Examining exposure to modelled air-borne fine particulates in Greater London

Scenario:

The London Atmospheric Emissions Inventory (LAEI) is a key public health database for informing efforts to reduce population exposure to air-borne pollutants across the capital. Map layers depicting average annual concentrations of various air-borne pollutants are available, including NOx and air-borne particulates. These concentrations are modelled from domestic emissions (e.g. from wood burners), from traffic, from industry, and from other sources. You can download and explore further data from the LAEI at the link below, as well as find out more about it.

For this scenario, we will seek to quantify population exposure to high levels of fine air-borne particulates based on data from the LAEI. Such particulates can lead to reduced lung function, higher risk of cardiovascular and respiratory illness as fine particles pass through the lungs into the cardiovascular system, as well as reduced life expectancy.

Data

Pm25_2016: A 20m spatial resolution tiff file showing the modelled distribution of fine particulates (pm 2.5) across Greater London, taken from the London Atmospheric Emissions Inventory, 2016. Values are in micrograms per cubic metre of air. The original data are available here: https://data.london.gov.uk/dataset/london-atmospheric-emissions-inventory--laei--2016.

MSOA_2011_London_gen_MHW: Middle level Super Output Area boundaries for Greater London (2011 census boundaries), including usual residents and resident households. These boundaries are taken from here: https://data.london.gov.uk/dataset/statistical-gis-boundary-files-london . There are unique IDs for each MSOA in the field **MSOA11CD**. **USUALRES** contains the number of usual residents in each MSOA.

Task

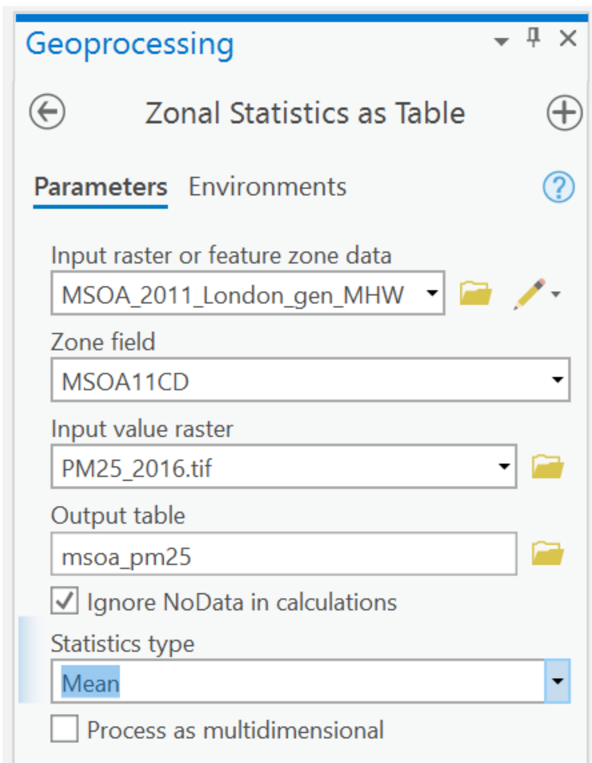
1. Calculate the size of the usual resident population exposed to more than 13 micrograms of pm2.5 fine particulates per cubic metre of air on average during 2016.

Try and do this yourself, but if you are not sure, turn to the next page for instructions.

Calculate the fine air-borne particulate levels in each MSOA

To do this, you will need the Spatial Analyst extension activated. This can be activated via *Projects* menu / *licencing / configure your licencing options* and then checking *spatial analyst*.

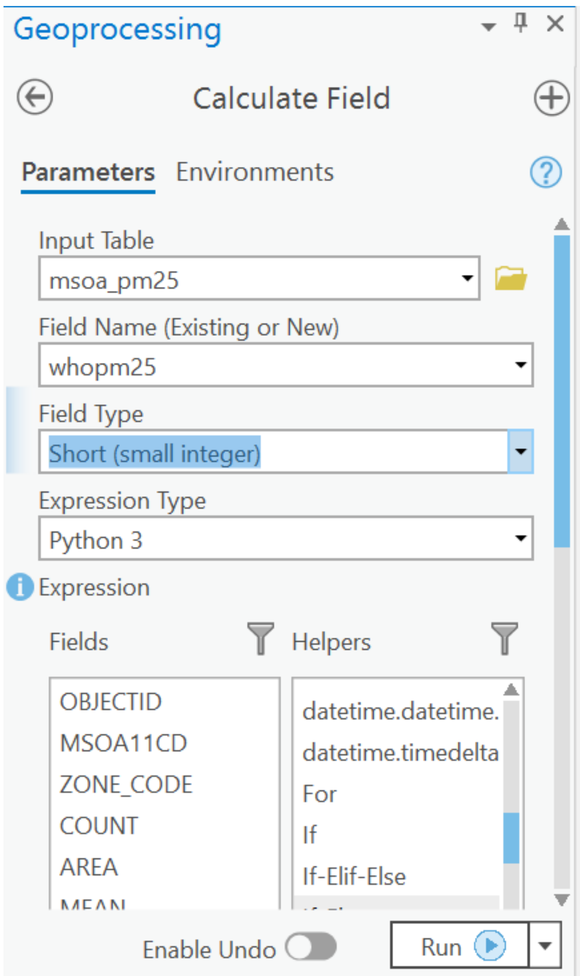
Head for the *analysis* menu, then *tools*, and then search for *Zonal Statistics as Table.* You should be able to use this tool to calculate the mean air-borne particulate levels per MSOA as shown below. <u>Note:</u> If you use *Statistics type* = ALL, then you can optionally explore the intra-MSOA variation in air-borne particulates later on in this exercise, so you may wish to choose that option.



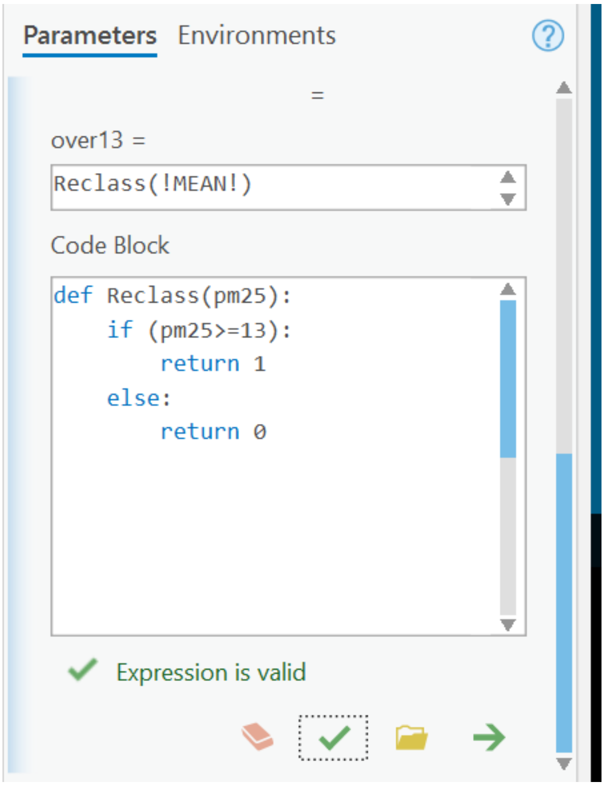
All being well, this should produce a table called **msoa_pm25** that contains records of the PM2.5 particulates in each MSOA. If you add your table to your project, you should be able to right-click on it in the left-hand panel, choose *open*, and then inspect its contents.

Identifying MSOAs with mean PM2.5 over 13 micrograms per cubic metre of air in 2016

There are various ways that you can do this. However, one way would be to use the *calculate field* tool (be sure to close down the table you just created before running the tool though). Within the table you just created, you can use this to create a new field of *type* **short integer** called **whopm25** (note: the WHO guideline value for PM2.5 is actually 10micrograms/m^3, but we will use a slightly higher value for this exercise):



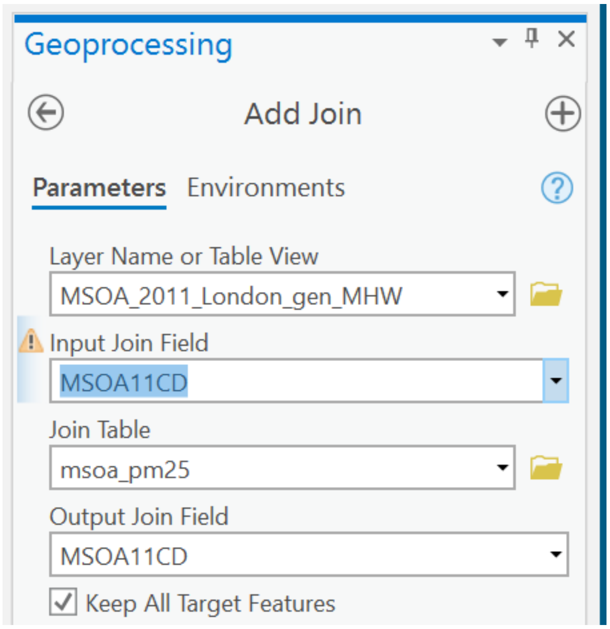
You can then use an ArcPy (Python) function to find those records above 13 micrograms/m^3. The top box in the screen shot below contains the function, which takes the value of the MEAN field created by zonal statistics as an input (the !MEAN! signifies a field).



The screenshot above shows how to add a value of 1 to the new field using Python script where the pm2.5 value is above 13 and 0 otherwise. Within the *code block*, the **Reclass** function is defined with **pm25** as an argument. Return sets up the values to be returned by the function. Note that the indentation and lower / upper case are important when writing Python, so you should include all indentation and use upper / lower case as shown above, otherwise your script will not work. The green 'tick' button can be used to check that you have entered the Python correctly without errors. If you run the code, you should be able to open up your table again and see a new field containing 1s and 0s.

Join the zonal statistics output back to the MSOA layer

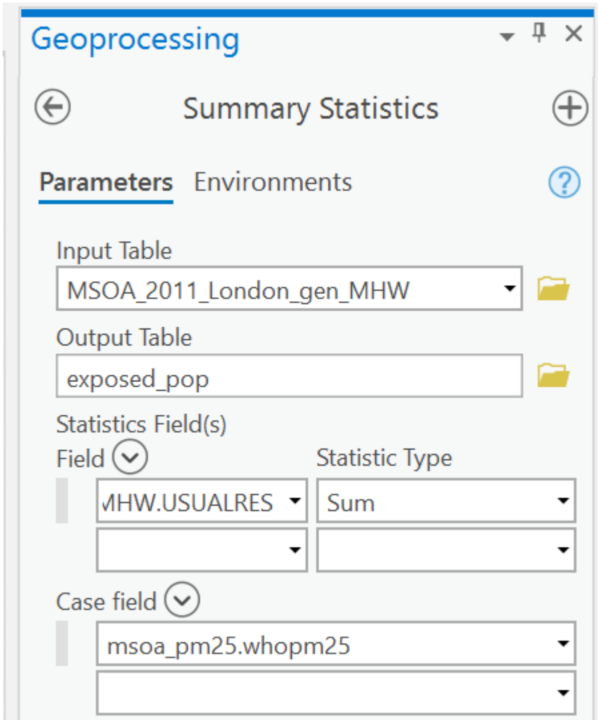
To do this, right click on the MSOA layer, and then choose *joins and relates/ add join*. You should then be able to use the *add join* tool to join the output table from zonal statistics back to the MSOA layer's attribute table, matching up the unique identifier codes for each MSOA that are held in the field **MSOA11CD:**



You can open up the MSOA layer's attribute table to check if this has worked.

Count up the population living in MSOAs with high fine air-borne particulate levels

Finally, you can use *summary statistics* to calculate the number of usual residents living in MSOAs with high levels of PM2.5 (greater than 13 micrograms / m^3). In the screenshot below, unique values of the *case field* (**WHOPM25**, which we created earlier containing 1s and 0s for high versus low PM2.5) are used to define rows in the output table. *Statistics fields* can be included in each row: we can ask that field values across all rows with a given value in the **WHOPM25** field are summed:



The results are stored in a new table called **exposed_pop**. Notice the syntax for identifying fields in the joined table: the table name appears first, then the field name, separated by '.'.

All being well, you should see a table which looks like this when you open up the output, **exposed_pop**:

OBJECTID	over13	FREQUENCY	SUM_MSOA_2011_London_gen_MHW.USUALRES
1	0	418	3424407
2	1	565	4749534
Click to add new row.			

[Note: I called my field **over13** in the screenshot above, but your table will probably contain a field called **whopm25**, with 0 where pm2.5<13 micrograms/m^3 of air and 1 otherwise. The USUALRES sum in the right-hand column is the number of usual residents exposed to a given level of air pollution.

Extension activities:

What changes in the population exposed to high PM2.5 do you see if you look at the maximum or minimum level of PM2.5 within each MSOA, instead of the mean (and thereby explore intra-MSOA, localised variation in air quality)?