

Where is the body?

A victim is kidnapped and dumped in the heathland. Pollen samples and vegetation debris are used to locate the victim

After a kidnapping and subsequent dumping of the victim, a suspect is arrested. The suspect denies any involvement in the case and is not helpful to the investigation. It is unknown if the victim is still alive, or where the victim is left behind. Therefore, it is very important to handle fast and in effective way. From the clothes and shoes of the suspect pollen samples and other vegetation debris are collected for analysis, to obtain any information of the surroundings the suspect has been lately. Concurrently a tactical investigation is started to obtain information by i.e. witness statements.

Reduce time and costs of an investigative search by narrowing down the search area

An investigative search is a labour intensive and therefore costly task. Narrowing down the search area would be able to reduce these costs considerably. This information can come from both forensic evidence and tactical information. If we are able to gather information that is site specific, we could start a search to verify our predictions. Off course it is always possible to alter the search area based on new information. The search area will be greatly reduced, and therefore - and this is especially important in matter of life or death – more effort can be put in the sites where the victim is expected to be found. In this module we will use a small dataset of a part of the Drenthe province to simulate this approach.

Global outline of the assignment

Predict the dumping site of the victim based on pollen samples, vegetation debris and tactical information

During this assignment, we will predict the location of a dumping site based on analysis of pollen samples and other vegetation debris, retrieved from the shoes, clothes, and nasal cavity of the suspect. The analysis of the vegetation and pollen samples indicate the presence of the species *Calluna vulgaris*, *Carex panicea*, *Erica tetralix*, *Molinea caerulea*, *Rhynchospora alba* and *Rhynchospora fusca* (see Figures 1-6).

We will use different sources of information to find a solution the problem. We use the Top10vector, a dataset containing information on distribution of heathland patches in Drenthe and a dataset containing tactical information about the case. Moreover we will use data extracted from the EcoGRID database that contains information about the flora and fauna of the Netherlands.

Figure 1 *Calluna vulgaris*

Figure 2 *Carex panicea*

Figure 3 *Erica tetralix*



Figure 1 *Molinia caerulea*

Figure 2 *Rynchnospora alba*

Figure 3 *Rynchnospora fusca*



TOP10vector

TOP10vector is the basis of the topographic map in the Netherlands, scale 1:10,000

The TOP10vector is the digital format that is the basis of the topographic map, scale 1:10,000, in the Netherlands. The Netherlands are one of the first countries in the world to have a countrywide and very detailed topographic file. This file is called TOP10vector and is the most detailed file made available by the Topographic Service. TOP10vector is a vector file with a closed polygon structure, built from coded and mutual connected line elements. Object types and attributes are attached by element coding. The various topographic elements in the file can be selected separately or in combination, without disturbing the structure of the underlying data. By mutual connection of all line elements in the TOP10vector sub-objects are formed. This gives the user the opportunity to compose an object oriented file for specific applications. The TOP10vector file is divided in files that represent an area of 10 x 6.25 km. All TOP10vector files are in the Rijksdriehoek coordinates system. Information about cultivation, (main) roads, vegetation, land use and geographic borders are gathered through aerial photography combined with terrain exploration. All these data is stored in the TOP10vector file.

In this module we will use the TOP10vector files of the Drenthe province to create a map for the area of our interest. In the first part of this exercise you will learn how to use these TOP10vector files.

Adding data in ArcMap

Open the map TOP10vectorDrenthe.mxd stored in your data folder. Here you see the TOP10vector of a part of Drenthe. As you can see, there is a part missing. Turn of the three Symbology layers, and turn the layers Houses, polygons and lines on (see [Using ArcMap page 78, Turning a layer on or off](#)). You need to add the shapefiles that contain 'vlakken', 'huizen' and 'lijnen' (see [Using ArcMap page 110, adding data in ArcMap](#)) to complete the map of Drenthe. These files are stored in the folder TOP10vectorDrenthe in your data folder. Define with use of the 'File Overview' stored in the literature folder, which area is missing. The codes displayed on this overview map correspond with the folder where the data can be found. A coded area is subdivided in two distinct shapefiles (left and right) due to the size of the shapefiles. For adding one coded area you therefore have to add two shapefiles.

Use the File Overview to determine which data you have to add from the TOP10vector folder

For example: If you want to add the polygon layers of the area coded bij 18AN you choose, **add data | data folder | Top10vectorDrenthe | 18AN1 | shape | vlakken | vlakken18an1.shp**, subsequently you do the same for **vlakken18an2.shp** too.

The shapefiles containing the houses are saved in the folder **huizen**, the lines shapefiles are stored in the folder **lijnen**. As you notice the adding of the different files is very time-consuming. Now add all house, polygon and line shapefiles of the missing part of Drenthe.

TIP: To facilitate copying data to and from your network disk, ArcMap allows you to store relative pathnames to data sources referenced on a map:

File | Map Properties | Data Source Options | Store relative pathnames

If you now store your map and data in the same folder, the references stored in the map will be correct regardless of the disk location. Save your work regularly!

Group layers

When you have added the separate shapefiles, move these into the correct grouped layer (see [Using ArcMap page 144, adding layers to a group layer](#)). Now you have three grouped layers that contain the polygons, lines and houses of this specific part of Drenthe. TOP10vector has its own symbology to show the different objects on the map. Symbology can only be assigned to shapefiles, and therefore not directly to the grouped layers. Since it is very time-consuming to assign the symbology to every separate shapefile you will merge all house shapefiles into one (see [ESRI ArcGIS Web Help Merge](#)). Then you only have to assign the symbology to the merged output layer, which is still a shapefile. Tools like **Merge** can be used in different ways. You can run them via the dialog box (see [Geoprocessing in ArcGIS page 2, Running tools via their dialog boxes](#)), at the command line (see [Geoprocessing in ArcGIS page 3, Running tools at a command line](#)) or you can build a model (see [Geoprocessing in ArcGIS page 4, Building models of your work flow](#)). The choice depends on the data, the tool and your personal preference (see [Geoprocessing in ArcGIS page 72-74, Using dialog boxes and the command line](#)). You can try different ways to get familiar with the differences in geoprocessing methods. Give the merged layers an appropriate name (i.e. merged_houses) and save them into your data folder. Do the same for the polygon layers and line layers. To assign the symbology add the three symbology layers from the TOP10vector folder (**add data | data | TOP10vectorDrenthe | ArcGIS Top10Vector Symbology v080 | layer of choice**). Subsequently, you need to provide spatial information from the layer that you want to symbolize. In order to do so, click the red exclamation mark

Merge layers to assign symbology

Tools can be run via the dialog box, command line, or a model can be build

Assign symbology to the three merged layers

Provide spatial information to the symbology layers

and subsequently the merged layer of choice from your data folder. Now you can remove the three previous symbology layers (see [Using ArcMap page 142, Removing a layer](#)).

Save the created map to your data folder

Now you have created the map from the part of Drenthe you will be working with. Save this map as TOP10vectorDrentheComplete.mxd to your data folder.

Which heathland areas contain the vegetation type that corresponds with the found samples?

Extract heathland patches from TOP10vector

The first thing you want to do is to extract only the heathland patches of Drenthe. The vegetation of the collected evidence can only be found in these heathland patches. Thereby, the investigation area is reduced. This is a geoprocessing operation (see [Geoprocessing in ArcGIS page 69-91, Geoprocessing basics](#)). Open the attribute table of the merged polygon layer **Options | Select by attributes** and select the heathland patches (Heide) (see [Using ArcMap page 328, Selecting records by attributes](#)). You want to create a shapefile of this selection. You can use two tools to perform this task, the **clip tool** (see [ESRI ArcGIS Web Help Clip](#)) or the **select tool** (see [ESRI ArcGIS Web Help Select](#)) from the extract toolbox (see [ESRI ArcGIS Web Help Extract Toolbox](#) or [Geoprocessing quick reference guide page 3](#)).

Use select by attributes to select the heathland patches from the attribute table

Use an extraction tool to extract the heathland patches from the TOP10vector map

Question 1: Which tool is best suitable for this task and why?

Perform the extraction and save the output shapefile to your data folder. Turn all other layers off. Now you have a map which shows only the heathland patches in Drenthe.

EcoGRID is a database system that provides access to data about the distribution of flora and fauna in the Netherlands

The collected evidence indicates the presence of 5 different plant species. Your task is to narrow down the search area to the locations where these species occur. Therefore, vegetation data is extracted from EcoGRID. EcoGRID is a database system that discloses the Dutch nature observations for nature management, conservation and legislation. EcoGRID provides anyone interested, access to the data stored in the National Databank Flora and Fauna (NDFF) in an understandable and responsible manner. The NDFF is a system that stores the nature data of the Netherlands. The NDFF consists of a collection of different databases managed by various organizations. All databases share the same EcoGRID data model. The core of this data model is implemented in each of the connected databases. Each organization can locally extend its model beyond this core. The NDFF is a growing database and is based on observations. Of each observation the species, location and time, as well as the number of individuals, the way the observation has been done, the life stage

it is in, its current activity and the biotope it resides in are stored, if possible. NDFP is a collection of data sources while EcoGRID is a database system to disclose this information in a useful, responsible and centralized way.

Pollen and vegetation debris of five species are found on the belongings of the suspect

Nature observations are made in so-called kilometre quadrangles in the Netherlands

Add the feature class containing those kilometre quadrangles to the map

Add the species distribution data derived from EcoGRID

Join or relate the EcoGRID table to the kilometre quadrangle feature class

At the clothes of the suspect samples are taken *Calluna vulgaris*, *Carex panicea*, *Erica tetralix*, *Molinea caerulea*, *Rhynchospora alba* and *Rhynchospora fusca*. From the EcoGRID database the observation data of these species is retrieved. In the Netherlands observations are made in kilometre quadrangles. These are areas from 1 x 1 kilometre that are related to the Rijksdriehoek coordinates system. It is the usual concept to map biodiversity and the distribution of plant and animal species. Since you do not readily know where the kilometre quadrangles are located on the map, you first need to add a layer with this particular information. This shapefile is stored in your data folder called 'kilometre quadrangles'. Add this feature class to your map (see [Using ArcMap page 110, adding data in ArcMap](#)). Select this layer and zoom to its extent. You now see the Netherlands represented by the quadrangles. Change the symbology of this layer to hollow (see [Using ArcMap page 164, Changing the symbol](#)). Zoom to the Drenthe province again.

Next thing you want to know is which heathland patches are vegetated by the species from the collected evidence. Therefore, you need the EcoGRID data. This data is stored in the geodatabase 'Forensic/Tactical Data' in your data folder. Add the database 'Vegetation Drenthe' (see [Using ArcMap page 110, adding data in ArcMap](#)) to your map and take a look at the attribute table (see [Using ArcMap page 315, Opening a layer's attribute table](#)). It only contains data of the specific species that are found on the suspect or his belongings. What you want to do is to show on the map where this data is observed. You need to do this with use of the kilometre quadrangles, since that is the only common spatial information. Therefore you need to attach the table to the feature class kilometre quadrangles. Therefore, you can use a *join* or a *relate* (see [Using ArcMap page 340, Joining the attributes in one table to another](#), [Using ArcMap page 342, Relating the attributes in one table to another](#)). Read [Using ArcMap pages 337-339](#) to better understand the difference between joining and relating tables.

Question 2: What is the difference between a join and a relate? And which one would you preferred in this case?

Select all records in the 'Vegetation Drenthe' attribute table (see [Using ArcMap page 329, Selecting all records](#)). The corresponding kilometre quadrangles are simultaneously selected and accessible (see [Using ArcMap page 343, Accessing](#)

Extract the kilometre quadrangles that contain the five species of interest

[related records](#)). The attribute table of the kilometre quadrangle feature class opens directly. From this selection you subsequently want to create a shapefile. You obtain this by performing the similar analysis as above (**Analysis Toolbox | Extract | Select**). Save the feature class to your data folder.

Question 3: Describe what the output of this analysis means.

Use a spatial join to define the heathland patches that are vegetated by the species of interest

Now, the heathland patches are isolated and it is known in which kilometre quadrangles the specific species are present. It is however not yet known which heathland patches are vegetated by the species of the collected evidence. Therefore, you have to analyse the relation between these two outputs. This can be done by a tool from the Overlay toolbox (see [ESRI ArcGIS Web Help Overlay toolbox](#)). In this case you will perform a *spatial join* (see [ESRI ArcGIS Web Help Spatial join](#)).

Question 4: Describe what a spatial join does.

Question 5: Which parameters or values, and why, do you use in the dialog box for:

- Target feature class?
- Join features?
- Out feature class?
- Join-to-one/Join-to-many?
- Keep all/Keep common?
- Match option?

Save the created map to your data folder as finalforensic.mxd

Save the output of the spatial join to your data folder. This layer contains only these heathland patches where the five species of our interest are present. Based on the forensic data so far, it is not possible to reduce the investigation area further. Create a map that is easy to read, objective and nicely visualized (see [Using ArcMap page 453-509 Laying out and printing maps](#)). It needs to contain a legend, north arrow and scale bar. Add what you think is necessary to understand the map. Save your complete map, finalforensic.mxd, to your data folder.

Tactical Information

Tactical information is stored in the file geodatabase

Use specific symbology for crime analysis

CASE is a GIS extension to perform crime analysis

Read the CASE manual carefully

Use the sequential analysis tool to provide information about the time schedule of the case

Enable the CASE extension

In the meantime the tactical police have been working on this case as well and also collected some investigative leads. This data is also stored in the file geodatabase 'Forensic/Tactical Data' in your data folder. Add the feature class to your map, and have a look at the point data and its attributes. There are leads based on witness statements, the home addresses or found items. Change the symbology of the point data so that you are able to recognize the different types of information (**Properties | Symbology | Categories | Unique Values**) (see [Using ArcMap page 165, Drawing a layer showing unique values](#)). Visualize the three types of category information. ESRI gives the opportunity to use symbols that are specifically suitable for crime analysis. Therefore, double click a symbol, you then enter the symbol selector (see [Using ArcMap page 164, Changing the symbol](#)). Choose **more symbols | crime analysis**. Assign three appropriate symbols to the categories (resize if necessary). You can clearly see that the tactical leads are focused around one heathland patch. For the analysis of this kind of data a GIS extension is developed, called Crime Analysis Spatial Extension (CASE). This extension contains tools that help mapping and analysing crime. In this module we will use only one of its functionalities. Keep in mind that it is originally developed for the analysis of crime series and therefore has no scientific founding in forensic science yet. It is possible to encounter the different investigative leads this way since they can be seen as series as well. First study the manual of this CASE extension, which is located in your literature folder, carefully before you proceed.

The tool you will use is the *sequential analysis tool*. This tool provides information about the movement of the suspect and victim in time, assuming that they travelled together and have only separated in the heathland. The sequential analysis provides information about the end-point of their trip. Off course, keep in mind that the time frames are based on eye witness statements. To enable the CASE extension, go to **Tools | Extensions** and make sure CASE is checked on. If you do not see the toolbar yet, choose **View | Toolbars** and click CASE (see [Using ArcMap page 517, Hiding and showing toolbars from the view menu](#)). Now the toolbar must be enabled. The sequential analysis tool can be found in the **Movement menu**. Fill in the parameters and perform the sequential analysis.

Question 6: Describe what the output of this analysis shows.

Question 7: What are the conclusions you draw based on this analysis?

Perform a proximity analysis to provide information about the movement space of the suspect and possibly the victim

Look at the last three points. The left car of the suspect suggests that from this point the suspect and victim have moved by foot. Since the detection of the vehicle the suspect is seen in two near locations. What you can do now is called a *proximity analysis* (see [ESRI ArcGIS Web Help Proximity toolset](#)). Therefore, you have to select the points of interest in the tactical information feature class and use the **Buffer tool** (see [ESRI ArcGIS Web Help Buffer](#)). Choose for the distance 3000 metre, since you assume they were by foot. Save the output to your data folder. The result from this analysis gives an indication of the area the suspect and victim have moved in. Now you can use this information for narrowing down the investigative search area once more.

Question 8: How would you do this? Which tool do you think is appropriate here?

Use an overlap tool to define the heathland patch that is in the movement space

You want to investigate the overlap of the buffer with the heathland patches that contain the specific species. Perform the appropriate analysis and save the output feature class to your data folder . The result is the area that will be thoroughly investigated by the police which will hopefully lead to the victim.

Measure roughly the investigative area

Use the **measurement tool** (see [Using ArcMap page 89, Measuring distance](#)) to make a rough indication of the size of the investigative area (polygon).

Question 9: What is the approximate size of your investigative area?

Save the map as finaltactical.mxd to your data folder

Create a map that is easy to read, objective and nicely visualized. Save your map as finaltactical.mxd to your data folder (see [Using ArcMap page 453-509 Laying out and printing maps](#)).

Hand in:

1. The answers to the questions in this module
2. The maps finalforensic.mxd and finaltactical.mxd

Finally, copy your data folder (in stead of using Explorer, use ArcCatalog to manage your GIS files!) to your personal N:\data folder.