Travel time and distance calculations in the cloud: ArcGIS Online

Objectives:

This exercise aims to introduce some of the analytical functionality of ArcGIS Online, but particularly travel time and distance calculations that make use of transport network held remotely.

Background:

Working with Network Analyst requires that you either import or create your own network data set, held locally. Typically, such a network data set may be time-consuming to create or maintain, will cover a local area only, and have network weights that reflect either long-term average driving conditions or a particular point in time. Given that ArcGIS Online works with transport network data held remotely, ArcGIS Online overcomes all three of these potential drawbacks of using a local network data set. However, there are restrictions on the size of files that can be uploaded for analysis (e.g. there is a maximum of 1,500 points for many of the online analyses described in this exercise), so ArcGIS Online is not well suited to very large data sets. The ArcGIS Online processing interface owes much to its predecessor, the GeoCommons platform, which was acquired by ESRI in 2012.

Study site and data:

For this exercise, we are going to explore Kibera in Kenya, one of Nairobi's most well-known slums and believed to be among the largest informal settlements in Africa. Most people living in this area lack basic services such as electricity, clean water and sanitation facilities and there are few health facilities or schools serving this area despite its large population. A local non-governmental organisation, Map Kibera (http://mapkibera.org/), has pushed for the community to map its own infra-structure, including via OpenStreetMap (https://wiki.openstreetmap.org/wiki/Nairobi) , so as to support better service planning for this community in the future.

We will look at some OpenStreetMap (OSM) data generated in part by the Map Kibera project for this exercise. One particular map layer has been made available for this exercise:

- **Kibera_hospitals3**: This comprises OSM nodes with the 'amenity' key = the 'hospital' tag. The data are stored in comma separated values (.csv) format, with two fields containing latitudes and longitudes of hospitals in geographic coordinates referenced to the WGS 1984 datum. These are stored in two fields called **x** and **y** (note that instead of using a .csv file, we could also load up a zip file containing all the constituent files that make up a shape file - .shp, .prj, .dbf, etc. Whatever the format, for use with ArcGIS Online, the map layer needs to be in geographic coordinates referenced to the WGS 1984 datum).

If you would like a little more detail on downloading OSM data and using them in ESRI software, there are some additional notes at the end of this practical.

Practical Instructions

Registering for ArcGIS Online

There are two ways in which you can access ArcGIS Online. One route is to use the University of Southampton's ArcGIS Online service, for which you should have been provided with a username and password. Note that you will need to change the password the first time you use your university ArcGIS account. To access the university's ArcGIS Online service, follow this link:

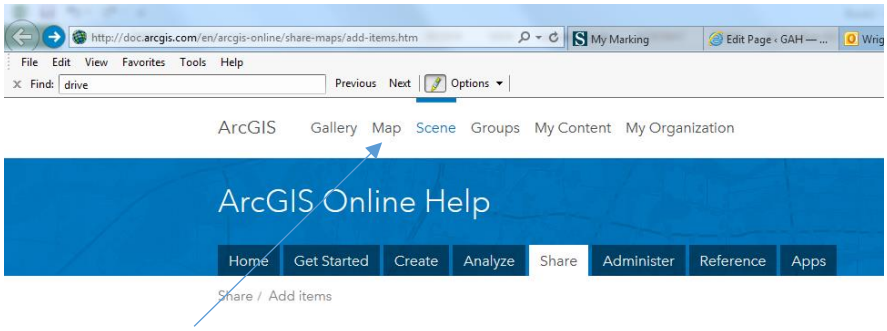
https://soton-uni.maps.arcgis.com/home/signin.html

As an alternative, you can also sign up for a free ArcGIS Online trial for a limited period by following this link:

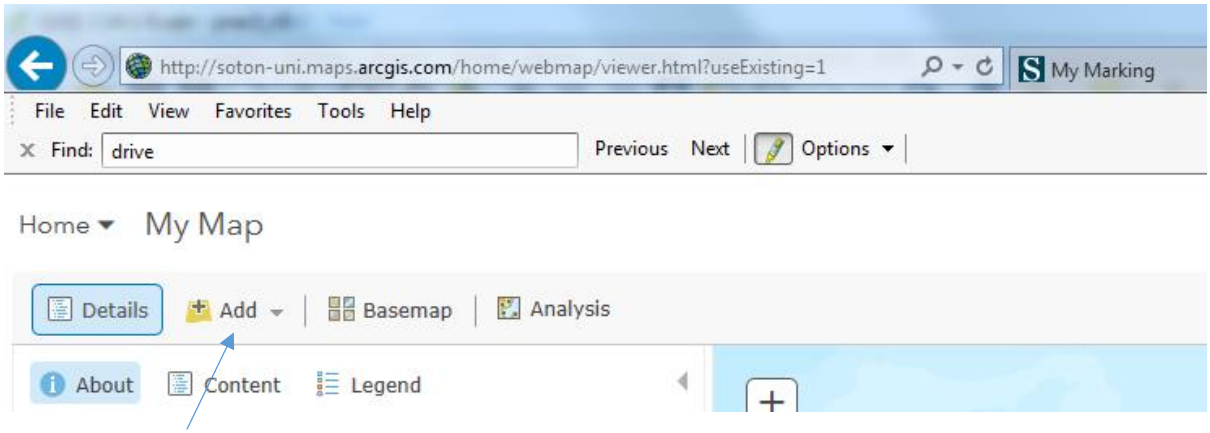
http://www.esri.com/software/arcgis/arcgisonline/evaluate

Loading up data into ArcGIS Online:

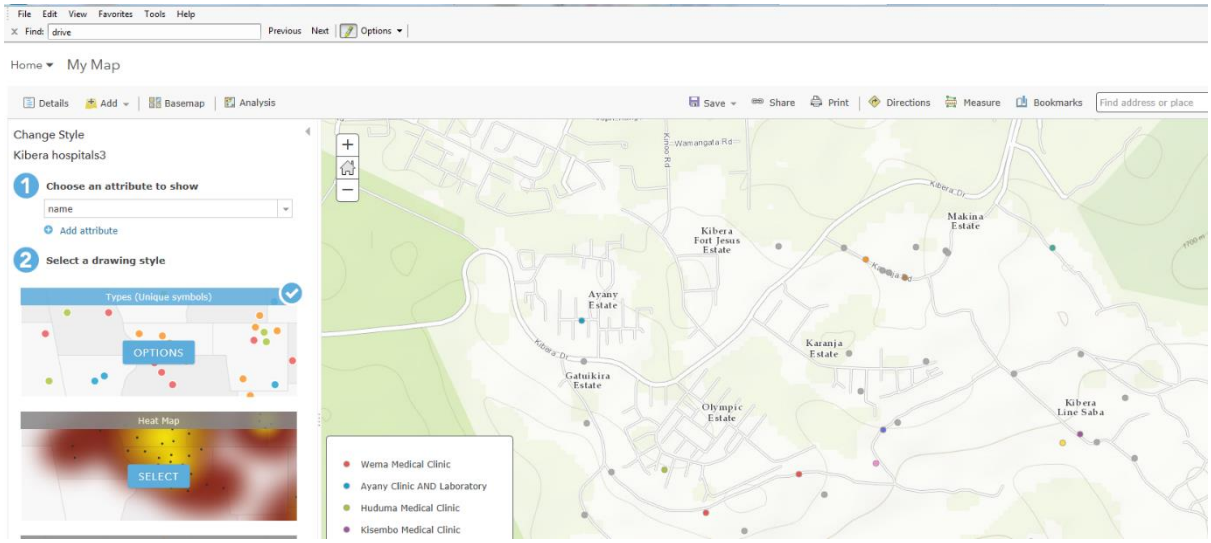
After you log in to ArcGIS Online, you should see a screen that looks something like this:



Follow the 'map' link at the top of the screen to create a new online equivalent of a map document, into which you can load up data.

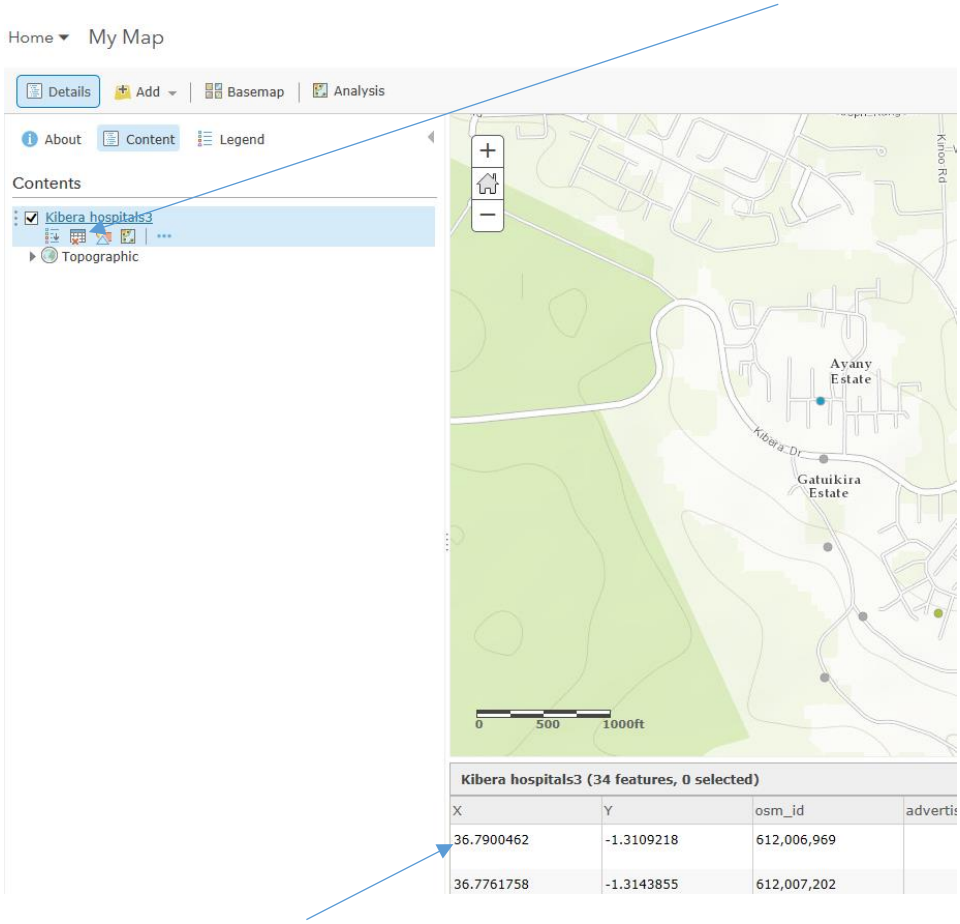


Click on the *Add* button, then select *Add layer from file* to load up the **kibera_hospitals3** data that we just saw. As noted above, this is a comma separated values (.csv) file, with two fields containing latitudes and longitudes of hospitals based on the WGS 1984 datum. ArcGIS Online should be able to automatically identify these two fields and map them on top of a default basemap (tip: in this case, our .csv has fields called x and y. If instead it is not obvious from their names which attribute fields contain the point coordinates, before the data can be mapped, you will be presented with an additional dialog box where you will be asked to identify the fields that do contain the coordinates). You should see something like this:



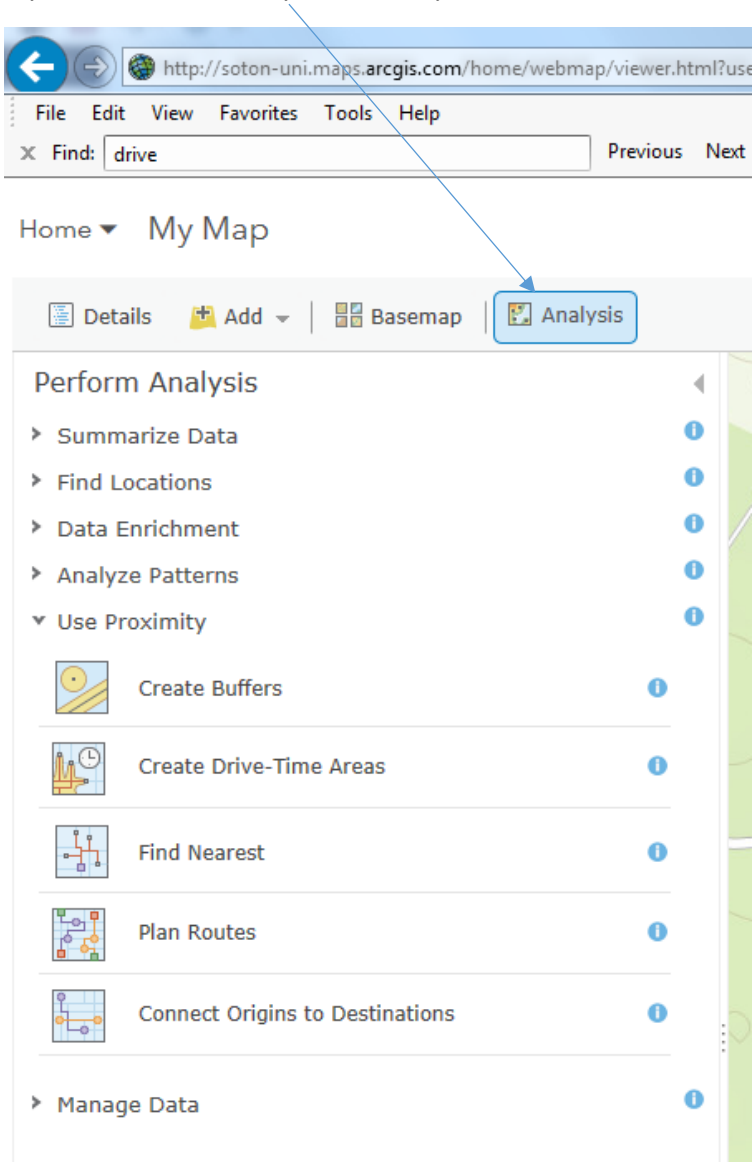
Note that you can vary the way in which the data are visualised – by default, the names of the facilities will be used. However, you could choose another attribute field and drawing style to visualise the points, if for example, there were data available on the number of staff at each hospital. Click *done* in the left-hand panel to move on.

In much the same way as with desktop ArcGIS, you can examine the attributes of this layer by hovering your mouse over the layer name and pressing the 'show table' button:



This brings up the attributes, such as the unique ID for the feature in OSM and X and Y coordinates.

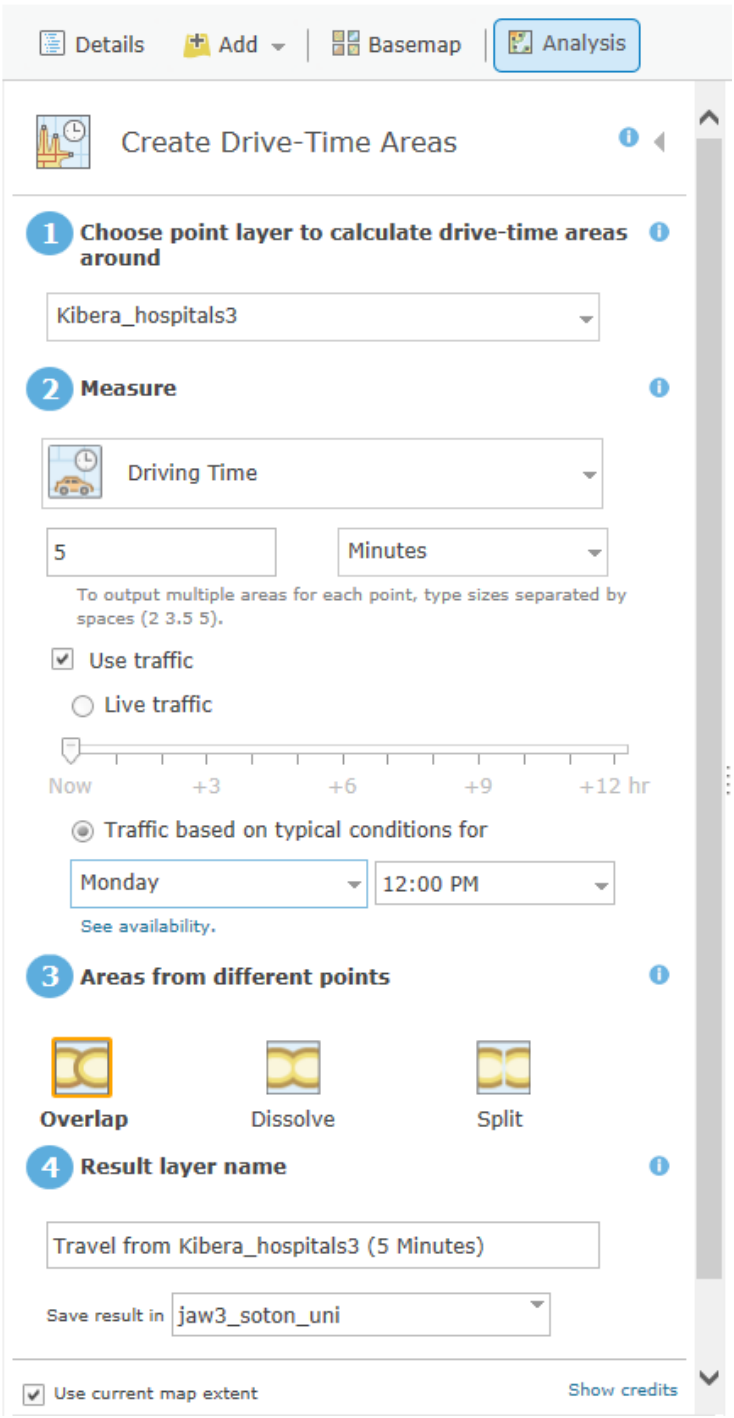
If you click on the 'Analysis' button, you can now work with the points that you have uploaded:



If you click on *use proximity*, you will find a set of options (apart from 'create buffers', the first one, which is similar to the buffering tools you find in the ArcToolBox) that are very similar to those in the ArcGIS Desktop Network Analyst extension:

- *Create drive-time areas* is very similar to the *service areas* functionality in Network Analyst
- *Find Nearest* is very similar to *Find closest facility* in Network Analyst
- *Plan Routes* is very similar to *route analysis* in Network Analyst
- *Connect Origins to Destinations* is very similar to *origin-destination cost matrix analysis* in Network Analyst

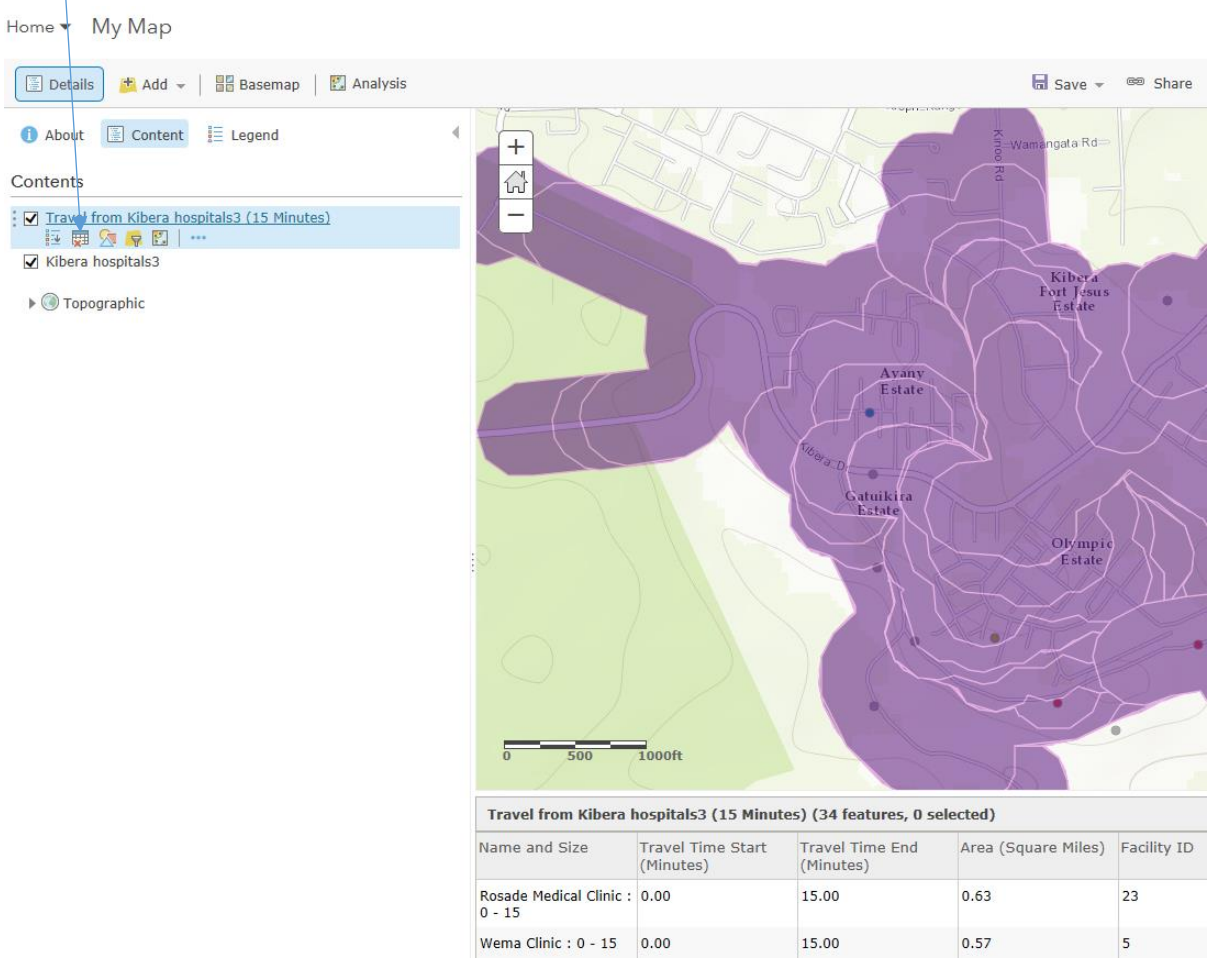
Let us explore 'create drive-time areas' in more detail:



Step 1 indicates the features that drive-time contours (also known as isochrones) will be based around – our hospitals. Step 2 indicates which metric will be used – either a non-Euclidean distance or a travel time in minutes. In step 2, you can also specify the mode of transport – walking, by car, by truck or 'rural' (meaning that dirt roads can be used). Here, you can also specify the maximum contour to be used, or a series of values separated by spaces, if you would like multiple drive-time contours. If you specify a drive-time rather than walking, as shown above, you can specify how the weights for the road network will be derived. As ArcGIS Online is drawing on a remotely stored network data set, in contrast to an ArcGIS Desktop calculation, you can choose to use a 'live' traffic feed here to reflect near-current driving conditions, or long-term average conditions for a particular time of the week. Feel free to experiment with different metrics and settings here.

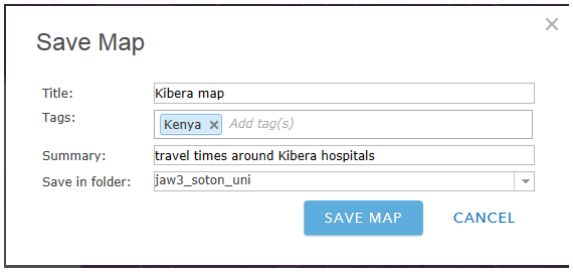
In Step 3, you can decide how to handle overlaps between different catchment areas – whether you will have drive-time polygons for different hospitals that overlap with one another, or whether the boundaries are 'dissolved' to show the shortest distance or travel time to the nearest facility. Finally, in step 4, you can name the layer that will be created.

When you press 'run analysis', the drive-time contours will be calculated – this may take a minute or so. The output is then mapped. You may find it helpful to bring up the attribute table for your new layer of drive-time contours as we did before (hover your mouse over the output layer name).

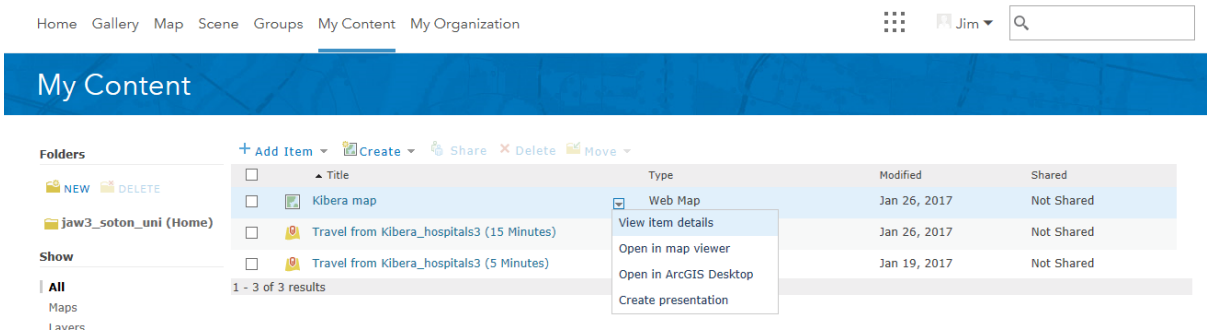


The attribute fields will look a little different, depending on how you configured the analysis to run. However, if you chose overlapping outputs (as above), each feature includes details of the input facility it relates to (all of the attributes for the feature, including the input facility ID and name). It also includes the area that the travel zone covers, as well as the minimum and maximum distances or travel times that define the zone's boundaries.

At this point, you can save your work in the ArcGIS Online environment. If you head for the 'Save' button above your map, you can give the map composition a title and save it:



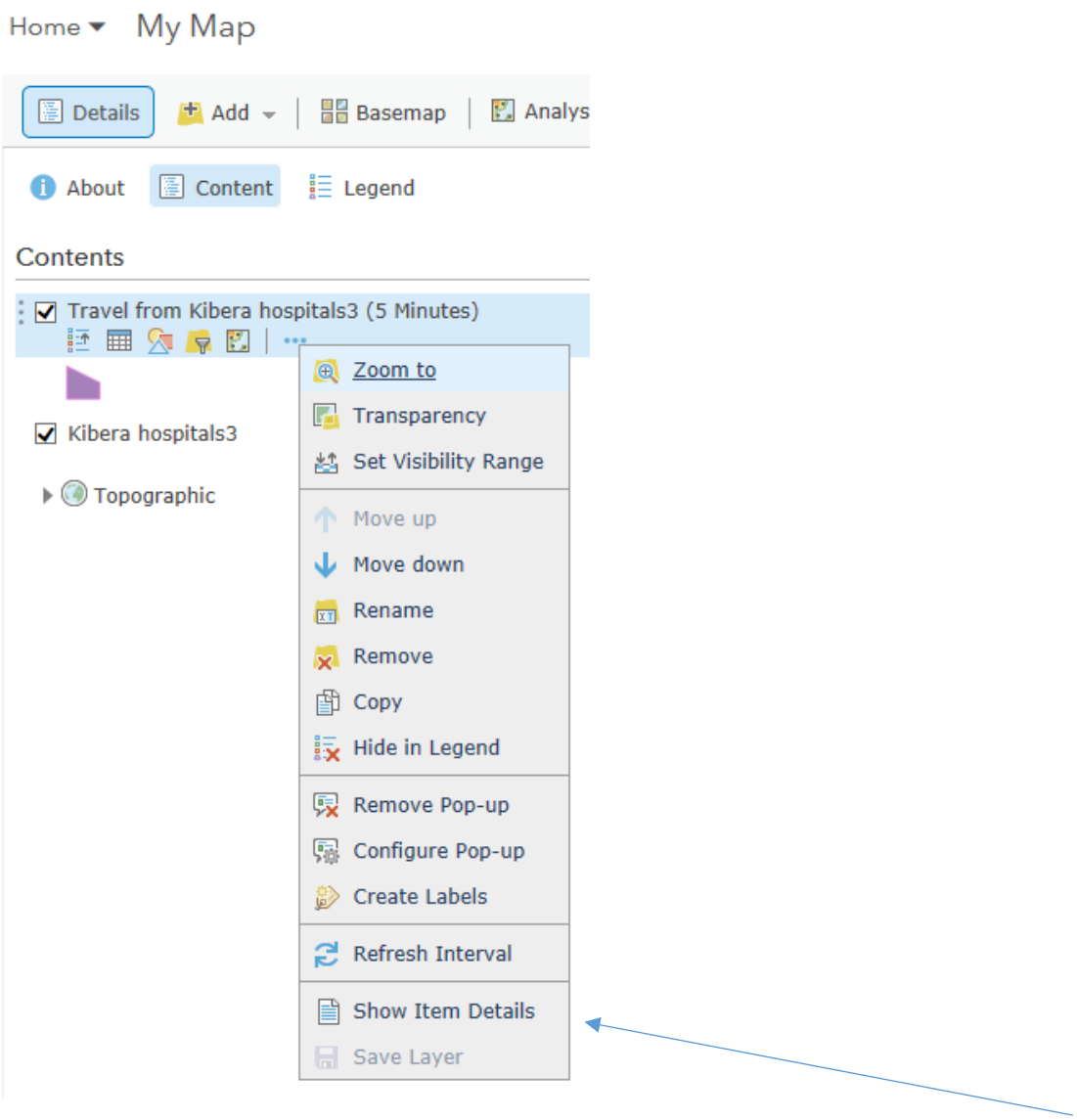
If you wish to return to this map composition again, similar to a map document in ArcGIS Desktop, you can do so by clicking on 'my content' at the top of your screen:



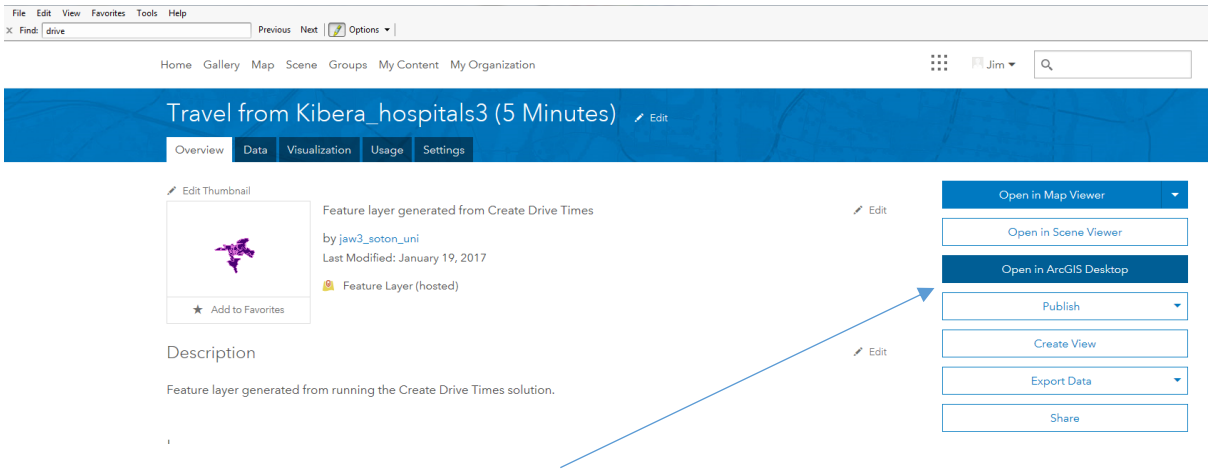
This contains the results of any calculations you may have done (e.g. travel time layers that you just calculated, but also the web map composition that you just saved. 'Open in map viewer' returns you to the web map display that you just saw.

Downloading your output map layer to ArcGIS Desktop

If you want to download the output to ArcGIS Desktop for further analysis for example, you can do so as follows from your web map screen (you can also do so by clicking on *my content* as above, then hovering your mouse over a layer name and selecting *open in ArcGIS Desktop*):



If you click on the … symbol to the right and below the name of the map layer you generated, *show item details* brings you to a screen with more details on this layer:

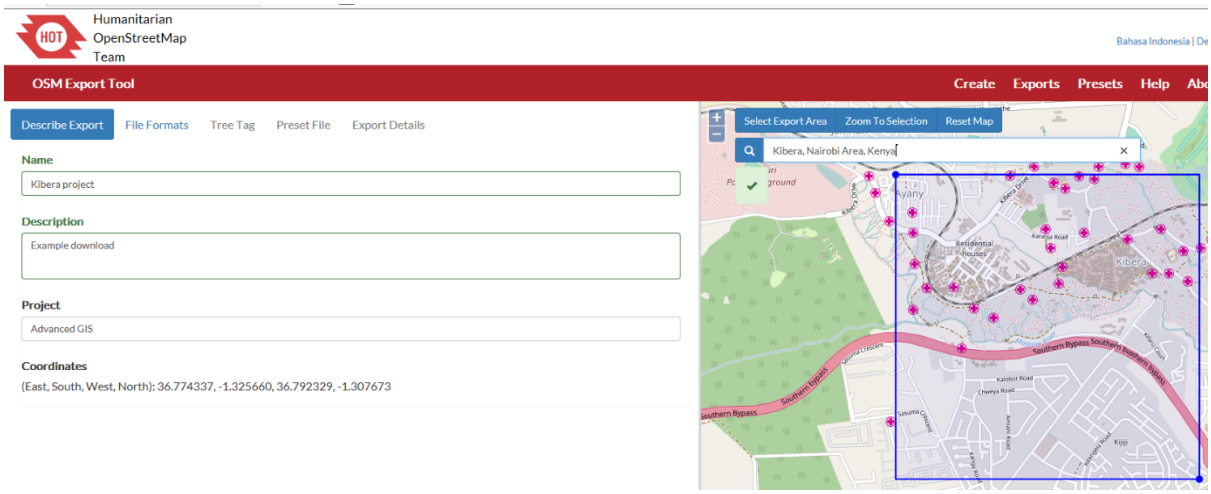


To the right, there is an option to *open in Arcgis desktop.* This will start up ArcGIS desktop on your machine, and you will need to re-enter your ArcGIS Online username and password, so the desktop version of the software can access your online data.

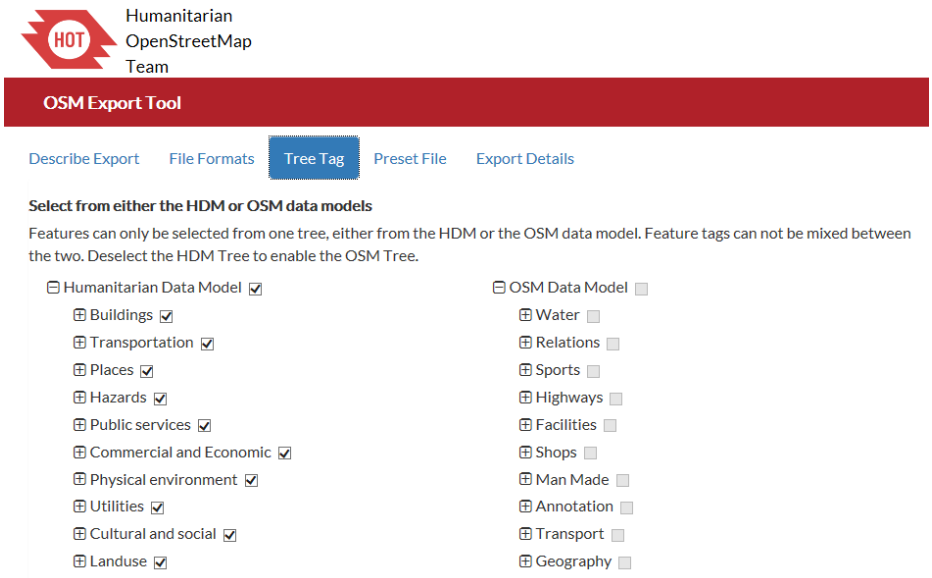
Having done so, you should be able to see your map layer, but in ArcGIS Desktop this time. Right-clicking on the map layer, then choosing *data* and *export data* will enable you to permanently save a local copy of this file.

More about where the data for this exercise came from:

How did we obtain the data for this exercise? We went to Humanitarian OpenStreetMap's tool, which is here: http://export.hotosm.org/en/. We then created an OSM account, logged in with it, and clicked 'grant access'. After that, we gradually filled out the information needed for our data request, starting by choosing our study area of Kibera and giving it a name and description:



You can then choose a particular *file format* via the next tab (we chose an ESRI Shape file on the OSM Schema) and pick out particular types of feature (e.g. 'water') using either humanitarian open street map terms or 'standard' OSM terms from a 'tree tag'.



Finally, we hit 'create export' on the 'export details' tab. If you are really interested in OSM data, optionally, you might want to explore this facility for yourself.

This particular tool is focussed on the developing world, but there are other tools (e.g. http://extract.bbbike.org/) that can be used to extract OSM data throughout the world. There are also what are known as 'planet' files – dumps of OSM data at a given date that in some cases may cover the entire globe or entire continents. Relative to online tools such as the above, extraction of OSM data from planet files is both more complex and processor-intensive given the typical file sizes involved.