

Spatial data input

Analysis and modeling in a GIS requires input of relevant data. The data consist of two types: *spatial data* representing geographic features (points, lines and areas) and *attribute data* (descriptive information). Data input should be done with utmost care, as the results of analyses heavily depend on the quality of the input data. In ILWIS data can be entered by:

- *Digitizing*, if you want to use data from analog (paper) maps;
- *Keyboard entry*, for entering tabular data;
- *Scanning*, if you want to use paper prints of satellite images, aerial photographs, maps and pictures;
- *Importing* existing data files from other sources.

This chapter explains how to digitize maps. The next chapter deals with the import of digital map data, and in chapter 5 the import and creation of tables is treated.

Before you can start with the exercises, you should start up ILWIS and change to the subdirectory `c:\ilwis21\data\usrguide\chap03`, where the data files for this chapter are stored.

Apart from a segment map used in exercise 3.5, you will create all digital data for this chapter yourself.



- Double-click the ILWIS program icon in the ILWIS program group.
- Change the working drive and the working directory until you are in the directory `c:\ilwis21\data\usrguide\chap03`.

Digitizing

The most common method of entering spatial data in ILWIS is *digitizing*. Features on a paper map or other analog documents (e.g. a photo-interpretation on a piece of tracing film) can be digitized. This can be done using a device called a digitizing tablet, or digitizing table, or simply *digitizer*. A digitizer contains a pointing device (*digitizer cursor*) to trace spatial features. The position of the digitizer cursor is registered electronically to a precision of fractions of a millimeter. This is done through a fine grid of wires embedded in the digitizer (figure 3.1).

The vertical wires record the X-coordinates; the horizontal ones the Y-coordinates. The range of digitizer coordinates depends, amongst other things, on the density of the network of wires: *digitizer resolution*. The cursor contains a small transparent window with a cross-hair, and a number of buttons (at least four buttons are needed to work with ILWIS). When you press one of the buttons, an electromagnetic signal is transmitted and the position of the cross-hair is recorded by one of the horizontal and one of the vertical wires. From it a coordinate pair, in digitizer units, is defined and sent to the computer.

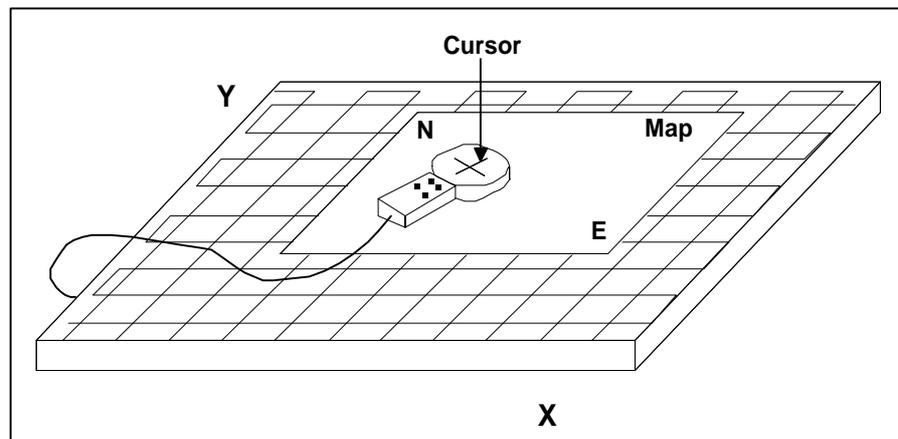


Figure 3.1: Operation of a digitizer (simplified)

3.1 Map referencing

A digitizer records the location of spatial features by means of *digitizer coordinates*. To correctly register features in a map, the relationship between map and digitizer coordinates needs to be established. A minimum of three *control points* and the corresponding *map coordinates*, should be specified by the user in order to calculate the transformations between digitizer and map coordinates. Since both coordinate systems are metric, an affine transformation is used.

With the map coordinates of the control points expressed as X_i, Y_i and the digitizer coordinates as $X_{dig,i}, Y_{dig,i}$ (figure 3.2), the following formula for an *affine transformation* is used to calculate the transformation coefficients:

$$\begin{aligned} X_i &= a_{1,1} * X_{dig,i} + a_{1,2} * Y_{dig,i} + b_1 \\ Y_i &= a_{2,1} * X_{dig,i} + a_{2,2} * Y_{dig,i} + b_2 \end{aligned}$$

where:

$a_{i,j}$ and b_i are the affine transformation coefficients.

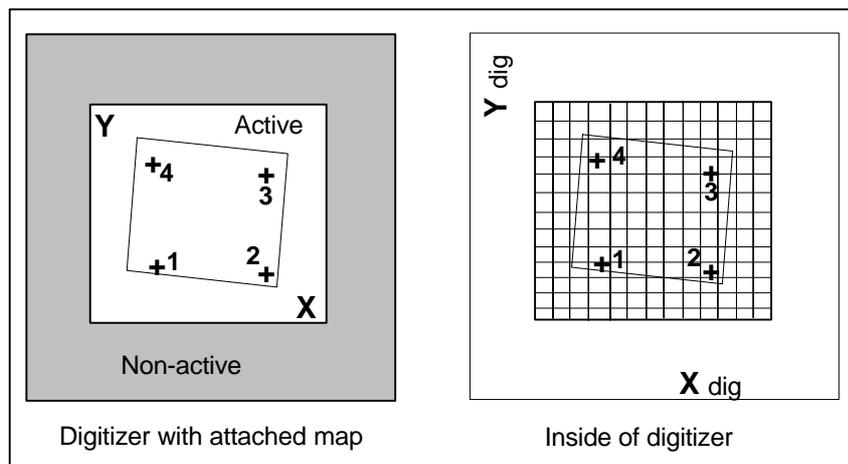


Figure 3.2: Referencing a map to a digitizer (simplified). Left: the digitizer contains an active area. Only within that area, the horizontal and vertical wires inside the digitizer can pick up a signal from the digitizer cursor (right)

To determine the six transformation coefficients, at least three coordinate pairs are required. If three or more coordinate pairs are entered, the equations are complete and the coefficients are calculated. Using the affine transformation, new sets of coordinate pairs are calculated for the control points. The differences between the actual and the calculated coordinates of the control points (the *residuals*), indicate how well the control points have been digitized and entered. Errors in location or typing result in large residuals.

Creating a coordinate system

Before you can start digitizing, you should first pay attention to the coordinate system in which you will digitize your map. You may for instance use user-defined coordinates, coordinates defined by a national standard or coordinates of a certain UTM zone. The information on the coordinates of the maps you use in a project, is stored in a *coordinate system*. A coordinate system defines the possible minimum and maximum X's and Y's that can be used in a map, along with other information on map datum, projection etc., as was mentioned in the previous chapter. A *map projection* defines the relationship between the map coordinates and the geographic coordinates latitude and longitude.

ILWIS has two standard coordinate systems:

- **Latlon:** Geographical coordinates in degrees
- **Unknown:** This is the coordinate system you can use if you do not want to specify the projection used in your maps. In that case you define your own local coordinate system; only the minimum and maximum X and Y values are stored and there is no need for projection parameters.

In most situations, however, it is better to generate a new coordinate system for the area where you are working, especially when the dataset that you prepare is intended to be used for a longer period, and may have to be combined with maps from other sources, which may be in another projection.

In principle, all the maps that are used of a certain area should have the same coordinate system. ILWIS expects that all maps that you want to superimpose or display together in one map window have the same coordinate system. Therefore, when you start with a project you first create a coordinate system, and you use this for all the maps which you digitize or that you import from other sources.

It may be so that you do not know the map projection of the map that you are going to digitize. In that case you cannot fill in the projection parameters in the coordinate system, and therefore, you don't know the relationship between metric and geographic coordinates. This is not a problem as long as you don't want to combine your data with maps in other projections.

We strongly advise you not to digitize your map in a coordinate system that you invent yourself, for example just by taking the lower left corner of the map as X=0 and Y=0. If you do so it will be very difficult to combine your own digitized data with that from other sources. Each topographic map should contain information on the map projection that was used. For example, on the topomap of Cochabamba, the following information is given:

- **Ellipsoid:** International.
- **Projection:** Transverse Mercator.
- **Vertical Datum:** Sea level.
- **Horizontal datum:** Provisional South America 1956.
- **UTM zone:** 19 K.

In the next chapter there will be more explanation on map projections, and especially about UTM.

The map that you are going to digitize first, is shown in figure 3.3. As you can see from that map the actual study area is located between the following coordinates (which are in UTM zone 19):

- minimum X = 795000
- maximum X = 808500
- minimum Y = 8071500
- maximum Y = 8090500

Now that you know the coordinate boundaries of your map and the projection information, you can generate the coordinate system that will be used for all maps of the Cochabamba area.

! Note that if you want to extend your study area and digitize adjacent areas you need to extend the range of coordinates as defined in the coordinate system.



- Double-click the **New CrdSys** item in the **Operations-list**. The **Create CoordSystem** dialog box is opened.
- Type for the **Coordinate System Name**: Cochabam.
- Type for the **Description**: Coordinate system of Cochabamba in UTM.
- Click **OK**. The **Edit Coordinate System** dialog box is opened.
- Press the **Projection** button and select the projection **UTM**. Click **OK**.
- Click the **Ellipsoid** button, and select the ellipsoid: **International 1924**. Click **OK**.
- Click the **Datum** button and select the datum: **Provisional South American 1956** and select the **Area**: **Bolivia**. Click **OK**.
- Clear the check box **Northern Hemisphere**.
- Enter for the **UTM zone**: 19
- Type for **Min X**: 795000 , Type for **Min Y**: 8071500
- Type for **Max X**: 808500 , Type for **Max Y**: 8090500
- Click **OK** in the **Edit Coordinate System** dialog box.

The coordinate system Cochabam is now created and you can proceed with the referencing of your map.

Referencing a map to the digitizer

! Before starting map referencing check whether the digitizer setting is correct. This can be done by opening the **Options** menu in the main window and select **Digitizer, Setup Digitizer** (see the **ILWIS Installation Guide** for a detailed description on how to set-up your digitizer).

To digitize a map, the coordinate system of the map must be referenced to that of the digitizer. In this exercise the point map shown in figure 3.3 will be referenced.



- Make a photocopy of figure 3.3.
- Position this map in the center of your digitizer and fasten it to the digitizer with tape. With some digitizers you can also place the paper under a plastic cover, so that it remains fixed.
- From the **Options** menu of the main window, select **Digitizer**.
- Choose **Map Reference** from the sub-menu.

The **Map Referencing** dialog box is opened. In this box you can select or create a coordinate system, in which minimum and maximum X and Y coordinates of the map are defined, as well as the map projection. The information is used to describe how coordinates on the earth surface are related to corresponding coordinates on the map.

The option buttons in the dialog box are used to select metric or geographic coordinates. Note, if you choose geographic coordinates, a projection and associated parameters have to be defined. The information is needed for transformation of geographic coordinates to metric ones.

! You can use the **Transform Coordinates** operation, to check whether the transformation from metric to geographic coordinate system and vice versa are correct (see also chapter 4, exercise: Map projections).



- Select Cochabam in the list box **Coordinate System**.
- Accept the defaults by clicking the **OK** button.

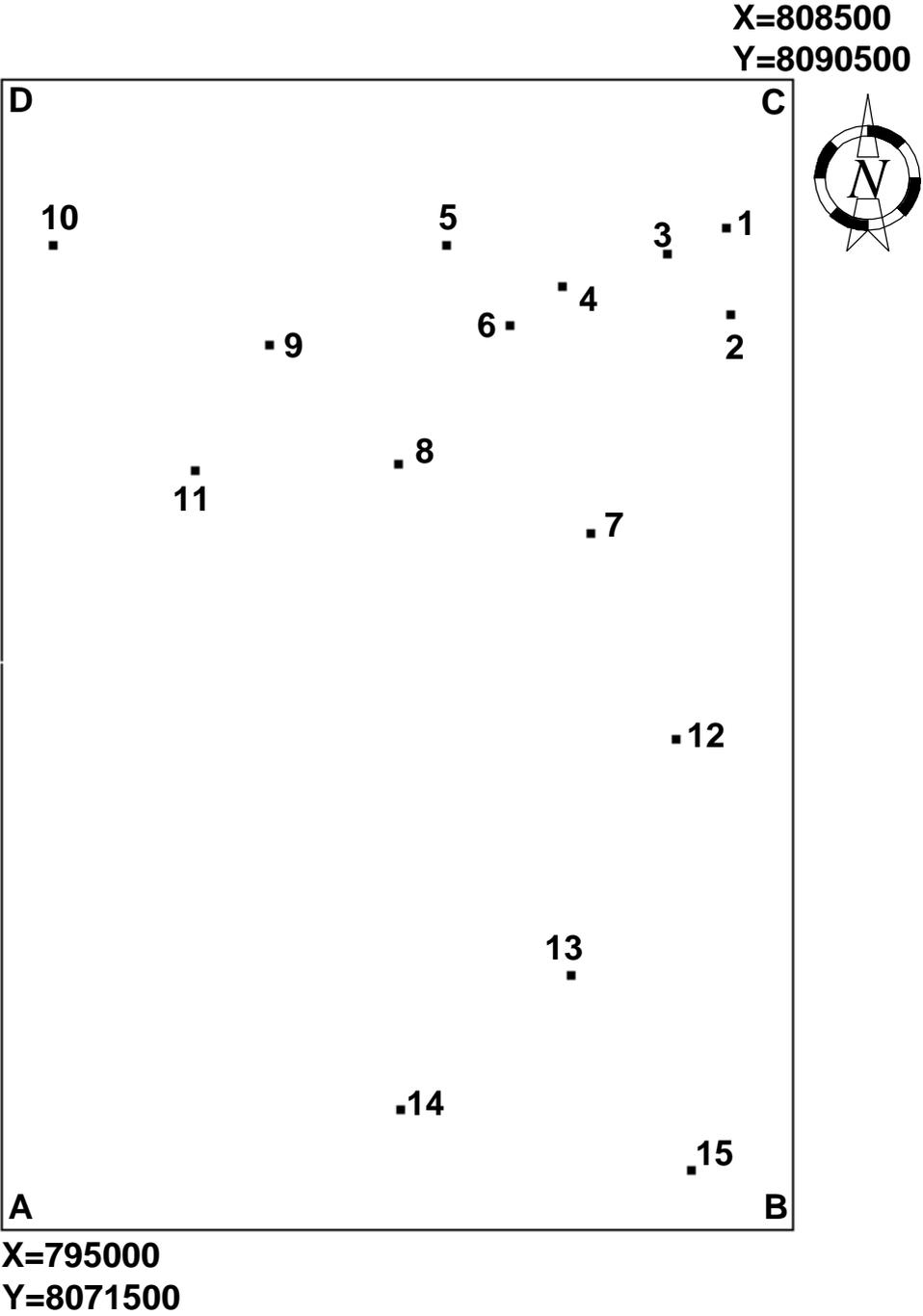


Figure 3.3: Point map Mountop

The Map Referencing dialog box (figure 3.4) and MapReferencing command box (figure 3.4) are opened. The Map Referencing command box shows the coordinates of the digitizer cursor location and contains the options: Digitize Point, Next Point and Delete Point. The numbers (0, 1, 2, 3,) refer to the digitizer cursor buttons which are normally labeled 0, 1, 2, 3, or 1, 2, 3, 4, or A, B, C, D. The commands in this window are used for digitizing control points and have the following meaning:

- Button 0: Digitizes a control point on the map.
- Button 1: Moves to the next control point.
- Button 2: Deletes the currently active control point.



- Move your digitizer cursor over the digitizing table. When you do so you should see the coordinates change in the upper part of the Map Referencing command box.



When you don't see any coordinates in the Map Referencing command box, or when the coordinates remain the same while you move the digitizer cursor over the digitizer, your digitizer is not set-up properly. Check the digitizer installation (See ILWIS Installation Guide).

Digitizing control points



- Position the digitizer cursor at point A of the map and press the 0 button.
- Type 795000 for the X coordinate (left) and 8071500 for the Y coordinate (right) of the point.
- Position the digitizer cursor to point B and press the 0 button.
- Type 808500 for the X coordinate and 8071500 for the Y coordinate of the point.
- Move the digitizer cursor to point C and press the 0 button.
- Type 808500 for the X coordinate and 8090500 for the Y coordinate of the point.
- Move the digitizer cursor to point D and press the 0 button.
- Type 795000 for the X coordinate and 8090500 for the Y coordinate of the point.

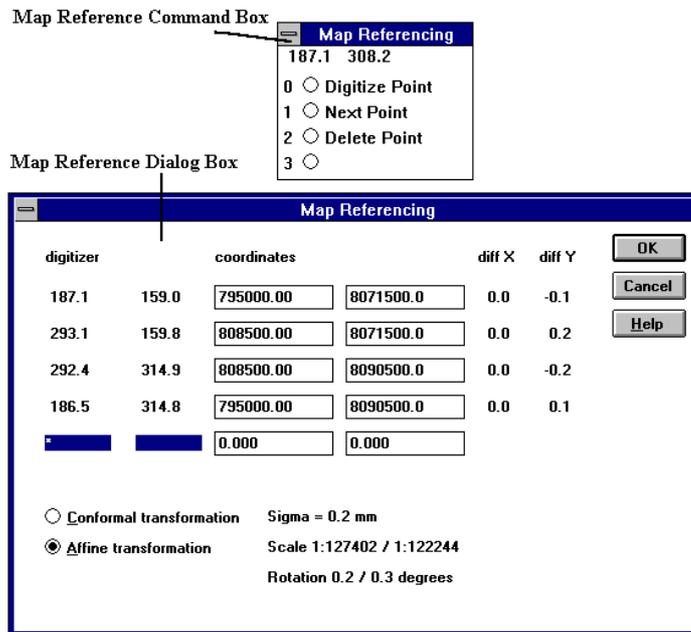


Figure 3.4: The Map Reference dialog box and the Map Reference command box (upper left). The actual values displayed on your computer may be different from the ones shown in the figure, depending on the type of digitizer you used, the precision (lines per inch), and the accuracy with which you digitized the four points

The Map Referencing dialog box shows information such as:

- **Digitizer:** The digitizer coordinates in millimeters.
- **Text boxes Coordinates:** The real world X and Y coordinates (metric or geographic, depending on what you selected in the first Map Reference dialog box; in this case metric).
- **diff X diff Y:** The diff X and diff Y columns indicate deviations (in millimeters) between the actual map coordinates and the calculated ones. A large deviation may signify that the coordinate pairs were entered incorrectly. If less than three points have been digitized, diff X and diff Y are 0 since no deviation can be calculated.
- **Sigma:** The value of Sigma (in millimeters) for the current data, indicates the accuracy with which the control points have been digitized. If the value of sigma is much larger than 1, this indicates that an error was made when digitizing the points, or when entering the coordinates. Sigma is the standard deviation calculated from the differences between the digitized and the calculated control points.

- **Scale:** The calculated scale in horizontal and vertical or X and Y axes assumes that the entered coordinates are metric. It also takes into account the resolution of the digitizer (lines/mm or lines/inch as specified in the digitizer configuration).
- **Rotation:** The rotation of the map coordinates (X and Y axes) relative to the digitizer X and Y axes.
- **Option buttons transformation:** The formulas used to calculate the transformation between digitizer and real world coordinates. Affine transformation is a first order function requiring a minimum of three tie-points. The order of this transformation is sufficient to account for changes in scale on the X and Y axes and for the map translation and rotation. The Conformal transformation is also a first order function but needs a minimum of two tie-points. By selecting the Conformal transformation, the program only accounts for scale differences in X and Y axes and for map rotation. Although mathematically two or three tie-points are needed for the conformal or affine transformations, it is preferred to use at least four tie-points to derive a notion of accuracy.



- Accept the default (Affine transformation).
- If the sigma is less than 1, click the OK button.
- If the sigma is larger than 1, repeat entering the tie-points until the sigma is less than 1 and then click the OK button.

-
- ! When you digitize paper maps that are quite old, or that have been exposed to sunlight, the paper may not contain the same scale in X and Y direction, due to shrinking. In such a case you will also not reach a sigma that is around 1, and you either have to get a better paper copy to digitize, or accept that it is less accurate.
When producing a map from image interpretation that is to be used for digitizing, it is therefore recommended, not to use paper, but a transparent film type that will not shrink.
-

The digitizer is referenced to the map. The map reference setting is stored and will remain unchanged until you enter a new reference setting. If the position of the map on the digitizer has changed, or if you start to digitize another map, it is necessary to reference the map again.

Summary: Map referencing

- A digitizer records the coordinates of spatial features by means of digitizer coordinates. The relationship between the map and digitizer coordinate is established by referencing the coordinates of the map to that of the digitizer.
- A minimum of three control points and the corresponding map coordinates are required to reference the map. The map reference settings are stored and will remain unchanged until you enter new reference settings.

3.2 Digitizing a point map

In this exercise a point map called `Mountop` will be created. The points in the map show the peaks of mountains and hills in the Cochabamba area, Bolivia. A hard-copy of the map is presented in figure 3.3. A photocopy of the same map was used in the previous exercise for map referencing.

! It is assumed that the photocopy of figure 3.3 is still attached in the same position on your digitizer table. If you removed the map, you will have to repeat the map referencing (explained in the previous exercise), since the position of the control points on the digitizer may have changed.



- Double-click `New PntMap` in the Operations-list in the Main window. The `Create Point Map` dialog box is opened.
- Type `Mountop` in the `Map Name` text box.
- Type for the `Description`: `Points indicating mountain tops`.
- Select the `Coordinate system`: `Cochabam`. This is the coordinate system that you have created in the previous exercise. Note that the display of the minimum and maximum X and Y coordinates changes, as the values of the coordinate system are used.
- Click the `Create` button next to the `Domain` list box. The `Create Domain` dialog box is opened.

As explained in the previous chapter, *service objects* such as a Domain and a Coordinate System, are needed to create a map (*data object*). A list of IDs or classes, or the value ranges and the precision used to codify elements in a map, are defined in a Domain. The domain contains all possible names or values that may occur in a map. See also chapter 2 for more information about domains.



- Type `Mountop` in the text box `Domain Name`.
- Select the option `Identifier`.

The domain type Identifier (ID) is selected for this point map, because each point in the map is identified by a unique number. Selecting the domain type Identifier, a text box with the default value 0 appears. Optionally, you can use the text box to define the number of items in the domain. It is also possible to give each item a prefix (e.g. `nr`, or `point`).



- Accept the default for the Number of Items (0) and click OK.

The Domain Editor is opened. The editor can be used to add, change or delete items in the domain. When you digitize you can either:

- First describe all domain items before you digitize, or;
- Define the domain items while you digitize.

The point IDs will be entered during digitizing.



- Close the Domain Editor. You are now back in the Create Point Map dialog box. Note that the domain Mountop, which you just created, is indicated in the list box Domain.
- Click OK in the Create Point Map dialog box. The Display Options - Points dialog box is opened.
- Accept the defaults by clicking the OK button in this dialog box.

The Point Editor and the Point Editor command box are opened (figure 3.5).

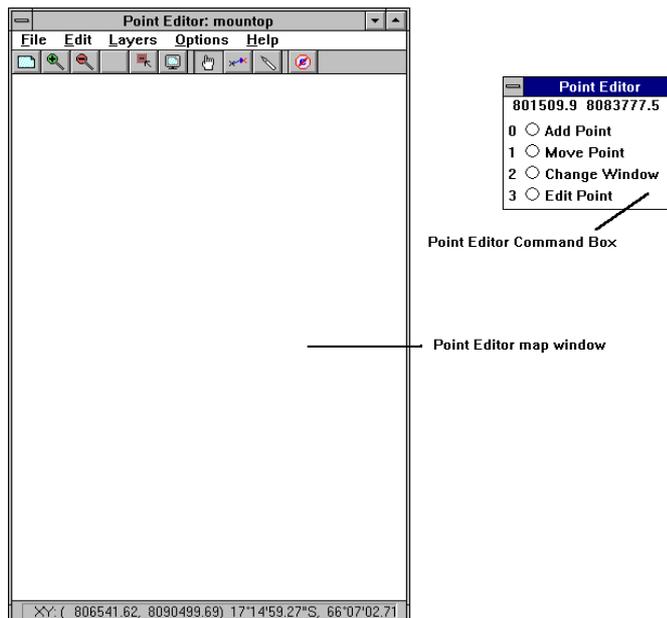


Figure 3.5: The Point Editor map window and the Point Editor command box

The Point Editor command box shows the position of the digitizer cursor and consists of the following commands:

- Button 0: Add point: For digitizing a new point.
- Button 1: Move point: Allows you to move a point.
- Button 2: Change window: For changing the window displayed on the screen.
- Button 3: Edit point: For editing the label of a point.

The following buttons on the button bar of an ILWIS Editor window are shortcuts to select different modes and to exit the Editor:



Select Mode: this allows selection of one or more existing features (points, segments, polygons or pixels) in the Editor. When you click the **Select Mode** button the mouse cursor appears as a little hand. In this mode you can select a feature by clicking it.



Move Point Mode: this allows you to select a point (or a point within a segment) and drag it to a new position. When you click the **Move Point Mode** button, the mouse pointer appears as a pair of little tweezers.



Insert Mode: this allows you to insert new features. When in the **Insert Mode**, the mouse cursor appears like a little pencil.



Exit the Editor: used to exit the Editor.

The Point Editor works in the **Select**, **Move Point** and **Insert Modes**.

Digitizing points



- Position the digitizer cursor at point 1 and press button 0 (**Add point**).
- A small box is opened at the digitized point. Type p1 in this box and press Enter.
- Digitize the rest of the points (figure 3.3) and label them as follows:

Table 3.1: The codes used for digitizing the points in figure 3.3

Point #	Point label	Point #	Point label	Point #	Point label
1	p1	6	p6	11	p11
2	p2	7	p7	12	p12
3	p3	8	p8	13	p13
4	p4	9	p9	14	p14
5	p5	10	p10	15	p14

When you enter the label p14 for the point 15, the Point Editor message box is opened indicating that the label p14 is used for another point. Although the Identifier domain allows for duplicate names, it is not very logical to have two points in an ID domain with the same name. To enter the correct label for this point:



- Select No from this box and enter a new name for this point.
- Type p15 and Enter.

Editing a point

The label (ID) of a point can be edited or changed if incorrectly entered. To edit or change the label of a point:



- Position the digitizer cursor at the point which has to be edited, in this case point 15 and press button 3. Type a new label for this point, e.g., p16 and Enter.

Moving a point



- Position the digitizer cursor at the point which has to be moved, in this case point 14 and press button 1.

The Move Point command box is shown (figure 3.6). It has the following options:

- Button 0: New position: Specifies the new position for the selected point.
- Button 1: No function
- Button 2: Change window: Changes the window displayed on the screen.
- Button 3: Return: Returns to the Point Editor command box.

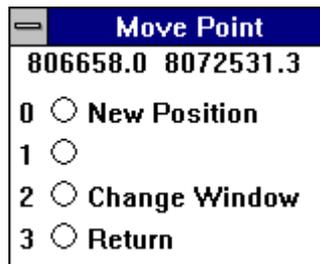


Figure 3.6: The Move or Edit Point command box

- 
- Move the cursor about a centimeter above the point 14 and Press button 0.

If during digitizing points were incorrectly entered, they can be repositioned afterwards.

Deleting a point

- 
- Choose with the mouse the **Select Mode**.
 - Put the mouse pointer on point 16 and select it.
 - Press the right mouse button to open the **Context-sensitive menu** and select **Delete**. You can also press the **Delete** key on the keyboard.
 - Click **Yes** in the opened **Point Editor** message box to confirm.

Multiple points can be selected by pressing the **Shift**, or the **Ctrl** key while you select more points. The digitizing of points is now finished, so you can exit the **Point Editor**.

- 
- Click the **Exit** button in the button bar.
 - Click the **OK** button in the opened **Display Options - Points** dialog box.
 - Close the map window.

3.3 Digitizing a segment map

Before you continue with digitizing a segment map, it may be good to explain first a little about how points, segments and polygons are digitized. Points, segments and polygons are three types of spatial features used in ILWIS. An individual point is defined by a pair of X and Y coordinates. A segment is composed of a series of *intermediate points*, connected by straight lines, with a starting and ending *node*. A polygon is a closed area consisting of one or more segments. All segments forming a polygon have to be connected at intersections. Each intersection or end connection of segments has a node (figure 3.7).

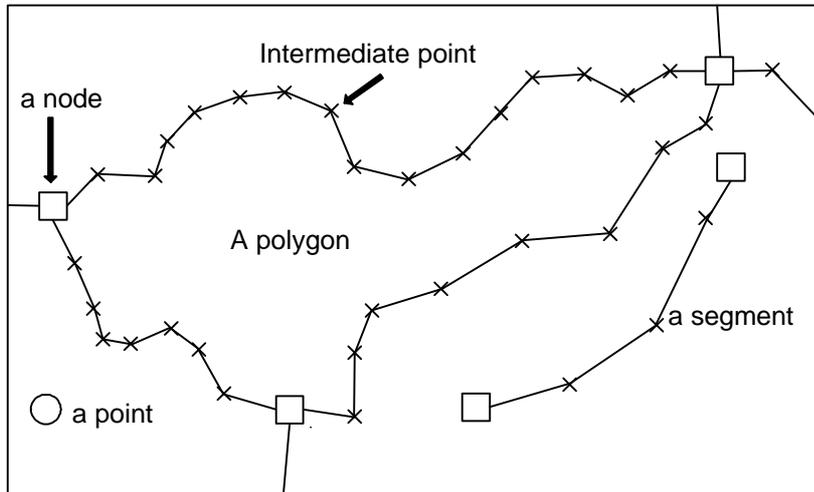


Figure 3.7: Presentation of points, segments and polygons in ILWIS

When you digitize a polygon, the boundary lines of this polygon should be connected. The connection of one line to another is called *snapping*. Snapping always takes place at a node (the end of a line). Snapping is needed for polygons, and for segment maps that represent a network (e.g. a drainage network, or a road network). Snapping is not required for other segment maps, such as a contour map. When you digitize a contour map, you can only snap lines that have equal altitude.

You can digitize a line, by holding down the cursor button and simultaneously moving the cursor on the line (digitizing in *stream mode*). The line coordinates are recorded at regular time intervals. The disadvantage is that many points are needed to define the segment. Many of these points do not improve the accuracy of the line and are considered redundant.

You can also digitize a line, by pressing the cursor button only when a point in the segment needs to be digitized (digitizing in *point mode*). In this way coordinates are only recorded if the button is pressed. The number of points used to store a segment depends on the complexity of the line, and on the accuracy of the person digitizing.

To reduce the number of coordinates defining a segment, a data reduction procedure called *tunneling* is carried out automatically (figure 3.8). The necessity of each coordinate, is evaluated by connecting the adjacent coordinates by a line or tunnel with a pre-defined width. When the evaluated coordinate lies inside the tunnel, it is considered redundant, and is removed. If it lies outside the tunnel, it is kept and the same operation is carried out for the next coordinate.

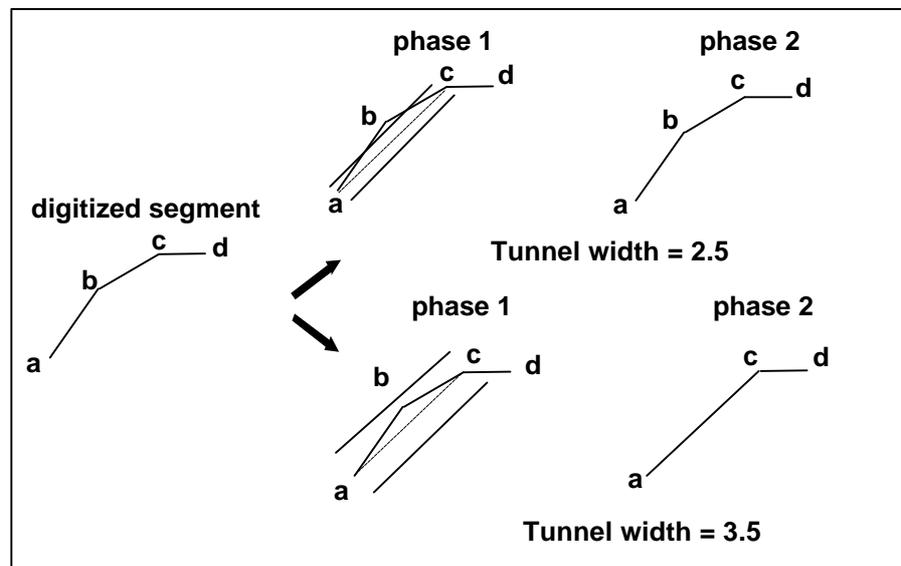


Figure 3.8: The process of tunneling using two different tunnel widths. See text for explanation

In this exercise, a segment map which contains information about the road network in the area will be created. This segment map is presented in figure 3.9.



- Make a photocopy of figure 3.9.
- Remove the photocopy of figure 3.3 if it is still on the digitizer. Position the photocopy of figure 3.9 in the center of your digitizer, and fasten it to the digitizer with tape. With some digitizers you can also place the paper under a plastic cover, so that it remains fixed.
- From the Options menu of the main window, select Digitizer.
- Choose Map Reference from the sub-menu. The Map Reference dialog box is opened.

When a new map is placed on the digitizer, or when you have moved the map that you were digitizing before, you will have to reference the map again. However, the Map reference dialog box still contains the X and Y values of the control points of the previous map. So if the new map uses the same control points, the only thing to

do is to digitize the four points. Once a map is referenced, it remains like that, until you make a new map reference. So even if you turn off the computer and later on want to continue digitizing, and the map on the digitizer is still in the same position, you don't have to reference your map anymore.



- Accept the defaults by clicking the OK button. The Map Referencing dialog box (figure 3.4) and MapReferencing command box (figure 3.4) are opened.
- Digitize the four control points of figure 3.9. Make sure to digitize the correct points for the X-Y coordinates that are already given in the Map Reference dialog box. When the sigma value is around 1 or lower, the error is tolerable. Otherwise digitize the four points again. Click OK.
- From the File menu of the main window, select Create and Create Segment Map. The Create Segment Map dialog box is opened.
- Type Road in the text box Map Name.
- Select Cochabam from the list box Coordinate System.
- Click the Create Domain icon in the list box Domain. The Create Domain window is opened. Type Road in the text box Domain Name.
- Make sure the option Class is selected as the domain type. Click OK. The Domain Editor is opened.

It is possible to write the names of the domain items in the domain editor directly. You will, however, create the names during digitizing.



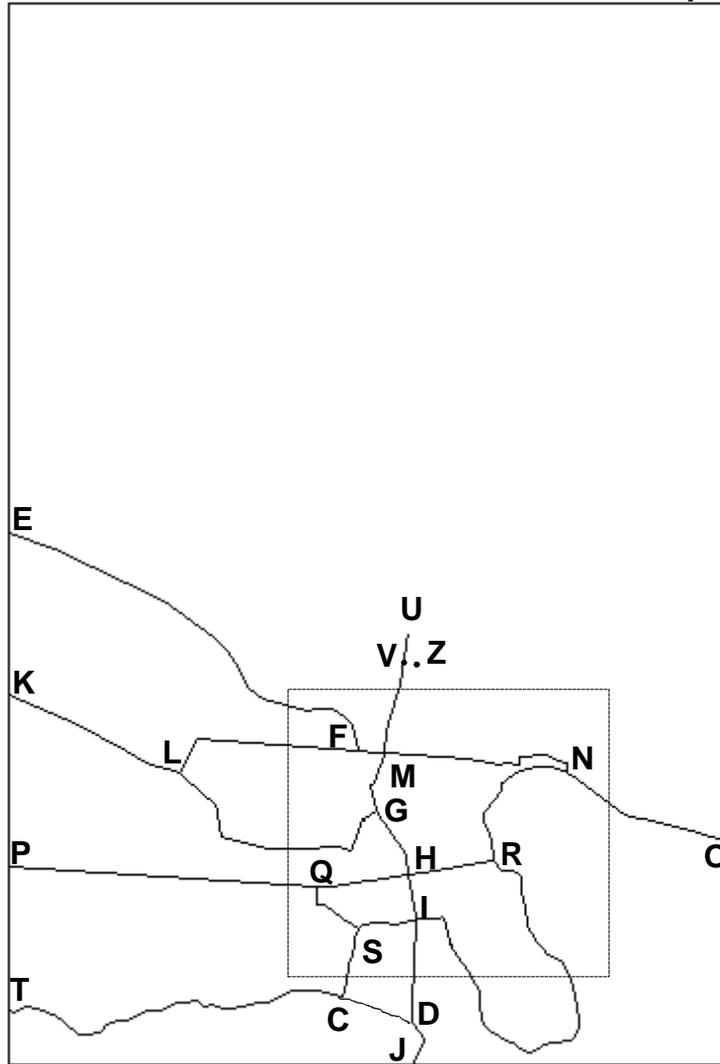
- Close the Domain Editor. You are back in the Create Segment map dialog box. Click OK. The Display Options- Segment Map dialog box is opened. Click OK.

The Segment Editor and the Add Segments command box are opened. The Segment Editor works in Select Mode, Move Points Mode, Split/Merge and Insert Mode.



Split/Merge Mode: This is only used in the Segment Editor. It allows the splitting of segments and the creation of a node. It also allows the removal of unnecessary nodes. When you click this button the mouse pointer changes to a pair of scissors.

X=808500
Y=8090500



X=795000
Y=8071500

LEGEND	
Segments EF, PQ, HR and RNO	= highway
Segments LFN, MGH, HID and ISQ	= main road
Segments KLG, CS and TCD	= motorway
Segments MU, DJ and IR	= earth road

Figure 3.9: The segment map road (not according to the real situation). The nodes of each line have a code in this example to facilitate the explanation on how to digitize

The Add Segment command window shows the position of the digitizer cursor and the commands. The commands in this window are:

- Button 0: **Begin Segment**. Selects the option for digitizing a new segment, with its starting point not connected to another segment.
- Button 1: **Snap Segment**. Selects the option for digitizing a new segment, with its starting point connected to another segment: *snapping*.
- Button 2: **Change Window**. Changes the window displayed on the screen (zoom in or zoom out).
- Button 3: **Move Points**. Switches the program to the Move Point Mode.



- Move the digitizer cursor away from the part of the digitizer covered by the map. You will hear a beeping sound. This is to remind you that the digitizer cursor is outside of the georeferenced area.
- Move the digitizer cursor back inside the part of the digitizer covered by the map. The sound stops.

Zooming in

Before you start digitizing a part of the map, we recommend you to zoom in on that area, so that you can digitize as detailed as possible. This is especially important when you are going to connect segments.



- Press digitizer button 2 (**Change Window**). Now the **Change Window** command box appears.
- Position the digitizer cursor on the upper left corner of the box indicated in figure 3.9 with a hatched line. Press digitizer button 1 (**1st Point**).
- Move the digitizer to the opposite corner of the box with a hatched line and press digitizer button 2 (**2nd point**). The map window now only displays the area inside the box. Check this by moving your digitizer cursor through the box.

Note that you can use button 0 (**entire map**) to zoom out again.

You can also zoom in by using the mouse pointer. In that case, click the **Zoom in** button and define the area you want to zoom in.

Digitizing segments

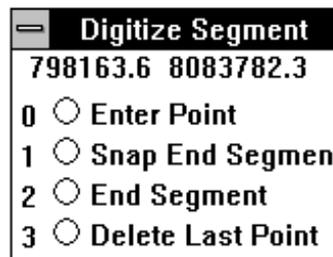
In figure 3.9 each node has a code. This is only used here so that we can explain better how to digitize. To digitize the segment QHISQ:



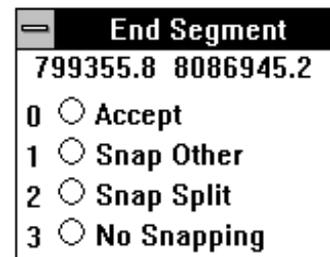
- Click the Maximize button with the mouse pointer to enlarge the map window.
- Position the digitizer cursor at point Q in the map.
- Press digitizer button 0 to enter the point (starting point of the segment).

The program proceeds to the command box Digitize Segment (figure 3.10 (a)). In this box:

- Button 0: Enter Point. Enters the points of the segment.
- Button 1: Snap End Segment. Ends a segment by connecting it to another or by creating a closed segment: *Snapping*.
- Button 2: End Segment. Ends the segment, not connected to another segment.
- Button 3: Delete Last Point. Deletes wrongly digitized point(s) at the end of the segment.



(a)



(b)

Figure 3.10: (a) The Digitize Segment command box, (b) the End Segment command box



- Move the digitizer cursor along the line QHISQ while holding down the button 0 of the digitizer cursor.

Note, since the button 0 is continuously pressed the coordinates are recorded at regular time intervals (see section 3.2). This is digitizing in *stream mode*.



- Release the button 0 when you are just before the starting point (Q) of the line QHISQ.

It is important to stop digitizing a little bit before you reach the actual point where you want to connect the segment. This is done to ensure that no additional intermediate coordinate is digitized, which is in fact on the other side of the connection point, and which will cause an error when you check the segments later.



- Press button 1 (Snap Segment).

The snap segment ensures that the segment is linked to the starting node. The program proceeds with the **End Segment** command box (figure 3.10 (b)). In this box, you can select:

- Button 0: **Accept**. Accepts the point to which the segment will be snapped.
- Button 1: **Snap Other**. Selects a node, within the snap tolerance, to be snapped.
- Button 2: **Snap Split**. Splits the selected segment into two and snaps the segment to the two new segments.
- Button 3: **No Snapping**. Returns to the **Digitize Segment** command box.



- Press the 0 button to snap the last point to the starting point.

The **Edit** dialog box is opened. In this box you can select one of the existing classes or **New** to enter a new name for the digitized segment or for the segment which will be digitized. In this exercise the domain does not yet contain any class. Therefore, you have to select **New** in order to enter a label for the digitized segment.



- Select **New** from the list box **Value**.

The **Add Item to Domain** dialog box is opened. Here a name, a code and a color for the digitized segment can be entered. The colors defined here will be used to display the segments in the map window. It is optional to give codes to segments.

- ! It is advised to enter codes (letters or numbers), especially, when the class names are long and you intend to use the map for further MapCalc operations. The codes can be used in the map calculation formula instead of the class names.
-



- Type `Main road` in the text box **Name**.
- Type `Mr` in the text box **Code**.
- Select a color in the list box **Color**. This color will only be shown after you leave the editor.
- Click **OK** in the **Add Item to Domain** dialog box.
- Click **OK** in the **Edit** dialog box.

The lines EF, PQ, HR and RNO represent highways in the map. Before digitizing the lines, a new class `Highway` should be added to the domain. To add a new class:



- From the **Edit** menu, select **Insert Code**. The **Edit** dialog box is opened.
- Select **New** from the list box **Value**. The **Add Item to Domain** dialog box is opened.
- Type `Highway` in the text box **Name** and `Hw` in the text box **Code**.
- Select a color in the list box **Color**.
- Click **OK** in the **Add Item to Domain** dialog box.
- Click **OK** in the **Edit** dialog box.

Now you can also digitize the lines representing highways.



- Zoom in on the lower part of the map between point E and the lower right corner of the map.
- Position the digitizer cursor at point E and press the **0** button.
- Keep pressing this button and move the cursor along the line EF.
- Release the button when the cursor is at point F.
- Press the **2** button (**End Segment**).
- Digitize segments KLG and TCD, following the same steps as described for segments EF.

Now, if you want to digitize segment CS, there is a problem. Since there is no node yet at point C, the segment TCD should be split first before you can digitize segment CS. You can split a segment during digitizing, or by selecting the Split/Merge mode.



- Click the **Split/Merge** button. The mouse pointer changes to a pair of scissors.
- Position the mouse pointer at point C (check with digitizer cursor) and click with the mouse. The following message is shown:
Split segment hi: Highway ?
- Click **Yes**. The segment is now split and an intermediate node is shown. Click the newly created node. The message appears:
Merge segment hi: Highway with segment hi: Highway? Click No.

With the **Split/Merge** mode you can split segments into two, connected by a node. You can also use it to remove unnecessary nodes.



- Position the digitizer cursor at point C and press button 1 (snap segment).
- Press digitizer button 0 (accept).
- Press digitizer button 0 and move along the line CS until you are near to S.
- Position the mouse pointer on point S and press digitizer button 1 (snap end segment). With a sound it is indicated that the segment cannot be connected to point C, since there is no node yet. The **End Segment** command box appears.
- Press digitizer button 2 (**Snap Split**) to split the segment QHISQ.
- Press digitizer button 0 (**Accept**) to accept the location where the segment QHISQ will be split and where the segment CS will be connected.

The segments KLG, CS, TC and CD are representing **Motorways** on this map. Since no new class name has been defined for them yet, they will automatically get the same class name (**Highway**) as the last digitized segment: EF. Hence, names of the segments need to be changed to **Motorway**.



- Press the **Select Mode** button with the mouse pointer.
- Position the mouse pointer on the segment KLG and select it.
- Press the **Shift** key and put the mouse pointer on the segment CS and select it. This way you can select multiple segments.
- Do the same for the segments TC and CD. Note that TCD now consists of two segments, since you have split it.
- Click the right mouse button, to open the **Context-sensitive** menu and select **Edit**. The **Edit** dialog box is opened.
- Select **New** in the **Edit** dialog box. The **Add Item to Domain** dialog box is opened.
- Type **Motorway** in the text box **Name**. Type **Mw** in the text box **Code**. Select a color in the list box **Color** and click **OK**.
- Click **OK** in the **Edit** dialog box.

The names of the segments can also be changed by double-clicking the segment.



- Double-click the segment TC.
- The list of the existing segment labels is displayed, and you can see that the selected name for segment TC is **motorway**.

As you have seen, the connection of one segment to another is done via *snapping*. This is to ensure that the segments are linked precisely through the nodes. Snapping only succeeds if a point exists within the snapping tolerance distance. A beep warns if this is not the case. Reposition the cursor near the point you want to snap and try again. The snap command only functions when you snap to the starting or ending point of a segment. To snap to an intermediate point, the segment has to be split and then snapped. The *snap tolerance* is a distance within which the program will accept a node to snap to it. You can define the snap tolerance yourself in the **Customize Segment Editor** dialog box.



- From the **File** menu of the map window, select **Customize**. The **Customize Segment Editor** dialog box is opened.

Within the **Customize Segment Editor** dialog box you can see that the default value for the *snap tolerance* is 126.666 meters. This means that if you want to connect two segments, and the cursor is less than 126.666 meters from a node, this node will be used to connect the two segments. The snap tolerance is defined by the

system when you start the **Segment Editor**, based on the coordinate boundaries (and the scale) of your map. The user may enter another value if needed. A large value for the snap tolerance will make the map less accurate. A very small value for the snap tolerance will make the digitizing difficult, since you have to zoom in a lot before you can snap.

Note also another value in the **Customize Segment Editor**: The *tunnel tolerance*. This value (in this case 12.66) defines the width of corridor between the first and last of three points (see figure 3.8). If the second point falls within this corridor, it will not be used as intermediate point, and therefore not stored. If it falls outside of the corridor, it will be used as intermediate point. So by selecting the tunnel tolerance you can influence the detail of the lines that you digitize. If you increase the tunnel tolerance, the segments will be digitized rather coarsely, with only a few intermediate points. If you make the tunnel tolerance very small, many intermediate points will be stored and the size of your segment map will become large.

Note also that the default setting for **AutoSnap** in the **Customize Segment Editor** is: **Selected**. This means that when you end a segment with the mouse, the system will automatically try to snap it.

Now you will practice some more with snapping segments.



- Click **OK** in the **Customize Segment Editor** dialog box.
- Put the digitizer cursor at point **F** and press the button **1**, to snap the starting point of the new segment to point **F** of the segment **EF**.
- Digitize segment **FL** by pressing the button **0**. Stop just before **L**.
- Press button **1** to snap this segment to point **L** of segment **KL**. The program proceeds to **End Segment** command box.
- Press button **2** to split the segment **KL** to segments: **KL** and **LG**.
- Press button **0** to snap the segment **FL** to one of the segments (**KL** or **LG**).
- Digitize the rest of the segments, snap or split and snap them where necessary. To codify the segments, follow the legend of figure 3.9.

Change the position of a point

An incorrectly digitized point can be corrected by re-positioning it afterwards. Assume that the correct position of point **V** on the line **UM** (figure 3.9) is at point **Z**. To change the position of this point:



- Return to the **Add Segment** command box. Press button **3** to select the **Move Point Mode**.

The program proceeds to the **Move Points** command box. In the **Move Points Mode**, all segment nodes appear as little boxes, and all intermediate coordinate pairs appear as small crosses.

The **Move Points Mode** can also be selected from the Edit menu or from the Button bar.

The commands in the **Move Points** command box (figure 3.11 (a)) are:

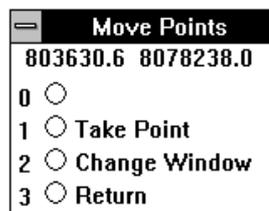
- Button 1: **Take Point**. Selects the point to be moved.
- Button 2: **Change Window**. Changes the window displayed on the screen.
- Button 3: **Return**. Return to the **Add Segments** command box.



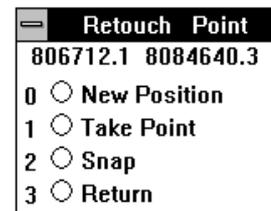
- Zoom in on the area surrounding point V.
- Position the digitizer cursor (box) on the point V and press button 1.

The program proceeds to the **Retouch Points** command box (figure 3.11 (b)). The commands in this command box are:

- Button 0: **New Position**. Specifies the new position of the selected point.
- Button 1: **Take Point**. Selects the point to be moved.
- Button 2: **Snap**. Snaps the taken point, to a point on the segment on which it has been positioned.
- Button 3: **Return**. Return to the **Move Point** command box.



(a)



(b)

Figure 3.11: The **Move Points** (a) and **Retouch point** (b) command boxes



- Position the cursor at the new position, point Z and press button 0.

You can also use **Move point** mode to correctly snap nodes, for example the end point of segment EF.



- Zoom in on the area around node F.
- Put the cursor at node F, and press button 1. The **Retouch Points** command box is opened. The line EF is shown in red.
- Press digitizer button 1 again. Now the segment LF is shown in red (if it was connected). Press 1 again and the segment FM is shown in red.
- Connect it to the other segments by pressing button 2.

Deleting a segment

An incorrectly digitized segment can be deleted. Suppose the segment UM was incorrectly digitized, and you want to delete it:



- Zoom in on the area of segment UM.
- Choose with the mouse pointer the **Select Mode**. Select segment UM.
- Click with the right mouse button and select **Delete** from the **Context-sensitive** menu.

A deleted segment can be undeleted. If the segment UM was deleted by mistake and you want to undelete it:



- Open the **Context-sensitive** menu and select **Undelete segments**.
- The deleted segments will be displayed in the map window with a different color. Selecting the segment MU is enough to undelete it.

Deleted segments are shown in a different color, which can be changed in the **Customize Segment Editor** dialog box. If you want to remove the deleted segments completely, you can select the option **Pack** from the **File** menu.



- From the **File** menu in the map window select **Pack**.
- Answer **OK**, to the question whether you want to pack the data.

Packing the data (removing deleted segments and coordinates), is recommended before you generate a polygon map from a segment map.

Displaying segments in different colors

You can quickly see how many classes exist in a segment map, by displaying the segments in different colors or in the colors defined in a **Representation**.



- Open the Context-sensitive menu in the map window by clicking the right mouse button, and select **Customize**.

The **Customize Segment Editor** dialog box is opened. From this box you can choose to display the segments in Normal color, colors defined in the representation (**Domain**), or in primary colors.



- Select **Domain** from this box. Click **OK**.
- Click the **Exit Editor** button. Click **OK** in the **Display Options** dialog box. The segment map is displayed. Close the map window.

The final part of segment digitizing is the checking of the segments. The items that are checked are intersections of lines without a node, dead ends in segments, self overlapping segments and consistency of the codes.

The checking of segments is not treated here. In section 3.5 a detailed explanation will be given of the procedure for checking segments, and correcting errors.

3.4 Digitizing contour lines

In the previous exercise you have seen how to digitize a segment map with a class domain. Now you will learn how to digitize segments with a value domain: Contour lines. Each contour line is digitized with the corresponding height as the value. The contour value is given in the map (figure 3.12). This contour map can be used to create a Digital Elevation Model (see chapter 10). Digitizing contour lines is quite a tedious job. To simplify the exercise, only the southern part the contour map of the study area will be digitized. When digitizing, take the following into consideration:

- Always digitize contour lines a little bit further outside the boundaries of the study area, to prevent the boundaries of the area having wrong results after contour interpolation.
- Where many contour lines are close to each other, it is preferred to digitize only a few to minimize errors in the interpolation.
- Hilltops should be digitized as small lines, to prevent the hill having a flat top, defined by the highest closed contour line.



- Make a photocopy of figure 3.12.
- Remove the photocopy of figure 3.9 if it is still on the digitizer. Position the photocopy of figure 3.12 in the center of your digitizer, and fasten it to the digitizer.
- From the **Options** menu of the main window, select **Digitizer**.
- Choose **Map Reference** from the sub-menu. The **Map Reference** dialog box is opened.
- Reference the map (figure 3.12) to the digitizer, similarly, as described in section 3.3.
Note that the coordinates of the corners of this map are not the same as shown in the **Map referencing** dialog box. You need to change them. Do not select the X and Y coordinates of the map corners, but make the minimum X and Y values a bit lower (100 m) and the maximum ones a bit higher (100 m). This way you can digitize the contour lines a little bit outside the map boundaries.
- Double-click **New SegMap** in the **Operations-list**. The **Create Segment Map** dialog box is opened.
- Type **Isolines** for the name of the map.
- Select **Cochabam** from the list box **Coordinate System**.
- Select the domain **Value** in the list box **Domain**.
- Type **2000** and **4000** in the **Range** text boxes, and type **0.1** in the text box **Precision**.

- Click OK.
- Select the check box **Info** in the **Display Options** dialog box and click OK.

The **Segment Editor** and the **Add Segments** command box are opened.



- From the **Edit** menu of the map window select **Insert Code**. The **Edit** dialog box is opened.
- Type the value: 2560.
- Click OK.
- Digitize the contour lines with the altitude 2560.
- Press the right mouse button and select **Insert Code**. Type the value 2580. Digitize the contour lines with this altitude.
- Digitize all the contour lines.
- Make sure to snap different parts of the same contour line.
- Do not digitize the boundary.

When you finish digitizing the contours, you can easily check whether an error was made, by checking the *code consistency*. The code consistency check is done to find segments that are connected, but have different values. This can not be true for contour lines.



- From the **File** menu of the map window, select **Check Segments, and Code Consistency**
- Accept the defaults and click OK.
If the program finds an error, it will indicate the place of the error with a red box and a dialog box appears stating the nature of the error: **Different codes at node**.
- Correct the errors (if any) by recoding the wrong segments.
- Press the **Exit Editor** button when the digitizing is finished. The **Display Options** dialog box is opened.
- Select the check box **Info**.
- Select **Pseudo** representation. Click OK. The map is displayed.
- Close the map window.

3.5 Creating a polygon map

Now you will see how to digitize a polygon map. A polygon map can be created using the following steps:

- Digitizing the boundaries of the polygons as segments in the Segment Editor;
- Checking the segments in the Segment Editor;
- Digitizing the labels of the polygons as a point map in the Point Editor;
- Polygonizing the segments using the point map as labels in the Segment Editor.

The digitizing of segments is not treated here anymore. This was already explained in section 3.3. You will start this exercise with a segment map that contains a number of errors, which will be detected and corrected during the checking of the segments.

The file with which you will work is called `Checkseg`. It is the digital version of figure 3.14. It contains segments with the label `Unitbound`.

-
- ! If you have already done this exercise before, and want to repeat it, you should reinstall the data again, since the errors from the segment map are then removed (for data installation: See ILWIS installation guide).
-



- Make a photocopy of figure 3.14 and fix this to the digitizer.
- Reference this map with the method explained in 3.2.
- Click the segment map `Checkseg` with the right mouse button and select `Edit` from the context-sensitive menu.
- Click `OK` in the `Display Options` dialog box.

The Segment Editor and the Add Segments command box are opened.

Checking segments

After the segments in the map are connected by snapping, you can check whether this has been done correctly. The most important errors that may occur during digitizing are shown in figure 3.13:

- **Dead end in segment.** The segment is not connected to another segment. This is shown in example 1.
- **Intersection without node.** The segment overlays another segment without a node. Several examples are shown in 2 and 3.

- The same segment is digitized twice. This may happen in large files, or in files you obtain from someone else. This is illustrated in example 4.
- Self Overlap. The segment crosses itself. This is shown in example 5.

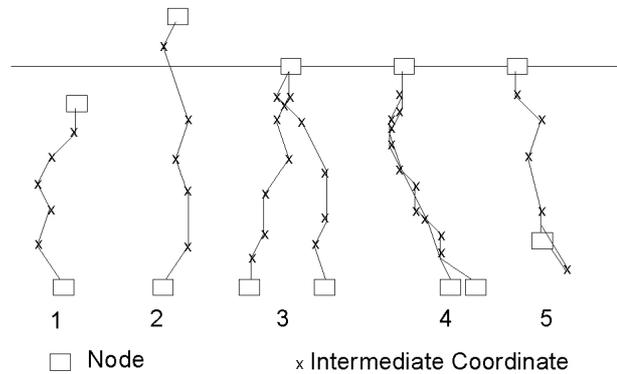


Figure 3.13: Different types of digitizing errors that are detected during the checking of segments. See text for explanation

Before the map can be polygonized it should be checked whether the segments have been digitized in an appropriate way. This check is done using the option **Check Segments** from the **File** menu of the **Segment Editor** map window. It can also be done when you select the option **Polygonize** from the **File** menu.

From the **File** menu of the map window, select **Check Segment and Self Overlap**. The **Check Segments** dialog box is opened. Click **OK**.

- The map is now checked for segments that overlap themselves. The program checks and will give an error message:
Segment unitbound crosses itself. Remove false polygon?
- Click **Cancel**. Zoom in on the part where the error occurs, indicated with a red box. This is near **D** in the map.

The situation near point **D** is shown in figure 3.15 (a). As you can see the segment crosses itself. To correct it automatically, there are two possibilities:

- Remove the false polygon (shown in figure 3.15 (b)).
- Split the segment (shown in figure 3.15 (c)).

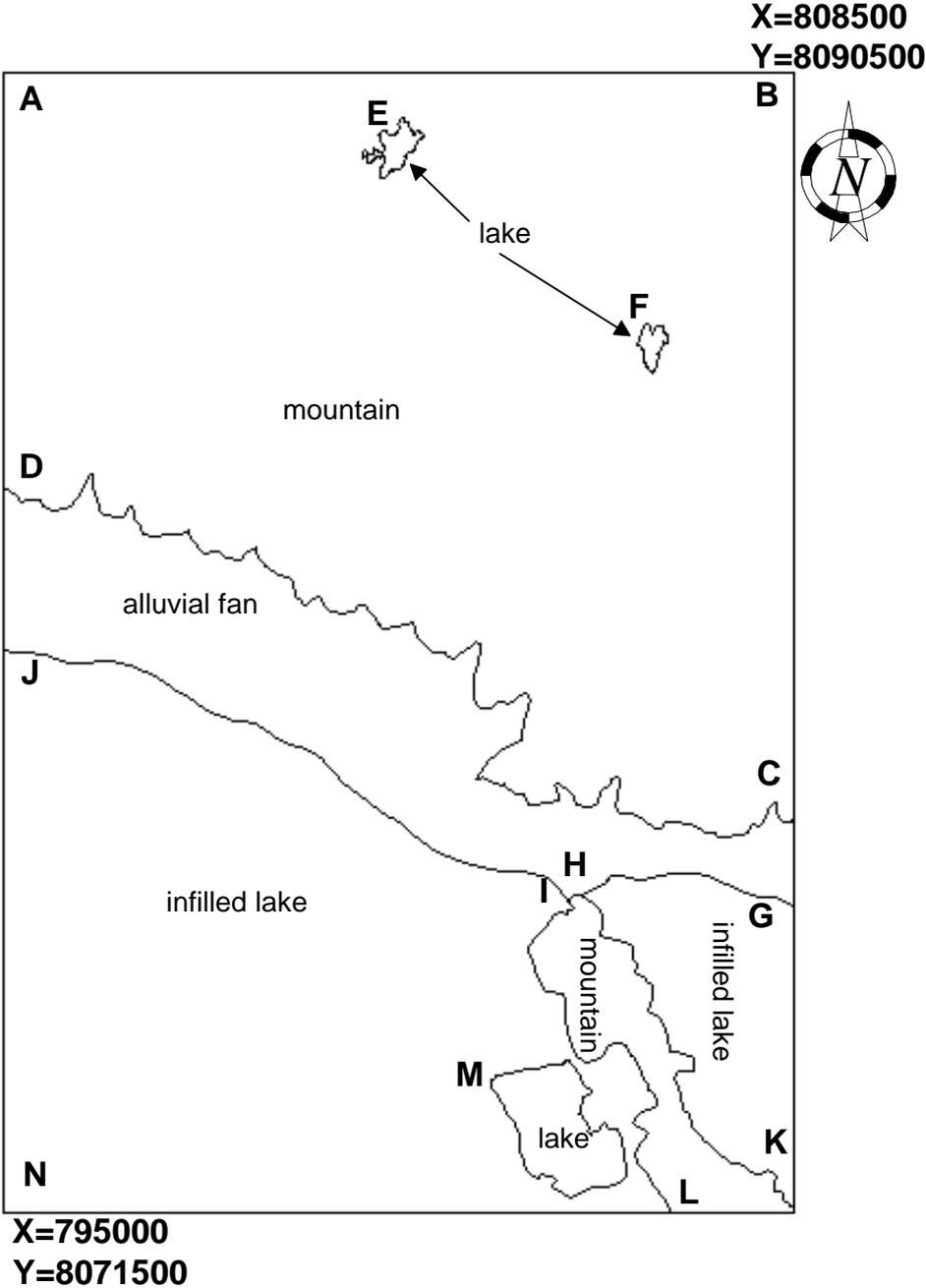


Figure 3.14: Polygon map geom

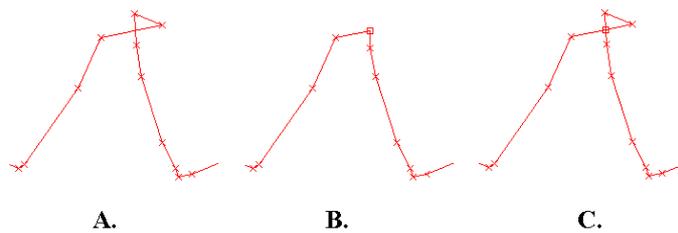


Figure 3.15: Self overlap error near point D in figure 3.14. A: Original situation showing the overlap. B: Situation after automatic removal of false polygon. C: Situation after automatic splitting segments



- From the **File** menu of the map window, select again **Check Segment and Self Overlap**. The **Check Segments** dialog box is opened. Click **OK**.
- The program will give an error message: **Segment unitbound crosses itself. Remove false polygon?** for the same point near D.
- Click **Yes**.
- The program is now checking further on segments that overlap themselves. It will give again the same error message: **Segment unitbound crosses itself. Remove false polygon?** now for a point near M.
- Click **Cancel**. Redraw the map window and zoom in on the part around point D. Compare the result with figure 3.15 (b). Then zoom in on the area around M. Check that there is an error.
- Again select **Check Segments, Self Overlap**. Click **OK**. The point near M with the error is again identified and the message **Segment unitbound crosses itself. Remove false polygon?** appears.
- Click **No**. Now the message: **Split segment unitbound?** appears.
- Click **Yes**. The program continues checking and will find another segment overlapping itself. Click **Cancel** in the error message box.
- Zoom in on point M and check the result. The situation is comparable with the one shown in figure 3.15 (c).

It is in general not advisable to use the automatic editing options (such as **Remove false polygon**, or **Split Segment**), since this may lead to many small polygons (if you use the **Split segment** option), or to unwanted generalization of the segment

(if you use the **Remove false polygon** option). Instead it is often better to edit the error manually using the **Move Point Mode**.



- Redraw the map window and zoom in on the area with the red box (below M).
- From the **File** menu in the map window, select **Check Segment and Self Overlap**. The **Check Segments** dialog box is opened.
- Select the check box **Start at Number**. The number of the last checked segment is shown. Click **OK**. The checking is resumed.
- The map is now checking further on segments that overlap themselves. The program checks and will give an error message: **Segment unitbound crosses itself. Remove false polygon?** now again for the point near M.
- Click **No**. Now the message: **Split segment unitbound?** appears.
- Click **No**. The editor changes to the **Move Points** mode and the place of the error is indicated by a small quadrangle.
- Zoom in on the lower part of the lake M and use the mouse pointer, that is now in the form of little tweezers, to move the intermediate points of the segment, until they no longer overlap. Click the **Entire map** button when finished.
- From the **File** menu in the map window, select **Check Segments and Self Overlap**. The **Check Segments** dialog box is opened.
- Select the check box **Start at Number**. The number of the last checked segment is shown. Click **OK**. The checking is resumed and, if you made the corrections well, no other self overlapping segments are found.

The next check that will be made is on *dead ends in segments* (see figure 3.13-1).



- From the **File** menu in the map window, select **Check Segments and Dead Ends**. The **Check Segments** dialog box is opened. Click **OK**. The map is now checked for segments that are not connected to others (*dead ends*). An error message will appear: **Dead end in segment unitbound**. The location of the point is indicated by a red box, in this case close to point A.
- Click **OK** and the editor changes to the **Move Points** mode.
- Zoom in on the quadrangle near point A in the map. Pick the end of the segment and move it so that it connects with the other one.
- Display the entire map.

- From the File menu in the map window, select Check Segments and Dead Ends. The Check Segments dialog box is opened.
- Select the check box Start at Number. The number of the last checked segment is shown. Click OK. The checking is resumed. Again an error will be found, now near point H.

The situation near point H is shown in figure 3.16.

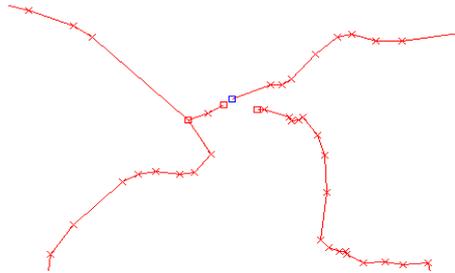


Figure 3.16: Dead ends in segments, near point H in the map of figure 3.14

As you can see there are three segments at point H which are not properly connected.



- Zoom in on the area around H and use the mouse pointer to move the nodes of the segments until they connect. Click the Entire map button when finished.
- From the File menu of the map window, select Check Segments and Dead Ends. The Check Segments dialog box is opened.
- Select the check box Start at Number. The number of the last checked segment is shown. Click OK. The checking is resumed. Again an error message will appear, now near point D.
- Correct the error at point D and resume checking dead ends. There will be another error at point J. Continue checking dead ends until no more error messages appear.

The last check that will be made is on *intersections without nodes* (see figure 3.13-2 and 3).



- Display the entire map.
- From the **File** menu of the map window, select **Check Segments and Intersections**. The **Check Segments** dialog box is opened. Click **OK**. The map is now checked for segments that are intersecting without a node.
- An error message will appear: **Intersection without node in segment unitbound. Split segment?** in a location near point **E**.
- Click **No** and zoom in on the area around **E**.

The situation near point **E** is shown in figure 3.17 (a).

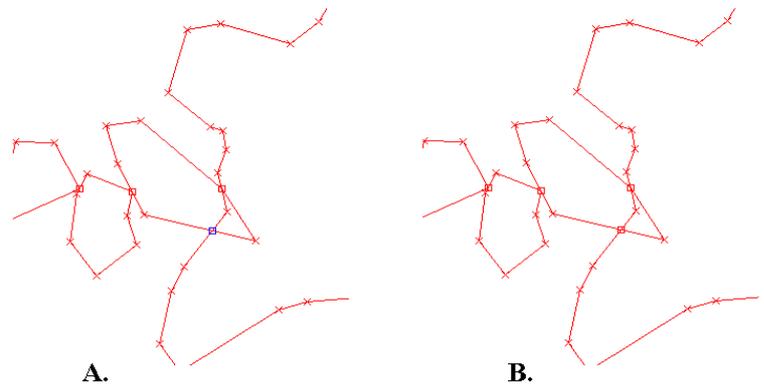


Figure 3.17: Intersection without node near point **E** in figure 3.14. **A**: Original situation. **B**: Situation after automatic correction



- From the **File** menu in the map window, select again **Check Segments and Intersections**. Click **OK**.
- An error message will appear: **Intersection without node in segment unitbound. Split segment?** Referring again to a location near point **E**. Click **Yes**. The program resumes checking intersections and will display an error message for an error near point **L**. Don't accept automatic correction and select **No**.

The situation near point **E** after automatic correction is shown in figure 3.17 (b). As you can see, it is not always advisable to use the automatic editing option since this may lead to many small polygons. Instead it is often better to edit the error manually using the **Move Point Mode**.



- Display the entire map.
- Zoom in on the area around L and use the mouse pointer to move the nodes of the segments so that the two segments no longer intersect. Click the **Entire map** button when finished.
- From the **File** menu in the map window, select **Check Segments and Intersections**. The **Check Segments** dialog box is opened. Select the check box **Start at Number**. The number of the last checked segment is shown. Click **OK**. If you corrected the previous errors well, no more errors are found.

There is one more option to check segments: *Code consistency*. This is useful only in situations where you want only segments with the same code to be connected. For example, in the case of contour lines, where only lines with the same altitude code should be connected. In the example of the segment map *Checkseg* this is not a useful option, since there is only one segment code (*Unitbound*).

To better see the effect of automatic editing, you will now correct for the small polygons that were generated during the automatic editing in point M and point E.



- Zoom in on the area around M.
- Choose the **Select Mode**, select the small unwanted segments and delete them by pressing **Del**.
- Repeat the same procedure for the area around point E.

The segments of the map *Checkseg* are now error free, and you can proceed with the creation of the polygon map.

Creating a label point file

When you create a polygon map, the best procedure is to digitize the boundary lines of the segments in a segment map, and the labels or names of the polygons as points in a point map. Now you will digitize a point map, containing the names of the units in the map of figure 3.14.



- Double-click **New PntMap** in the **Operations-list** in the main window. The **Create Point Map** dialog box is opened.
- Type **Landunit** in the **Map Name** text box.
- Type for the **Description**: `Points indicating the labels of land unit polygons.`

- Select the **Coordinate system**: `Checkseg`. This is the coordinate system that was used for the segment map `Checkseg`. The coordinate system of the point map should be the same as the one of the segment map.
- Click the **Create** button next to the **Domain** list box. The **Create Domain** dialog box is opened.
- Type `Landunit` in the text box **Domain Name**.
- Select the option **Class**. Click **OK**. The **Domain Editor** is opened.
- Press the **INS** key and add the domain item: `Alluvial fan`. Click **OK**. Add also the domain items: `Infilled lake`, `Lake` and `Mountain`. Close the **Domain Editor**. You are now back in the **Create Point Map** dialog box.
- Click **OK**. The **Display Options- Point Map** dialog box is opened, Click **OK**.
- The **Point Editor** and the **Point Editor** command box are opened (figure 3.5).
- Digitize a point within each of the units indicated in figure 3.14. See exercise 3.2 on how to digitize points.
- When you are finished digitizing the points, click the **Exit Editor** button in the **Point Editor**. Click **OK** in the **Display Options** dialog box. The point map is displayed.
- Close the point map.

Creating the polygon map

Now that the segments are checked and you have a label point file, you can proceed with the polygonization.



- Activate the **Segment Editor** of the map `Checkseg`.
- From the **File** menu in the map window, select **Polygonize**. The **Polygonize Segment Map** dialog box is opened..

At this point you have the possibility to polygonize the map using a point map with labels (containing the name of the polygons), to use a domain, or to *Auto identify* the polygons (in which default names will be assigned to the polygons).



- Select the option **Label points** and select the point map `Landunit`.
- Type `Landunit` for **Output polygon Map**.

- Type: Polygon map of land units for Description. Select **Show** and click **OK**. The segments are checked again and the map is now polygonized. The **Display Options** dialog box is opened.
- Click **OK**. The polygon map is shown. Click the units to find out their names.
- Activate the **Segment Editor**, displaying the segment map **Checkseg** and click the **Exit Editor** button. Click **OK** in the **Display Options** dialog box. The segment map is shown. Close the segment map **Checkseg**. Close also the polygon map **Landunit**.

The polygon map is now created. The last step is to edit the polygons. In order to be able to edit it, you should first break the dependency link between the polygon map **Landunit** and the segment map **Checkseg**.



- Click polygon map **Landunit** with the right mouse button and select **Properties** from the **Context-sensitive** menu. The **Properties** dialog box is opened. Click the **Break Dependency Link** button and confirm with **Yes**.
- Click polygon map **Landunit** with the right mouse button and select **Edit** from the **Context-sensitive** menu. Click **OK** in the **Display Options** dialog box.

Editing polygons

The **Polygon Editor** and the **Polygon Editor** command box are opened. The **Polygon Editor** command box only contains two options:

- Button 0: Edit value: Changing the name of a polygon.
- Button 1:
- Button 2: Change window: Changing the window displayed on the screen.
- Button 2:



- Zoom in on the area around E and F.
- Edit the names of the small lake polygons.
- When finished, press the **Exit Editor** button. The **Display options** dialog box is opened. Click **OK**.
- The map **Landunit** is now ready. Close the map window when finished.

If you want to practice some more with the creation of a polygon map, you can digitize the segment yourself and do the segment check.



- Create a segment map Landun, now using the coordinate system Cochabam. Digitize the lines of figure 3.14 in a similar way as explained in exercise 3.3. Digitize all segments, including the boundaries of the map, and make sure to snap all segments. All segments in the map may receive the same code: Landun.
- Check the segments and correct the errors.
- Create a point map Landun, also using coordinate system Cochabam, digitize the labels, and use this point map together with the segment map Landun to create a polygon map Landun.

Summary: Digitizing maps

- Spatial data in ILWIS are digitized as point, segment or polygon maps.

An individual point is defined by X and Y coordinates.

A segment is composed of a series of intermediate points, connected by straight lines, with a starting and ending node.

A polygon is a closed area consisting of one or more segments.

- Point, segment and polygon maps are digitized and edited with the Point Editor, Segment Editor and Polygon Editor respectively.
- The Editors work in **Select**, **Insert** and **Move Point** modes. The Polygon Editor only has a **Select Mode**.
- You can add features to the selection, by clicking them while pressing and holding the **CTRL**- key. When you have completed the selection, release the **CTRL**- key. To select all points or pixels within a specific area, define a window enclosing them. This window can be defined by dragging it with the left mouse button. To deselect any of these features, press and hold the **SHIFT + CTRL** - keys and click on the selected features. When you have finish deselecting, release the **SHIFT + CTRL** - keys. To toggle between select and deselect features, press and hold down the **SHIFT** key, click the selected one to be deselected, and non-selected one to be selected. When finished, release the **SHIFT** key.
- Segments are digitized either by continuously digitizing them (stream mode), or by pressing the digitizer cursor only for some points along the line (point mode).
- A data reduction procedure called *tunneling* is carried out automatically, to reduce the number of points defining a segment.

- In a segment map, generally, it is not needed to connect segments to each other, except when it concerns linear features that will be used, e.g., in network analysis.
- In a polygon map, all segments forming a polygon have to be connected (snapped) to each other at intersections. In other words, all boundary lines of polygons should be snapped to each other at their nodes.
- Segments can be checked for **Dead ends** (a node that is not connected), **Intersection without node** (segment overlays without a node), and **Self Overlap** (a segment that crosses itself). For contour maps, it is also useful to check for **Code consistency** (check if connected segments have the same code).
- Polygon maps are made by first digitizing the boundary lines in the **Segment Editor** checking the segments and polygonizing them.
- A domain type ID, class or value, can be selected for a new map. The domain of a map is selected, based on the data represented by the map, e.g., a domain type class for a land use map, value domain for a segment map representing the contour lines.

