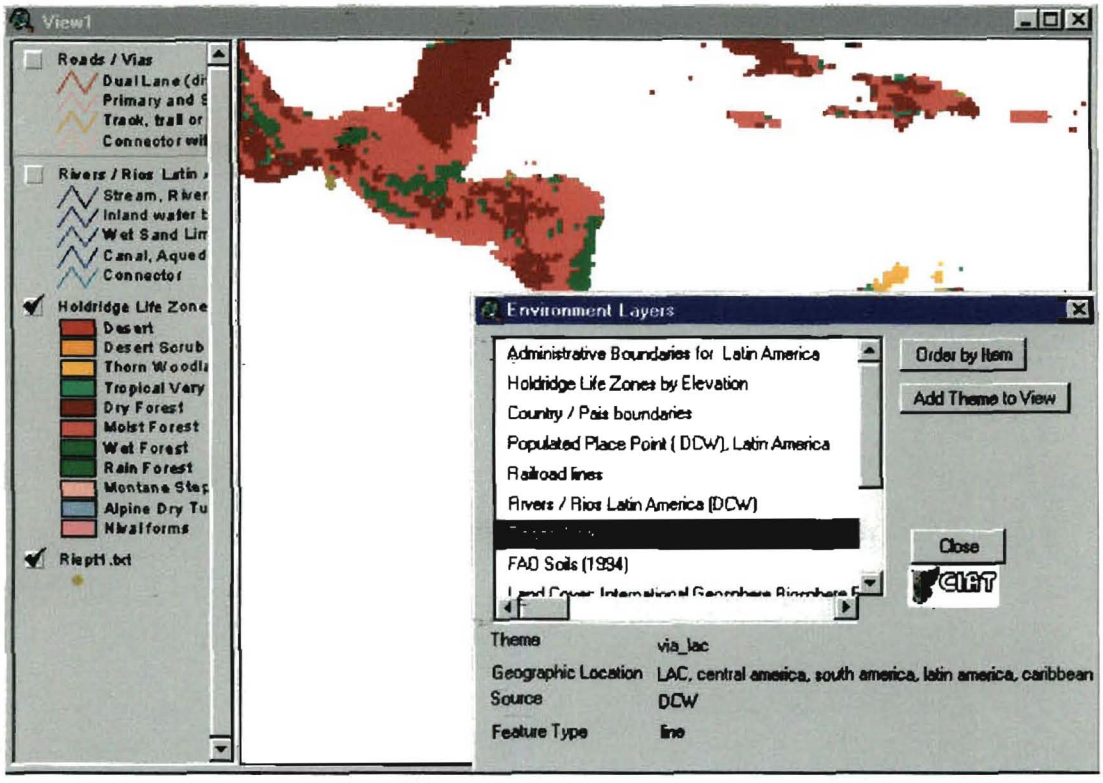
Mexico is the most complete at the present time.

For additional information regarding the crop information, please refer to Appendix 1 (data source information)

- **ENVIRONMENT**

Environmental Information

The environmental information contains the base information for the study area.



All of the environmental information included in the project was obtained from the GIS and Landuse department at CIAT. The information includes:

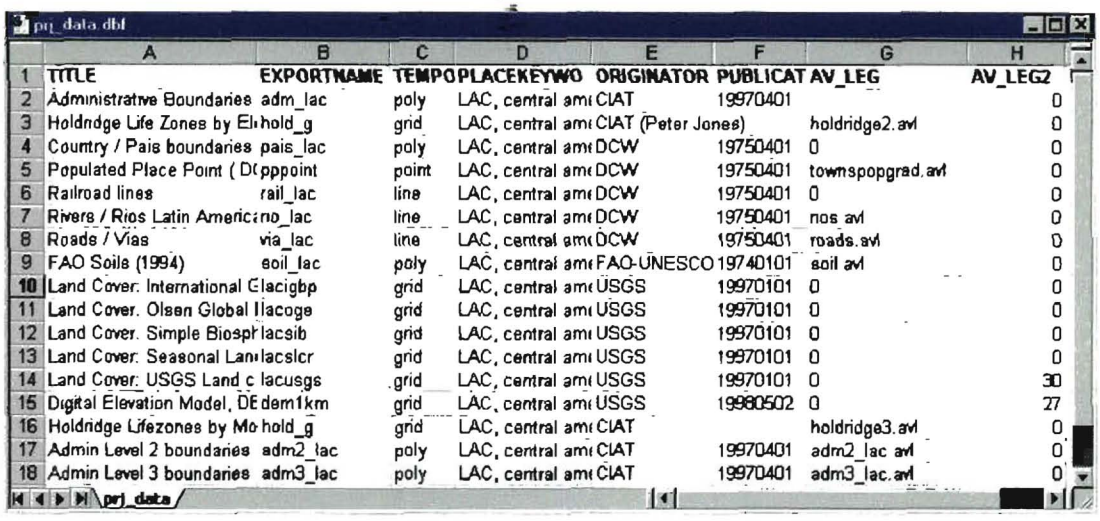
- Country, administrative level 2, level 3 and level 4 boundaries
- Roads, Rivers, Soils
- Towns, Population
- Landuse
- Slope, Aspect, Digital Elevation Model(DEM)

To add a coverage to the View be sure to double click the theme. When the theme is selected the corresponding information below the scrolling list box will be updated (ie. Theme: via_lac (where via_lac is the actual coverage name), Geographic Location, Source and Feature Type).

The coverage information is recorded in a dbf file in the *dbf_file* directory. The environment data is stored in the *prj_data.dbf*. The dbf_file is best edited in Arcview itself. To edit the table add it to the project and select *start editing* option in the Edit menu for Tables.

Prj_data.dbf Structure

The *prj_data.dbf* file has the same strucutre as the *prj_clima.dbf* file (see the image below).



prj_data.dbf

	A	B	C	D	E	F	G	H
1	TITLE	EXPORTNAME	TEMPO	PLACEKEYWO	ORIGINATOR	PUBLICAT	AV_LEG	AV_LEG2
2	Administrative Boundaries	adm_lac	poly	LAC, central ame	CIAT	19970401		0
3	Holdridge Life Zones by El	hold_g	grid	LAC, central ame	CIAT (Peter Jones)		holdridge2.avl	0
4	Country / Pais boundaries	pais_lac	poly	LAC, central ame	DCW	19750401	0	0
5	Populated Place Point (D	pppoint	point	LAC, central ame	DCW	19750401	townspopgrad.avl	0
6	Railroad lines	rail_lac	line	LAC, central ame	DCW	19750401	0	0
7	Rivers / Rios Latin Americ	rio_lac	line	LAC, central ame	DCW	19750401	rios.avl	0
8	Roads / Vias	via_lac	line	LAC, central ame	DCW	19750401	roads.avl	0
9	FAO Soils (1994)	soil_lac	poly	LAC, central ame	FAO-UNESCO	19740101	soil.avl	0
10	Land Cover: International Glacigbp		grid	LAC, central ame	USGS	19970101	0	0
11	Land Cover: Olsen Global I	lacoge	grid	LAC, central ame	USGS	19970101	0	0
12	Land Cover: Simple Biospl	lacsib	grid	LAC, central ame	USGS	19970101	0	0
13	Land Cover: Seasonal Lan	lacslcr	grid	LAC, central ame	USGS	19970101	0	0
14	Land Cover: USGS Land c	lacusgs	grid	LAC, central ame	USGS	19970101	0	30
15	Digital Elevation Model, DE	dem1km	grid	LAC, central ame	USGS	19980502	0	27
16	Holdridge Lifezones by Mo	hold_g	grid	LAC, central ame	CIAT		holdridge3.avl	0
17	Admin Level 2 boundaries	adm2_lac	poly	LAC, central ame	CIAT	19970401	adm2_lac.avl	0
18	Admin Level 3 boundaries	adm3_lac	poly	LAC, central ame	CIAT	19970401	adm3_lac.avl	0

prj_data

Note: the structure of the table should be maintained or else the theme tool will not work.

The table contains eight items:

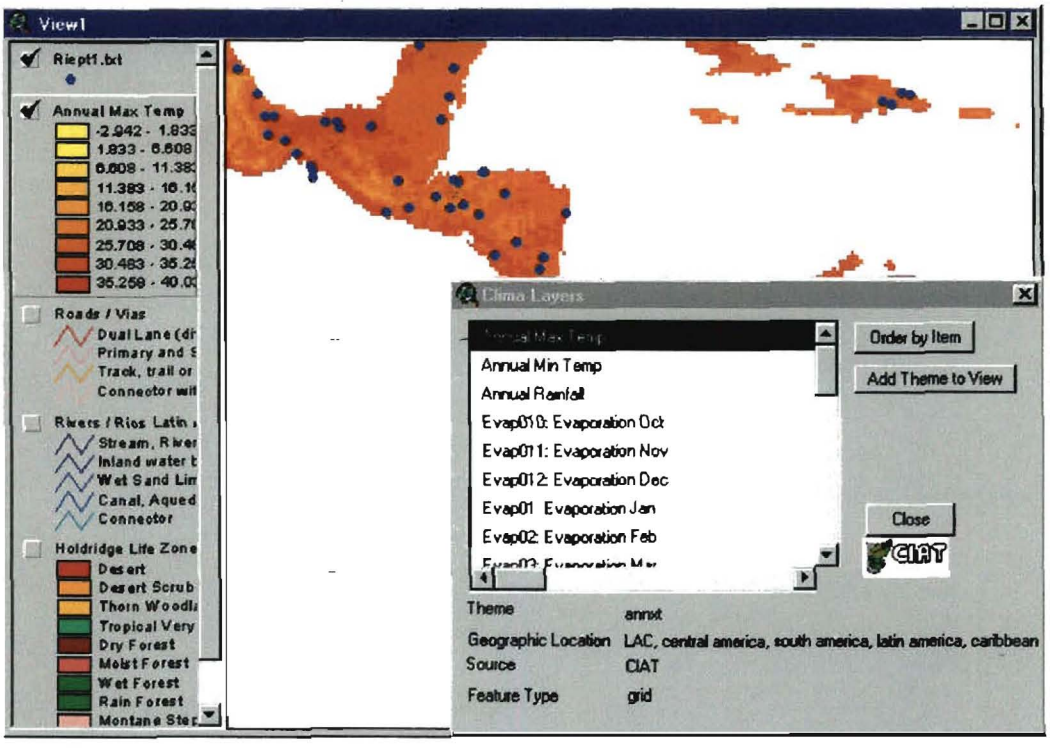
Title: The user enters the theme title name to appear
Exportname: **The user enters the name of the coverage**
Temporalke: The user enters the feature type. (Ie. **Poly** for polygons, **line** for lines, **point** for points, and **grid** for grids) For further help refer to the ArcView on-line help.
Placekeywo: The geographic location of that dataset
Originator: The source of the data
Publication: The publication data of the data source (year_month_day)
Av_leg: The arcview legend to use
Av_leg2: The shadeset to use in the case of grids

Note: When no specific legend is to be used put a 0 (zero) and arcview will create a default legend

CLIMATE

Climate Information

The user can display various climate surfaces. These include the annual climate surfaces as well as the monthly mean surfaces. First the user will be prompted for the climate type and then the surface to be displayed.



The climate information includes: rainfall, minimum temperature, maximum temperature, evapotranspiration and the number of dry months. The climate information includes the Caribbean.

The coverage information is recorded in a dbf file in the *dbf_file* directory. The climate data is stored in the *prj_clima.dbf* and follows the same structure as the *prj_data.dbf* file.

• SPATIAL CHARACTERIZATION

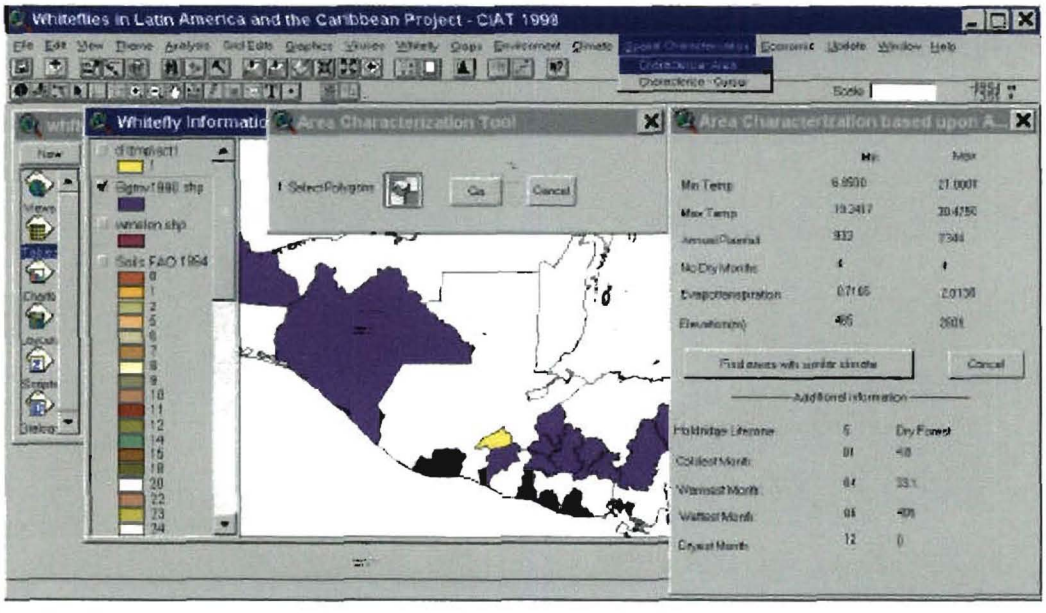
Spatial Characterization Information

a) Characterize – Area
b) Characterize – Cursor
c) Identify (various)

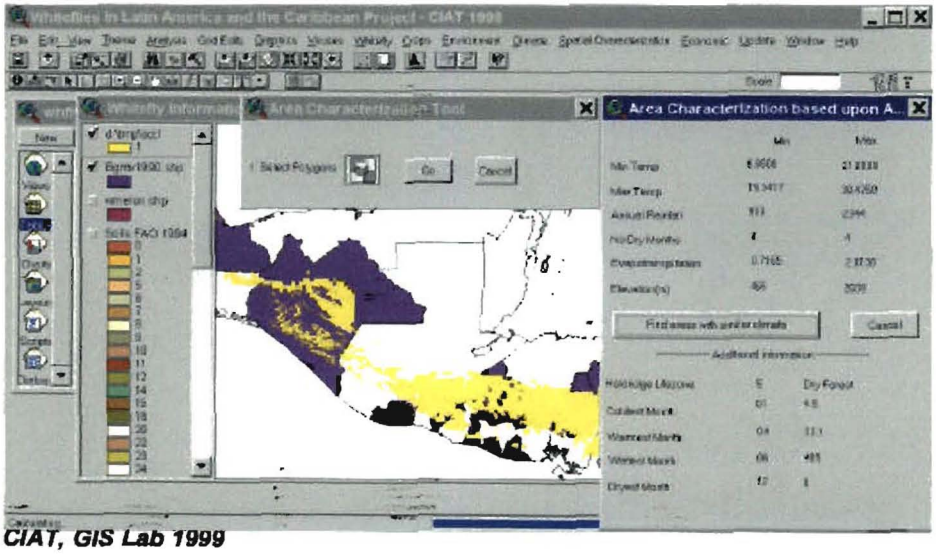
The user is able to characterize the area within a polygon or under a point. Once this is accomplished the user can locate other areas with similar climate.

a) Characterize – Area

Select a polygon(highlighted in yellow) and then press go. The coverage to be characterised must be active. Once a polygon is selected, press **GO**, and the climate characteristics will be summarized as illustrated below.



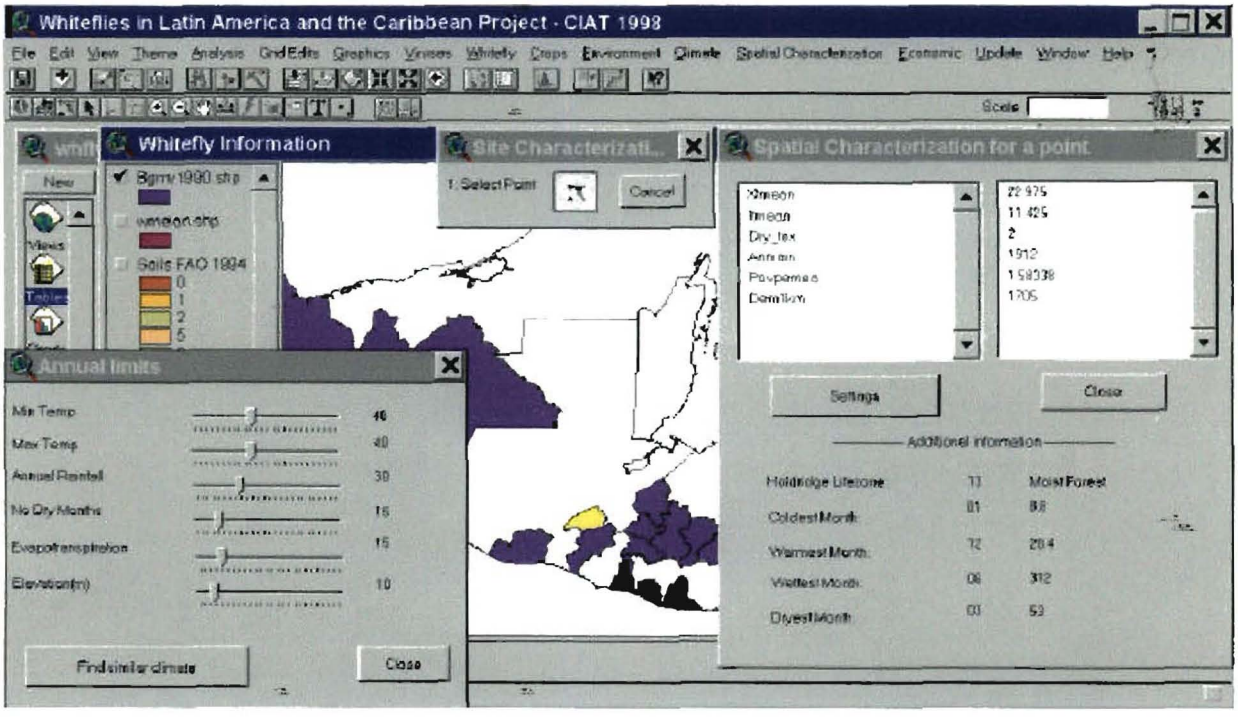
Once the polygon has been characterised the user can find other areas with the same climate characteristics, as illustrated below (in yellow).



J Klass: CIAT, GIS Lab 1999

b) Characterize – Cursor

The user can obtain climate information for a point. This is summerized in the menu illustrated. Additionally, the user can locate other sites with similar climate within a percent range.



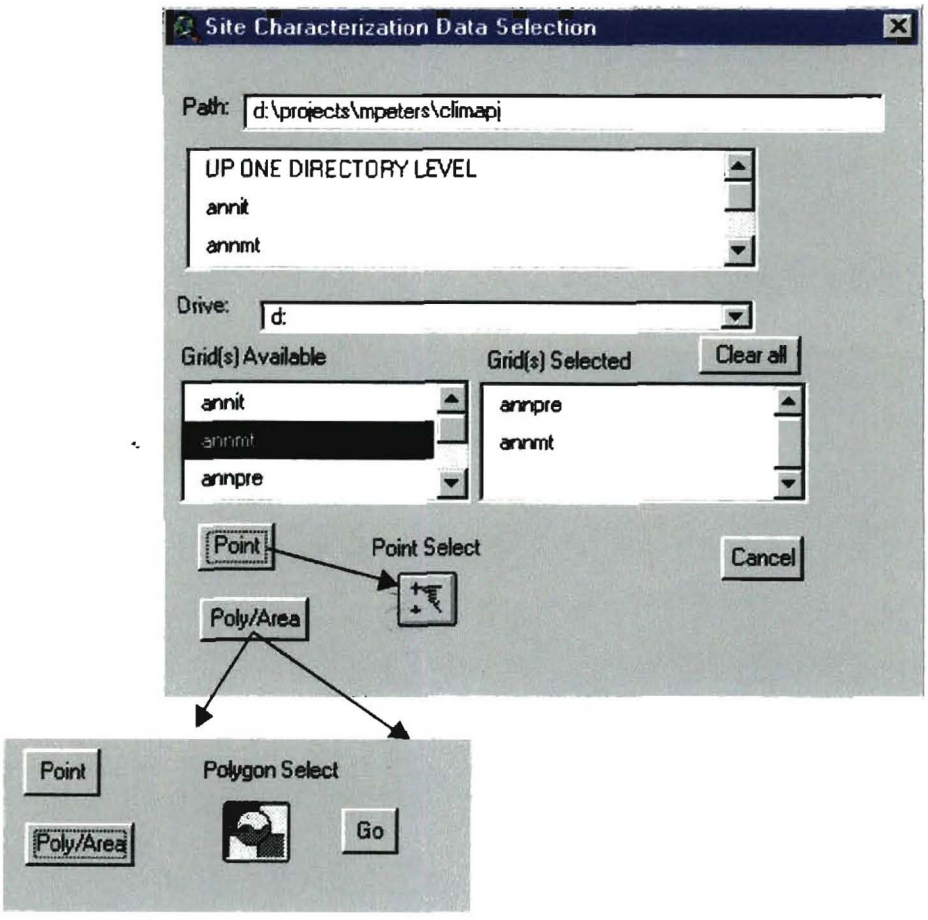
(c) Identify (various)
Spatial Characterization Information

The site characterization allows the user to identify the values at a given point or within a given area for up to **10** grids. Using the values occurring at a given location the user is able to find areas of similarity. The user has two options:

a) Characterize – Area (Poly/Area Button, illustrated below)
b) Characterize – Cursor (Point Button, illustrated below)

When the user clicks on the appropriate button the buttons required to perform the characterization will appear, as illustrated below.

Menu:The Main Site Characterization Menu



Features

The Characterization tool allows the user to :

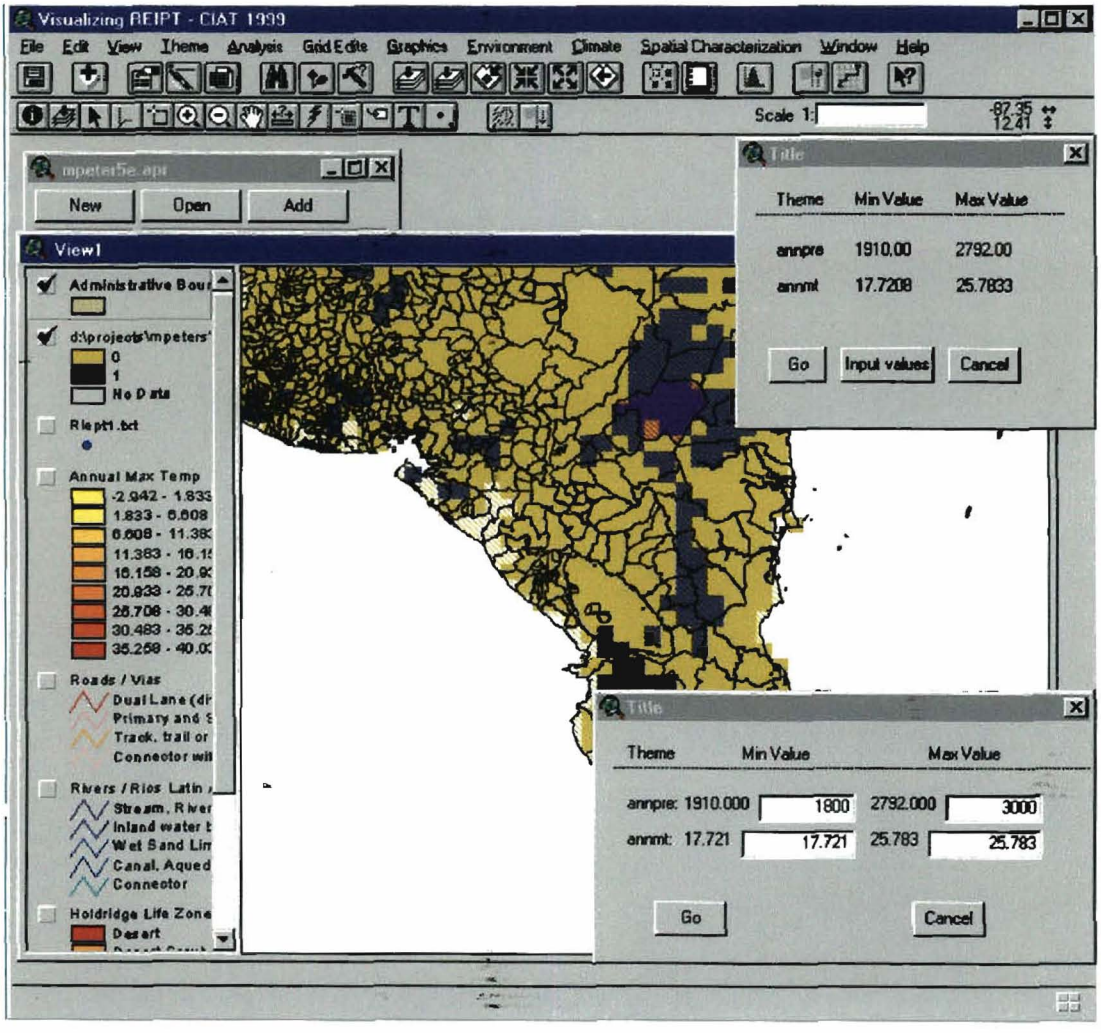
- Select up to 10 grids without having to bring them into View
- Perform a characterization based on a point. Using a percent range +/- the original value
- Perform a characterization based on the min and max values occurring within a polygon/area
- Perform a characterization based on the min and max values occurring within a polygon/area, but the user can alter the min and max values to use

The characterization is very simple. The appropriate ranges are selected from the grid resulting in a boolean grid, (ie where the selection is TRUE a value of 1 is assigned or else where FALSE, 0 is assigned). Each grid is combined where all cases are TRUE resulting in a new grid called SCT containing the values 0 or 1.

a) Characterize – Area

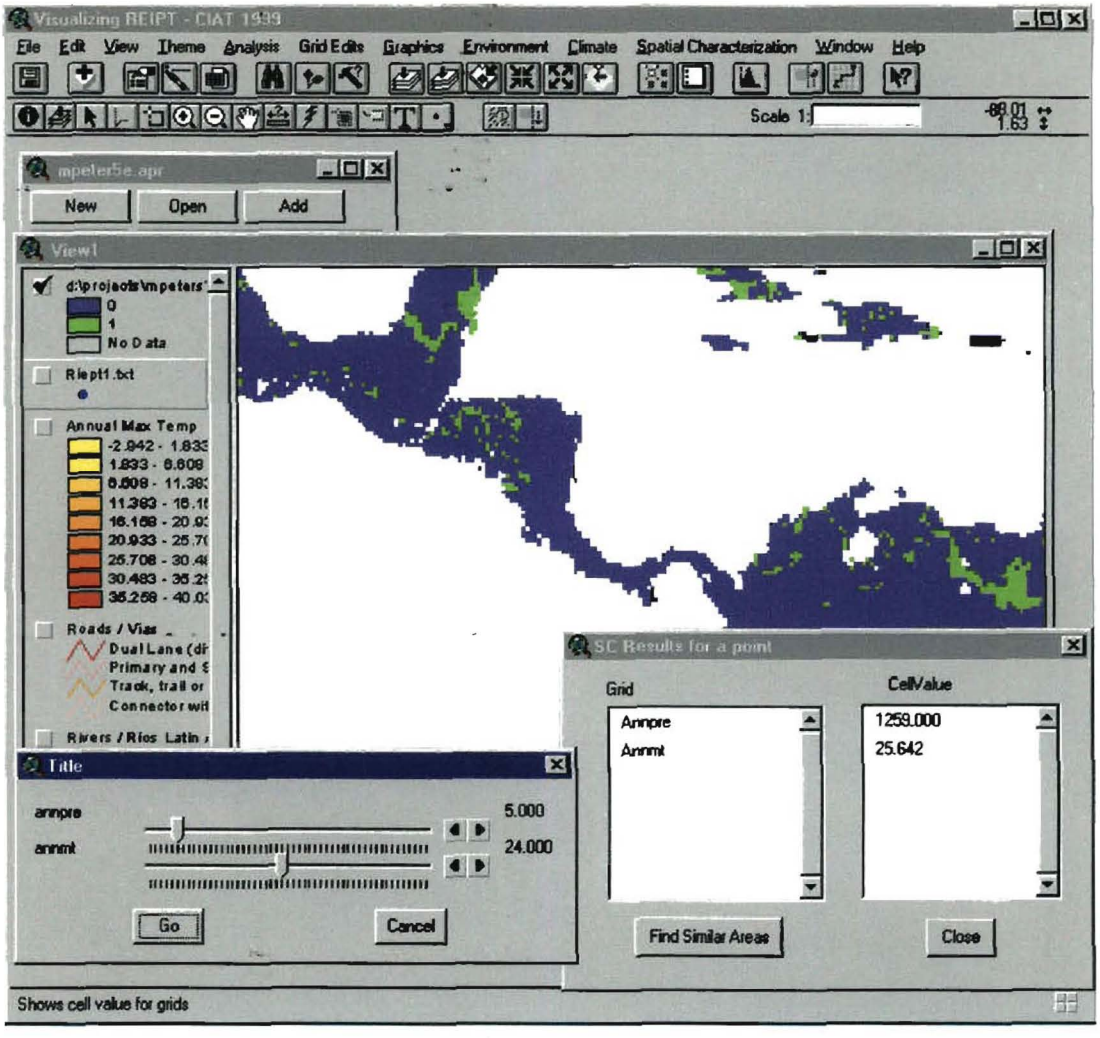
Need to first put a polygon coverage in the VIEW and ensure it is active. Select a polygon (highlighted in pink . Once a polygon is selected, press **GO**, and the characterization will take place on the inputs the user has selected.

Once the polygon has been characterised the user can find other areas with the same climate characteristics, as illustrated below (in yellow).



b) Characterize – Cursor

The user can obtain climate information for a point. This is summerized in the menu illustrated. Additionally, the user can locate other sites with similar features within a percent range, upto 50%



NOTE: all the characterization tools in this version use a simple boolean technique to find areas of similarity. For example, once the areas on either percent of the value have been selected. Areas lying within the range will be assigned 1 while all other areas will be assigned 0. In this example the new annpre and annmt grids will be combined as follows

SCT_new (site characterization grid) = bool_annpre **AND** bool_annmt

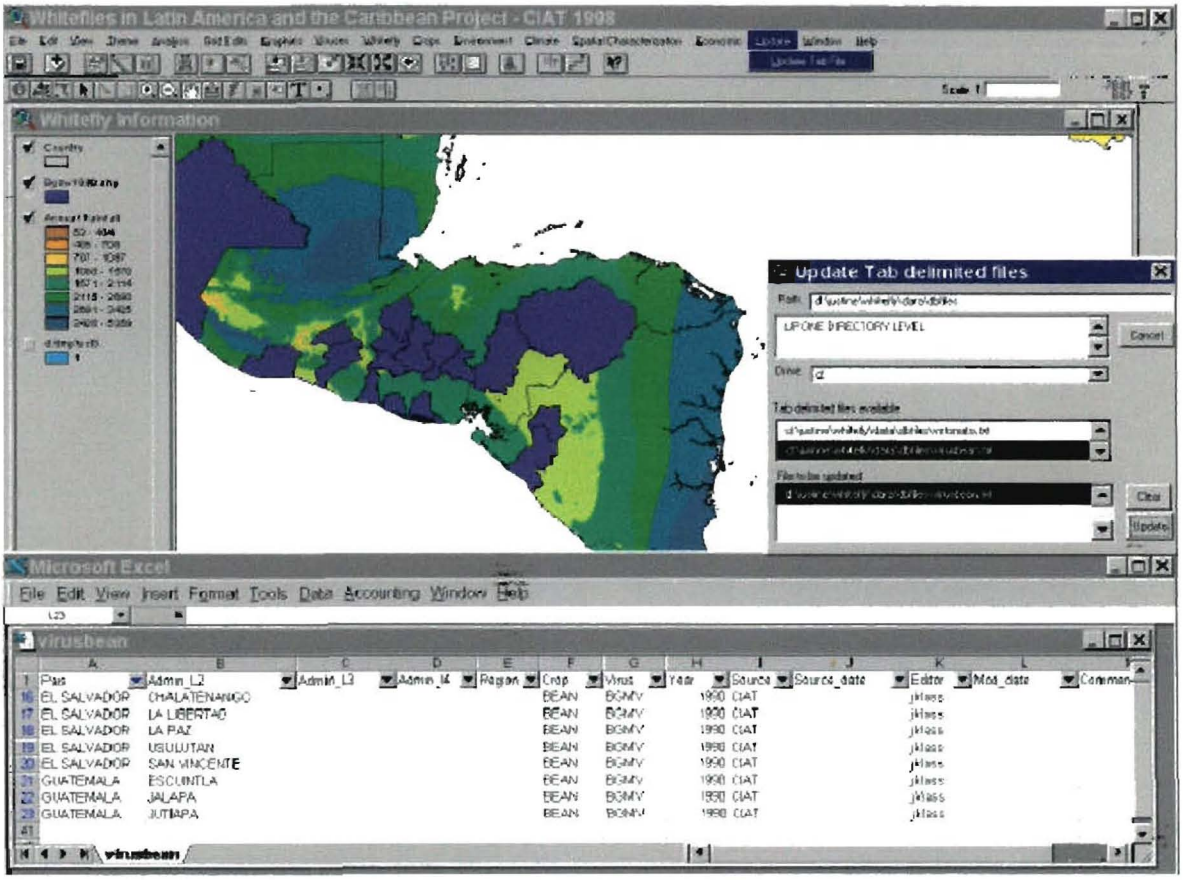
Therefore, the new characterization grid (SCT_new) will be the result of areas where both bool_annpre and bool_annmt are 1. All other value combinations such as (1,0; 0,0; 0,1) will be assigned 0.

UPDATE

Update Tab Dlimited Text File Information

The user can update a tab delimited text file in Excel and create a new coverage based upon the updated information. This can only be done for information at the following administrative boundary levels: country, administrative level 2 and administrative level 3.

NOTE: When adding country or administrative level 2 information ensure it is in capital letters or else the link will not be made between the coverage and the file.



(c) The Datasets

The information used for this project was obtained from various sources. Some of these include the data created at the GIS lab at CIAT, information downloaded from the Internet and through the collaboration of various institutes throughout Central America and the Caribbean.

All the data sets were processed using Arc/INFO 7.1 on a UNIX workstation.

Data Information

The data used in this analysis were collected from various sources, including surveys and creating data layers by the digitizing team, past and present students, senior scientists and researchers at CIAT. All the data has been processed in the GIS lab at CIAT using a range of available GIS and remote sensing software. These include Arc/Info [ESRI], Arcview3 GIS [ESRI], PCI, Imagine [Erdas] and Idrisi [Clark University].

The information used in the whitefly study included;

- Data obtained via the internet from sites such as the USGS
- National agricultural censuses
- CIAT's climate database
- Personal communications from national program staff visiting CIAT
- Personal communication with national program staff in each of the study sites

The source of each data set is briefly discussed with a more detailed explanation of the steps taken in the development of coverages/surfaces, also known as themes or layers, to be used in the analysis. The data included the creation of environmental data (includes climate surfaces), the location of crops and location of whitefly transmitted gemini-viruses.

The data that has been collected and included on the cdrom has been summarized in Table C.1.1.1. Table C.1.1.1 summarizes, by country, the data that was available at the time. The table highlights areas where data is missing and can aid in developing future data collection strategies.

Table C.1.1.1: Summary of available data by country

Theme	Mexico	Belize	Guatemala	Honduras	Nicaragua	El Salvador	Costa Rica	Panama	Cuba	Haiti	Dom Republic
Virus											
Bean virus (various scales)	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Tomato Virus (various scales)	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
BGMV 1994 (region)			✓	✓	✓	✓					
Whitefly Occurrence (97)	✓poly				✓poly						
Whitefly Occurrence (97) (Point)		✓pnt	✓pnt	✓pnt	✓pnt	✓pnt	✓pnt	✓pnt	✓pnt	✓pnt	✓pnt
Algodon											✓
Calabaza											✓
Chile											✓
Pimenton											
Melon											✓
Pepino											✓
Sandia											✓
Tabaco											✓
Eggplant											✓
Chinese Vegetables											✓
Climate:											
Min Monthly Temp (Jan to Dec)	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Max MonthlyTemp (Jan to Dec)	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Monthly Rainfall (Jan to Dec)	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Evapotranspiration	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓

Theme	Mexico	Belize	Guatemala	Honduras	Nicaragua	El Salvador	Costa Rica	Panama	Cuba	Haiti	Dom Republic
Crops:											
Frijol CIAT (point) (91)	✓	✓	✓	✓	✓	✓	✓	✓			
Frijol	✓muni	✓dept	✓ muni (79)	✓aldea	✓dept	✓region	✓pais	✓muni			
Tomato	✓muni		✓ muni (79)	✓aldea							
Algodon	✓muni			✓aldea							
Calabaza	✓muni			✓aldea							
Chile	✓muni		✓ muni (79)	✓aldea							
Pimenton	✓muni			✓aldea							
Melon	✓muni		✓ muni (79)	✓aldea							
Pepino	✓muni			✓aldea							
Sandia	✓muni		✓ muni (79)	✓aldea							
Soya	✓muni		✓ muni (79)	✓aldea							
Tabaco	✓muni		✓ muni (79)	✓aldea							
Seed Varieties:											
Bean			✓	✓	✓	✓					
Growing Seasons:											
Various crops			✓ (some)	✓							
Economic Losses:											
Losses (various, ie by crop)											
Other:											
Accessibility	✓	✓	✓	✓	✓	✓	✓	✓			
DEM	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Hillshade	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Slope	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Aspect	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓

Theme	Mexico	Belize	Guatemala	Honduras	Nicaragua	El Salvador	Costa Rica	Panama	Cuba	Haiti	Dom Republic
Rivers	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Roads	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Towns	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Soils	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Landuse	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Holdridge Life zones	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Boundaries:											
Country Boundaries	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Admin Boundaries L2	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Admin Boundaries L3	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Admin Boundaries L4				✓		✓					
Regions	✓		✓	✓	✓						

C.2 Environmental Data:

The environmental data is composed of data sets describing the environment. The source and the scale of the data available is listed in Table C.2.1.1 followed by a more detailed explanation of each data set.

Table C.2.1.1: Summary of Environmental Data Sets

Description	Geog Locn	Cover name	Feature	Projection	Source	Scale
Dem (elevation)	LAC	Dem1km	grid	DD(wgs84)	USGS	1km
Hillshade (from dem1km)	LAC	Hillshade	grid	DD(wgs84)	CIAT (1998)	1km
Rivers	LAC	rios	line	DD(wgs84)	DCW (1984)	1:1000000
Roads	LAC	roads	line	DD(wgs84)	DCW (1984)	1:1000000
Towns with popn	LAC	Town_all	point	DD(wgs84)	DCW (1984)	1:1000000
Municipio Boundary	LAC	Lacmun_r	poly	DD(wgs84)	DCW / CIAT	1:1000000
Access	LAC	Access_g	grid	DD(wgs84)	CIAT (1998)	0.019
Lancover (USGS)	LAC	Lacusgs	grid	DD(wgs84)	USGS (1996)	0.016
Landcover (IGBP)	LAC	lacigbp	grid	DD(wgs84)	USGS (1996)	0.016
Cultivated Areas (USGS)	LAC	Usgscrop	grid	DD(wgs84)	USGS (1996)	0.016
Cultivated Areas (IGBP)	LAC	Igbpcrop	grid	DD(wgs84)	USGS (1996)	0.016
Slope	LAC	Slope	grid	DD(wgs84)	USGS (1996)	0.016
Aspect	LAC	Aspect	grid	DD(wgs84)	USGS (1996)	0.016
Holdridge Lifezones	LAC	Hold_g	Grid	DD(wgs84)	CIAT (199)	0.167

C.2.2 Digital Chart of the World (DCW)

The Digital Chart of the World (DCW) (1984) is a global coverage of topographic information equivalent in detail to a 1:1,000,000 scale map. There are 17 thematic layers ranging from airport points to road and river networks. The DCW and the Operational Navigation Chart (ONC) series are products of NIMA (USGS, 1999b). For the purpose of this study the DCW layer was used as a base map for the administration level boundaries, as is discussed in further detail later in this section.

The accuracy of the contours collected from ONCs source is ±610 meters, while that of the spot elevations is 30 meters. For all features derived from the ONC, the absolute horizontal accuracy is 2040 meters rounded to the nearest 5 meters at 90% Circular Error (CE), World Geodetic System (WGS84). The absolute horizontal accuracy of the DCW for all features derived from Jet Navigation Charts (JNCs) is 4270 meters at 90% Circular Error. The absolute vertical accuracy of the DCW is the same as for the original ONC and JNC lithographs at 90% Linear Error (LE), Mean Sea Level (MSL) (USGS, 1995).

Refer to: Rios, Roads, Towns_all

C.2.3 USGS Digital Elevation Model (DEM)

The DEM was developed by the U.S. Geological Survey's EROS Data Center, Sioux Falls, South Dakota, 1996. The elevations are regularly spaced at 30-arc seconds (0.008333333 degrees), approximately 1 kilometer (USGS, 1997). The DEM was derived from eight data sources, both vector and raster. These include the digital terrain elevation data (DTED) with a horizontal grid spacing of 3-arc seconds (90 meters), digital chart of the world (DCW), the USGS 1 –degree DEM's, Army map Service (AMS) 1:1,000,000-scale maps and the International map of the world (IMW) 1:1,000,000-scale map. For Central America the main sources used was from the DTED with enhancements made by the DCW data (USGS, 1999b; USGS, 1997).

Of the DCW data, the hypsography and drainage layers were the most applicable to be included in the DEM generation, since these contain topographic information. For elevations below 305 metres, the primary contour interval on the source ONC's is 305 meters with supplemental contours at 76 meters intervals. For higher elevations the supplemental contours are at 152-meter intervals. The DTED and USGS DEM's have a vertical accuracy of + or - 30 meters linear error at the 90 percent confidence level (USGS, 1997).

Refer to: dem1km, hillshade, slope, aspect

C.2.3.1 Hillshade

A shaded relief was created in arc/info using the hillshade command using *dem1km*.

C.2.3.2 Slope

The slope surface was created in arc/info using the slope command using *dem1km*.

C.2.3.3 Aspect

The aspect grid was created in arc/info using the aspect command using *dem1km*.

C.2.4 USGS Land Cover

The U.S. Geological Survey (USGS), the University of Nebraska-Lincoln (UNL), and the European Commission's Joint Research Centre (JRC) generated a 1-km resolution global land cover database. The land cover was developed on a continent-by-continent basis with a 1-km nominal spatial resolution, based upon 1-km Advanced Very High-Resolution Radiometer (AVHRR) data from April 1992 through March 1993. The final land cover is composed of several data sources; AVHRR Data, Digital Elevation Model (DEM) Data, Ecoregions Data and Map Data (USGS, 1999c).

The final land cover was determined using a 'convergence of evidence approach' which used three interpreters to insure consistency. This included the seasonal land cover regions as defined by the Global Ecosystem framework which were cross-reference to the land cover classes of the Simple Biosphere Model (SIB), Simple Biosphere 2 Model, the Biosphere Atmosphere Transfer Scheme (BATS), International Geosphere Biosphere Programme (IGBP), and the USGS/Anderson (USGS, 1999c).

The final task associated with this step is the generation of the derived data sets,including land cover and seasonal measures. In this step, the seasonal land cover regions are aggregated (or renumbered) into the appropriate classes of the output classification legends. Urban areas, extracted from the Digital Chart of the World (Defense Mapping Agency, 1992) are added to three of the derived data sets: Global Ecosystems, IGBP Land Cover, and the USGS Land Use/Land Cover system.

Refer to: Lacusgs, Usgscrop, Iacigbp, Igbpcrop

C.2.5 Accessibility

The accessibility surface was created at CIAT by A. Nelson (1998) using the following information and methodology. The accessibility model is a land based model and does not account for air travel, which may play an important role for more remote areas. The model also ignores the transport of perishable goods that are often freighted by air. Coastal access by launch or ferry is also ignored. The projection used to create the surfaces was Lambert equal area azimuthal.

The model is based on the cost distance function in arc /info which requires a point based grid for source locations and a friction surface which defines the ease with which each cell can be traversed. The influencing factors which composed the friction surface include: -roads, rail, navigable rivers, slope, land cover, urban areas

The data sources included:
(roads (DCW); rail (DCW); rivers (DCW);
slope (GTOPO30: http://edcwww.cr.usgs.gov/landdaac/gtopo30/gtopo30.html);
land cover (IGBP:http://edcwww.cr.usgs.gov/landdaac/glcc/glcc.html);
urban areas (NOAA:http://www.ngdc.noaa.gov:8080/production/html/biomass/night.html))

Each of these is in the form of a 1km resolution grid that is classified to describe it's contribution to the friction surface. The factors were combined in arc/info to create a friction surface.

Refer to: access_g

Reference: ftp://geog.leeds.ac.uk/pub/andynelson/accessibility.doc

C.2.6 Climate data information

The climate surfaces were developed by Peter Jones at CIAT, and are based upon 30 year climate averages from about 10,000 meteorological stations in Latin America (Jones and Gladkov, 1999). They provide information on the following variables: (1) mean minimum monthly temperature (Jan to Dec), (2) mean maximum monthly temperature (Jan to Dec), and (3) monthly rainfall (Jan to Dec).

The surfaces were created at a 5 km cell resolution which was interpolated using 'the inverse square of the distance between the five nearest stations and the interpolated point'. The temperature surfaces were 'standardized to the elevation of the pixel in the DEM using a lapse rate model' (Jones and Gladkov, 1999). The methods used to create the climate surfaces are summarized in Table C.2.6.1. The surfaces included are as follows;

Table C.2.6.1: Summary of climate surfaces
All climate data is located in /data/clima2/

Description	Geog Locn	Cover name	Feature	Projection	Source	Resolution
Rainfall Jan 91	LAC	Pre01	grid	DD(wgs84)	Pjones (CIAT)	0.167
Rainfall Feb 91	LAC	Pre02	grid	DD(wgs84)	Pjones (CIAT)	0.167
Rainfall Mar 91	LAC	Pre03	grid	DD(wgs84)	Pjones (CIAT)	0.167
Rainfall Apr 91	LAC	Pre04	grid	DD(wgs84)	Pjones (CIAT)	0.167
Rainfall May 91	LAC	Pre05	grid	DD(wgs84)	Pjones (CIAT)	0.167
Rainfall Jun 91	LAC	Pre06	grid	DD(wgs84)	Pjones (CIAT)	0.167
Rainfall Jul 91	LAC	Pre07	grid	DD(wgs84)	Pjones (CIAT)	0.167
Rainfall Aug 91	LAC	Pre08	grid	DD(wgs84)	Pjones (CIAT)	0.167
Rainfall Sep 91	LAC	Pre09	grid	DD(wgs84)	Pjones (CIAT)	0.167
Rainfall Oct 91	LAC	Pre010	grid	DD(wgs84)	Pjones (CIAT)	0.167
Rainfall Nov 91	LAC	Pre011	grid	DD(wgs84)	Pjones (CIAT)	0.167
Rainfall Dec 91	LAC	pre012	grid	DD(wgs84)	Pjones (CIAT)	0.167
Max Temp Jan 91	LAC	Xt01	grid	DD(wgs84)	Pjones (CIAT)	0.167
Max Temp Feb 91	LAC	Xt02	grid	DD(wgs84)	Pjones (CIAT)	0.167
Max Temp Mar 91	LAC	Xt03	grid	DD(wgs84)	Pjones (CIAT)	0.167
Max Temp Apr 91	LAC	Xt04	grid	DD(wgs84)	Pjones (CIAT)	0.167
Max Temp May 91	LAC	Xt05	grid	DD(wgs84)	Pjones (CIAT)	0.167
Max Temp Jun 91	LAC	Xt06	grid	DD(wgs84)	Pjones (CIAT)	0.167
Max Temp Jul 91	LAC	Xt07	grid	DD(wgs84)	Pjones (CIAT)	0.167
Max Temp Aug 91	LAC	Xt08	grid	DD(wgs84)	Pjones (CIAT)	0.167
Max Temp Sep 91	LAC	Xt09	grid	DD(wgs84)	Pjones (CIAT)	0.167
Max Temp Oct 91	LAC	Xt010	grid	DD(wgs84)	Pjones (CIAT)	0.167
Max Temp Nov 91	LAC	Xt011	grid	DD(wgs84)	Pjones (CIAT)	0.167
Max Temp Dec 91	LAC	xt012	grid	DD(wgs84)	Pjones (CIAT)	0.167
Min Temp Jan 91	LAC	It01	grid	DD(wgs84)	Pjones (CIAT)	0.167
Min Temp Feb 91	LAC	It02	grid	DD(wgs84)	Pjones (CIAT)	0.167
Min Temp Mar 91	LAC	It03	grid	DD(wgs84)	Pjones (CIAT)	0.167
Min Temp Apr 91	LAC	It04	grid	DD(wgs84)	Pjones (CIAT)	0.167

Description	Geog Locn	Cover name	Feature	Projection	Source	Resolution
Min Temp May 91	LAC	lt05	grid	DD(wgs84)	Pjones (CIAT)	0.167
Min Temp Jun 91	LAC	lt06	grid	DD(wgs84)	Pjones (CIAT)	0.167
Min Temp Jul 91	LAC	lt07	grid	DD(wgs84)	Pjones (CIAT)	0.167
Min Temp Aug 91	LAC	lt08	grid	DD(wgs84)	Pjones (CIAT)	0.167
Min Temp Sep 91	LAC	lt09	grid	DD(wgs84)	Pjones (CIAT)	0.167
Min Temp Oct 91	LAC	lt010	grid	DD(wgs84)	Pjones (CIAT)	0.167
Min Temp Nov 91	LAC	lt011	grid	DD(wgs84)	Pjones (CIAT)	0.167
Min Temp Dec 91	LAC	lt012	grid	DD(wgs84)	Pjones (CIAT)	0.167
Evapotranspiration Jan	Cen Am	etp01	grid	DD(wgs84)	Pjones (CIAT)	0.167
Evapotranspiration Feb	Cen Am	etp02	grid	DD(wgs84)	Pjones (CIAT)	0.167
Evapotranspiration Mar	Cen Am	etp03	grid	DD(wgs84)	Pjones (CIAT)	0.167
Evapotranspiration Apr	Cen Am	etp04	grid	DD(wgs84)	Pjones (CIAT)	0.167
Evapotranspiration May	Cen Am	etp05	grid	DD(wgs84)	Pjones (CIAT)	0.167
Evapotranspiration Jun	Cen Am	etp06	grid	DD(wgs84)	Pjones (CIAT)	0.167
Evapotranspiration Jul	Cen Am	etp07	grid	DD(wgs84)	Pjones (CIAT)	0.167
Evapotranspiration Aug	Cen Am	etp08	grid	DD(wgs84)	Pjones (CIAT)	0.167
Evapotranspiration Sep	Cen Am	etp09	grid	DD(wgs84)	Pjones (CIAT)	0.167
Evapotranspiration Oct	Cen Am	etp10	grid	DD(wgs84)	Pjones (CIAT)	0.167
Evapotranspiration Nov	Cen Am	etp11	grid	DD(wgs84)	Pjones (CIAT)	0.167
Evapotranspiration Dec	Cen Am	etp12	grid	DD(wgs84)	Pjones (CIAT)	0.167

Using the surfaces in Table C.2.6.1 additional climate surfaces were created. These include annual surfaces (*rainfall, minimum temperature, maximum temperature*), diurnal and mean monthly temperature, as listed in Table C.2.6.2.

Table C.2.6.2: Additional climate surfaces

Description	Geog Locn	Cover name	Feature	Projection	Source	Resolution
Annual Rainfall	LAC	Annrain	grid	DD(wgs84)	CIAT 1998	0.167
Annual Min Temp	LAC	Annxt	grid	DD(wgs84)	CIAT 1998	0.167
Annual Max Temp	LAC	Annit	grid	DD(wgs84)	CIAT 1998	0.167
Diurnal Temp Jan 91	LAC	Diur01	grid	DD(wgs84)	CIAT 1998	0.167
Diurnal Temp Feb 91	LAC	Diur02	grid	DD(wgs84)	CIAT 1998	0.167
Diurnal Temp Mar 91	LAC	Diur03	grid	DD(wgs84)	CIAT 1998	0.167
Diurnal Temp Apr 91	LAC	Diur04	grid	DD(wgs84)	CIAT 1998	0.167
Diurnal Temp May 91	LAC	Diur05	grid	DD(wgs84)	CIAT 1998	0.167
Diurnal Temp Jun 91	LAC	Diur06	grid	DD(wgs84)	CIAT 1998	0.167
Diurnal Temp Jul 91	LAC	Diur07	grid	DD(wgs84)	CIAT 1998	0.167
Diurnal Temp Aug 91	LAC	Diur08	grid	DD(wgs84)	CIAT 1998	0.167
Diurnal Temp Sep 91	LAC	Diur09	grid	DD(wgs84)	CIAT 1998	0.167

Description	Geog Locn	Cover name	Feature	Projection	Source	Resolution
Diurnal Temp Oct 91	LAC	Diur010	grid	DD(wgs84)	CIAT 1998	0.167
Diurnal Temp Nov 91	LAC	Diur011	grid	DD(wgs84)	CIAT 1998	0.167
Diurnal Temp Dec 91	LAC	Diur012	grid	DD(wgs84)	CIAT 1998	0.167
Mean Temp Jan 91	LAC	Mt01	grid	DD(wgs84)	CIAT 1998	0.167
Mean Temp Feb 91	LAC	Mt02	grid	DD(wgs84)	CIAT 1998	0.167
Mean Temp Mar 91	LAC	Mt03	grid	DD(wgs84)	CIAT 1998	0.167
Mean Temp Apr 91	LAC	Mt04	grid	DD(wgs84)	CIAT 1998	0.167
Mean Temp May 91	LAC	Mt05	grid	DD(wgs84)	CIAT 1998	0.167
Mean Temp Jun 91	LAC	Mt06	grid	DD(wgs84)	CIAT 1998	0.167
Mean Temp Jul 91	LAC	Mt07	grid	DD(wgs84)	CIAT 1998	0.167
Mean Temp Aug 91	LAC	Mt08	grid	DD(wgs84)	CIAT 1998	0.167
Mean Temp Sep 91	LAC	Mt09	grid	DD(wgs84)	CIAT 1998	0.167
Mean Temp Oct 91	LAC	Mt010	grid	DD(wgs84)	CIAT 1998	0.167
Mean Temp Nov 91	LAC	Mt011	grid	DD(wgs84)	CIAT 1998	0.167
Mean Temp Dec 91	LAC	Mt012	grid	DD(wgs84)	CIAT 1998	0.167

Table C.2.6.3: Summary of method and errors for the climate surfaces

Surface	Source	Method	Known Error
Monthly Rainfall (Jan to Dec)	Jones P. G. (1997) Digital coverage of annual rainfall for Latin America. CIAT. Cali. Colombia	Constructed from interpolated climate file based on NOAA 10 minute grid DEM and CIAT climate database Interpolation from approximatly 10,000 met stations each pixel estimated from the nearest 5 stations using inverse square distance weighting.	Due to mismatch when splicing files. Missing pixels at col 394, row 333 long -53.2, lat -21.57 col 419, row 332 long -49.03, lat -21.4 col 447, row 330 long 44.4, lat -21.7
Mean maximum monthly temperature (Jan to Dec)	Jones P. G. (1997) Digital coverage of climate, Latin America. CIAT. Cali. Colombia	Constructed from interpolated climate file based on NOAA 10 minute grid DEM and CIAT climate database. Interpolation from approximatly 10,000 met stations each pixel estimated from the nearest 5 stations using inverse square distance weighting. Corrected to elevation of the pixel by a lapse rate model for the mean tropical atmosphere from night soundings in the Caribbean. Data from Rhiel, H. (1979) Climate and weather in the tropicas. Academic Press London. p 62.	Due to mismatch when splicing files. Missing pixels at col 394, row 333 long -53.2, lat -21.57 col 419, row 332 long -49.03, lat -21.4 col 447, row 330 long 44.4, lat -21.7
Mean minimum monthly temperature (Jan to Dec)	Jones P. G. (1997) Digital coverage of climate, Latin America. CIAT. Cali. Colombia	Constructed from interpolated climate file based on NOAA 10 minute grid DEM and CIAT climate database. Interpolation from approximatly 10,000 met stations each pixel estimated from the nearest 5 stations using inverse square distance weighting. Corrected to elevation of the pixel by a lapse rate model for the mean tropical atmosphere from night soundings in the Caribbean. Data from Rhiel, H. (1979) Climate and weather in the tropicas. Academic Press London. p 62.	Due to mismatch when splicing files. Missing pixels at col 394, row 333 long -53.2, lat -21.57 col 419, row 332 long -49.03, lat -21.4 col 447, row 330 long 44.4, lat -21.7
Mean monthly evapotranspiration (Jan to Dec)	Jones P. G. (1997) Digital coverage of climate, Latin America. CIAT. Cali. Colombia	Constructed from interpolated climate file based on NOAA 10 minute grid DEM and CIAT climate database. Interpolation from approximatly 10,000 met stations each pixel estimated from the nearest 5 stations using inverse square distance weighting. Calculated after Linacre E. T. (1977). A simple formula for estimating evaporation rates in various climates, using temperature data alone. Agric. Met. 18:409-424	Due to mismatch when splicing files. Missing pixels at col 394, row 333 long -53.2, lat -21.57 col 419, row 332 long -49.03, lat -21.4 col 447, row 330 long 44.4, lat -21.7
Annual	CIAT 1998	Sum of all months / 12 except for rainfall	"
Diurnal monthly temp	CIAT 1998	Max temp – Min Temp	"
Mean monthly temp	CIAT 1998	(Max temp + Min Temp) / 2	"

C.2.7 Number of dry months (consecutive)

For this study a dry month was defined as one containing less than 60 mm of rainfall, although Köppen[3] defines a dry climate as one where potential evaporation and transpiration exceeds precipitation. The monthly rainfall surfaces were re-classed such that cells with less than 60 mm of rain assigned a value of 1 and all other cells were assigned 0. Each cell was re-classed for each month and the number of consecutive dry months was calculated. The calculation was accomplished by evaluating the value of each grid cell for a month, where value = 1, with the next month, where value = 1, until value = 0. The algorithm can be written as:

$$Dry\_month = \Sigma_{1=jx} ((G_j = 1) \text{ and } (G_{j+1} = 1), G_j + G_{j+1}, 0)$$

Where *j* represents the months January (1) to December (12) and *jx* is the number of cells in *j*. Thus, when the value of cell 1 is 1 in consecutive months then the value will be summed. The values will continue to be summed for subsequent months until a cell value of 0 is located. When a cell value of 0 is found the total summed value will be written to a new data layer. The process will continue until all cells for all months have been analyzed. When the first month is completed, the same process will be applied to the next month and so forth. A single year has 12 months and the evaluation process starts in January and ended in December. However, to ensure continuity between January and December, the process was run for 24 months. This was done in Arcview 3.

Refer to: dry

C.2.8 Holdridge LifeZones

Constructed from interpolated climate file based on NOAA 10 minute grid DEM and CIAT climate database. Interpolation from approximately 10,000 met stations each estimated from the nearest 5 stations using inverse square distance weighting. The Holdridge classifications were defined by Holdridge, (1967).

Refer to: hold_g

Reference: Jones P. G. (1998) Holdridge life Zones of Latin America, Digital Image. CIAT. Cali. Colombia

Holdridge, L.R., 1967. Life zone ecology. Tropical Science Center, San Jose, Costa Rica

[3] The Köppen Climate Classification System is the most widely used system for classifying the world's climates. Its categories are based on the annualand monthly averages of temperature and precipitation and recognizes five major climatic types. Köppen was a German botanist and climatologist who developed his classification system in 1931 (http://everest.hunter.cuny.edu/; http://www.arts.ouc.bc.ca/geog/, 1998).

C.2.9 CIAT's Administration Boundary Coverage

The data on administrative boundaries was derived from the CIAT administration boundary coverage that was digitized in the GIS lab at CIAT in 1996. For each country, administrative boundaries (provinces, departments, municipalities, and districts, etc.) were digitized from topographic maps at various scales (refer to Table C.2.9.1) (Barona, 1997). These were then resampled to the DCW (Digital Chart of the World) country boundary. The information contained in the coverage includes three administration boundary levels; the country boundary, province or department (also referred to as admin level 2) and municipalities (also referred to as admin level 2).

Errors: Datasets are currently being checked.

For all admin coverages refer to: lacsaall or admlacsa

For admin level 2 refer to: adm2_lac.shp

For admin level 2 refer to: adm3_lac.shp

For admin level 2 refer to: pais_lac.shp

In directory (/data/latlong)

Table C.2.8.1: Scale of administration boundary level by country

Country	Admin Level 2	Admin Level 3	Admin Level 4	Year	Digitized from Scale	Source
El Salvador	Department	District	*Cantons*	1997	1:20,000	Direccion General de Estadistica y Censos, Unidad de *Cartografia1987*. Mapa de la Republica de El Salvador, Division Politico- Administrativa. Copia Heliografica.
Guatemala	States	District			1:75,000	Mapa de la Regionalizacion de la Republica de Guatemala. Ministerio de Agricultura. Copia Heliografica
Honduras	Department	Municipality		1987	1:12,000 – 1:30,000	Instituto Geografico Nacional. Secretaria de Comunicaciones, Obras Publicas y Transporte. 1987. Proyeccion Transversal de Mercator. Planchas y escalas: Dpto. de Choluteca 1:200000 Dpto. de Atlantida 1:200000 Dpto. de Comayagua 1:200000 Dpto. de Colon 1:200000 Dpto. Santa Barbara 1:200000 Dpto. de Cortes 1:200000 Dpto. de Fco.Morazan 1:200000 Dpto. de Paraiso 1:230000 Dpto. Gracias a Dios 1:300000 Dpto. Intibuca 1:150000 Dpto. Islas de la Bahia 1:200000 Dpto. La Paz 1:120000 Dpto. de Lempira 1:200000 Dpto. de Copan 1:200000 Dpto. de Olancho 1:350000 Dpto. de Yoro 1:230000 Dpto. Ocotepeque 1:120000 Dpto. Valle 1:200000
Costa Rica	Provinces	Cantons		1984	1:1500,000	Instituto Geografico Nacional. 1984. Mapa de Provincias y Cantones.
Panama	Province	District	Corregi mientos	1990	1:1000000	Ministerio de Obras Publicas Instituto Geografico Nacional "TOMMY GUARDIA". 1990. Mapa de la Republica de Panama Division Politico - Administrativa.
Nicaragua	Department	Municipality		1993	1:750.000	Instituto Nicaraguense de Estudios Territoriales. Ministerio de Construccion y Transporte. 1993. Mapa de la Republica de Nicaragua Division Politico- Administrativo. Proyeccion Transversal de Mercator
Mexico	State	Municipality		1981	1:1000.000	Mapa Geoestadistico. Secretaria de Programacion y Presupuesto. (S.P.P.). 4 hojas: Norte, Centro, Noroeste y Sureste
Belize	State				1:750.000	Mapa de la Regionalizacion de la Republica de Guatemala. Ministerio de Agricultura. Copia Heliografica

Source: Adapted from Barona (1997)

C.3 Crop Data

During the data collection phase of the whitefly project the location and growing season of host plants were not available for all countries.

If an accurate risk map is to be created it is very important to consider the growing seasons of all crops since host plants influence the development rates and the number of whiteflies. It is important to identify the crops being grown concurrently for a particular season that will need to be considered when running risk analysis.

Table C.3.1.1: Crop data information

Directory: /data/latlong/						
Description	**Geog Locn**	**Cover name**	**Feature**	**Projection**	**Source**	**Scale**
Bean points	LAC + Colombia	Bea_ciat	point	DD(wgs84)	CIAT	
Beans poly	LAC	Bea_mun	poly	DD(wgs84)	CIAT	Municipio
Directory: /data/dbfiles/crops/mexico/ **Join to the lac_adm coverage using item: isodepmun**						
Algodon (cotton)	Mexico	Algodon.txt	Txt file (tab delimited)		INEGI, 1991	Municipio
Brocoli	Mexico	brocoli.txt	Txt file (tab delimited)		INEGI, 1991	Municipio
Calabaza (squash)	Mexico	calab.txt	Txt file (tab delimited)		INEGI, 1991	Municipio
Calabacita	Mexico	calabz.txt	Txt file (tab delimited)		INEGI, 1991	Municipio
Calabaza para semilla	Mexico	calems.txt	Txt file (tab delimited)		INEGI, 1991	Municipio
Chile verde (green chiles)	Mexico	chilev.txt	Txt file (tab delimited)		INEGI, 1991	Municipio
Chile seco (dry chiles)	Mexico	chiles.txt	Txt file (tab delimited)		INEGI, 1991	Municipio
Frijol (beans)	Mexico	frijol.txt	Txt file (tab delimited)		INEGI, 1991	Municipio
Melon (melon)	Mexico	melon.txt	Txt file (tab delimited)		INEGI, 1991	Municipio
Pepino (cucumber)	Mexico	pepino.txt	Txt file (tab delimited)		INEGI, 1991	Municipio
Sandia (watermelon)	Mexico	sandia.txt	Txt file (tab delimited)		INEGI, 1991	Municipio
Soya (soya)	Mexico	soya.txt	Txt file (tab delimited)		INEGI, 1991	Municipio
Tabaco (tobacco)	Mexico	tobaco.txt	Txt file (tab delimited)		INEGI, 1991	Municipio
Tomate rojo (red tomato)	Mexico	tom-r.txt	Txt file (tab delimited)		INEGI, 1991	Municipio
Tomate verde (green tomato)	Mexico	tom-v.txt	Txt file (tab delimited)		INEGI, 1991	Municipio
Directory: /data/dbfiles/crops/guate/						
Chile	Guatemala	Chile_79.xls	Excel worksheet		Agricultural Census of Guatemala, 1979	Departme nt
Beans	Guatemala	Frijol_79.xls	Excel worksheet		Agricultural Census of Guatemala, 1979	Departme nt
Maize	Guatemala	Maiz_79.xls	Excel worksheet		Agricultural Census of Guatemala, 1979	Departme nt

Directory: /data/latlong/						
Description	**Geog Locn**	**Cover name**	**Feature**	**Projection**	**Source**	**Scale**
Watermelon and melon	Guatemala	Sandia_melon_79.xls	Excel worksheet		Agricultural Census of Guatemala, 1979	Department
Soya	Guatemala	Soya_79.xls	Excel worksheet		Agricultural Census of Guatemala, 1979	Department
Tobacco	Guatemala	Tabaco_79.xls	Excel worksheet		Agricultural Census of Guatemala, 1979	
Tomato	Guatemala	Tomate_79.xls	Excel worksheet		Agricultural Census of Guatemala, 1979	Department
Wheat	Guatemala	Trigo_79.xls	Excel worksheet		Agricultural Census of Guatemala, 1979	Department
Directory: /data/dbfiles/crops/honduras/cen_93/aldea Tables need to be joined to the aldea coverage (/data/dbfiles/crops/honduras/cen_93/aldea/hon_ald.shp) using Codigo (in table) with aldnum88 in the shapefile table. Source: Republica de Honduras Secretaria de planificacion, coordinacion y presupuesto, Secretaria de recursos naturales, Abril-May 1993						
Algodon (cotton)	Honduras	Algodon.txt	Txt file (tab delimited		Honduras, 1993	Aldea
Brocoli	Honduras	Brocoli.txt	Txt file (tab delimited		Honduras, 1993	Aldea
Calabaza (squash)	Honduras	Calabaza.txt	Txt file (tab delimited		Honduras, 1993	Aldea
Chile (chili)	Honduras	Chili.txt	Txt file (tab delimited		Honduras, 1993	Aldea
Chile dulce (sweet peppers)	Honduras	Chili_dulce.txt	Txt file (tab delimited		Honduras, 1993	Aldea
Arroz postrera (rice)	Honduras	Arroz_pos.txt	Txt file (tab delimited		Honduras, 1993	Aldea
Arroz primera (rice)	Honduras	Arroz_prim.txt	Txt file (tab delimited		Honduras, 1993	Aldea
Frijol asociado postrero (beans - mixed)	Honduras	Frij_asoc_pos.txt	Txt file (tab delimited		Honduras, 1993	Aldea
Frijol asociado primero (beans - mixed)	Honduras	Frij_asoc_prim.txt	Txt file (tab delimited		Honduras, 1993	Aldea
Frijol solo postrero (beans - alone)	Honduras	Frij_sol_pos.txt	Txt file (tab delimited		Honduras, 1993	Aldea
Frijol solo primero (beans - alone)	Honduras	Frij_sol_prim.txt	Txt file (tab delimited		Honduras, 1993	Aldea
Maize asociado postrera (maize - mixed)	Honduras	Maize_asoc_pos.txt	Txt file (tab delimited		Honduras, 1993	Aldea

Directory: /data/latlong/						
Description	**Geog Locn**	**Cover name**	**Feature**	**Projection**	**Source**	**Scale**
Maize asociado primero (maize mixed)	Honduras	Maize_asoc_prim.txt	Txt file (tab delimited		Honduras, 1993	Aldea
Maize solo postrera (maize)	Honduras	Maize_sol_pos.txt	Txt file (tab delimited		Honduras, 1993	Aldea
Maize solo primero (maize)	Honduras	Maize_sol_prim.txt	Txt file (tab delimited		Honduras, 1993	Aldea
Maizcillo asociado (mixed)	Honduras	Maizecillo_asoc.txt	Txt file (tab delimited		Honduras, 1993	Aldea
Maizcillo solo ()	Honduras	Maizecillo_solo.txt	Txt file (tab delimited		Honduras, 1993	Aldea
Melon (melon)	Honduras	Melon.txt	Txt file (tab delimited		Honduras, 1993	Aldea
Papa (potato)	Honduras	Papa.txt	Txt file (tab delimited		Honduras, 1993	Aldea
Pepino (cucumber)	Honduras	Pepino.txt	Txt file (tab delimited		Honduras, 1993	Aldea
Sandia (watermelon)	Honduras	Sandia.txt	Txt file (tab delimited		Honduras, 1993	Aldea
Sorgo (sorghum)	Honduras	sorgo.txt	Txt file (tab delimited		Honduras, 1993	Aldea
Soya postrera (soya)	Honduras	Soya_pos.txt	Txt file (tab delimited		Honduras, 1993	Aldea
Soya primera (soya)	Honduras	Soya_prim.txt	Txt file (tab delimited		Honduras, 1993	Aldea
Tabaco (tobacco)	Honduras	Tobaco.txt	Txt file (tab delimited		Honduras, 1993	Aldea
Tomate (tomato)	Honduras	Tomato.txt	Txt file (tab delimited		Honduras, 1993	Aldea
Trigo (wheat)	Honduras	Trigo.txt	Txt file (tab delimited		Honduras, 1993	Aldea
Semilla_mejorada (improved seed)	Honduras	Semilla_mejorada.txt	Txt file (tab delimited		Honduras, 1993	Aldea

Table C.3.1.2: Growing Season Information by Country

Theme	Mexico	Belize	Guatemala	Honduras	Nicaragua	El Salvador	Costa Rica	Panama	Cuba	Haiti	Dom Republic
Virus Outbreak:											
BGMV (1994)	✓		✓	✓	✓	✓	✓		✓		✓
Tomato Virus											
Crops:											
Eggplant											
Chinese Vegetables											
Frijol	✓		✓ 3 seasons	✓ 2 seasons	✓ 4 seasons	✓ 3 seasons					
Tomato	✓		✓								
Algodon	✓		✓								
Calabaza	✓		✓								
Chile	✓		✓								
Pimenton	✓		✓								
Melon	✓		✓								
Pepino	✓		✓								
Sandia	✓		✓								
Soya											
Tabaco	✓		✓								

C.3.2 Beans

C.3.2.1 Beans: CIAT bean point distribution map (1987)

In 1987 the Agroecological Studies Unit at CIAT produced a bean distribution map for Central America. In 1991, James Fairbairn, improved upon the bean distribution by including climate (altitude, latitude, temperature and estimated evapotranspiration), land use (sowing dates and systems), and soil (rooting depth from FAO typical profiles, soil classes for beans) (Fairbairn, 1993). The result was a bean map where each point represents 1000 hectares.

Refer to: bea_ciat

C.3.2.2 Beans: Location of Bean Growing Areas from Census data

In Central America, farms are fragmented, small in size, use mixed agricultural systems, are labour intensive and located on valley floors as well as on steep hillside slopes. These factors make it difficult to identify all cultivated areas using satellite imagery and expert local knowledge is required for identifying the location of a crop within a country.

CIAT, as part of its goals to study land use patterns and dynamics, has developed a crop production database for Latin America, as illustrated in Table C.3.2.2.1. The data are based upon the availability of agricultural census information at varying administrative levels (Hyman, 1997).

Table C.3.2.21: Bean Production Data available

Country	Administrative Level	Year	Collection Method	Comments
El Salvador	Region (administrative level 2)	1994	Sample	Beans
Guatemala	Department (administrative level 2)	1989-95	Sample	Beans
Honduras	Town	1993	Census	Beans
Costa Rica	Country	1993-95	Sample	
Panama	Municipality	1990-91	Census	Beans
Nicaragua	Department	1995	Sample	Beans
Mexico	Municipality	1991	Census	Beans
Belize	Department	1994	Census	Beans

The crop information tends to be coarse such as department or regional level scale that allows for much within region variability with the exception of the Honduras town level information. To improve upon the bean location map a raster crop redistribution model was used using Uwe Deichmann's (1996) vector to raster redistribution model for population (Hyman, 1997).

This involved the use of the land cover map developed by the USGS with an accessibility cover, developed at CIAT (Nelson, 1998) using a cost-distance approach (Hyman, 1997). This assumes that the distribution of crops are more likely to be cultivated near to a transportation network for easy access to markets (Hyman, 1997). We applied this method to the agricultural census data available for beans.

By combining the accessibility grid with the administrative bean information, the total crop area was redistributed based on their accessibility to market (Hyman, 1997). This was accomplished by transforming the region into a municipality level potential surface by dividing the value at each grid cell by the sum of the indices within each municipality, thus weighting each area according to their ease of accessibility to market (Hyman, 1997). The weighted potential surface was then combined with the crop data to estimate the distribution within municipalities (Hyman, 1997).

The results of the model did not agree with the CIAT (1993) bean data points that were based on bean-growing factors such as climate and soil. For example no beans are reported to occur in the department of Yoro (Honduras) while the CIAT (1993) bean data points indicate two production areas. This could be due to several factors:- the inaccuracy of the classification of the cultivated areas on the USGS (1993) land cover map, land use pattern changes since the data sets were created, inaccuracies in the original CIAT (1987) bean data, inaccuracies of the soil and climate data used by Fairbairn (1993) to update the CIAT (1987) bean data points, and the assumption of accessibility to market. This assumption can be applied to farmers supplying beans to a local market, but in Latin America, beans are a main staple and tend to be a subsistent crop, much of which is grown for local consumption.

Thus, the question of where specifically in the study area beans are grown still remains. An alternative approach to defining the bean growing area was therefore adopted. This used a combination of sources to identify the bean-growing areas including:- the agricultural census available at the smallest administration unit (as defined in Table C.3.2.2.1), elevation best suited for cultivating beans, interviewing local bean-plant breeders, delineating bean growing areas on topographic maps by local experts and referencing existing bean maps, where available.

Once a suitable crop location model can be identified we will be able to map the location of other crops contained in an agricultural census database.

C.3.2.3 Other crops

Table C.3.2.3.1: Other Crop Production Data available (hectares and tonnes)

Directory: /data/crop_cov/				
Country	**Administrative Level**	**Year**	**Dataset**	**Comments**
El Salvador	Region (administrative level 2)	1994	Sal_cu	Beans
Guatemala	Department (administrative level 2)	1989-95	Guat_cu	Beans
Honduras	Town	1993	Hon_cu	Beans
Costa Rica	Country	1993-95	Cri_cu	
Panama	Municipality	1990-91	Pan_cu	Beans
Nicaragua	Department	1995	Nic_cu	Beans
Mexico	Municipality	1991	Mex_cu	Beans
Belize	Department	1994	Bel_cu	Beans, Melon, Squash, cucumber, red peppers, tomato, watermelon, potato

C.3.3 Varieties

C.3.3.1 Bean varieties

With the increased outbreaks of BGMV during the 1970s bean plant breeders developed new virus-resistant varieties in an effort to reduce the spread of the virus. Resistant varieties were adopted by farmers throughout Central America and by 1996 it was reported that between 40 to 80 percent of the bean areas were being planted to improved varieties (Viana, 1998; Viana *et al.* 1997).

Of the varieties released, it was necessary to identify the resistance of each variety to BGMV and where each bean seed ~~type~~ is currently ~~being used~~. The information was gathered from bean experts, bean breeders, virologists and local bean experts familiar with the problem. This information was available either at department or *municipio* level and a new coverage was appropriately coded (1 = resistance, 2 = susceptible, 0=unknown).

The mapping of bean variety information resulted in the identification of missing information, ie where there is no knowledge on the type of bean variety currently in use. For example, for the entire bean-growing regions in Guatemala, Honduras and El Salvador bean variety information was missing for more than 60 percent of the total area. Information on the distribution of different bean variety information should be further investigated and included since it plays an important role in the reduction of BGMV infection and can be used as a surrogate for identifying areas with BGMV problem, or other virus or pest problems for that matter. (Refer to Appendix A.1 for bean variety information for Honduras, Guatemala and El Salvador)

Refer to: beanvars4.txt (directory: /data/dbfiles/bean_variety)

C.4 Gemini-virus Data

Virus Data:

Directory: /data/latlong/						
Description	**Geog Locn**	**Cover name**	**Feature**	**Projection**	**Source**	**Scale**
Bean Viruses	LAC,S America	BGMV94	poly	DD(wgs84)	P Anderson and F Morales (CIAT)	Muncipio + pais
Tomato Viruses	LAC, S + N America	lacsaall	poly	DD(wgs84)	P Anderson and F Morales (CIAT)	Municipio + pais
BGMV	Cen Am	BGMV94_g	grid	DD(wgs84)	Bean Golden Mosaic, Research Advances 1994, CIAT	Regions
Directory: /data/dbfiles/						
Chinese Vegetables	LAC	virchveg.txt	Txt file (tab delimited)		CIAT 1998	Municipio, regions, pais
Algodon (cotton)	LAC	vircotton.txt	Txt file (tab delimited)		CIAT 1998	Municipio, regions, pais
Eggplant	LAC	vireggplant.txt	Txt file (tab delimited)		CIAT 1998	Municipio, regions, pais
Beans	LAC	virfrijol.txt	Txt file (tab delimited)		CIAT 1998	Municipio, regions, pais
Hot Peppers	LAC	virhpepper.txt	Txt file (tab delimited)		CIAT 1998	Municipio, regions, pais
Melon	LAC	virmelon.txt	Txt file (tab delimited)		CIAT 1998	Municipio, regions, pais
Sweet Peppers	LAC	virspepper.txt	Txt file (tab delimited)		CIAT 1998	Municipio, regions, pais
Squash	LAC	virsquash.txt	Txt file (tab delimited)		CIAT 1998	Municipio, regions, pais
Tobacco	LAC	virtobacco.txt	Txt file (tab delimited)		CIAT 1998	Municipio, regions, pais
Tomato	LAC	virtomato.txt	Txt file (tab delimited)		CIAT 1998	Municipio, regions, pais
Beans	LAC	virusbean.txt	Txt file (tab delimited)		CIAT 1998	Municipio, regions, pais
Watermelon	LAC	virwatermelon.txt	Txt file (tab delimited)		CIAT 1998	Municipio, regions, pais

C.4.1 Bean golden Mosaic Virus

Locations of bean golden mosaic virus (BGMV) areas

Maps such as those of CIAT (1993) and Fairbairn's were available to show the bean growing areas, however no maps were available showing the current distribution of BGMV outbreak areas. Three data sources were used to create the map showing the distribution of BGMV in the study area. These include; (1) the publication *Mosaico Dorado del Frijol: Avances de Investigacion* (Morales, 1994); (2) expert local knowledge drawn on 1:75,000 scale maps, and (3) publications obtained from bean experts (Cabrera *et al* 1997).

The data obtained from *Mosaico Dorado del Frijol: Avances de Investigacion* (1994) show the location of the virus within each country. Each map was scanned and saved as images in a TIFF format. The images were georeferenced to the administration boundary coverage using the register/rectify command in Arc/info. A minimum number of links representing the geographic extent of the country ~~were added, registered and~~ the results analyzed and viewed. Three to five points were selected depending on the size of the country. A good fit was accomplished using both RMS error and visually checking the fit between the image and boundary information.

Each registration had a RMS error of less than 0.01 decimal degrees. Once the image was satisfactorily georeferenced to the coverage, the six-parameter affine transformation was applied, using a nearest neighbor interpolation. The image coordinates were then converted from map units to real world coordinates. In this case the image was transformed to latitude and longitude. By adding coordinates to the image, it can be viewed concurrently with the existing digital data sets. Finally, the BGMV information contained in the images for Guatemala and Honduras were digitized in ARC/INFO.

The areas affected by BGMV were coded 1 and converted to raster format where each pixel represented 1 km. For the case of El Salvador, BGMV affected areas were coded 1 at *canton* level using the '*Zonas Productoras de Frijol a Nivel Cantonal El Salvador 1997*' map in *Situatcion Actual del Cultivo de Frijol en El Salvador* (Cabrera, 1997).

The BGMV areal data contained errors that can be attributed to the generalization of the data. In this case the areal data will result in errors of ommission/commission of the virus. To minimize this problem the historical information can be used to eliminate areas above a specific elevation or use bean variety information as a surrogate for illustrating BGMV problem areas. The new coverage showed areas affected by BGMV where areas containing the virus were coded 1 and 0 for no-BGMV areas.

Coverage of information digitized from Mosaico Dorado del Frijol: Avances de Investigacion, 1994

Refer to: bgmv94 (directory: /data/latlongl)

BGMV 1990's information provided by F Morales (1998)

Refer to: bgmv90s.shp and bgmv90info.dbf (directory: /data/virusl)

C.5 Environmental factors influencing whitefly distribution

Temperature and humidity are considered to be of particularly important in influencing whitefly distribution since they influence the development, survival and mortality rate of the whitefly (Arnez, 1997; Cohen, 1991; Van Lenteren and Noldus, 1991; Horowitz, 1983; Berlinger *et al.*, 1986). Arnez (1997) summarizes the climatic factors (Table C.5.1.1) and identified five risk classifications ranging from very low (1) to very high (5) where each risk class is characterized by elevation, precipitation, number of consecutive dry months and temperature ranges. The climate information is based on annual averages and is best used to obtain a generalized picture of the problem.

The limitations of Arnez's classification are the use of annual climate averages and the lack of important cropping information. Virus outbreaks do not occur throughout the year and tend to be more severe during one season (for example most whitefly problems occur in the *primera* and the *epoca de apante* bean growing seasons in El Salvador). The annual climate ranges, defined by Arnez, can be redefined by performing a site characterization, which is a process used to describe the environment at a particular place (Corbett and O'Brien, 1997). By examining the climate information for the months with reported BGMV outbreaks Arnez's risk classes can be redefined to better represent the climate occurring during times of virus outbreak.

Another important factor that should be included in the analysis are the different cropping systems occurring concurrently with bean production. Morales (1999) modified Arnez's (1997) original risk classes to include the different crops important in hosting and attracting whitefly populations (refer to Table C.5.1.1). Whiteflies prefer cotton, soybean, melons, squash followed by tobacco, tomato, eggplant and cucumber, and lastly bean, potatoes and peppers. Although beans are not a highly preferred host crop they are an important food staple grown by rural farmers throughout Central America and are susceptible to gemini-virus infections which results in losses in bean production and income.

Table C.5.1.1: Environmental factors influencing the distribution of *Bemisia tabaci*

Physical Characteristics		**Unit**	**Risk Classification**				
Incidence of the virus occurrence			Very low (1)	Low (2)	Moderate (3)	High (4)	Very high (5)
Climate							
Humidity for ***Bemisia tabaci***	Elevation	Msnm	<100 >1500	1500-2000	1000-1500	--------	500-1000
	Precipitation	Mm	>3000	2500-3000	2000-2500	1500-2000	<1500
	Consecutive dry months	Month	<1	1-2	2-3	3-4	>4
Temperature requirements	Temperature	C	<19 >30	26-30	--------	19-22	22-26

Source: adapted from Arnez, 1997

Table C.5.1.2: Updated environmental factors influencing the distribution of *Bemisia tabaci*

Factors	Characteristics	Unit	Risk Classification (Incidence of virus occurrence)				
			Very low (1)	Low (2)	Moderate (3)	High (4)	Very High (5)
Environ-mental factors	Elevation	Masl	>1500	1200-1500	1000-1200	500-1000	0-500
	Precipitation	Mm/year	>3000	2000-3000	1500-2000	1000-1500	<1000
	Consecutive dry months	No of Month	0	0-1	1-2	2-3	3-6
	Temperature	°C	<12 >32	12-16	17-21	22-26	27-31
Cropping Systems	Risk Assessment	Crop type	Cereals	Vegetables not in 3-5	Bean, potato, peppers (sweet and chili)	Tobacco, tomato, eggplant, cucumber	Cotton, soybean, melons, squash

Source: Morales (personal communication 1999)

Critical Parameters Data:

Table C.5.1.3: Distributionof *Bemisia tabaci* based on parameters provided by F Morales, 1998. Grids are located in /data/models/

Description	Geog Locn	Cover name	Feature	Projection	Source	Scale
Bemisia tabaci optimum factors (elev: 0-1250, Temp: 20-30)[1]	LAC	Btopt	Grid	DD(wgs84)	Pjones (CIAT) Climate	.167
Bemisia tabaci critical factors (elev: 0-1250,Temp: 15-32)[1]	LAC	Btcrit	Grid	DD(wgs84)	Pjones (CIAT) Climate	.167
Bemisia tabaci elevation (0-1250 m)	LAC	Bemt_elev	Grid	DD(wgs84)	USGS	.0083333 (1km)

Please Note: The environmental factors described here are not the only factors influencing the distribution of whiteflies and gemini-viruses. The problem is complex and should include biological parameters such as population dynamics models of the whitefly as well as mortality and survival rates.

C.6 Limitations of the data

In describing the data, their sources and how the data sets were constructed it is important to acknowledge many errors will have been incorporated into the final data to be used for the analysis. In this section some of the limitations of the data will be discussed. These include problems associated with data creation and data sources. Lastly, the problems associated with particular data sets used in this analysis will be addressed and how some of these problems were overcome.

C.6.1 Limitations associated with data creation

Errors will result while creating digital data. These can result from both hardware and human influences. Errors induced by hardware limitations are not always fixable but we should be aware of their existence and the magnitude. In addition, human influences can result in error propagation. For the remainder of this section we will discuss some of the errors associated with data creation.

C.6.1.1 Image distortion while scanning

Scanning can result in many distortions in the original data. Some of the more noticeable errors include:- (1) the magnification or reduction of the map to fit the viewer, (2) varied distortion of information throughout the image itself (ie increase in distortion from the center towards the edge, also edge effects or warping at the edge), (3) distortions caused through the glass, (4) quality of the scanner itself, (5) resolution at which the image was scanned (ie dots per image (dpi), and (6) crookedness of the page in the scanner. Each of the above mentioned points will cause some errors, although minor. The distortions caused by the hardware and software are difficult to overcome but in some cases the distortions were very obvious and required the maps to be rescanned.

C.6.1.2 Digitizing

Errors will have occurred during digitizing and include source and human errors. The source errors may include existing errors on the paper map, shrinkage of the paper and the distortion of features as they are recorded in projected map units on a flat surface. The human errors include inaccurate digitization of lines or points and editing of the coverage and the building of topology in ARC/INFO.

C.6.1.3 Converting from vector to raster

The data sets were converted from vector to raster to be used later in the analysis. While converting between the two data formats information is lost or altered depending on the cellsize selected. If the cellsize is too large, the outline of a feature will become blocky and boundaries will be altered.

C.6.1.4 Changing projections (ie. Latitude/Longitude to UTM meters)

The data were digitized as Latitude/Longitude and later converted to the Universal Transverse Mercator (UTM) projection. When converting between projections information will be altered due to the transformation process and mathematical calculations that take place.

C.6.2 Problems associated with data sources

The data used in this analysis was derived from a variety of sources at different geographical and time scales. Each source uses a different set of standards and methodologies while compiling and creating the data. In many cases the methodologies are not properly documented making it difficult to ascertain the accuracy or inaccuracies associated with the data which can lead to contradictions between data sets.

C.6.2.1 Age of Data

The age of data is always a concern. In many cases it takes several years to collect and compile data sets which are then published years after the initial collection dates. For example,

agricultural census information is collected in a year and may not be released another year or two.

C.6.2.2 Scale

Data is available at a variety of scales. In this case the data ranges from town *(aldea)* level (points) to department level (administration level 2) and regional level (ie map scale of 1: 1,000,000). Scale effects, such as boundary distortions and projection effects are incorporated into paper maps that can lead to digital inaccuracies. For example, inaccurate location of areal boundaries on a map (Haining, 1997), when digitized will also be incorrect in the digital data set.

In addition scale and resolution are important in determining the type of results attainable when modelling the data. For example, the host crop data is available at a department or municipality level therefore the best results than can be obtained using this information is at a municipality or department level. Hence, the results can ~~only~~ be as good as the input data in terms of the source, age and scale of the data.

C.6.2.3 Incompleteness of Data

Although digital data is becoming more available with the increased use and accessibility of computers, data sets are not always complete. This can be due to instrument failure while the data is being recorded, confidentiality of the data (ie census data), human recording errors (ie input wrong climate figures), or due to external factors such as public holidays, war and lack of available funds (ie daily climate recording) (Haining, 1997).

C.6.3 Errors associated with specific data sets

Limitations associated with data creations and sources were identified above. Now we will discuss some of the limitations associated with specific data sets used for the analysis.

C.6.3.1 Climate

Climate is a complex phenomenon that is dependent on numerous factors some of which include, elevation, latitude, proximity to waterbodies/mountain ranges, air moisture content, prevailing winds, season, vegetation cover and so forth. Many scientists have agonized trying to simulate and model climate based on historical station records to try to determine the climate occurring at an unknown point. Jones and Gladkov (1999) created climate surfaces for temperature and rainfall (Jones *et al.*, 1997a) throughout Central America. The limitations of the climate surfaces include (1) its resolution and (2) the aggregation of daily records to produce mean monthly surfaces, and (3) data errors while recording the climate at the station and adding to the information to the digital database.

First, the spatial resolution and accuracy of the climate surfaces are dependent on the digital elevation model (DEM) used for the interpolation. For this analysis two climate surfaces at different resolutions were used. These were 5km and 18km. The coarser the resolution the less detailed the climate surface and the blockier the results. However, since climate is a regional phenomenon the resolution at which it should be represented should not be too fine or else, it too will appear blocky and loose its meaning.

Secondly, climate surfaces were compiled from data collected over 20 years and averaged for each month. By averaging the daily data over time, extreme weather incidences are smoothed and generalized. Therefore, it must be remembered that the predicted results will be averages (Craig *et al.* 1999). At the regional and continental level these results will suffice in highlighting problematic areas but they mean that the final results can only be an average situation and they mask extreme events/outbreaks.

Crops - the case of beans for Honduras, Guatemala and El Salvador

The bean locations were obtained from a variety of sources ranging from publications, agricultural census, bean breeders and local experts drawing on maps. This data was available at a variety of scales and time periods. A problem with using a variety of sources from differing years is the information is not always consistent and sometimes conflicts making it difficult to determine what data are the most accurate.

C.6.3.2 Bean and BGMV Data

The bean and BGMV data used to create the digital data sets were constructed from a variety of sources using several techniques. Each method has limitations and will be discussed next. First the limitations of the bean data will be addressed followed by that for BGMV affected areas.

C.6.3.2.1 Beans

The bean locations were obtained from a variety of sources ranging from publications, agricultural census, bean breeders and local experts drawing on maps. This data was available at a variety of scales and time periods. A problem with using a variety of sources from differing years is the information is not always consistent and sometimes conflicts. Making it difficult to determine what data are the most accurate. To overcome these problems maps were created using the most up-to-date information and verified elther in the field or by experts. Beans are an important staple in Central America and are grown almost everywhere. However, for the purpose of this study only the main bean-growing regions were identified and used.

C.6.3.2.2 BGMV

The data representing areas affected by BGMV outbreaks were in the form of polygons drawn on paper maps that were converted to digital data. The BGMV information was represented as areal units representing presence/absence of the virus. The areas will cause errors by inclusion and exclusion of virus and non-virus areas. To minimize this error additional information such as historical data was used to delineate the virus prone areas.

The data on BGMV affected areas were created using scanned and digitized maps. Several steps were necessary to get the data from its original source, on paper, to the final digital dataset to be included in the analysis. At each data processing stage errors will have occurred affecting the final coverage. Some of the identified errors include, image distortion while scanning, errors caused while registering and transforming the image to the digital dataset, digitizing, converting the data from vector to raster, changing between different projections (ie. Latitude/Longitude to UTM meters), and lastly the data itself.

C.6.3.2.3 Cropping Data Information

The data sources for beans, host crops and BGMV were available for various years (refer to Table 2.4.3.2.3.1) at a variety of scales and level of completeness. The age of the data ranges from 1964 to 1999 for a range of scales (town to region) making it difficult to compare and contrast the data since there is little overlap in terms of time between the different types of data available.

Table C.6.3.2.3.1: Comparison of data source dates for beans, host crops and BGMV in Guatemala, Honduras and El Salvador.

Theme	Guatemala	Honduras	El Salvador
BGMV	Published 1994 Source date: 1979-1994	Published 1994 Source date: 1964-1994	Published 1997 Source date: 1997
Beans	1999 Source date: 1990-1994	1999 Source date: 1993-1999	1999 Source date: 1997
Host Crops	Published 1979	Published 1993	Published 1994
Bean Varieties	1999 Source date:1979-1998	1999 Source date: 1984-1996	1999 Source date: 1968-1997
Bean growing seasons	1999	1999	1999
Host crop growing seasons	1999	1999	1999

Additionally several incomplete data sets have been identified during this study. These include incomplete crop databases (ie production and location (refer to Table 2.3.12.1) and known crop growing seasons within each country (refer to Table B.5.1-3, appendix B). Due to the incomplete host crop information it was excluded from the analysis.

C.6.3.2.4 BGMV bean resistant varieties and BGMV

The information provided for BGMV resistant bean varieties, beans locations and BGMV outbreaks were compiled from data sources of varying years (see Table C.6.3.2.3.1). Discrepancies between BGMV bean resistant varieties in use, current bean growing locations and BGMV reported outbreaks are illustrated in Map 2.3.11.1. This can be attributed to the varied yearly reports for each data type and suggests that the data is not compatible since there are problems with what is currently being reported and what is actually occurring. The difference in BGMV outbreaks and the bean variety data illustrates that the virus problem could have moved into new areas within the last 5 years.

In addition a standard BGMV outbreak reporting procedure is not being followed. For example Map 2.3.11.1 illustrates that BGMV is still being reported for some areas where BGMV bean resistant varieties are currently in use, while in other areas this is not the case. This suggests that since the release of resistant varieties people familiar with the problem are still reporting the original problem sites. Therefore for the purpose of this study it will be assumed that he BGMV locations are current with bean growing locations and BGMV resistant variety information will be ignored until further data is collected.

C.6.3.2.5 Whitefly Information

The whitefly information for this study was limited and included the areal locations of the presence and/or absence of whitefly/virus and annual climate generalizations influencing areas of risk. At this time detailed information such as whitefly biotypes, population dynamics and models, and intensity of disease outbreaks for the study area were not available. Therefore population dynamics were not included for the analysis and instead a climate-based modelling approach was taken using the risk classifications defined in section 2.3.13.

In this section we have discussed some of the data limitations. However, please note that there are additional limitations that need to be considered associated with spatial analysis (ie measurement error, continuity effects and spatial heterogeneity, dependency in spatial data, spatial distribution of data points and boundary effects, assessing model fit, model sensitivity to the areal system and extreme data values). For a more detailed description on problems associated with spatial analysis modelling refer to Chapter 2 in Haining, 1997.

(d) Known Problems

During development the network extension was included and when this is switched off problems occur, therefore it is necessary to include the network extension.

Sometimes the project looks for a script names SDE.ExportTable. If this occurs go to the project file tool, open a new script and call it:: - SDE.ExportTable. Compile the script and save the project. With the empty script.

D.1 Requirements

Version of ArcView: ArcView 3.0a
Due to the links with Microsoft office, this project can only work on an environment that has access to microsoft office.

Extensions Required: Spatial Analysis
Network Analysis
~~Database Themes~~
Dialog Designer

D.2 Technical Notes

D.2.1 Running the project:

Copy the ArcView project onto your computer and edit the ***aaastart*** script. It is edit the following information to point to where the data is located on the your computer. (ie drive e:\ or d:\)

It is necessary to change the paths to access the location of the data on the users system. The ***aaastart*** script needs to be edited. The items that are in bold need to be altered.

Script: ***aaastart***

```
drive_name = "d:\whitefly"

' this section sets the global variables
_pathbase = drive_name+"\data\latlong\".Asstring

'legend
 _pathleg = drive_name+"\legend\".Asstring

 'climate
_pathclim = drive_name+"\data\clima2\".Asstring

 'economic
_pathecon = drive_name+"\data\dbfiles\".Asstring

'documentation
_pathdoc = drive_name+"\documentation\".Asstring

'Netscapeprogram file
 _netscapepath = "c:\Program Files\Netscape\Communicator\Program\netscape.exe"
```

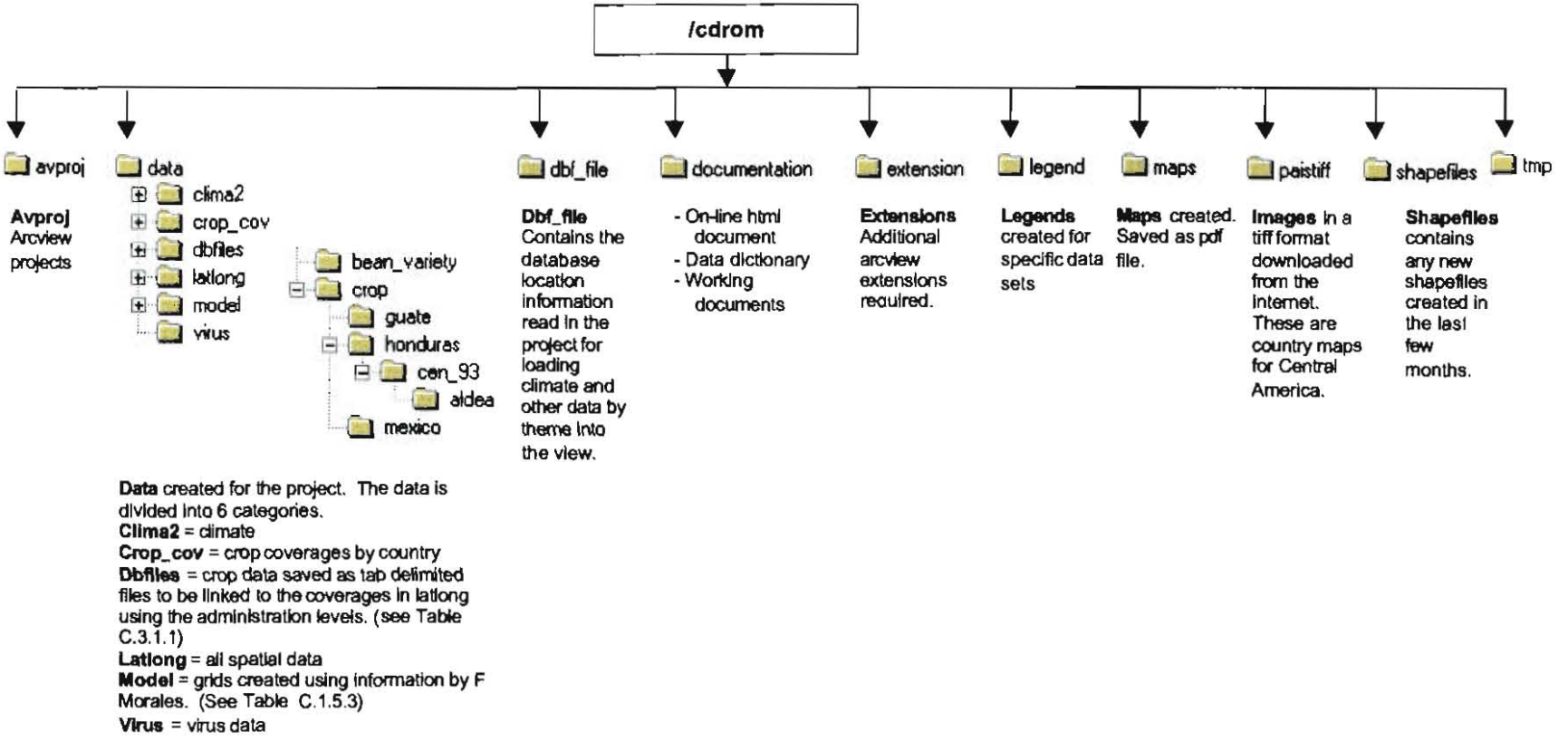
D.2.2 Programmer's Notes

Scripts: The scripts are documented.

(e) Data Structure

The data information file structure is illustrated in Figure E.1.1.

Figure E.1.1: Directory Structure of Information



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Software:

The data was collected by CIAT and the analysis was performed using the following software: ARC/INFO, ArcView GIS 3.1, Idrisi, PCI, Splus and Excel.

Appendix A

A.1 Bean Varieties for Honduras, Guatemala and El Salvador

Table A.1.1: Bean varieties used in Honduras

Variety	Year	Res	% Loss	Where Used	Comments
ACACIAS 4	1980	S			Never Released
COPAN	1982	S			Never Released
ILAMA	1982	S			Never Released
ESPERANZA 4	1984	S		Esperanza (Highlands)	
ARAULI 85	1987	S		Danli	
CATRACHITA	1987	S		Danli, F. Morazan	
DORADO	1990	R		Danli, F. Morazan	
ORIENTE	1990	S			Never Released
DON SILVIO	1992	R			
Tio Canela	1994	R		Danli, F. Morazan, Comayagua	
DICTA 113	1996	R		Danli, F. Morazan, Olancho	
DICTA 122	1996	R		Danli, F. Morazan, Olancho	
Desarrural 1R		S			
Zamorano		S		Danli,F.Morazan	
Chingo		S		Yoro	
Danli-46		S		Danli	

R = resistant; T = tolerant; I = intermediate; S = susceptible
Source: Mosaico Dorado del Frijol; CIAT Impact Data Base (www.CGIAR.CIAT/IMPACT), F Morales (personal communication, 1999); S Beebe (personal communication, 1999)

Map A.1.1: Bean varieties mapped by department in Honduras

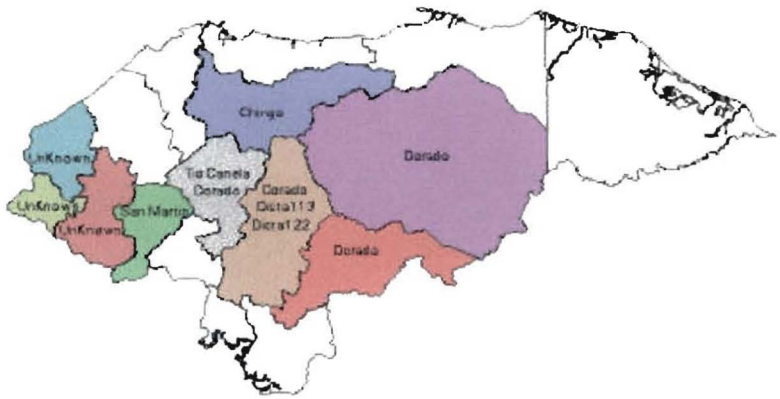


Table A.1.2: Bean varieties used in Guatemala

Variety	Year	Res	% Loss	Where Used	Comments
Compuesto Chimalteco 1	1958	S			Never Released
Compuesto Chimalteco 2	1958	S			Never Released
Culipa 72	1972	S			Never Released
Ipala 72	1972	S			Never Released
Jalpatagua 72	1972	S			Never Released
San Pedro Pinula 72	1972	S			Never Released
Culma	1977	S			Never Released
SUCHITAN	1978	R		Jutlapa	Never Released
ICTA-Jutlapan	1979	R			Never Released
ICTA-Quetzal	1979	R		Jutiapa (800-1000), Jalapa (low elevations), Huehuetenango (low elevations), Baja Verapaz (800-1000), Zacapa (130-1300)	
ICTA-Tamazulapa	1979	R		Jutiapa (800-1000), Jalapa (low elevations), Huehuetenango (low elevations), Quiche (low elevations+l1), Baja Verapz (800-1000), Zacapa (130-1300), Chiquimula(450-1000), El Progresso(1000-1200)	
ICTA-S.Martin	1979	S		Jalapa (alta), (Quezalenango, Totonicapan, San Marcos (1500-2400m)), El Progresso(1200-1900)	
ICTA-Quinack-Ché	1985	S		Jalapa (alta), Quiche (alta), (Quezalenango, Totonicapan, San Marcos (1500-2400m)), Solola	
ICTA-Parramos	1985	S		Jalapa (alta)	
ICTA-Ostúa	1986	R		Jutiapa (800-1000), Jalapa (bajo), Huehuetenango (baja), Quiche (baja), Baja Verapz (800-1000), Zacapa (130-1300), Chiquimula(450-1000), El Progresso(1000-1200)	
ICTA-Texel	1989	S		(Quezalenango, Totonicapan, San Marcos (1500-2400m)), Solola	
DORICTA	1992	R		coast	Never Released
ICTA-Costeña	1992	R		coast	
ICTA-Sta. Gertrudis	1992	R		Jutiapa	
ICTA-Chapina	1992	R		Jutiapa	
ICTA-Altense	1993	R		Chimaltenango	
ICTA-Hunapú	1993	S		Chimaltenango; Quetzaltenango	
ICTA LIGERO	1998	R		Jutiapa	
Turrialba 1 N		R			Never

Variety	Year	Res	% Loss	Where Used	Comments
					Released
ICTA-Chivarreto		S		Quetzalenango y Totonicapan (2500-2700 m); Cabrican, Huitan, San Carlos Sija, La Union, Sbilla, San Francisco el Alto	

R = resistent; T = tolerant; I = intermediate; S = susceptible

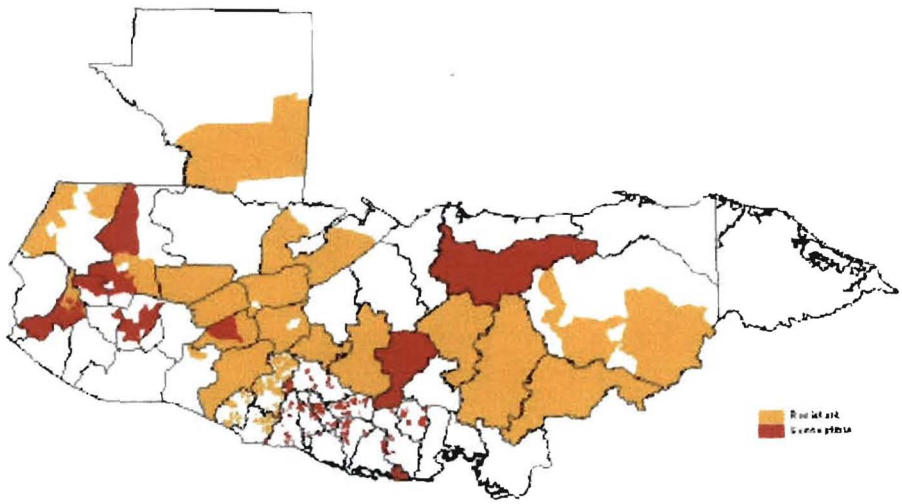
Source: Mosaico Dorado del Frijol; [1]Rodriguez, R., Problematica del Complejo Mosca Blanca-Virus el Mosaico Dorado en Frijol *Phaseolus vulgaris* L. en Centro America (1994); ICTA Recomendaciones 1990; F Morales (personal communication, 1999); S Beebe (personal communication, 1999)

Table A.1.3: Bean varieties used in El Salvador

Variety	Year	Res	% Loss	Where Used	Comments
Porrillo Sintético	1968	R		Ahuachapán, Santa Ana, Sonsonate	
Porrillo 70	1970	R			
Rojo 70	1970	S			Never Released
CENTA TAZUMAL	1982	R			Never Released
CENTA JIBOA	1988	R			Never Released
Rojo Savadoreño 1	1997	S		Ahuachapán, Santa Ana, Sonsonate	
CENTA-Cuzcatleco		R		Ahuachapán, Santa Ana, Sonsonate	
LineaDOR585		R		Ahuachapán, Santa Ana, Sonsonate	not officially used
27 R		R			
Nahulzalco negro		S			
Nahulzalco Rojo		R			
Porrillo 1		R			
Rojo de Seda		S			
Frijol Mono		S			
Arbolito Rojo		S			
Cuarenteño		S			
LineaDOR582		R		Coastal	
Corneta		S			
Sangre de Toro		S			

R = resistent; T = tolerant; I = intermediate; S = susceptible;
Source: Mosaico Dorado del Frijol; [1]Data Collection Trip, by Cabrera y Puquirre;
[2]Situación Actual del Cultivo de Frijol en El Salvador, 1997; [3]Importancia del Frijol en El Salvador;
F Morales (personal communication, 1999); S Beebe (personal communication, 1999)

Map A.1.2: Varieties mapped by resistance to BGMV for Honduras, Guatemala and El Salvador



The use of GIS Spatial Analysis to model the Occurrence of Bean Golden Mosaic Virus and predict areas susceptible to outbreaks in Guatemala, Honduras and El Salvador (J Klass (1998))

Data Dictionary for all datasets

NOTE: All spatial data sets are located in /data/latlong.

All climate data are located in /data/clima2

Cover Name:	**access_g: Accessibility**		
Source:	CIAT	**Source Date:**	1998
		Comments:	
Cell Size	0.019		
Data Type:	Integer		
Number of Rows	4823	**Number of Values**	12
Number of Columns	6524	**Attribute Data (bytes)**	12
BOUNDARY STATISTICS			
Xmin	-133.715	**Minimum Value**	0.000
Xmax	-11.512	**Maximum Value**	11.000
Ymin	-55.269	**Mean**	5.423
Ymax	35.072	**Standard Deviation**	2.299
COORDINATE SYSTEM DESCRIPTION			
Projection	GEOGRAPHIC	**Spheroid**	WGS84
Datum	WGS84	**Units**	DD
Parameters:			

ACCESS_G.VAT							
COLUMN	**ITEM NAME**	**WIDTH**	**OUT PUT**	**TYPE**	**N.DEC ALTERNATE NAME**	**INDEXED?**	**Description**
1	VALUE	4	10	B	-	Indexed	
5	COUNT	4	10	B	-	-	
9	INVERTED	4	10	B	-	-	Travel values in hours

Cover Name:	**Admlacsa: boundaries by country, admin_l2, admin_l3 and admin_l4**		
Source:	CIAT fitted to DCW boundary	**Source Date:**	1998
		Comments:	
Feature Class	Spatial Subclass	**Features**	Topology?
ARCS			
POLYGONS	17308	**406**	Yes
NODES			
Polygon Labels	17307		
Fuzzy	0.000	**Dangle**	0.000
BOUNDARY STATISTICS			
Xmin	-117.300	**Precision**	Double
Xmax	-55.759		
Ymin	-34.787		
Ymax	32.717		
COORDINATE SYSTEM DESCRIPTION			
Projection	GEOGRAPHIC	**Spheroid**	WGS84
Datum	WGS84	**Units**	DD
Parameters:			

ADMLACSA.PAT							
COLUMN	ITEM NAME	WIDTH	OUT PUT	TYPE	N.DEC ALTERNATE NAME	INDEXED?	Description
1	AREA	8	18	F	5	-	

9	PERIMETER	8	18	F	5	-	
17	ADMLACSA#	4	5	B	-	-	
21	ADMLACSA-ID	4	5	B	-	-	
25	FEATURE	25	25	C	-	-	
50	FEATURE-ID	10	10	I	-	-	
60	FEATURE_TYPE	13	13	C	-	-	
73	PAIS	25	25	C	-	-	Country boundary
98	ADMIN_L2	25	25	C	-	-	Admin level 2 boundary
123	ADMIN_L3	25	25	C	-	-	Admin level 3 boundary
148	ADMIN_L4	25	25	C	-	-	Admin level 4 boundary
173	ISO	4	4	C	-	-	ISO code
177	ISO_N	4	4	I	-	-	ISO number
181	DEP	14	14	I	-	-	Admin_l2 code
195	MUN	14	14	I	-	-	Admin_l3 code
209	ISODEPMUN	16	16	I	-	-	ISO, admin_l2, admin_l3 unique code
225	SOURCE	60	60	C	-	-	Data source
285	SOURCE_DATE	6	6	I	-	-	Data source date
291	EDITOR	20	20	C	-	-	Data editor
311	MOD_DATE	6	6	I	-	-	Modification date
317	COMMENTS	40	40	C	-	-	Comments
357	BIB_REF	50	50	C	-	-	Bibliographic Reference

Cover Name:	**Aspect: Aspect created from dem**		
Source:	CIAT	**Source Date:**	1998
		Comments:	
Cell Size	0.010		
Data Type:	Floating Point		
Number of Rows	4347		
Number of Columns	6912		
BOUNDARY STATISTICS			
Xmin	-124.118	**Minimum Value**	-1.000
Xmax	-54.998	**Maximum Value**	359.999
Ymin	-3.468	**Mean**	48.259
Ymax	40.002	**Standard Deviation**	95.450
COORDINATE SYSTEM DESCRIPTION			
Projection	GEOGRAPHIC	**Spheroid**	WGS84
Datum	WGS84	**Units**	DD
Parameters:			

Cover Name:	**Bea_ciat: bean points**		
Source:	CIAT	**Source Date:**	1998
		Comments:	One point = 1000 ha
Feature Class	**Features**	**Bytes**	**Topology?**
Points	2314	50	
Fuzzy	0.002	**Dangle**	0.000
BOUNDARY STATISTICS			
Xmin	-111.683	**Precision**	Single
Xmax	-68.716		
Ymin	0.831		
Ymax	29.667		
COORDINATE SYSTEM DESCRIPTION			
Projection	GEOGRAPHIC	**Spheroid**	CLARKE1866
Datum		**Units**	DD

Parameters:							
BEA_CIAT.PAT							
COLUMN	ITEM NAME	WIDTH	OUT PUT	TYPE	N.DEC ALTERNATE NAME	INDEXED?	Description
1	AREA	4	12	F	3	-	
5	PERIMETER	4	12	F	3	-	
9	BEA_CIAT#	4	5	B	-	-	
13	BEA_CIAT-ID	4	5	B	-	-	
17	BEANDD_COV#	4	5	B	-	-	
21	BEANDD_COV-ID	4	5	B	-	-	
25	PAIS_BND#	4	5	B	-	-	
29	PAIS_BND-ID	4	5	B	-	-	
33	PAIS	18	18	C	-	-	

Cover Name:	**bea_muni: bean production by municipality**		
Source:	CIAT	**Source Date:**	1997
		Comments:	
Feature Class	**Spatial Subclass**	**Features**	**Topology?**
ARCS		28	
POLYGONS	4784	142	Yes
NODES			
Polygon Labels	4783		
Fuzzy	0.000	**Dangle**	0.000
BOUNDARY STATISTICS			
Xmin	-117.299	**Precision**	Single
Xmax	-77.174		
Ymin	7.198		
Ymax	32.717		
COORDINATE SYSTEM DESCRIPTION			
Projection	GEOGRAPHIC	**Spheroid**	WGS84
Datum	WGS84	**Units**	DD
Parameters:			

BEA_MUNI .PAT							
COLUMN	ITEM NAME	WIDTH	OUT PUT	TYPE	N.DEC ALTERNATE NAME	INDEXED ?	Description
1	AREA	4	12	F	3	-	
5	PERIMETER	4	12	F	3	-	
9	BEA_MUNI#	4	5	B	-	-	
13	BEA_MUNI-ID	4	5	B	-	-	
17	ATLAS_S	25	25	C	-	-	Admin_l2 name
42	ATLAS_P	25	25	C	-	-	Admin_l3 name
67	ATLAS_T	25	25	C	-	-	Admin_l4 name
92	PAIS	18	18	C	-	-	Country Name
110	FAO	4	4	C	-	-	
114	DEP	6	6	C	-	-	Department
120	HAFRIJOL	8	11	I	-	-	Beans produced (hectares)
128	TNFRIJOL	8	11	I	-	-	Beans produced (tonnes)
136	MUN	7	7	I	-	-	Municipio number

Cover Name:	**BGMV94: Bean golden mosaic virus 1994**		
Source:	Mosaico Dorado del Frijol, Avances de Investigacion 1994, CIAT	**Source Date:**	1994
		Comments:	
Feature Class	**Features**	**Bytes**	**Topology?**
Polygons	29	70	Yes
ARCS			
NODES			
Polygon Labels	28		
Fuzzy	0.000	**Dangle**	0.000
BOUNDARY STATISTICS			
Xmin	-112.183	**Precision**	Double
Xmax	-70.585		
Ymin	9.902		
Ymax	27.041		
COORDINATE SYSTEM DESCRIPTION			
Projection	GEOGRAPHIC	**Spheroid**	WGS84
Datum	WGS84	**Units**	DD
Parameters:			

BGMV94.PAT							
COLUMN	ITEM NAME	WIDTH	OUTPUT	TYPE	N.DEC ALTERNATE NAME	INDEXED?	Description
1	AREA	4	12	F	3	-	
5	PERIMETER	4	12	F	3	-	
9	BGMV94#	4	5	B	-	-	
13	BGMV94-ID	4	5	B	-	-	
17	COMMENTS	40	40	C	-	-	Comments
57	DATE	4	4	I	-	-	Date created
61	SOURCE	4	4	C	-	-	Source of information
65	CROPINFO	3	3	I	-	-	1: Affected Beans 2: Affected horticultural crops 3: Affected Beans and horticultural crops 4: Critically affected Beans 5: Critically affected horticultural crops 6: Critically affected Beans
68	BGMV-ID	3	3	I	-	-	

Cover Name:	**bt_crit: Bemisia tabaci locations based upon critical temperature range and elevation**		
Source:	CIAT (factors by P Anderson and F Morales)	**Source Date:**	1998
		Comments:	
Cell Size	0.167		
Data Type:	Floating Point		
Number of Rows	173		
Number of Columns	322		
BOUNDARY STATISTICS			
Xmin	-117.708	**Minimum Value**	20.047
Xmax	-64.041	**Maximum Value**	30.724
Ymin	4.317	**Mean**	24.799
Ymax	33.151	**Standard Deviation**	1.520
COORDINATE SYSTEM DESCRIPTION			

Projection	GEOGRAPHIC	**Spheroid**	WGS84
Datum	WGS84	**Units**	DD
Parameters:			

Cover Name:	**bt_opt: Bemisia tabaci locations based upon optimum temperature range and elevation**		
Source:	CIAT (factors by P Anderson and F Morales)	**Source Date:**	1998
		Comments:	
Cell Size	0.167		
Data Type:	Floating Point		
Number of Rows	173		
Number of Columns	322		
BOUNDARY STATISTICS			
Xmin	-117.708	**Minimum Value**	22.260
Xmax	-64.041	**Maximum Value**	27.303
Ymin	4.317	**Mean**	25.281
Ymax	33.151	**Standard Deviation**	0.766
COORDINATE SYSTEM DESCRIPTION			
Projection	GEOGRAPHIC	**Spheroid**	WGS84
Datum	WGS84	**Units**	DD
Parameters:			

Cover Name:	**Cen_bnd: central america country boundary**		
Source:	DCW, 1:1000000	**Source Date:**	1984
		Comments:	
Feature Class	**Features**	**Bytes**	**Topology?**
ARCS		28	
POLYGONS	1008	38	Yes
NODES			
Polygon Labels	1007		
Fuzzy	0.002	**Dangle**	0.000
BOUNDARY STATISTICS			
Xmin	-92.242	**Precision**	Single
Xmax	-77.174		
Ymin	7.199		
Ymax	18.497		
COORDINATE SYSTEM DESCRIPTION			
Projection	GEOGRAPHIC	**Spheroid**	WGS84
Datum	WGS84	**Units**	DD
Parameters:			

CEN_BND. PAT							
COLUMN	ITEM NAME	WIDTH	OUT PUT	TYPE	N.DEC ALTERNATE NAME	INDEXED ?	Description
1	AREA	4	12	F	3	-	
5	PERIMETER	4	12	F	3	-	
9	CEN_BND#	4	5	B	-	-	
13	CEN_BND-ID	4	5	B	-	-	
17	PAIS	18	18	C	-	-	
35	SYMBOL	3	3	I	-		

Cover Name:	**Cen_lbl: Central American Pais labels**		
Source:	CIAT	**Source Date:**	1998
		Comments:	
Feature Class	**Features**	**Bytes**	**Topology?**
Points	12	34	
Fuzzy	0.002	**Dangle**	0.000
BOUNDARY STATISTICS			
Xmin	-103.338	**Precision**	Single
Xmax	-66.870		
Ymin	-4.248		
Ymax	24.584		
COORDINATE SYSTEM DESCRIPTION			
Projection	GEOGRAPHIC	**Spheroid**	WGS84
Datum	WGS84	**Units**	DD
Parameters:			

CEN_LBL.PAT

COLUMN	ITEM NAME	WIDTH	OUT PUT	TYPE	N.DEC ALTERNATE NAME	INDEXED ?	Description
1	AREA	4	12	F	3	-	
5	PERIMETER	4	12	F	3	-	
9	CEN_LBL#	4	5	B	-	-	
13	CEN_LBL-ID	4	5	B	-	-	
17	PAIS	18	18	C	-	-	Country name

Cover Name:	**dem1km: Digital elevation model (meters)**		
Source:	USGS, http://edcwww.cr.usgs.gov/landdaac/gtopo30/gtopo30.html	**Source Date:**	1998
		Comments:	
Cell Size	0.008		
Data Type:	Integer		
Number of Rows	3461	**Number of Values**	4682
Number of Columns	6434	**Attribute Data (bytes)**	8
BOUNDARY STATISTICS			
Xmin	-117.708	**Minimum Value**	1.000
Xmax	-64.092	**Maximum Value**	5500.000
Ymin	4.317	**Mean**	679.627
Ymax	33.158	**Standard Deviation**	760.626
COORDINATE SYSTEM DESCRIPTION			
Projection	GEOGRAPHIC	**Spheroid**	WGS84
Datum	WGS84	**Units**	DD
Parameters:		**Zunits**	METERS

Cover Name:	**Hillshade: Shaded relief**		
Source:	CIAT, Created in Arc/Info v7.1.1 using dem1km	**Source Date:**	1998
		Comments:	
Cell Size	0.010		
Data Type:	Integer	**Number of Values**	203
Number of Rows	4169	**Attribute Data (bytes)**	8
Number of Columns	6630		
BOUNDARY STATISTICS			
Xmin	-124.116	**Minimum Value**	0.000
Xmax	-54.992	**Maximum Value**	253.000

Ymin	-3.470	**Mean**	179.419
Ymax	39.996	**Standard Deviation**	8.737
COORDINATE SYSTEM DESCRIPTION			
Projection	GEOGRAPHIC	**Spheroid**	WGS84
Datum	WGS84	**Units**	DD
Parameters:			

Cover Name:	**hold_g: holdridge life zones**		
Source:	CIAT, Peter Jones	**Source Date:**	1998
		Comments:	
Cell Size	0.167		
Data Type:	Integer	**Number of Values**	38
Number of Rows	540	**Attribute Data (bytes)**	8
Number of Columns	510		
BOUNDARY STATISTICS			
Xmin	-119.000	**Minimum Value**	0.000
Xmax	-34.000	**Maximum Value**	38.000
Ymin	-56.000	**Mean**	2.991
Ymax	34.000	**Standard Deviation**	6.599
COORDINATE SYSTEM DESCRIPTION			
Projection	GEOGRAPHIC	**Spheroid**	CLARKE1866
Datum		**Units**	DD
Parameters:			

HOLD_G. VAT

COLUMN	ITEM NAME	WIDTH	OUT PUT	TYPE	N.DEC ALTERNATE NAME	INDEXED?	Description
1	VALUE	4	10	B	-	Indexed	1 : T-d, Tropical Desert 2 : T-ds, Tropical Desert scrub 3 : T-tw, Tropical Thorn woodland 4 : T-vdf, Tropical Very dry forest 5 : T-df, Tropical Dry forest 6 : T-mf, Tropical Moist forest 7 : T-wf, Tropical Wet forest 8 : T-rf, Tropical Rain forest 9 : S-d, Premontane Desert 10 : S-ds, Premontane Desert scrub 11 : S-tw, Premontane Thorn woodland 12 : S-df, Premontane Dry forest 13 : S-mf, Premontane Moist forest 14 : S-wf, Premontane Wet forest 15 : S-rf, Premontane Rain forest 16 : W-d, Lower montane Desert 17 : W-ds, Lower montane Desert scrub 18 : W-tw, Lower montane Thorn woodland 19 : W-df, Lower montane Dry forest 20 : W-mf, Lower montane Moist forest 21 : W-wf, Lower montane Wet forest 22 : W-rf, Lower montane Rain forest 23 : C-d, Montane Desert 24 : C-ds, Montane Desert scrub 25 : C-s, Montane Steppe 26 : C-mf, Montane Moist forest 27 : C-wf, Montane Wet forest 28 : C-rf, Montane Rain forest 29 : B-d, Subalpine Desert

							30 : B-ds, Subalpine Desert scrub 31 : B-mf, Subalpine Moist forest 32 : B-wf, Subalpine Wet forest 33 : B-rf, Subalpine Rain forest 34 : SP-dt, Alpine Dry tundra 35 : SP-mt, Alpine Moist tundra 36 : SP-wt, Alpine Wet tundra 37 : SP-rt, Alpine Rain tundra 38 : P, Nival forms

Cover Name:	**hspcc_g: Hotspots for caribbean**		
Source:	CIAT, Data provided by F Morales	**Source Date:**	1998
		Comments:	
Cell Size	0.120		
Data Type:	Integer	**Number of Values**	6
Number of Rows	128	**Attribute Data (bytes)**	8
Number of Columns	172		
BOUNDARY STATISTICS			
Xmin	-90.832	**Minimum Value**	0.000
Xmax	-70.192	**Maximum Value**	6.000
Ymin	7.725	**Mean**	2.468
Ymax	23.085	**Standard Deviation**	2.378
COORDINATE SYSTEM DESCRIPTION			
Projection	GEOGRAPHIC	**Spheroid**	WGS84
Datum	WGS84	**Units**	DD
Parameters:			

HSPCC_G.VAT

COLUMN	ITEM NAME	WIDTH	OUTPUT	TYPE	N.DEC ALTERNATE NAME	INDEXED ?	Description
1	VALUE	4	10	B	-		0: Not affected 1: Affected Beans 2: Affected horticultural crops 3: Affected Beans and horticultural crops 4: Critically affected Beans 5: Critically affected horticultural crops 6: Critically affected Beans
5	COUNT	4	10	B	-		

Cover Name:	**Hsp_car: hotspot areas for Caribbean**		
Source:	CIAT, Data provided by F Morales	**Source Date:**	1998
		Comments:	
Feature Class	***Features***	**Bytes**	**Topology?**
Points	20	84	
Fuzzy	0.002	**Dangle**	0.000
BOUNDARY STATISTICS			
Xmin	-120.002	**Precision**	Single
Xmax	-70.259		
Ymin	18.236		
Ymax	35.000		
COORDINATE SYSTEM DESCRIPTION			
Projection	GEOGRAPHIC	**Spheroid**	WGS84
Datum	WGS84	**Units**	DD

Parameters:							
HSP_CAR .PAT							
COLUMN	ITEM NAME	WIDTH	OUT PUT	TYPE	N.DEC ALTERNATE NAME	INDEXED?	Description
1	AREA	4	12	F	3	-	
5	PERIMETER	4	12	F	3	-	
9	HSP_CAR#	4	5	B	-	-	
13	HSP_CAR-ID	4	5	B	-	-	
17	PPPTTYPE	2	2	I	-	-	1:Populated Place 2: populated place(within urbanized areas) 3: Places associated with a special symbol 4: kampong 5: Circular village
19	PPPTNAME	40	40	C	-	-	Name of place
59	PPPTFLAG	2	2	I	-	-	
61	DATE	4	4	I	-	-	Date of data
65	POP	8	8	I	-	-	Population
73	SOURCE	4	4	C	-	-	Source of information
77	POPEST	5	5	I	-	-	Population estimate
82	CROPINFO	3	3	I	-	-	1: Affected Beans 2: Affected horticultural crops 3: Affected Beans and horticultural crops 4: Critically affected Beans 5: Critically affected horticultural crops 6: Critically affected Beans

Cover Name:	**Hsp_cen: hotspot areas for Central America**		
Source:	CIAT, Data provided by F Morales	**Source Date:**	1998
		Comments:	
Feature Class	**Features**	**Bytes**	**Topology?**
Points	28	84	
Fuzzy	0.002	**Dangle**	0.000
BOUNDARY STATISTICS			
Xmin	-120.002	**Precision**	Single
Xmax	-80.276		
Ymin	7.785		
Ymax	35.000		
COORDINATE SYSTEM DESCRIPTION			
Projection	GEOGRAPHIC	**Spheroid**	WGS84
Datum	WGS84	**Units**	DD
Parameters:			

HSP_CEN. PAT							
COLUMN	ITEM NAME	WIDTH	OUT PUT	TYPE	N.DEC ALTERNATE NAME	INDEXED?	Description
1	AREA	4	12	F	3	-	
5	PERIMETER	4	12	F	3	-	
9	HSP_CEN#	4	5	B	-	-	
13	HSP_CEN-ID	4	5	B	-	-	
17	PPPTTYPE	2	2	I	-	-	1:Populated Place 2: populated place(within

							urbanized areas) 3: Places associated with a special symbol 4: kampong 5: Circular village
19	PPPTNAME	40	40	C	-	-	Name of place
59	PPPTFLAG	2	2	I	-	-	
61	DATE	4	4	I	-	-	Date of data
65	POP	8	8	I	-	-	Population
73	SOURCE	4	4	C	-	-	Source of information
77	POPEST	5	5	I	-	-	Population estimate
82	CROPINFO	3	3	I	-	-	1: Affected Beans 2: Affected horticultural crops 3: Affected Beans and horticultural crops 4: Critically affected Beans 5: Critically affected horticultural crops 6: Critically affected Beans

Cover Name:	**Hspa_lbl: hotspot labels**		
Source:	CIAT	**Source Date:**	1998
		Comments:	
Feature Class	**Features**	**Bytes**	**Topology?**
Points	62	84	
Fuzzy	0.002	**Dangle**	0.000
BOUNDARY STATISTICS			
Xmin	-120.002	**Precision**	Single
Xmax	-67.691		
Ymin	7.701		
Ymax	35.000		
COORDINATE SYSTEM DESCRIPTION			
Projection	GEOGRAPHIC	**Spheroid**	WGS84
Datum	WGS84	**Units**	DD
Parameters:			

HSPA_LBL .PAT							
COLUMN	ITEM NAME	WIDTH	OUT PUT	TYPE	N.DEC ALTERNATE NAME	INDEXED ?	Description
1	AREA	4	12	F	3	-	
5	PERIMETER	4	12	F	3	-	
9	HSPA_LBL#	4	5	B	-	-	
13	HSPA_LBL-ID	4	5	B	-	-	
17	PPPTTYPE	2	2	I	-	-	1:Populated Place 2: populated place(within urbanized areas) 3: Places associated with a special symbol 4: kampong 5: Circular village
19	PPPTNAME	40	40	C	-	-	Name of place
59	PPPTFLAG	2	2	I	-	-	
61	DATE	4	4	I	-	-	Date of data
65	POP	8	8	I	-	-	Population
73	SOURCE	4	4	C	-	-	Source of information
77	POPEST	5	5	I	-	-	Population estimate
82	CROPINFO	3	3	I	-	-	1: Affected Beans

							2: Affected horticultural crops 3: Affected Beans and horticultural crops 4: Critically affected Beans 5: Critically affected horticultural crops 6: Critically affected Beans

Cover Name:	**Hspa_pnt: hotspot points**		
Source:	CIAT, Data provided by F Morales	**Source Date:**	1998
		Comments:	
Feature Class	**Features**	**Bytes**	**Topology?**
Points	48	84	
Fuzzy	0.002	**Dangle**	0.000
BOUNDARY STATISTICS			
Xmin	-90.772	**Precision**	Single
Xmax	-70.259		
Ymin	7.785		
Ymax	23.051		
COORDINATE SYSTEM DESCRIPTION			
Projection	GEOGRAPHIC	**Spheroid**	WGS84
Datum	WGS84	**Units**	DD
Parameters:			

HSPA_PNT .PAT

COLUMN	ITEM NAME	WIDTH	OUT PUT	TYPE	N.DEC ALTERNATE NAME	INDEXED ?	
1	AREA	4	12	F	3	-	
5	PERIMETER	4	12	F	3	-	
9	HSPA_PNT#	4	5	B	-	-	
13	HSPA_PNT-ID	4	5	B	-	-	
17	PPPTTYPE	2	2	I	-	-	1:Populated Place 2: populated place(within urbanized areas) 3: Places associated with a special symbol 4: kampong 5: Circular village
19	PPPTNAME	40	40	C	-	-	Name of place
59	PPPTFLAG	2	2	I	-	-	
61	DATE	4	4	I	-	-	Date of data
65	POP	8	8	I	-	-	Population
73	SOURCE	4	4	C	-	-	Source of information
77	POPEST	5	5	I	-	-	Population estimate
82	CROPINFO	3	3	I	-	-	1: Affected Beans 2: Affected horticultural crops 3: Affected Beans and horticultural crops 4: Critically affected Beans 5: Critically affected horticultural crops 6: Critically affected Beans

Cover Name:	**Hspcalbl: hotspot labels**		
Source:	CIAT	**Source Date:**	1998
		Comments:	
Feature Class	**Features**	**Bytes**	**Topology?**
Points	20	84	
Fuzzy	0.002	**Dangle**	0.000
BOUNDARY STATISTICS			
Xmin	-120.002	**Precision**	Single
Xmax	-67.691		
Ymin	18.182		
Ymax	35.000		
COORDINATE SYSTEM DESCRIPTION			
Projection	GEOGRAPHIC	**Spheroid**	WGS84
Datum	WGS84	**Units**	DD
Parameters:			

HSPCALBL .PAT							
COLUMN	ITEM NAME	WIDTH	OUT PUT	TYPE	N.DEC ALTERNATE NAME	INDEXED ?	
1	AREA	4	12	F	3	-	
5	PERIMETER	4	12	F	3	-	
9	HSPCALBL#	4	5	B	-	-	
13	HSPCALBL - ID	4	5	B	-	-	
17	PPPTTYPE	2	2	I	-	-	1:Populated Place 2: populated place(within urbanized areas) 3: Places associated with a special symbol 4: kampong 5: Circular village
19	PPPTNAME	40	40	C	-	-	Name of place
59	PPPTFLAG	2	2	I	-	-	
61	DATE	4	4	I	-	-	Date of data
65	POP	8	8	I	-	-	Population
73	SOURCE	4	4	C	-	-	Source of information
77	POPEST	5	5	I	-	-	Population estimate
82	CROPINFO	3	3	I	-	-	1: Affected Beans 2: Affected horticultural crops 3: Affected Beans and horticultural crops 4: Critically affected Beans 5: Critically affected horticultural crops 6: Critically affected Beans

Cover Name:	**Hspcelbl: hotspot labels**		
Source:	CIAT	**Source Date:**	1998
		Comments:	
Feature Class	**Features**	**Bytes**	**Topology?**
Points	28	84	
Fuzzy	0.002	**Dangle**	0.000
BOUNDARY STATISTICS			
Xmin	-120.002	**Precision**	Single
Xmax	-80.087		

Ymin	7.701		
Ymax	35.000		
COORDINATE SYSTEM DESCRIPTION			
Projection	GEOGRAPHIC	**Spheroid**	WGS84
Datum	WGS84	**Units**	DD
Parameters:			

HSPCELBL.PAT

COLUMN	ITEM NAME	WIDTH	OUTPUT	TYPE	N.DEC ALTERNATE NAME	INDEXED ?	
1	AREA	4	12	F	3	-	
5	PERIMETER	4	12	F	3	-	
9	HSPCELBLT#	4	5	B	-	-	
13	HSPCELBL-ID	4	5	B	-	-	
17	PPPTTYPE	2	2	I	-	-	1:Populated Place 2: populated place(within urbanized areas) 3: Places associated with a special symbol 4: kampong 5: Circular village
19	PPPTNAME	40	40	C	-	-	Name of place
59	PPPTFLAG	2	2	I	-	-	
61	DATE	4	4	I	-	-	Date of data
65	POP	8	8	I	-	-	Population
73	SOURCE	4	4	C	-	-	Source of information
77	POPEST	5	5	I	-	-	Population estimate
82	CROPINFO	3	3	I	-	-	1: Affected Beans 2: Affected horticultural crops 3: Affected Beans and horticultural crops 4: Critically affected Beans 5: Critically affected horticultural crops 6: Critically affected Beans

Cover Name:	**Hspmelbl: hotspot labels**		
Source:	CIAT	**Source Date:**	1998
		Comments:	
Feature Class	**Features**	**Bytes**	**Topology?**
Points	14	68	
Fuzzy	0.002	**Dangle**	0.000
BOUNDARY STATISTICS			
Xmin	-120.002	**Precision**	Single
Xmax	-88.648		
Ymin	16.500		
Ymax	35.000		
COORDINATE SYSTEM DESCRIPTION			
Projection	GEOGRAPHIC	**Spheroid**	WGS84
Datum	WGS84	**Units**	DD
Parameters:			

HSPMELBL.PAT

COLUMN	ITEM NAME	WIDTH	OUTPUT	TYPE	N.DEC ALTERNATE NAME	INDEXED ?	

1	AREA	4	12	F	3	-	
5	PERIMETER	4	12	F	3	-	
9	HSPMELBL #	4	5	B	-	-	
13	HSPMELBL - ID	4	5	B	-	-	
17	PPPTTYPE	2	2	I	-	-	1:Populated Place 2: populated place(within urbanized areas) 3: Places associated with a special symbol 4: kampong 5: Circular village
57	DATE	4	4	I	-	-	Name of place
61	SOURCE	4	4	C	-	-	Source of Data
65	CROPINFO	3	3	I	-	-	1: Affected Beans 2: Affected horticultural crops 3: Affected Beans and horticultural crops 4: Critically affected Beans 5: Critically affected horticultural crops 6: Critically affected Beans

Cover Name:	**Hspmepol: Hotspots in Mexico**		
Source:	CIAT, Data provided by F Morales	**Source Date:**	1998
		Comments:	
Feature Class	**Features**	**Bytes**	**Topology?**
Polygons	15	68	Yes
ARCS			
NODES			
Polygon Labels	14		
Fuzzy	0.000	**Dangle**	0.000
BOUNDARY STATISTICS			
Xmin	-116.977	**Precision**	single
Xmax	-87.037		
Ymin	14.565		
Ymax	32.711		
COORDINATE SYSTEM DESCRIPTION			
Projection	GEOGRAPHIC	**Spheroid**	WGS84
Datum	WGS84	**Units**	DD
Parameters:			

HSPMEPOL .PAT							
COLUMN	ITEM NAME	WIDTH	OUT PUT	TYPE	N.DEC ALTERNATE NAME	INDEXED ?	
1	AREA	4	12	F	3	-	
5	PERIMETER	4	12	F	3	-	
9	HSPMEPOL#	4	5	B	-	-	
13	HSPMEPOL-ID	4	5	B	-	-	
17	PPPTNAME	40	40	C	-	-	Place name
57	DATE	4	4	I	-	-	Date created
61	SOURCE	4	4	C	-	-	Source of Information
65	CROPINFO	3	3	I	-	-	1: Affected Beans 2: Affected horticultural crops 3: Affected Beans and horticultural crops

							4: Critically affected Beans 5: Critically affected horticultural crops 6: Critically affected Beans

Cover Name:		**Igbpcrop: Cultivated landuse information from IGBP(Land Cover: International Geosphere Biosphere Program)**					
Source:		USGS, http://edcwww.cr.usgs.gov/landdaac/glcc/glcc_sa.html				**Source Date:**	1998
						Comments:	
Cell Size		0.016					
Data Type:		Integer					
Number of Rows		2309				**Number of Values**	1
Number of Columns		3617				**Attribute Data (bytes)**	8
BOUNDARY STATISTICS							
Xmin		-117.299				**Minimum Value**	12.000
Xmax		-59.427				**Maximum Value**	12.000
Ymin		-4.230				**Mean**	12.000
Ymax		32.714				**Standard Deviation**	0.000
COORDINATE SYSTEM DESCRIPTION							
Projection		GEOGRAPHIC				**Spheroid**	CLARKE1866
Datum						**Units**	DD
Parameters:							
IGBPCROP.VAT							
COLUMN	ITEM NAME	WIDTH	OUT PUT	TYPE	N.DEC ALTERNATE NAME	INDEXED?	Description
1	VALUE	4	10	B	-	Indexed	12: Croplands

Cover Name:		**Igbplac: from IGBP(Land Cover: International Geosphere Biosphere Program) Central America**					
Source:		USGS, http://edcwww.cr.usgs.gov/landdaac/glcc/glcc_sa.html				**Source Date:**	1998
						Comments:	
Cell Size		0.016					
Data Type:		Integer					
Number of Rows		1805				Number of Values	16
Number of Columns		3355				Attribute Data (bytes)	8
BOUNDARY STATISTICS							
Xmin		-117.713				Minimum Value	1.000
Xmax		-64.102				Maximum Value	17.000
Ymin		4.317				Mean	14.533
Ymax		33.160				Standard Deviation	4.825
COORDINATE SYSTEM DESCRIPTION							
Projection		GEOGRAPHIC				**Spheroid**	CLARKE1866
Datum						**Units**	DD
Parameters:							
IGBPLAC.VAT							
COLUMN	ITEM NAME	WIDTH	OUT PUT	TYPE	N.DEC ALTERNATE NAME	INDEXED ?	Description

1	VALUE	4	10	B	-	Indexed	1: Evergreen Needleleaf Forest 2: Evergreen Broadleaf Forest 3: Deciduous Needleleaf Forest 4: Deciduous Broadleaf Forest 5:Mixed Forest 6:Closed Shrublands 7: Open shrublands 8: woody Savannas 9:Savannas 10:Grasslands 11:Permanent Wetlands 12:Croplands 13:Urban and Built-up 14:Cropland/Natural Vegetation Mosaic 15:Snow and Ice 16:Barren or Sparsely Vegetated 17:Waterbodies

Cover Name:	**Lacmun_r: municipio regions**		
Source:	Admin_l3 boundaries created in CIAT linked to DCW	**Source Date:**	1998
		Comments:	
Feature Class	**Features**	**Bytes**	**Topology?**
Polygons	3516	42	Yes
ARCS			
NODES			
REGIONS (MUN3)	388	42	Yes
Polygon Labels	3516		
Fuzzy	0.000	**Dangle**	0.000
BOUNDARY STATISTICS			
Xmin	-117.299	**Precision**	single
Xmax	-34.788		
Ymin	-55.761		
Ymax	32.717		
COORDINATE SYSTEM DESCRIPTION			
Projection	GEOGRAPHIC	**Spheroid**	WGS84
Datum	WGS84	**Units**	DD
Parameters:			

LACMUN_R.PAT							
COLUMN	ITEM NAME	WIDTH	OUTPUT	TYPE	N.DEC ALTERNATE NAME	INDEXED ?	
1	AREA	4	12	F	3	-	
5	PERIMETER	4	12	F	3	-	
9	LACMUN_R#	4	5	B	-	-	
13	LACMUN_R-ID	4	5	B	-	-	
17	ADMIN_L2	25	25	C	-	-	Admin_l2 name

Cover Name:	**Lacpais_r: country regions**		
Source:	country boundaries created in CIAT linked to DCW	**Source Date:**	1998
		Comments:	
Feature Class	**Features**	**Bytes**	**Topology?**
Polygons	3331	34	Yes
ARCS			
NODES			
REGIONS (PAIS3)	79	34	Yes
Polygon Labels	3331		
Fuzzy	0.000	**Dangle**	0.000
BOUNDARY STATISTICS			
Xmin	-117.299	**Precision**	single
Xmax	-34.788		
Ymin	-55.761		
Ymax	32.717		
COORDINATE SYSTEM DESCRIPTION			
Projection		**Spheroid**	
Datum		**Units**	
Parameters:			

LACPAIS_R.PAT

COLUMN	ITEM NAME	WIDTH	OUTPUT	TYPE	N.DEC	ALTERNATE NAME	INDEXED ?	
1	AREA	4	12	F	3	-	-	
5	PERIMETER	4	12	F	3	-	-	
9	LACPAIS_R#	4	5	B	-	-	-	
13	LACPAIS_R-ID	4	5	B	-	-	-	
17	PAIS	18	18	C	-	-	-	

Cover Name:	**Lacsaall: tomato virus information**		
Source:	CIAT, Tomato virus data provided by P Anderson	**Source Date:**	1998
		Comments:	
Feature Class	**Features**	**Bytes**	**Topology?**
Polygons	14179	224	Yes
ARCS			
NODES			
Polygon Labels	14178		
Fuzzy	0.000	**Dangle**	0.000
BOUNDARY STATISTICS			
Xmin	-117.299	**Precision**	single
Xmax	-34.788		
Ymin	-55.761		
Ymax	32.717		
COORDINATE SYSTEM DESCRIPTION			
Projection		**Spheroid**	
Datum		**Units**	
Parameters:			

LACSAALL.PAT

COLUMN	ITEM NAME	WIDTH	OUTPUT	TYPE	N.DEC ALTERNATE NAME	INDEXED ?	
1	AREA	4	12	F	3	-	
5	PERIMETER	4	12	F	3	-	
9	LACSAALL#	4	5	B	-	-	
13	LACSAALL-ID	4	5	B	-	-	
17	PAIS	18	18	C	-	-	Country Name
35	ADMIN_L2	25	25	C	-	-	ADMIN_L2 name
60	ADMIN_L3	25	25	C	-	-	ADMIN_L3 name
85	ADMIN_L4	25	25	C	-	-	ADMIN_L4 name
110	BGMV	2	2	C	-	-	Bean golden mosaic virus
112	BGMVNUM	2	2	I	-	-	
114	CDTV	2	2	C	-	-	Chino del tomato virus
116	PHV	2	2	C	-	-	Pepper Huasteco Virus
118	TPV	2	2	C	-	-	Texas pepper Virus
120	SGMV	2	2	C	-	-	Serrano Golden mosaic virus
122	STLCV	2	2	C	-	-	Sinaloa tomato leaf curl virus
124	TOMOV	2	2	C	-	-	Tomato mottle virus
126	TTOMOV	2	2	C	-	-	Taino tomato mottle virus
128	TYLCV	2	2	C	-	-	Tomato yellow leaf curl virus
130	PYMV	2	2	C	-	-	Potato yellow mosaic virus
132	TYMV	2	2	C	-	-	Tomato yelllow mosaic virus
134	TOYMOV	8	8	C	-	-	Tomato yellow mottle virus
142	TOYVSV	8	8	C	-	-	Tomato yellow vein streak virus
150	CDTV70	2	2	C	-	-	Chino del tomato virus (1970)
152	TYMV70	2	2	C	-	-	Tomato yellow mosaic virus (1970)
154	TGMV70	2	2	C	-	-	Tomato golden mosaic virus(1970)
156	TOMGV1	2	2	C	-	-	Tomato GV1
158	TOMGV2	2	2	C	-	-	Tomato GV2
160	BZ-IG	2	2	C	-	-	Tomato geminivirus BZ-Ig
162	BZ-UB	2	2	C	-	-	Tomato geminivirus BZ-Ub
164	VIRUS	10	10	C	-	-	Virus type
174	VIRUSTYPE2	50	50	C	-	-	Virus information within the cell

Cover Name:	**Pais_lbl: country labels**		
Source:	CIAT	**Source Date:**	1998
		Comments:	
Feature Class	**Features**	**Bytes**	**Topology?**
Points	12	34	
Fuzzy	0.002	**Dangle**	0.000
BOUNDARY STATISTICS			
Xmin	-103.338	**Precision**	Single
Xmax	-66.870		
Ymin	-4.248		
Ymax	24.584		
COORDINATE SYSTEM DESCRIPTION			
Projection	GEOGRAPHIC	**Spheroid**	WGS84
Datum	WGS84	**Units**	DD
Parameters:			

PAIS_LBL .PAT							
COLUMN	ITEM NAME	WIDTH	OUT PUT	TYPE	N.DEC ALTERNATE NAME	INDEXED ?	
1	AREA	4	12	F	3	-	
5	PERIMETER	4	12	F	3	-	
9	PAIS_LBL#	4	5	B	-	-	
13	PAIS_LBL-ID	4	5	B	-	-	
17	PAIS	18	18	C	-	-	Country Name

Cover Name:	**Rios: Rivers**		
Source:	DCW	**Source Date:**	1984
		Comments:	
Feature Class	**Features**	**Bytes**	**Topology?**
ARCS		32	
NODES			
ANNOTATIONS		624	
Fuzzy	0.000	**Dangle**	0.000
BOUNDARY STATISTICS			
Xmin	-120.002	**Precision**	Single
Xmax	-60.607		
Ymin	7.238		
Ymax	35.000		
COORDINATE SYSTEM DESCRIPTION			
Projection	GEOGRAPHIC	**Spheroid**	WGS84
Datum	WGS84	**Units**	DD
Parameters:			

RIOS.AAT							
COLUMN	ITEM NAME	WIDTH	OUT PUT	TYPE	N.DEC ALTERNATE NAME	INDEXED ?	Description
1	FNODE#	4	5	B	-	-	
5	TNODE#	4	5	B	-	-	
9	LPOLY#	4	5	B	-	-	
13	RPOLY#	4	5	B	-	-	
17	LENGTH	4	12	F	3	-	
21	RIOS#	4	5	B	-	-	
25	RIOS-ID	4	5	B	-	-	
29	DNLNTYPE	2	2	I	-	-	1 Stream, river, channelized river

							2 Inland water body shoreline 3 Wet sand limit 4 Canal,aqueduct, flume, penstock, etc. 5 Glacial limit 6 Snowfield, glacier, or ice limit 7 Ice free limit 8 Connector 9 Tile boundary or null arc 10 Underground 11 Above ground 88 Tile boundary 99 None
31	DNLNSTAT	2	2	I	-	-	1 Perennial 2 Nonperennial 3 Definite 4 Indefinite 5 Unsurveyed perennial 6 Unsurveyed nonperennial 7 Abandoned 8 Under construction 9 Suspended or elevated 10 Underground 11 Above ground 88 Tile boundary 99 None

Cover Name:	**Roads: roads**		
Source:	DCW	**Source Date:**	1984
		Comments:	
Feature Class	**Features**	**Bytes**	**Topology?**
ARCS		40	Yes
NODES			
ANNOTATIONS		87	
Fuzzy	0.000	**Dangle**	0.000
BOUNDARY STATISTICS			
Xmin	-120.002	**Precision**	Single
Xmax	-59.432		
Ymin	7.338		
Ymax	35.000		
COORDINATE SYSTEM DESCRIPTION			
Projection	GEOGRAPHIC	**Spheroid**	WGS84
Datum	WGS84	**Units**	DD
Parameters:			

ROADS.AAT							
COLUMN	ITEM NAME	WIDTH	OUT PUT	TYPE	N.DEC ALTERNATE NAME	INDEXED?	
1	FNODE#	4	5	B	-	-	
5	TNODE#	4	5	B	-	-	
9	LPOLY#	4	5	B	-	-	
13	RPOLY#	4	5	B	-	-	
17	LENGTH	4	12	F	3	-	
21	ROADS#	4	5	B	-	-	
25	ROADS-ID	4	5	B	-	-	
29	RDLNTYPE	2	2	I	-	-	1 Dual lane (divided) highway 2 Primary and secondary road

							3 Track, trail, or footpath 8 Connector within urbanized area
31	RDLNSTAT	2	2	I	-	-	1 Functioning 2 Under construction 3 Existence doubtful 4 Compiled road connector 5 Compiled from adjacent sheet 6 Compiled, under construction 9 Schematic road (urbanized areas only)
33	TIME	7	7	I	-	-	Travel time in hours

Cover Name:	**Soil_94**		
Source:	FAO, UNEP/ISSS/ISRIC/FAO 1993. Global and national soils and terrain database (SOTER). Procedures manual. World Soil Resources Report 74	**Source Date:**	1994
		Comments:	
Feature Class	**Features**	**Bytes**	**Topology?**
Polygons	2100	90	Yes
ARCS			
NODES			
ANNOTATIONS			
Polygon Labels	2100		
Fuzzy	0.036	**Dangle**	0.000
BOUNDARY STATISTICS			
Xmin	-117.114	**Precision**	double
Xmax	-59.426		
Ymin	7.199		
Ymax	32.717		
COORDINATE SYSTEM DESCRIPTION			
Projection	GEOGRAPHIC	**Spheroid**	WGS84
Datum	WGS84	**Units**	DD
Parameters:			

SOIL_94.PAT							
COLUMN	ITEM NAME	WIDTH	OUTPUT	TYPE	N.DEC ALTERNATE NAME	INDEXED ?	
1	AREA	8	18	F	5	-	
9	PERIMETER	8	18	F	5	-	
17	SOIL_94#	4	5	B	-	-	
21	SOIL_94-ID	4	5	B	-	-	
25	SNUM	4	4	I	-	-	is a sequential code, unique for each soil Mapping Unit, which links the first level of soil information to the World expansion data file (WORLDEXP.DAT). This number ranges from 1 to 6999, some numbers in the sequence have not been used (Columns 17-20).
29	FAOSOIL	17	18	C	-	-	is the Soil Unit map symbol, or independent miscellaneous land unit symbol, defines either (Columns 21-37): Soil Mapping Unit: the

							structure of this, starting with the main soil, is explained in Table 4 (list of soils in Annex I); or Independent miscellaneous land units: D/SS = Dunes or Shifting Sand SALT = Salt flats ROCK = Rock debris or desert detritus; or Soil-covering natural features: GL = Glaciers; or WAT = Inland water (lakes or double lined rivers)
46	PHASE1	2	3	C	-	-	comprise codes defining the phases by type: first and second phase of the mapping unit, if present(Columns 38-39 and 40-41): – = No phase or no second phase 01 = Stony 02 = Lithic 03 = Petric 04 = Petrocalcic 05 = Petrogypsic 06 = Petroferric 07 = Phreatic 08 = Fragipan 09 = Duripan 10 = Saline 11 = Sodic 12 = Cerrado
48	PHASE2	2	3	C	-	-	comprise codes defining the phases by type: first and second phase of the mapping unit, if present(Columns 38-39 and 40-41): – = No phase or no second phase 01 = Stony 02 = Lithic 03 = Petric 04 = Petrocalcic 05 = Petrogypsic 06 = Petroferric 07 = Phreatic 08 = Fragipan 09 = Duripan 10 = Saline 11 = Sodic 12 = Cerrado
50	MISCLU1	1	1	I	-	-	comprise the codes defining the dependent miscellaneous land units by type: first and second miscellaneous land unit type (Columns 42 and 43): – = no miscellaneous land unit or no second miscellaneous land unit

							1 = Dunes or shifting sands (2 = Not used) 3 = Salt flats 4 = Rock debris or desert detritus
51	MISCLU2	1	1	I	-	-	comprise the codes defining the dependent miscellaneous land units by type: first and second miscellaneous land unit type (Columns 42 and 43): -- = no miscellaneous land unit or no second miscellaneous land unit 1 = Dunes or shifting sands (2 = Not used) 3 = Salt flats 4 = Rock debris or desert detritus
52	PERMAFROST	1	1	I	-	-	- = Not a permafrost area 1 = Permafrost 2 = Discontinuous permafrost
53	CNTCODE	3	3	I	-	-	is a unique number for each country or area
56	CNTNAME	3	3	C	-	-	is a two letter code, unique for each country or area
59	COUNTRY_NAME	30	30	C	-	-	is the Country or area name
89	SOILCODE	2	2	I	-	-	Soil code
**	REDEFINED ITEMS	**					
25	SOIL-INFO	64	67	C	-	-	is a redefined item that comprises all items starting from column 17
29	SOIL-ASSOCIATION	24	27	C	-	-	is a redefined item that includes all soil information, with items starting from column 21 to 43

Cover Name:	**Soilcen, soils for central america**		
Source:	FAO, UNEP/ISSS/ISRIC/FAO 1993. Global and national soils and terrain database (SOTER). Procedures manual. World Soil Resources Report 74	**Source Date:**	1994
		Comments:	
Feature Class	**Features**	**Bytes**	**Topology?**
Polygons	1181	64	Yes
ARCS			
NODES			
ANNOTATIONS			
Polygon Labels	1180		
Fuzzy	0.000	**Dangle**	0.001
BOUNDARY STATISTICS			
Xmin	-117.114	**Precision**	single
Xmax	-59.384		
Ymin	7.189		
Ymax	32.718		
COORDINATE SYSTEM DESCRIPTION			
Projection	GEOGRAPHIC	**Spheroid**	WGS84
Datum	WGS84	**Units**	DD
Parameters:			

SOILCEN.PAT							
COLUMN	ITEM NAME	WIDTH	OUTPUT	TYPE	N.DEC ALTERNATE NAME	INDEXED?	
1	AREA	4	12	F	3	-	
5	PERIMETER	4	12	F	3	-	
9	SOILCEN#	4	5	B	-	-	
13	SOILCEN-ID	4	5	B	-	-	
17	SNUM	4	4	I	-	-	
21	FAOSOIL	17	18	C	#NAME?	-	
38	PHASE1	2	3	C	-	-	
40	PHASE2	2	3	C	-	-	
42	MISCLU1	1	1	I	-	-	
43	MISCLU2	1	1	I	-	-	
44	PERMAFROST	1	1	I	-	-	
45	CNTCODE	3	3	I	#NAME?	-	
48	CNTNAME	3	3	C	-	-	
51	COUNTRY_NAME	14	30	C	- C	-	
**	REDEFINED ITEMS	**					
17	SOIL-INFO	54	57	C	-	-	
21	SOIL-ASSOCIATION	24	27	C	-	-	

Cover Name:	**Slope: Slope created in Arc/INFO**		
Source:	CIAT, Arc/INFO v7.1.1 using dem1km(USGS)	**Source Date:**	1998
		Comments:	
Cell Size	0.080		
Data Type:	Floating Point		
Number of Rows	543	**Number of Values**	
Number of Columns	864	**Attribute Data (bytes)**	
BOUNDARY STATISTICS			
Xmin	-124.118	**Minimum Value**	0.000
Xmax	-54.996	**Maximum Value**	80.104
Ymin	-3.468	**Mean**	4.015
Ymax	39.973	**Standard Deviation**	9.523
COORDINATE SYSTEM DESCRIPTION			
	Projection	**GEOGRAPHIC**	Spheroid
WGS84	Datum	**WGS84**	Units
DD	Parameters:		

Cover Name:	**Town_all: Towns**		
Source:	DCW	**Source Date:**	1984
		Comments:	
Feature Class	**Features**	**Bytes**	**Topology?**
Points	379	82	Yes
Annotations		3223	
Fuzzy	0.002	**Dangle**	0.000
BOUNDARY STATISTICS			
Xmin	-120.002	**Precision**	Single
Xmax	-60.894		
Ymin	7.981		
Ymax	35.000		
COORDINATE SYSTEM DESCRIPTION			
Projection	GEOGRAPHIC	**Spheroid**	WGS84

Datum	WGS84					**Units**	DD
Parameters:							
TOWN_ALL. PAT							
COLUMN	ITEM NAME	WIDTH	OUT PUT	TYPE	N.DEC ALTERNATE NAME	INDEXED ?	Description
1	AREA	4	12	F	3	-	
5	PERIMETE R	4	12	F	3	-	
9	TOWN_ALL #	4	5	B	-	-	
13	TOWN_ALL-ID	4	5	B	-	-	
17	PPPTTYPE	2	2	I	-	-	1:Populated Place 2: populated place(within urbanized areas) 3: Places associated with a special symbol 4: kampong 5: Circular village
19	PPPTNAME	40	40	C	-	-	Name of place
59	PPPTFLAG	2	2	I	-	-	
61	DATE	4	4	I	-	-	Date of data
65	POP	8	8	I	-	-	Population
73	SOURCE	4	4	C	-	-	Source of information
77	POPEST	5	5	I	-	-	Population estimate

Cover Name:	**Town_min: Towns**		
Source:	DCW	**Source Date:**	1984
		Comments:	
Feature Class	**Features**	**Bytes**	**Topology?**
Points	3107	82	Yes
Fuzzy	0.002	**Dangle**	0.000
BOUNDARY STATISTICS			
Xmin	-117.048	**Precision**	Single
Xmax	-59.527		
Ymin	7.406		
Ymax	32.628		
COORDINATE SYSTEM DESCRIPTION			
Projection	GEOGRAPHIC	**Spheroid**	CLARKE1866
Datum	NAD27	**Units**	DD
Parameters:			

TOWN_MIN. PAT							
COLUMN	ITEM NAME	WIDTH	OUT PUT	TYPE	N.DEC ALTERNATE NAME	INDEXED ?	Description
1	AREA	4	12	F	3	-	
5	PERIMETE R	4	12	F	3	-	
9	TOWN_MIN #	4	5	B	-	-	
13	TOWN_MIN-ID	4	5	B	-	-	
17	PPPTTYPE	2	2	I	-	-	1:Populated Place 2: populated place(within urbanized areas)

							3: Places associated with a special symbol 4: kampong 5: Circular village
19	PPPTNAME	40	40	C	-	-	Name of place
59	PPPTFLAG	2	2	I	-	-	
61	DATE	4	4	I	-	-	Date of data
65	POP	8	8	I	-	-	Population
73	SOURCE	4	4	C	-	-	Source of information
77	POPEST	5	5	I	-	-	Population estimate

Cover Name:	**Usgscrop: USGS cultivated areas**		
Source:	USGS, http://edcwww.cr.usgs.gov/landdaac/	**Source Date:**	1998
		Comments:	
Cell Size	0.016		
Data Type:	Integer		
Number of Rows	2309	**Number of Values**	4
Number of Columns	3617	**Attribute Data (bytes)**	8
BOUNDARY STATISTICS			
Xmin	-117.299	**Minimum Value**	2.000
Xmax	-59.427	**Maximum Value**	6.000
Ymin	-4.230	**Mean**	3.031
Ymax	32.714	**Standard Deviation**	1.548
COORDINATE SYSTEM DESCRIPTION			
Projection	GEOGRAPHIC	**Spheroid**	CLARKE1866
Datum	NONE	**Units**	DD
Parameters:			

USGSCROP.VAT							
COLUMN	ITEM NAME	WIDTH	OUT PUT	TYPE	N.DEC ALTERNATE NAME	INDEXED?	Description
1	VALUE	4	10	B	-	Indexed	2: Dryland Cropland and Pasture 3: irrigated Cropland and Pasture 4: Mixed Dryland/Irrigated Cropland and Pasture 5: Cropland/Grassland Mosaic 6: Cropland/Woodland Mosaic

Cover Name:	**Usgslac: USGS land use/land cover system**		
Source:	USGS, http://edcwww.cr.usgs.gov/landdaac/	**Source Date:**	1998
		Comments:	
Cell Size	0.016		
Data Type:	Integer		
Number of Rows	1805	**Number of Values**	22
Number of Columns	3355	**Attribute Data (bytes)**	8
BOUNDARY STATISTICS			
Xmin	-117.713	**Minimum Value**	1.000
Xmax	-64.102	**Maximum Value**	27.000
Ymin	4.317	**Mean**	15.825
Ymax	33.160	**Standard Deviation**	4.451
COORDINATE SYSTEM DESCRIPTION			

Projection	GEOGRAPHIC					**Spheroid**	CLARKE1866
Datum	NONE					**Units**	DD
Parameters:							
USGSLAC.VAT							
COLUMN	ITEM NAME	WIDTH	OUT PUT	TYPE	N.DEC ALTERNATE NAME	INDEXED ?	Description
1	VALUE	4	10	B	-	Indexed	1:100,Urban or built-up Land 2: 211,Dryland Cropland and Pasture 3: 212,irrigated Cropland and Pasture 4: 213,Mixed Dryland/Irrigated Cropland and Pasture 5: 280,Cropland/Grassland Mosaic 6: 290,Cropland/Woodland Mosaic 7:311,Grassland 8:321,Shrubland 9:330,Mixed shrubland/Grassland 10:321,Shaparral 11:332,Savanna 12:411,Broadleaf Deciduous Forest 13:422,Evergreen Needleleaf Forest 14:423,subalpine Forest 15:430,Mixed Forest 16:412,Deciduous Needleleaf Forest 17:421,Evergreen Broadleaf Forest 18:500,Water Bodies 19:620,Herbaceous Wetland 20:610,Forested Wetland 21:770,Barren or Sparsely Vegetated 22:810,Wooded Tundra 23:820,Herbaceous Tundra 24:830,Bare Ground Tundra 25:840,WetTundra 26:850,Mixed Tundra 27:911,Perennial snow or ice