Using Indicator-Based Measures and Dispersion Modelling to Assess Air Pollution Risks from an Incinerator

Scenario:

It has been hypothesised that a new waste incinerator in the Kerrier area of Cornwall, UK is responsible for respiratory disease among neighbouring residents. The stack gas output from the incinerator is believed to contain carcinogenic pollutants such as arsenic, cadmium, dioxin, and PCBs. These pollutants have been linked to both lung cancer and larynx cancer. A recent study of a similar incinerator in Germany found that schoolchildren living within 5km of the incinerator had dioxin levels 1.7 times greater than the national average. Within 2km of the German incinerator, dioxin levels in the children's blood were 3 times the national average.

The potential risks from the new incinerator have received widespread media coverage. As a GIS analyst within the local borough council, you have been asked to evaluate the possible risks to residents, but so far no data have been forthcoming from the company that runs the incinerator, nor are atmospheric levels of any of the suspected carcinogens routinely monitored.

Data:

Incinerator: a Shape file that shows the location of the waste incinerator
Population at risk: Synthetic population data for the Kerrier area can be downloaded from the Output Area Demonstrator project: http://www.public.geog.soton.ac.uk/research/oa2001/oademon.asp. Choose the output areas produced under Scenario 8 at the bottom of the page for this exercise.

Note 1: the population data are supplied for information only. You do not need to work with these data in order to complete the exercise.

Note 2: Although the location of the incinerator and the air filter failure are fictitious, the overall background to the scenario is based on a real-life study in the Ribble Valley, UK (Diggle and Rowlinson, 1994).

Produce an indicator-based map of dioxin exposure

Task: Using the information provided above about potential risks to children, produce an indicator-based map of exposure to dioxins (e.g. using the *buffer* command within *analysis tools*).

Calculate the total population at risk - overview

Now we need to calculate the total population at risk in our study area. This is slightly more complicated. If you look at the map that you just produced, you can see that the buffer zones around the incinerator dissect several of the census tracts. Within these tracts, some of the population live within the zone exposed to dioxins and the remainder live outside the exposure zone. We are going to need to work out how many people live in the exposed sub-section of each census tract. Take a few moments to think about how you might do this, then look at a possible solution over the page.

The solution: how to find the population at risk

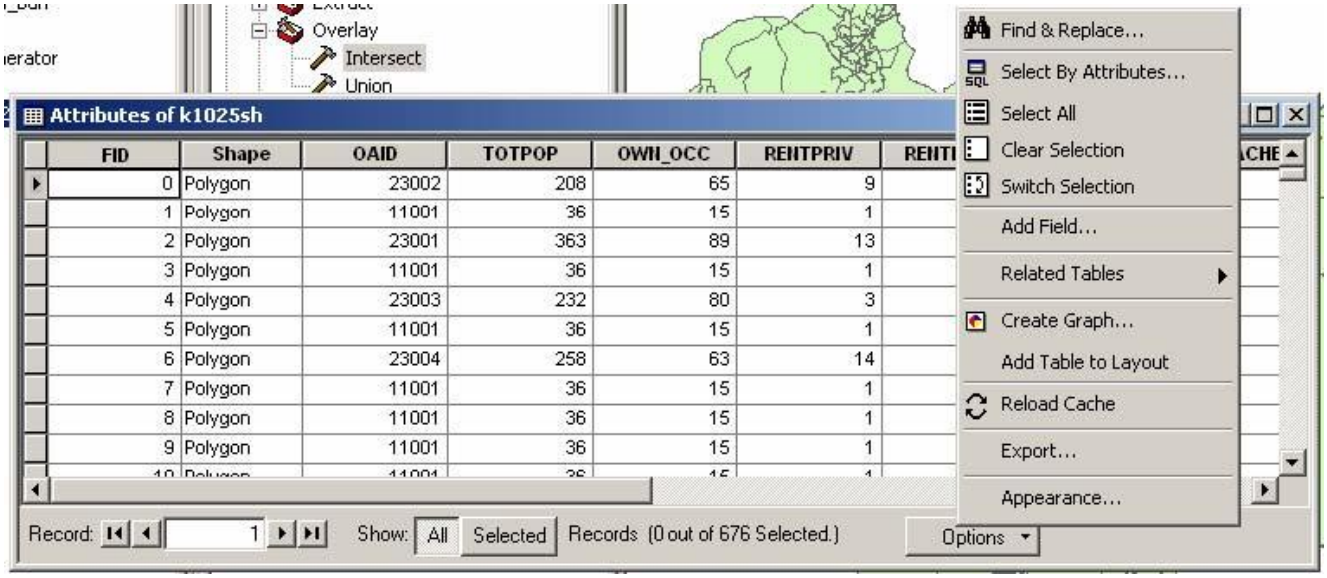
One way of solving this problem is to assume that the population density is the same everywhere in each census tract. Using this assumption, we can figure out the population at risk as follows:

1. work out the population density for each tract
2. overlay the dioxin exposure zone map layer and the census tracts
3. Using population density, work out the total population in the exposed parts of the census tracts.
4. Add up the total population in the exposed zone

Working with population density

We can figure out the population density of each tract as follows:

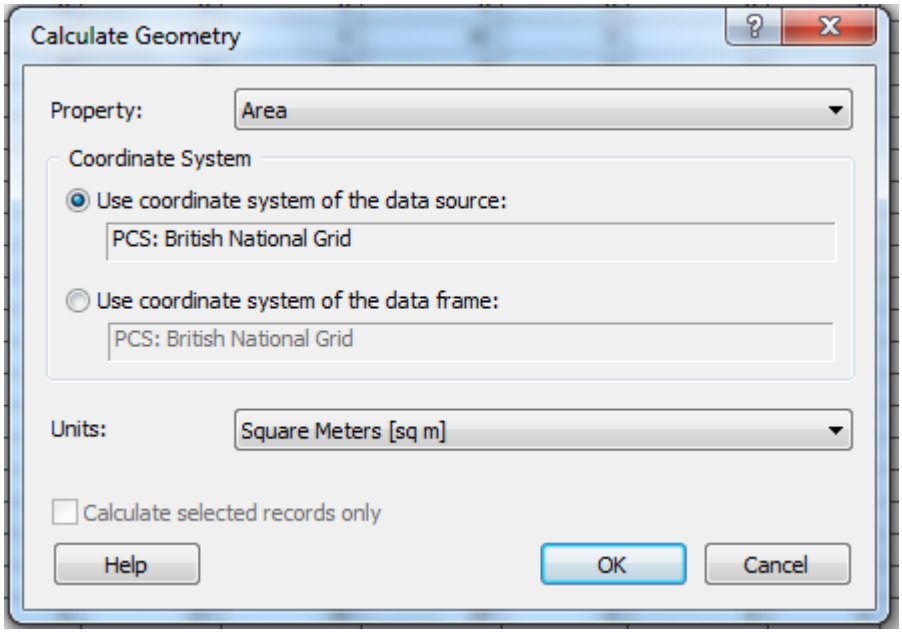
- Within ArcMap, right-click on your census tract map layer and choose *open attribute table*
- On the *editor toolbar*, choose *start editing*



- Click on *options* and then choose *add field*
- Create a new field called **tractarea** that is of *type* **double**
- Click on options again and choose *add field*
- Create a new field called **popdens** that is also of *type* **double**

If we want to figure out population density, the first thing we need to do is to figure out the area of each census tract in our Shape file – to do this, we need to use *calculate*

geometry. When looking at your table of attributes, right-click on the header of the **tractarea** field and then select *calculate geometry* from the pop-up menu. Select *area* as the *property* to calculate:



If things have gone to plan, you should now have the area of each census tract (in metres^2) in the **tractarea** field.

Now use *calculate values* to update the **popdense** field. In this field, you need to store the total population (**totpop**) divided by the area (**tractarea**).

On the *editor* toolbar, choose *save edits* and *stop editing*, then close the attribute window down.

Overlay the exposure zone and census tracts

Using *intersect* in the *analysis tools* within *overlay,* combine your census tracts map layer with the map layer depicting dioxin exposure.

To finish the calculation:

- Add two new fields to your resultant map layer. In the first field, calculate the area of each new polygon that you have created. In the second field, work out the population in the polygon. You can do this by multiplying its area by its population density.
- Using the *Statistics* command (accessible by right-clicking on the field name at the top of your new population column of figures), you should be able to work out the total number of people living in the exposed zone. The total population at risk will

appear next to *sum* in the output from the *statistics* command.