UPPSALA UNIVERSITET

Institutionen för Geovetenskaper
Geoinformatiklaboratoriet

LOCALISATION OF WELLS BASED ON GEOGRAPHIC AND ATTRIBUTE CRITERIA

Requirements
This exercise requires a PC with Windows 95/98 or Windows NT and the GIS software
ArcView 3.0 or later. The necessary data are available under the archive
…/Data/Arbetsstuga2000/arcveiw/… on the course CD as well as on the Earth server at
Geocentrum: earth2/_Sharedfiles/geoinformatik/data/arbetsstuga2000/arcview/…

Objectives
The aim of this exercise is to introduce search and query functions in GIS (ArcView).
    Students should acquire knowledge about different ways to select data based on
    spatial criteria as well as non-geographical attributes.

Task
In this exercise you should locate a well that is suited for the production of sausages.
The sausage industry in Kumla has given the following criteria:
• Driving distance from Kumla to the well should be between 10 and 30 kilometres
  round trip.
• Distance from the nearest road to the well should be less than 1 kilometre.
• The well should be situated on forested land.
• The well should have some kind of measure to prevent infiltration of surface water.
• It should be situated more than 1 kilometre from the nearest built-up area.
• The water capacity of the well should be more than 6000 l/h.
Your job is to find well(s) that matches these criteria and make a suggestion as to which
one is most suitable.
To complete the exercise, a map showing the location of the well and its co-ordinates
should be handed in. As you can see there are many criteria that need to be met and
there are several different ways to find a suitable well. The following is a suggestion of
how to go about the work. If you can find a way that is easier or faster, you are welcome
to do so.

Add Necessary Data

The first thing you should do is add the necessary themes from the data that is supplied. The themes needed are public roads (Rt_av94), built up areas (Rt_to90) from Röda kartan, land cover (Y1_10fsv) from Gröna kartan (all supplied by Metria) and wells (Brunn10f) from SGU.

Data layer	Archive …/Data/arbetsstuga2000…
Roads	/ arcview/metria/rodakartan/Rt_av94
Built up areas	/arcview/metria/rodakartan/Rt_to90
Land cover	/arcview/metria/gronakartan/vektor/10fsv/Y1_10fsv
Wells	/arcview/sgu/brunnar/brunn10f

Use the Add theme button 🞥 to navigate to the files and add theme to the View. When the themes are added to the view they are not turned on. To turn them on (make them visible) you have to click in the check box to the left of the legend symbol in the view's table of contents.
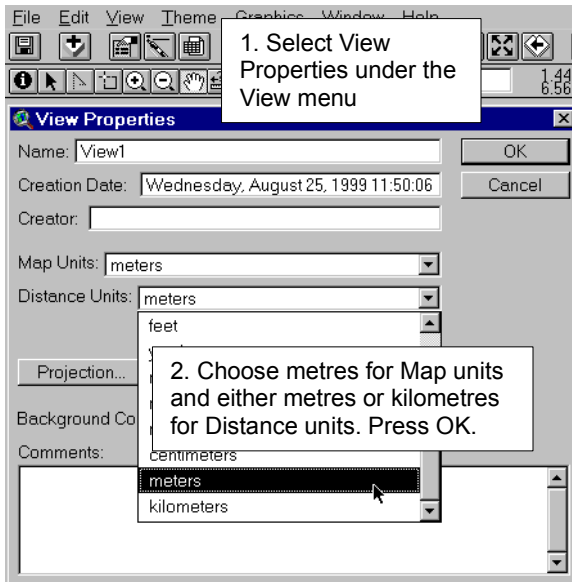
When you have the themes visible in the view, you should locate and select Kumla. This is done with the Find button 🔍. Kumla is a built up area (tätort) and you thus have to have the theme Rt_to90 active to search for it. Also put the theme Rt_to90 on top in the Table of Contents (TOC) by dragging it there so you can see Kumla when it is selected.
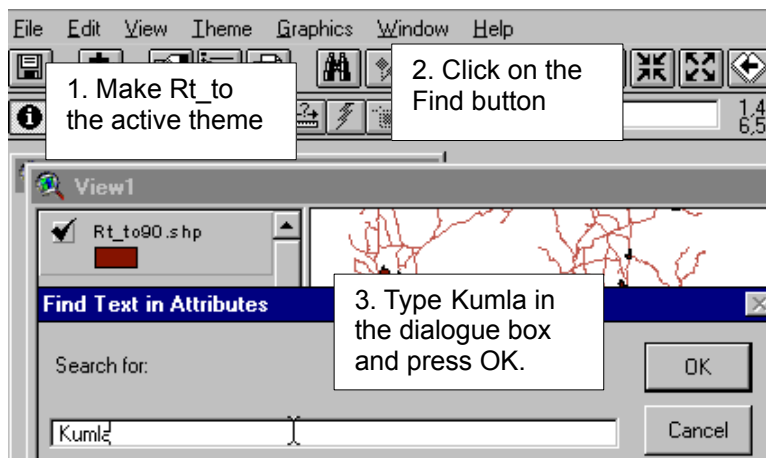
Make the theme with built up areas (Rt_to90) active, put it above the other themes in the TOC and use the Find button 🔍 to locate Kumla.

When ArcView has found Kumla for you, make sure the View is the active document and built up areas (Rt_to90) the active theme. Under the Theme menu, choose Convert to shapefile, this will convert the selected features into a separate shape file. In the dialogue box that appears, navigate to your working directory and save the file as Kumla.

The first criterion for the well is that it should be between 5 and 15 km from Kumla. For ArcView to be able to measure distances correctly, you must first set Map and Distance units. This is done under View - Properties.

1. Select View Properties under the View menu

2. Choose metres for Map units and either metres or kilometres for Distance units. Press OK.

All the themes that are included in the data set is in the co-ordinate system for rikets nät – which uses meter as unit distance. In the dialogue box for View Properties thus choose meters for Map units. Distance units you can set either metres or kilometres.

Proximity Criteria - Transportation

Now that the programme knows what units to measure the map in, you can select features within a certain distance from other features. You want to select wells that are situated 5 to 15 km from Kumla. This needs to be done in two steps. First, you need to select wells that are more than 5 km away. This can be done by using the Select by Theme command. First, you should make the Brunn (well) theme active and under the Theme menu, choose Select by theme. Select feature of active themes (well) that Are Within Distance Of the selected features of Kumla.shp

1. Make the Brunn theme active.

2. Choose Are Within Distance of, Kumla.shp and type 5000m (or 5 km). Press New Set.
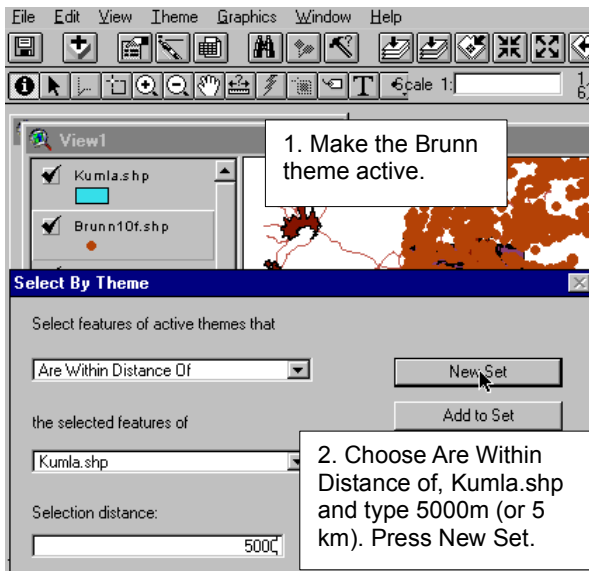
The selection you just made includes all wells that are *within* 5 km of Kumla. What you are seeking however, are wells that are *further* away than 5 km. To select these records, open the theme table for Brunn by clicking on the Open theme table button. Then click on the Switch Selection button. This tool will invert the selection, in this case deselecting records within 5 km and selecting those further away than 5 km. If you did this correct all wells with a proximity > 5 km away from Kumla should now be highlighted in yellow.

This was only the first step in selecting wells in the proper distance from Kumla. From the selected set, showing wells further away than 5 km from Kumla, you should now find the subset of all wells also *less than* 15 km away. This is done in a similar fashion as above. Make sure the Brunn theme is the active theme and go to Select by theme (the View has to be the active document type). This time, choose Are Within Distance of and Kumla.shp and type 15000 m but instead of pressing New Set, choose Select from Set. This command will only select among records that were already selected, i.e. records that are *more than* 5 km from Kumla. You have now specified the distance requirements so you can choose Convert to shapefile, save the file in your working directory as DistWells and add it to the View.

You can now click in the checkbox for the original Brunn theme to hide it from the View or delete the theme, under the Edit menu. Keeping it visible will just make the view more difficult to read and you do not need the original theme anyway.

Land Cover Criteria

Another criterion is that the well should be situated on forested land. The first step is to find all forested land around Kumla. The theme Y1_10fsv contains information about land cover, and you should thus open this theme. In the attribute table, you can see that there are many codes for different types of land cover (in the Detaljkod field). You must now find out what the different codes mean i.e. which are representing forests. These are found in a data description set that is found under Arbetsstuga2000. The coding list for Gröna kartan is in the archive …/arbetsstuga2000/html/kodgron.htm. The name of the theme is Y1, and you should thus look under Ytiskikt 1 and find the forest classes. When you have found the right codes, you must somehow select the "forest-records" in ArcView. Since the datatype in the "Detaljkod" field is numeric and not string, and there are many records to select, the best way to select all records is to use the Query builder.

Make the Y1_10fsv theme active and click on the Query builder button and create an expression that selects the records you want. There are several types of forest with separate codes. You want to include all types. Use the logical operator "or", If you would choose "and" as the operator, each Detaljkod record has to include both numbers to become selected, which is not possible.
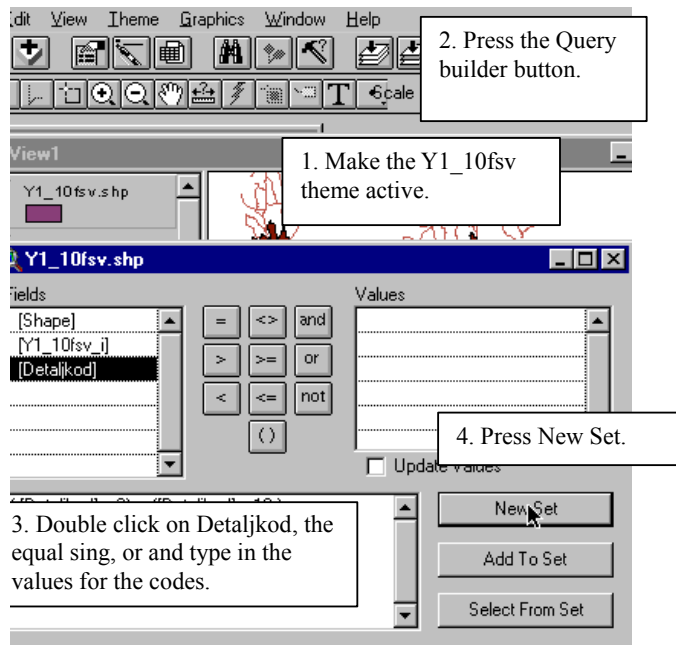
In the Query builder dialogue box, double click on the Fields, operators and Values (in this case you have to type in the values yourself).

When you are done, press New Set. Make the Y1_10fsv theme the active document and choose Convert to shapefile. Save the file as Forest in your working directory and add it to the View. (If you want, hide Y1_10fsv to make the view more comfortable to read.)

The second step is to select all wells that are situated in the forested land. To do this, you must make the theme Distwells active and choose Select by Theme. In the dialogue box that appears select those wells that Intersect with the Forest. After the selection is made, convert the selected records to a shapefile, save it as Forestwells and add it to the View.

Proximity Criteria - Quality

Now there are only two more geographical criteria for locating suitable well(s). First it should be situated more than 1 km from the nearest built-up area. From the theme Forestwells, which you should make the active theme, choose Select by theme under the Theme menu and choose Are within Distance of, Rt_to90 (built up areas) and type 1000 m in the box designating distance.
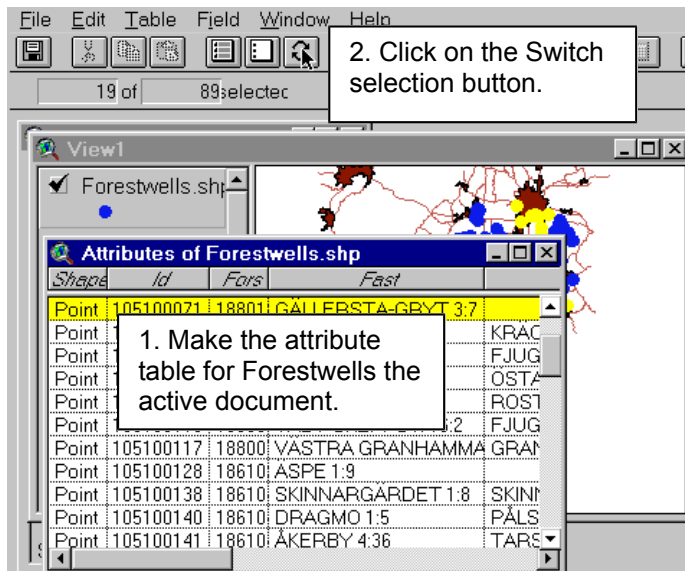
You should now have selected wells that are within 1 km of any built-up area, but what you want is to select records that are more than 1 km from built up areas. Use the same method as when you selected wells more than 5 km from Kumla, i.e. make the attribute table active and press the Switch selection button. After you have done this, make the theme the active document, convert the selection to a shapefile, save it as Ruralwells and add it to the view.

The last geographical requirement for the location of the well is that it should not be situated more than 1 km from a road. Use the theme Ruralwells to Select by Theme those wells that have proximity of less than 1000 m from a road. In the dialogue box that appears, specify Are Within Distance of the selected features of Rt_av94 and the selection distance to 1000 m.
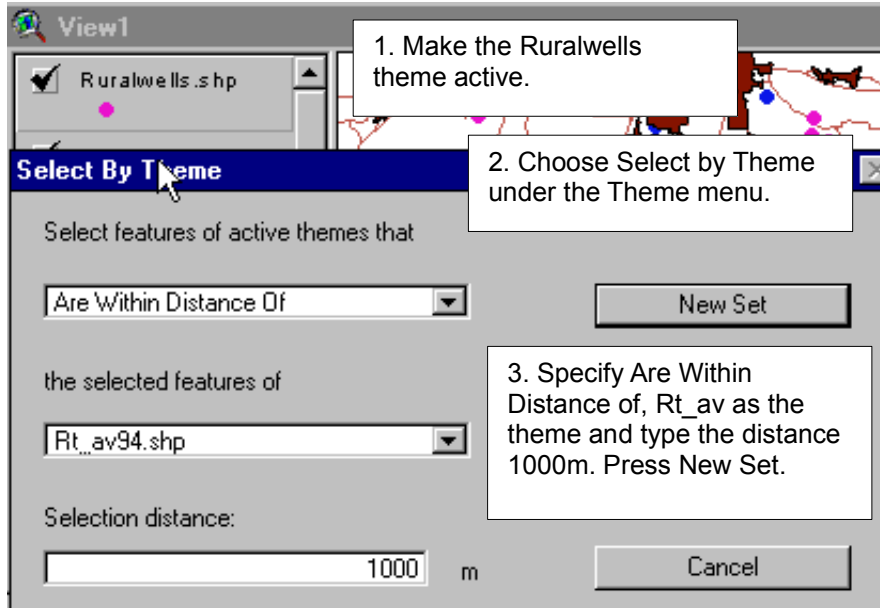

Once you have made the selection, make the Ruralwells theme the active document and convert the selection to a shapefile. Save the file in your working directory as Accesswells and add it to the view.

Quality And Capacity Criteria

Now the geographical criteria for the well are met. However, there are certain criteria for the well itself; it should have some kind of protective measure to prevent infiltration of surface water and also have a water capacity of more than 6000l/h. To find wells that

have protective measures you must open the codelist for wells in the same way as when finding the codes for forest from Gronakartan. This is found under …/data/arbetsstuga2000/html/databesk.htm. Navigate to the codelist for wells which is found under the SGU catalogue and find out which field is designated to protective measures (tätning). Once you have found the codes, make the theme Accesswells active and create a query expression that selects all wells with protective measures.
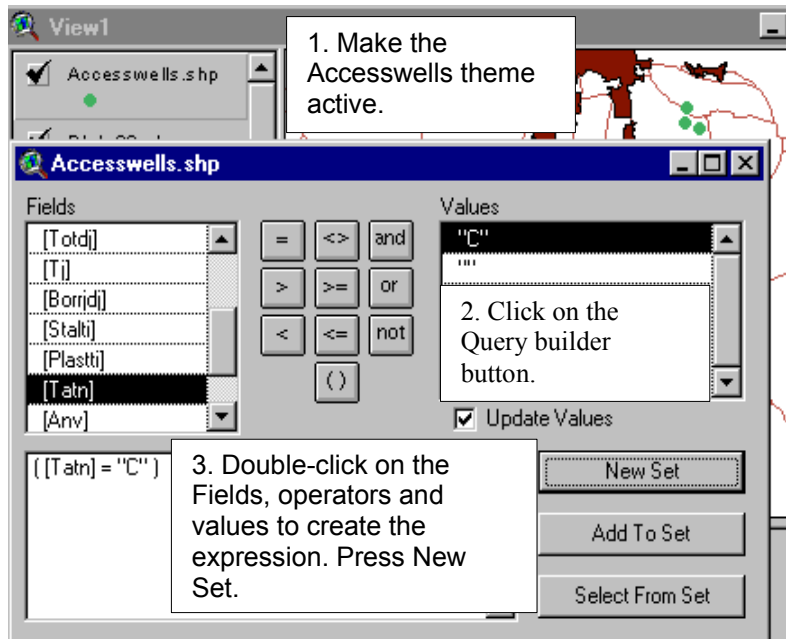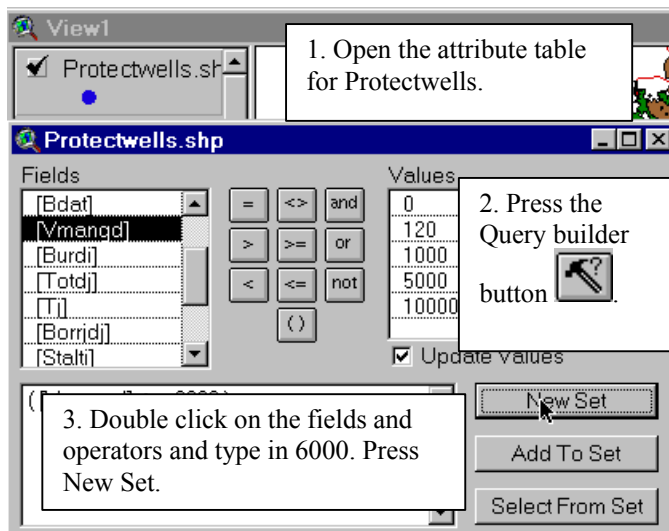

Make the Accesswells theme the active document and click on the Query builder button [icon]. Create an expression that will select wells with protective measures.

After making the selection, convert it to shapefile and save it as Protectwells in your working directory.

The last criterion for the well is that it should have a water capacity of at least 6000l/h. Look in the codelist for Brunn10f to find out which field is designated to water capacity. Make the theme Protectwells the active theme and build a Query expression for the capacity criteria. Since there is a minimum water capacity specified, use the "more or equal to" operator.

After making the selection, make the Protectwells theme the active document; choose convert to shapefile and save it in your working directory as Finalwells.

To pass the exercise, produce a layout with an appropriate scale showing roads, built up areas, Kumla and the selected well(s). From the Rt_av94 and Rt_to90 themes, select those records that are within a distance from Kumla that will produce a layout representing the areas closest to Kumla and the well, using the select by theme commands in the same way as previously. To create the layout, go to Layout under the View menu. Choose the appropriate format for the layout and once it appears, double click on the title, legend and scale bar to edit them. In the layout you must also give data for the well, including X and Y co-ordinates and estimated capacity. Work with the Text tool T. to write the required information.

Below is an example of how the final layout could look.

Hand the produced layout to the teachers either in paper or in digital format. To send it in digital format, have the layout as the active document and go to the File menu and choose Export. Save the file as JPEG and send it the JPEG file as an attachment to an e-mail to one of the teachers.