

# Basic concepts

## 2.1 ILWIS window types

Basically, there are four ILWIS window types: the Main window, map windows, table windows, pixel info windows.

The *Main window* is the window which is opened when ILWIS is started. The Main window consists of:

- a Command line on which you can type commands to display objects, map calculation formulae, expressions to perform complete operations, run scripts, etc.;
- a Catalog, which gives an overview of available objects in the current directory; you can for instance drag a map from the Catalog to an existing map window, or to an operation in the Operation-list;
- an Operation-list, and the Operations menu which list all ILWIS operations; and
- a navigator to go to other drives or directories.

A *map window* : one or more maps with optional annotation. You can open as many map windows as you like. When a raster map is displayed, you can display other point, segment or polygon maps on top of this raster map; add annotation; zoom in and out; and scroll through the map if the map does not fit in the map window. To add or remove layers, or to change display options of a layer, use the Layer Management command on the Layers menu. To see the value or meaning of a pixel, point, segment, or polygon displayed in a map window, press the left mouse button (info). When the displayed map has an attribute table, you can double-click in the map window to see and edit the attributes. You can use the map editors to edit positions, values or meanings of points, segments, polygons and pixels. A map window displaying one or more maps with optional annotation can be saved as a map view. Map views that consist of a time series can be displayed as a slide show.

A *table window* : a table and allows you to edit the table. You can open as many table windows as you like. A table can be shown as a whole, or record by record. When the table does not fit in the table window, scroll bars are provided. Fields in a table can be edited by clicking them. The width of a column and the order of columns can easily be changed. On the command line in a table window, you can enter table calculation statements. Besides table calculations, you can perform joins between tables, aggregations and a least squares fit. From a table window, you can create graphs in a graph window.

Further a table window displays histograms; you can calculate with the columns of the histogram. Also point maps, class/ID/picture domains and class representations can be opened as a table; you can perform special calculation with the coordinates, colors, etc.

In the *pixel info window*, you can see the values or meanings of multiple maps and attribute values stored the attribute tables of the maps at the current position of the mouse pointer in a map window.

Map windows, table windows and the pixel information window are called data windows because they can display data objects.

## 2.2 ILWIS objects and icons

There are several types of ILWIS objects: *data objects*, *service objects*, *special objects* and *annotation*.

Data objects are point, segment, polygon and raster maps, satellite images, tables and columns; that are the GIS/RS materials to work with. Maps can be displayed and edited in a map window, tables and columns in a table window. You can perform calculations and operations on data objects.

Data objects are:

	raster maps	(containing pixels)
	polygon maps	(containing area features)
	segment maps	(containing line features)
	point maps	(containing point features)
	map lists	(containing a set of raster maps)
	tables	(containing columns)
	columns	(not listed in Catalog)

Service objects are domains, representations, georeferences, and coordinate systems. Service objects are used by data objects; they contain accessories that data objects need besides the data itself. Service objects can be selected to serve one or more data objects; they can be created, edited, etc. through the properties of an object.

Service objects are:

	domains
	representations
	georeferences
	coordinate systems

Special objects are map views, histograms, sample sets, two-dimensional tables, matrices, filters, user-defined functions and scripts.

Special objects are:

	map views
	histograms of raster maps
	histograms of polygon maps
	histograms of segment maps
	histograms of point maps

-  sample sets
-  two-dimensional tables
-  matrices
-  filters
-  functions
-  scripts

Annotation can be added as one or more annotation layers to a map window: text, legend, boxes, scale bar, North arrow, grid lines, graticule, and bitmaps or pictures from disk. Pictures and bitmaps can also be pasted into ILWIS from other Windows application programs (via the clipboard). Annotation can be displayed in a map window in combination with maps: this can be saved as a map view.

For more information, refer to chapter 4 ILWIS objects, to Appendix B.1 ILWIS objects or to Appendix B.2 Relations between ILWIS objects.

## 2.3 Before creating ILWIS maps and tables

A map contains certain features and refers to the geographic position of those features:

-  point maps: a point map contains point features;
-  segment maps: a segment map contains line features;
-  polygon maps: a polygon map contains closed area features, and
-  raster maps: a raster map contains pixels. In ILWIS, most spatial operations are performed on raster maps.

When using satellite images, you already have raster maps. Pixels in a satellite image have values ranging from 0 to 255, although not every value may occur in your image. In ILWIS, satellite images have domain Image.

When starting from an analog paper map, you begin with:

- digitizing point features of interest with the point editor,
- digitizing line features of interest with the segment editor, and/or
- digitizing areas of interest with the segment editor and polygonize.
- digitizing the boundaries of area features of interest with the segment editor; then polygonizing these boundaries to obtain polygons; and editing the polygons with the polygon editor.

Afterwards, point, segment and polygon maps can be rasterized into a raster map.

However, before digitizing, you have to know that features in any map can be identified in the following manner:

- by ID: each feature is identified by its own name or number and occurs only once in the map,
- by Classes: features are identified by their class name and may occur in several places in the map,
- by Value: features are identified by a measured, calculated or interpolated value.

The following scheme illustrates the above:

Map type:	Features in map:	Identification of features by:	Example:
<b>Point map</b>	<ul style="list-style-type: none"> <li>* Points: indiv. sample points</li> <li>* Points: classes of farms</li> <li>* Points: height information</li> </ul>	<ul style="list-style-type: none"> <li>IDs</li> <li>Class names</li> <li>Values</li> </ul>	1,2,3 small farm, large farm 500, 600, 700 (m)
<b>Segment map</b>	<ul style="list-style-type: none"> <li>* Lines: individual rivers</li> <li>* Lines: classes of roads</li> <li>* Lines: isolines for height</li> </ul>	<ul style="list-style-type: none"> <li>IDs</li> <li>Class names</li> <li>Values</li> </ul>	rivsect1, rivsect2 prim. roads, sec. roads 500, 600, 700 (m)
<b>Polygon map</b>	<ul style="list-style-type: none"> <li>* Areas: indiv. cadastral plots</li> <li>* Areas: land use classes</li> <li>* Areas: acid deposition</li> </ul>	<ul style="list-style-type: none"> <li>IDs</li> <li>Class names</li> <li>Values</li> </ul>	plot 234a, plot 345b rice, maize, forest 1000, 2000, 5000 (mol/ha/y)
<b>Raster map</b>	<ul style="list-style-type: none"> <li>* Pixels: rasterized points, lines or areas with IDs</li> <li>* Pixels: rasterized points, lines, or areas with class names</li> <li>* Pixels: rasterized points, lines or areas with Values</li> <li>* Pixels: value outcome of calculations</li> </ul>	<ul style="list-style-type: none"> <li>IDs</li> <li>Class names</li> <li>Values</li> <li>Values</li> </ul>	plot 234a, plot 345b or rivsect1, rivsect2 rice, maize, forest  values  any value
<b>Raster map</b>	<ul style="list-style-type: none"> <li>* Pixels (satellite images)</li> </ul>	pixel values:	-
		0 to 255	

The user-defined collection or set of IDs, class names or values that may be used in a map is called the domain of a map. In ILWIS, we speak of maps with domains of the ID, class or value type, meaning that the elements in that map are either identified by IDs, class names or values.

Only maps with features identified by IDs or class names can have attributes; i.e. extra information about the point, segment, polygons or mapping units, in so-called attribute tables. When creating an attribute table, this table should have the same domain as your ID or class map. Afterwards you can add extra columns with the attribute information. The domain provides here the relational link between the map and the attribute table.

Maps containing values, for example a satellite image or a height map, cannot have attributes in an attribute table.

## 2.4 Working with domains

A domain defines the values, classes or identifiers that can be stored in a map or column. When you create a map or column, you also have to select or create a suitable domain for that map or column. When you create an attribute table for a map, the table must use the same domain as the map to which the table refers; the domain provides the link between the map and the table. Further, a domain uses a certain representation which defines the graphical representation of a map, e.g. the coloring.

All ILWIS data objects have a domain. One domain can be used for several data objects. To view the domain of a data object, open the properties of that data object. To list existing domains in the Catalog, refer to How to customize the Catalog.

The four main types of domains are:

- ID for data objects that contain unique identifiers (e.g. plot 1024, plot 1025)
- Class for data objects that contain classes (e.g. soil units: clay, sandy loam)
- Value for data objects that contain measurable values (e.g. height, concentration)
- Image for satellite images and scanned aerial photographs that contain values between 0 and 255.

#### **Domains for new maps**

When you create a new map, you should also select or create a suitable domain for the map. As described above, you can:

- create a class domain Soils when you want to digitize soil classes and fill this domain with your soil classes;
- create an identifier domain Plots when you want to digitize unique identified cadastral plots and;
- create a value domain Height when you want to digitize contour lines.

You can directly add classes to a class domain when you create the domain, but you can also add classes to the domain when actually editing or digitizing the map. Identifier domains can automatically be filled with numbers, but you can also add the identifiers yourself.

However, when working for instance with multiple land use maps of different years, the idea is that you create only one class domain Landuse in which you enter all possible land use classes of all years. This domain can then be used for all your land use maps and related attribute tables. It is not necessary that all classes in the domain actually occur in each map. As a domain is linked to a representation, the use of one domain for maps of the same theme ensures that these maps are also by default displayed in the same colors.

#### **Domains for attribute tables and columns**

For maps using a class or ID domain, you can create an attribute table. You have to make sure that the table uses the same domain as the map because the domain provides the link between them. In the table, the class names or IDs of the domain appear on the record buttons. You can add attribute columns to the table which contain additional information on the classes or IDs in the map. When you create columns in the attribute table, you may create suitable domains for each column; for general use of values however use the system domain Value.

#### **Domains for value maps and value columns**

When calculating with value maps and value columns, you can usually accept the default system domain Value and adjust the value range and precision for the output map if necessary. You only need to create a user-defined value domain (e.g. Height, pH, Yields, or concentration values):

- if the output values have a specific 'standardized' meaning that you want to document, and
- if you have, or want to create, a specific representation for these values (colors are linked to values).

A number of value domains are available in your ILWIS\SYSTEM directory: Value, Count, Distance, Min1to1, NOAA, Perc, Radar. For calculations on value maps, you can of course also use the Image domain.

### Other domain types

- **Bit** system domain Bit is available for maps and columns that have to store values 0 and 1.
- **Bool** system domain Bool and system domain Yes/No are available for maps and columns that have to store True, False or undefined values.
- **Picture** for raster maps which contain merely colors, the pixels have no meaning, for instance color composites or scanned pictures.
- **Color** for raster maps that are stored in 24-bit colors.
- **Group** a user-defined list of values and class names that can be used to classify a value map (similar to the ILWIS 1.41 classify tables)
- **String** system domain String is available for columns that contain text.

## 2.5 Attribute tables

Attribute tables store additional information on elements in a map, i.e. extra tabular data which relates to the mapping units, points, segments, or polygons in your maps.

Raster, polygon, segment and point maps that use a domain of the class or ID type can have attribute tables. The domain of the attribute table should be the same as the domain of the map to which it relates. The domain is the relational link between the map and the attribute table.

Maps of domain type Value contain purely values; they cannot have attributes.

When a map that is linked to an attribute table is displayed in a map window, and you double-click in the map, the attributes of the selected class or ID are shown and can be edited. Whether an attribute table is linked to a map can be inspected in the properties dialog box of the map.

The best way to create an attribute table is:

- open the properties of a point, segment, polygon or raster map,
- in the Properties dialog box, select the Attribute check box, and
- create a new table by clicking the create button or select an existing table (only tables with the same domain as the map are shown).

For more information, refer to How to view and edit the properties of an object and How to create a table.

You can perform calculations on your attribute data in the attribute table with Table Calculation, and you can also derive another map from a column in an attribute table with the Attribute Map, Attribute Polygon Map, Attribute Segment Map or Attribute Point Map operations.

**Example**

A map with terrain units may have the following classes: Lagoon plain, Coastal upland, Infilled valleys, Inland levees, Volcanic hills moderately steep, Volcanic hills steep, Colluvial footslopes, etc. Attributes for these classes might be: minimum and maximum slope, slope length, drainage density, genesis, etc.

## 2.6 Layers in a map window

When displaying multiple maps and/or annotation in a map window, two types of layers are distinguished: data layers and annotation layers.

Data layers are the different maps (data objects) displayed in one map window. For each map displayed in the map window, display options have to be specified, such as colors, width of segments, etc.

Annotation layers are the different annotation types displayed in one map window. For each annotation object displayed in the map window, display options have to be specified.

All layers (incl. display options) of a map window can be saved as a map view.

Layers of the current map window are listed:

- on the Layers menu, select the Display Options command: a cascading menu appears with the layers,
- on the Layers menu, select the Layer Management command: a dialog box appears with a list box of the layers in the map window,
- on the context-sensitive menu which appears when you click the right mouse button in a map window.

On the cascading and context-sensitive menus, shown layers are marked by a checkmark (✓). To change the display options of a layer, select a layer on one of these menus or in the Layer Management dialog box by double-clicking it.

## 2.7 Map views

When a set of data and annotation layers is displayed in a map window, you may store such a set as a map view. A map view contains the names of data layers and/or annotation layers to be displayed in one map window. Also, the display settings of the layers are stored; so the system knows the colors, widths etc. for the display of each layer. Further, the georeference is stored, meaning that when you save a map view when zoomed in on a part of the map, this zoomed area will be displayed when opening the map view later.

By opening a map view later, the map window appears exactly as it was saved. You do not need to select any data or annotation objects, nor specify their display options.

## 2.8 Drag and drop

The idea of drag and drop is that you can pick up an ILWIS object from the Catalog and release it somewhere else, in order to perform a certain task without using any menu.

The drag and drop mechanism can for example be used:

- to add maps or annotation objects to an existing map window,
- to add maps with their attribute table to the pixel information window,
- to start an operation with a certain map or table,
- to avoid typing any input object names in an operation dialog box.

In a table window, drag and drop is used to change the width and sequence of columns.

### How to drag and drop

1. Select an ILWIS data object from the Catalog by pressing and holding the left mouse button down, and
2. while holding the left mouse button down, move the mouse:
  - to a map window,
  - to the pixel information window,
  - to an operation in the Operation-list, or
  - to a drop-down list box in a dialog box (drag),
3. then release the left mouse button (drop).

### When to drag and drop

The drag and drop mechanism can be used in ILWIS:

- to add extra maps to an existing map window: drag a point, segment, or polygon map from the Catalog to the map window,
- to add maps and their attribute data to the pixel information window: drag a map from the Catalog to the pixel info window,
- to start an ILWIS operation with a certain map or table: drag a map or table from the Catalog to an operation in the Operation-list. The dialog box of the operation will appear, the input map or table is already filled in,
- to use a certain map or table name as input for an operation: drag the map, table or any other object to a drop-down list box on a dialog box,
- in a table window: change the order of columns by dragging a gray column name to another position; change the width of a column by positioning the mouse in between two column names (the mouse pointer changes into a double-sided arrow), and drag to the left or right. This decreases or increases the width of the left column.

## 2.9 Dependent data objects

Dependent maps, tables and columns are the result of a calculation with MapCalc or TabCalc (in which you used the definition sign =) or the result of another operation. The complete expression by which dependent output objects are created is stored by the output maps, tables and columns as their definition. Dependent data objects thus know how they were created and on which input data they depend.

### Example

You digitized roads as segments, you rasterized the segment map and then performed the Distance operation: you obtain a raster map with distances to the nearest road. Both the rasterized segment map and the output map of the Distance operation are dependent maps. When you edit the segment map later and added for instance new roads, it is obvious that both the rasterized segment map and the output distance map need to be updated according to the new situation, i.e. the dependent maps need to be recalculated.

### Advantages of working with dependent data objects

*Easy update:* when you have new information and you accordingly edited input maps, tables or columns, the dependent output maps, tables or columns can be recalculated as the system can execute their definition again. There is thus no need to repeat operations and choose input and output objects again: you can simply press the Make Up-to-Date button in the Properties dialog box of the dependent output maps, tables or columns.

*Easy change of calculation formulas:* MapCalculate and ColumnCalculate formulas that are stored as the definition of dependent raster maps and columns can be modified in the Properties dialog box of such a map or column. This enables you to quickly change calculation formulas and see results displayed in the same raster map or column. The need to create new maps and columns for each similar calculation is thus reduced. To edit the MapCalc formula by which a dependent raster map is created: press the Edit Definition button in the Properties dialog box of the raster map. The TabCalc formula of a dependent column can directly be edited in the Properties dialog box of the column.

*Minimum use of disk space:* when you perform a calculation or another operation, the outcome is a dependent map or table and in principle only the object definition file of the dependent map (.MPR, .MPA, .MPS, .MPP) or table (.TBT) is stored on disk. Object definition files are small ASCII files and they store amongst others the expression by which the output object is created and contain a reference to the output data file(s). You can directly continue to perform calculations and/or operations on the dependent objects that do not have calculated data files yet. The data files which may need a lot of disk space are automatically calculated and stored on disk when the map or table is displayed, i.e. when needed. In most cases, also the pixel information window can even show results of dependent raster maps that do not have calculated data files yet. The pixel information is able to calculate output values of pixels on the fly.

For dependent maps and tables that already have stored data files, you can delete the data files that are not needed immediately. As long as the object definition file of a dependent object remains, the data files can always be recalculated. To release disk space: press the Release Disk Space button in the Properties dialog box of a dependent map or table.

To protect the results of calculations or operations, you cannot directly edit dependent maps, columns in dependent tables, or dependent columns. In case you do want to edit a dependent map or column, you first have to break the dependency link between the dependent map or column and its input data. To break dependencies: press the Break Dependency Link button in the Properties dialog box of dependent maps or dependent columns.

### 2.10 Properties of objects

The Properties dialog box of a map, table or column or any other ILWIS object shows you important information on the object. In fact, an object's Properties dialog box lists the information that is stored in an object's object definition file and that is relevant to the user.

A Properties dialog box lists:

- object type, object name and its date, time and size,
- whether the object is read-only or not,
- the description of the object,
- other objects that this object uses, e.g. the domain of a map, table or column; the georeference of a raster map; the coordinate system of a point, segment or polygon map, etc., see also Appendices : relations between ILWIS objects;
- objects that use the current object,
- for maps and domains, whether an attribute table is linked to the map or the domain,
- some additional information on the object, e.g. the number of segments in a segment map, and the number of lines and columns and the pixel size in a raster map, and the number of records and columns in a table, etc.,
- whether a map, table or column is dependent or not, see also Basic concepts : dependent data objects;
- for dependent maps, tables and columns, the definition of the object, i.e. the expression by which the current object was created,
- for dependent maps, tables and columns, whether the object is up-to-date or not,
- for dependent maps, tables and columns, the objects on which the dependent object depends,
- for raster maps, whether the map is stored using 1 bit, or 1, 2, 4, or 8 bytes per pixel.

Further, a number of the following buttons may be available:

Used By:	Click this button to see by which other objects the current object is used.
Make Up-to-date:	For dependent data objects of which the input data has changed: click this button to redefine the dependent output object. See also How to make dependent data objects up-to-date.
Edit Definition:	For dependent raster maps that are the result of a map calculation (MapCalculate), click this button to modify the map calculation formula by which this map was created. The definition of a dependent column that is the result of a table calculation (ColumnCalculate), can be directly edited in the Properties dialog box of the column. See also How to change the definition of a dependent data object.
Break Dependency Link:	For dependent data objects: click this button to break the dependency links between the current dependent object and the objects it depends on. After breaking dependency links of a dependent map, table or column, the map, table, or column becomes editable. See also How to break dependency links.
Release Disk Space:	For dependent data objects with a calculated data file: click this button to delete calculated data files. Only the object definition file that contains the expression by which the object is defined remains. See also How to release disk space.
Calculate:	For dependent data objects without a calculated data file: click this button to execute the expression by which this object was created and store the calculated data file on disk.
Additional Info:	For objects that have extra information.
Edit Properties:	For advanced users: click this button to see and/or change the relations between the current editable object and other objects that the current object uses, such as domain, georeference, coordinate system, etc.

For more information, refer to section 8.38 How to view and edit properties of an object, or Appendix Relations between ILWIS objects.

