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Introduction to ILWIS GIS tool

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Abstract. ILWIS for Windows is a Windows-based, integrated GIS and Remote Sensing application consisting of: (i) Display of raster and multiple vector maps in map windows; (ii) Display of tables in table windows; (iii) Interactive retrieval of attribute information, (iv) Image processing facilities, (v) Manipulation of maps in a Map Calculator; (vi) Manipulation of tables in a Table Calculator; (vii) GIS analysis tools and (viii) Script language to perform 'batch' jobs. With Windows, you can start one operation and keep it running while you start one or more additional applications. This is a sort of multitasking. You may work with both Windows and DOS application programs, you can perform one or more ILWIS calculations in the background and at the same time display maps, run other ILWIS operations, print, etc. http://52north.org/communities/ilwis/

Keywords. ILWIS – GIS – Remote Sensing – Land and Water Management.

Introduction à l'outil SIG: ILWIS

Résumé. *ILWIS pour Windows est une application basée sur Windows, intégrant SIG et télédétection, composée de: (i) affichage d'images pixellisées et vectorielles multiples sous Map Windows, (ii) affichage de tableaux sous Table Windows, (iii) extraction interactive d'information sur les attributs, (iv) équipement de traitement d'image, (v) manipulation de cartes dans Map Calculator, (vi) manipulation des tables dans Table Calculator, (vii) outils d'analyse SIG, et (viii) langage de script pour effectuer des travaux groupés. Avec Windows, vous pouvez commencer une opération et la faire fonctionner pendant que vous démarrez une ou plusieurs applications supplémentaires. C'est une sorte de traitement multitâche. Vous pouvez travailler avec Windows et avec des applications DOS, vous pouvez effectuer un ou plusieurs calculs ILWIS en arrière-plan et en même temps afficher des cartes, exécuter d'autres opérations ILWIS, imprimer, etc. http://52north.org/communities/ilwis/*

Mots-clés. *ILWIS – SIG – Télédétection – Gestion de terres et des eaux.*

I – Introduction to ILWIS system

In late 1985, ITC obtained the Dutch government funds to expand its research activities in developing countries. Instead of spreading it into several small projects, ITC decided to concentrate these funds in a single research project that provided a multidisciplinary study and, thus, emphasized the applicability of the results. Allard Meijerink led this new research from ITC obtaining a Geographical Information System to identify land use and water management (Meijerink *et al.,* 1994).

For several months the project became known as *Project Sumatra*. Over time, the system under development became a more appropriate name: *Integrated Land and Water Information System (ILWIS).*

ILWIS is a geographic information system and integrated digital image processing working under Windows environment. Their tools allows to:

– Display a raster map and several vector maps in the same window.

– Display attribute tables, obtaining, interactively, attribute information.

– Digital Images process.

– Perform arithmetic operations with several raster maps.

– Perform arithmetic operations with tables.

– Perform spatial analysis.

– Generate script files to perform automatic calculations.

ILWIS tools for vector files include: scanning over screen or digitizing table, interpolation of lines or dots, calculation of density maps, analysis of patterns and poly.

The tools for raster files include: calculating distance maps, creation of digital elevation models, calculation of slope and aspect maps of slopes, calculating attribute maps, classification of maps from tables, spatial analysis with Boolean functions, –conditional and maths–, cross maps and so on. For satellite images, also has several tools to generate statistics, perform color compositions, classifications, filters and radiometric enhancements.

In addition, ILWIS contains routines to convert data to various formats, edit any kind of files, project transformations, and generation of annotations to print and/or plotter maps, charts and graphics.

II – Data Structure

The first consideration must be taken into account is that ILWIS format stores data of the same object in different files associated with each other, and whose coexistence is necessary. To protect against data loss or corruption of the maps, ILWIS has a tool that copies data from one directory to another without damaging the objects. This *copy* tool is responsible for moving all the files associated with the object or objects to copy (ILWIS, 1997).

There are three basic types of data: raster, vector (segments, polygons and points) and tabular data. Following it describes in more detail, the structure of these types.

1. Raster Maps

A raster map is a two-dimensional matrix consists of square cells. The size of this matrix is given by the number of rows and columns. Each cell, called *pixel*, has a certain value.

The format of the ILWIS raster map is an ASCII file with a .MPR extension, which includes the full description of the object, and a binary file, .MP# extension, which contains the data. Description file (.MPR) refers to the domain and the georeference used by the map, it means their properties.

The maximum size of a raster map is 2 billion lines. The maximum number of columns is: 32000 if is 1 bit map, 1 byte map or 2 bytes map; 16000 if it is 4 bytes map, and 8000 if it is 8 bytes map. The byte indicates the maximum number of different values that can have a pixel, so 1-bit = 2 values (2^1); 1-byte = 8-bit = 256 values (2^8); 2-bytes = 16-bit = 65536 different values (2^{16}), and so on.

2. Vector Maps

Here we must distinguish three types of vector maps based on the included elements. There are segments, polygons and points maps.

The *segment maps* are composed of lines (arcs) whose absolute geographic position is given by coordinate system and georeferene associated to each map. Each line has a certain value (code), which may be unique (ID) or shared with other segments (value, class, etc.). The segment map format is an ASCII file that describes the object and has a .MPS extension and three binary files containing the data, their extensions are:. CD#,. SC# and. SG#. As in the case of raster maps, the description ASCII file includes all the information about the map (domain, georeference, etc.). The maximum number of segments in the map is 32000, and the maximum number of coordinate pairs per segment is 1000.

The *polygons maps* are composed of lines (segments) that enclose areas, ie polygons. Absolute geographic position of the polygons is determined by the coordinate system and the georeference associated with to each map. Each polygon has a code that can be unique (ID) or shared with other polygons in the map (value, class, etc.). The format of a polygon map consists of a description ASCII file with a .MPA extension and five binary files containing data and with the extensions are: .PC#, .PD#, .PL#, .PS# and .TP#. The maximum number of polygons on a map is 32000 and the maximum number of pairs of coordinates on the edge of a polygon is 1000. This limitation derives from that which exists for the segments, as the edge of the polygon is made up of segments, joined together, form an enclosed area.

The *dot maps* are composed of points whose absolute geographical position is given by the coordinate system and georeference each map associated with it. Each point has a code that can be unique (ID) or shared with other parts of the map (value, class, etc.). The format of a point map is a description ASCII file with an .MPP extension, and a binary data with .MP#. Extension. Each point, therefore, has an associated set of coordinates that place it in space, and a value that depends on the domain of the map. The maximum number of points on a map is 2 billions.

3. Tables

A table is an object that stores columns with alphanumeric information. Such information usually is associated with one or more maps. The format of an attribute table in ILWIS is a description ASCII file with an .TBT extension, and a binary data file with .TB# extension.

The description file of a table stores their properties, this is the table name, their description, their dependence with another object, the number of containing columns and their description, as well as table and each columns domain. In principle, the maximum number of columns that can contain a table is 32000, and up to 2 billion records.

III – ILWIS Operations

Here are the most important operations that can be done in ILWIS, once the data has been entered into the system in the form of maps and / or tables.

They are grouped into 9 groups:

Visualization:

Show map or other object	Display an object in its corresponding window.
Color composite	Make a color composite from several raster maps.
Display 3D	Show a view in 3D perspective.
Apply 3D	Generates a 3D view.
Slide Show	From a list maps, a window is open showing, sequentially, the contained maps in the list.

Raster Operations:

Map Calculation	It is the calculation and spatial analysis module of ILWIS for raster maps. You can perform many mathematical calculations, Boolean algebra operations, conditional, etc.

Atribute map of raster map	Generate new maps from a raster map and an attribute table linked with it.
Cross	Crosses two raster maps and generate a table and/or a new raster map.
Aggregate map	Performs several operations with blocks of pixels: sum, mean, median, standard deviation, count...
Distance calculation	Assign to each pixel the less distance to a group of pixels specified by the user.

Digital Image Processing:

Filter	Apply filters to a raster maps. The filter can be created by users, but ILWIS includes standards filters too.
Stretch	Apply a process to enhance the contrast of a raster map (usually a satellite image or aerial photo).
Slicing	Clumps pixels with values in a number of intervals.
Cluster	It is a type of unsupervised classification. Pixels are grouped according to their spectral characteristics. The maximum number of bands that can be used is 4.
Classify	Make a multispectral image classification. This is based on the samples set created with the sample operation. The ranking is based on statistical criteria, and the four possible approaches include: parallelepiped, minimum distance, Mahalanobis minimum distance and maximum likelihood.
Resample	Resamples the pixels in a raster map to transform a georeference different. There are three methods for resampling: nearest neighbor, bilinear and cubic convolution.

Statistics:

Histogram	Calculate the histogram of a raster, polygons, segments or points maps, presenting the result table.
Autocorrelation-Semivariance	Calculate the correlation for a raster map between the values of the pixels map with the values of the pixels of the same map to different jumps in horizontal or vertical.
Principal component analysis	Calculate the relationships between different variables and reduces the amount of data needed to define the image.
Factor analysis	This operation is very similar to principal component analysis.
Variance-Covariance matrix	Calculate the variance-covariance of several raster maps. The variance is a way to express the diversity of values in a raster map. The covariance is a way of expressing the variability of values in two raster maps.
Correlation matrix	Calculated the correlation coefficients between several raster maps. These coefficients define the distribution of pixel values in the maps. Also calculates the mean and standard deviation of each map.
Neighbour polygons	Look adjacent polygons in a polygon map and calculates the length of the boundaries of these polygons. The result is a table.

Interpolation:

Densify	Reduce the size of pixel in a raster map, keeping the same projection.
Contour interpolation	This function first rasterized the contour lines, which are segments, and then calculate the values of all pixels that are not covered by segments.
Point interpolation	Realize interpolations between points randomly distributed and as a result provide a map of points on which they are located on a regular basis (gridding).

Vector Operations:

Unique ID	Assign all the elements of a vector map (segments, polygons or points) the same value. The result is a map and a table that displays a column with the original ID of the elements.
Attribute polygon map	Creates a new polygon map in which the original values are replaced by a table.
Mask polygons	Create a new polygon map in which only show those polygons whose values match those selected as a mask.
Assign labels to polygons	Allows recoding polygons from a points map that act as labels. Each polygon is identified with a point and takes its.
Transform polygons	Transform a polygon map to another projection and/or coordinate system.
Attribute segment map	Generates a new segments map in which the original values are replaced by a table.
Mask segments	Create a new segments map of in which only show those segments whose values match those selected as a mask.
Assign labels to segments	Allows recoding segments from a points map that act as labels. Each segment is identified with the closest point and takes its value.
Attribute point map	Generates a new map of points on which the original values are replaced by a table.

Rasterization:

Polygon to raster	Rasterize a polygon map that is transforming it into a raster map, using the same domain.
Segments to raster	Transforms a segments map into a raster map, using the same domain.
Points to raster	Transforms a point map in a raster map. The resulting map always uses the same domain as the point map.

Vectorization:

Raster to polygon	Generates a polygon map from a raster map. The resulting map use the same domain as the original raster map.
Raster to segment	Generate a segment map from a raster map.

Raster to point	Generates a map of points from a raster map. Each point of resulting map has the same value as the pixel from which comes.
Polygons to segments	Generates a segment map from a polygon map.
Polygon to points	Generates a map of points from a polygon map. Each point will have the same value as the polygon from which.
Segments to polygons	Generates a polygon map from a segment map. To perform this operation, all segments must be connected, forming enclosed areas.
Segments to points	Generates a point map from a segment map.

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