USER INSTRUCTIONS

Individualized Activity Space Modeler: A GIS toolbox

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Contents

Technical requirements

This toolbox needs ESRI ArcGIS 10.5 or above installed on the PC. ArcGIS needs advanced user license and include license for Spatial Analysis toolbox.

The toolbox (.tbx) may not be compatible with higher or lower versions of ArcGIS. However, using ArcCatalog the Tbx file can be converted to match the applicable version of ArcGIS

Installation

Clone the repository or download it as a zip file to you local machine. Extract the zipfile to a desired location on your local hard disc and remember the path. Under the root folder '-IASM-master', you can find two folders named 'My_toolboxes' and 'neighborhood_modeling_tools'. The first folder must include an ESRI toolbox file with '.tbx' extension. The second folder includes four python script files with '.py' extensions. The tools in the toolbox can be used in two ways:

1. Using the scripts outside ArcGIS

This method does not require any installation. You only need to open the python files from the folder 'neighborhood_modeling_tools', in your python IDE (Integrated Development Enviornment). In this method you can directly see/edit the script and directly provide parameteres using Python general guidelines. Please note, for the scripts to work you probably need to change your IDE's default Python shell to ArcGIS's Python package- python v.2.7 with pyside- (if you haven't done so before). This is the fastest method and it is recommended when intensive analyses on large datasets are performed.

Alternatively, if you do not have an IDE installed on your computer, you can open the Python files directly in ArcGIS or copy and Paste them into Arcmap's python window (Geoprocessing>Python).

2. Using the Graphic User Interface (GUI)

Using the GUI is a slower but easier way of using this toolbox. Using the ArcCatalog sidebar in ArcMap environment , navigate to the path where you have saved the software and open the 'My_toolboxes' folder. The folder includes an ESRI toolbox file named 'Modelin tools.tbx'. Once opened, four tools can be found in the toolbox. Double click on each of them to open and use the tool. You can also drag and drop the toolbox into Arc toolbox window for an easier future access.

*Please note that the toolbox works with relative paths, so please make sure you do not rename any file or folder or move them from their relative path.

*Please note that the toolbox is created with ArcGIS version 10.5 and it may not be compatible with some versions of ArcGIS. You can save the toolbox in a format matching your version of ArcGIS by right clicking the toolbox and clicking on save as.

Introduction

This document provides step-by-step user instructions for the GIS toolbox Individualized Activity Space Modeler. Please note, that the examples provided here are based on the sample dataset from four individuals, which is provided for non-commercial use on Github repository (https://github.com/kamyar68/-IASM).

Table 1 shows the overall requirements for the tools in the toolbox, including the data type, format, and the required data fields. Table 2 shows the requirements for the fields.

Table 1. General data requirements for tools.

Tool	Dataset	File format	Required fields
Home range distance identifier	Home points	Feature class/ shapefile	uid
	Visited points	Feature class/ shapefile	uid, dist
Home range modeller	Home points	Feature class/ shapefile	uid
	Visited points	Feature class/ shapefile	uid, dist (optional)
IREModeller	Home points	Feature class/ shapefile	uid, OBJECTID
	Visited points	Feature class/ shapefile	uid, OBJECTID, freq, tmod
	Home range boundaries (optional)	Feature class/ shapefile	uid
	Travel routes	Feature class/ shapefile (line)	uid, POI_ID
Maximum exposure area delineator	IREM outputs	Raster (.tif)	-

Table 2. Field descriptions.

Field name	Description	Type
uid *	A unique identifier that associates all spatial features with individuals.	Integer
OBJECTID *	A feature identifier. This usually exists by default in shapefiles.	Integer

POI_ID*	This refers to the OBJECTID of destination point.	Integer
freq*	Frequency or total time of visit	Double
tmod*	Mode of transportation used for visiting the destination.	String
dist	Distance from the point to the individual's home location.	Double

* Fields marked with an asterisk are not flexible with naming and thus must be named exactly as specified when using the interface. This can be modified in the script.

1. Home range distance identifier (HRDI)

Open the toolbox and double click on the tool "Jenk's home range distance identifier" as in Figure 1.

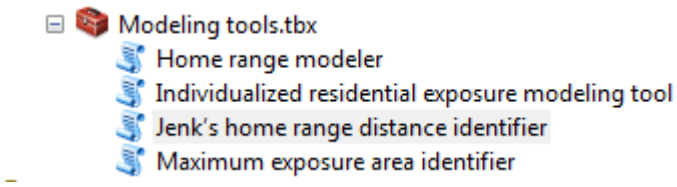

Figure 1. JHRDI tool in the toolbox

Now you should see the window shown in Figure 2. In the first row provide the path to your activity point data. If you are using the sample data, this will be the 'dep.shp' file. In the second row, provide the name of the field that contains the distance to the individual's home. If you are using the example data, this will be 'dist'. If you want to apply a distance threshold to exclude distant points from the analysis, check the "Apply a threshold" box and provide the desired distance. Once done, click OK and upon completion of analysis, you will see the results in the dialog box as shown in Figure 3. The result will be in the same unit as the 'dist' field– in this case meters.

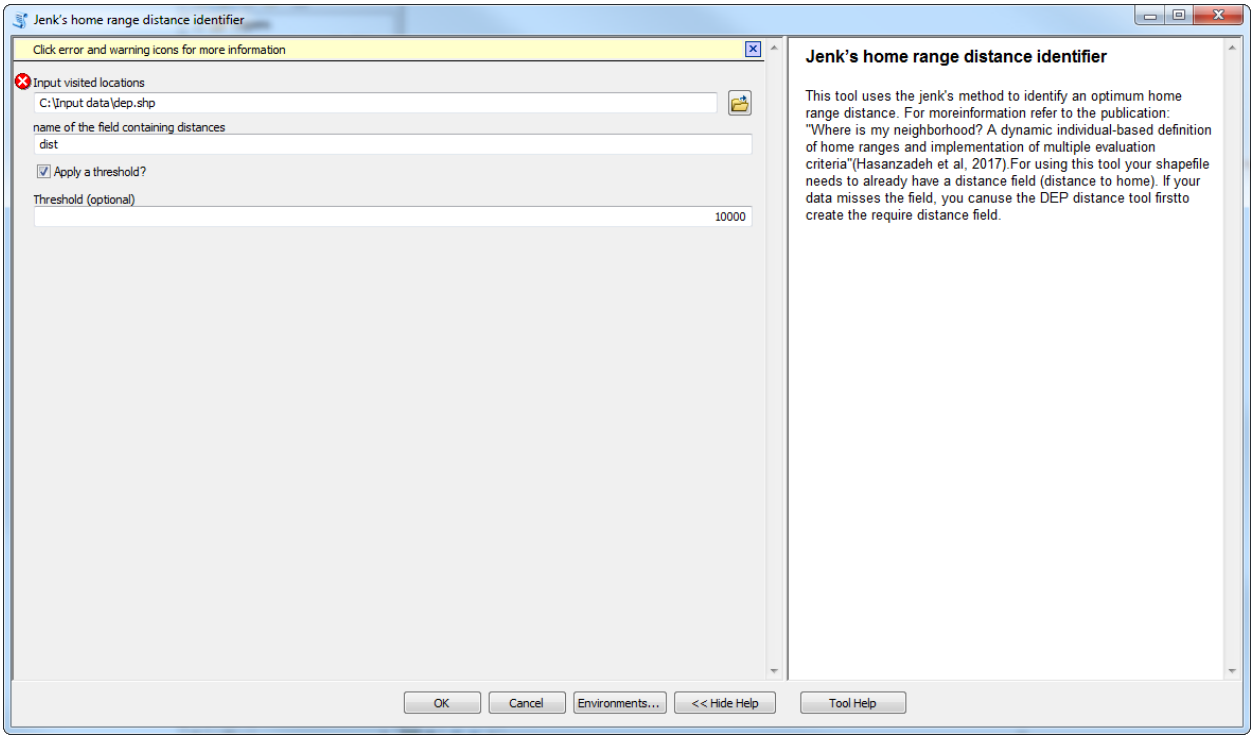

Figure 2. HRDI user interface

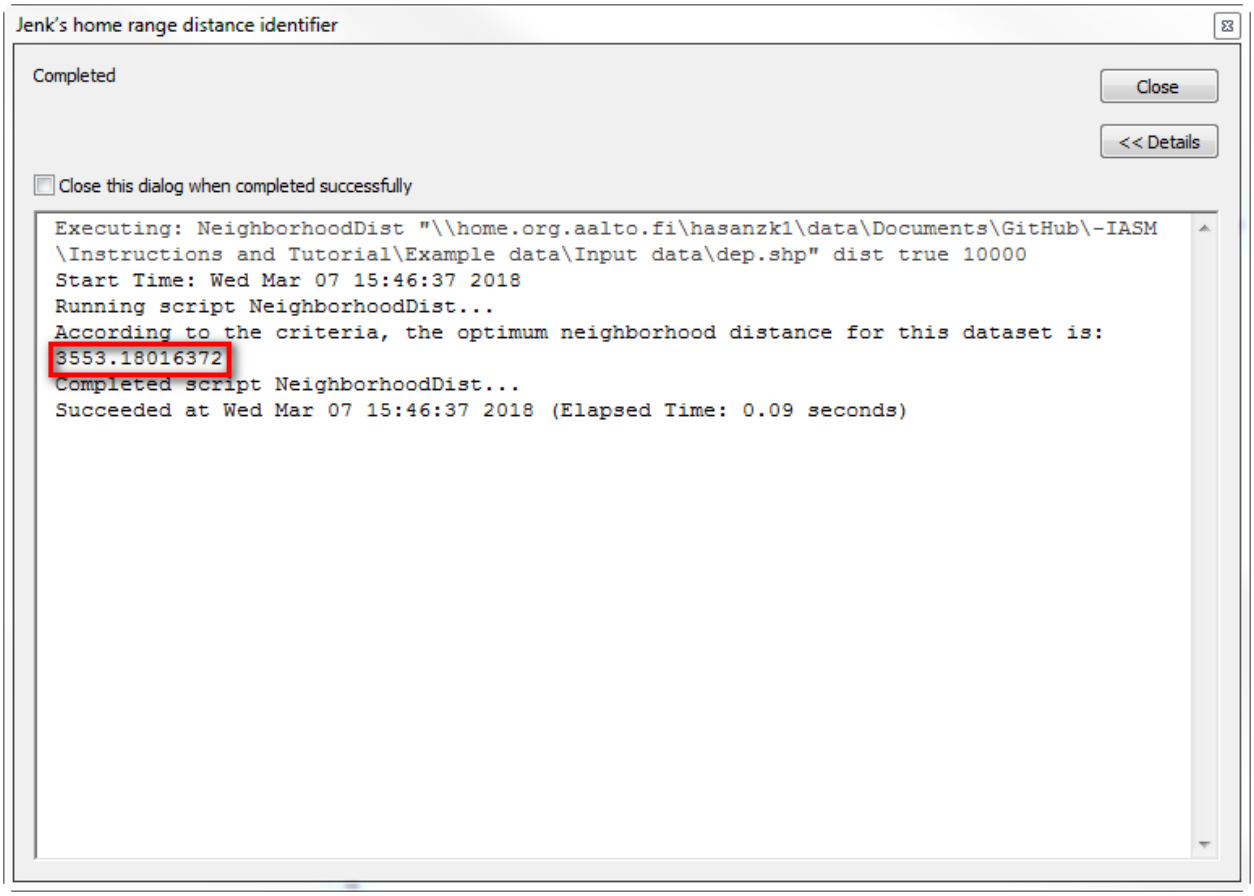

Figure 3. HRDI results

2. Home range modeler (HRM)

Open the toolbox and double click on the tool "Home range modeler" as in Figure 4.

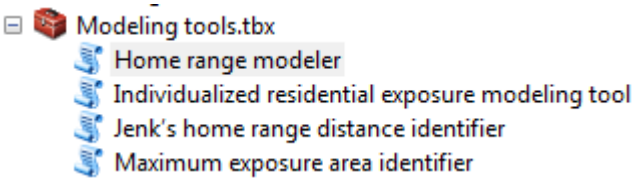

Figure 4. HRM in toolbox.

Now you should see the window shown in Figure 5. Provide the path to the Activity points and home points in the first and second row respectively. If you are using the example data, these will be 'dep.shp' and 'home.shp'. In the third row, provide a path and name for the output shaepfile. D1 is the circular buffer distance representing the immediate neighborhood of an individual. D2, is the distance used to create circular buffers around visited points. This is meant

to represent an estimated area of exposure around each activity point and to take the fuzzy characteristic of ASs into consideration. The recommended values for parameters D1 and D2 according to literature (Hasanzadeh, Broberg, & Kyttä, 2017), are already filled in the field as default. You can also change these values to your preferences. Finally, D3 is a home range distance that can optionally be used to filter out distant points. For using this feature, the activity point file needs to have a field named 'dist' containing distances to individuals' homes. This parameter determines whether the whole activity space or a subarea of it as home range will be mapped by the tool. The optimum value for D3 can be determined based on user knowledge or using systematic ways such as 'Home range distance identifier' tool.

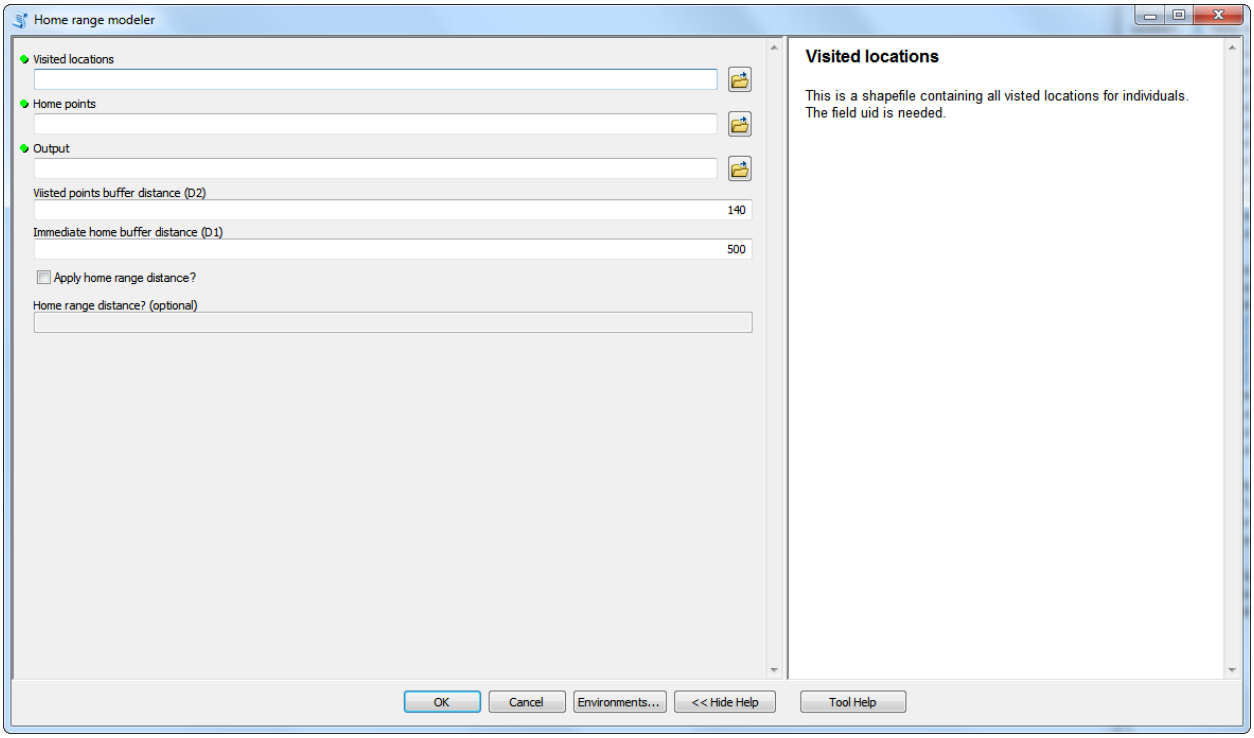

Figure 5. HRM interface.

Once completed, click on OK and wait a few moments until the process is completed. This waiting time can vary from a few seconds to hours depending on the size of dataset. Once completed you should be able to see the results (Figure 6) on the map. If the output is not mapped automatically upon completion, please add the output file manually to your ArcMap environment.

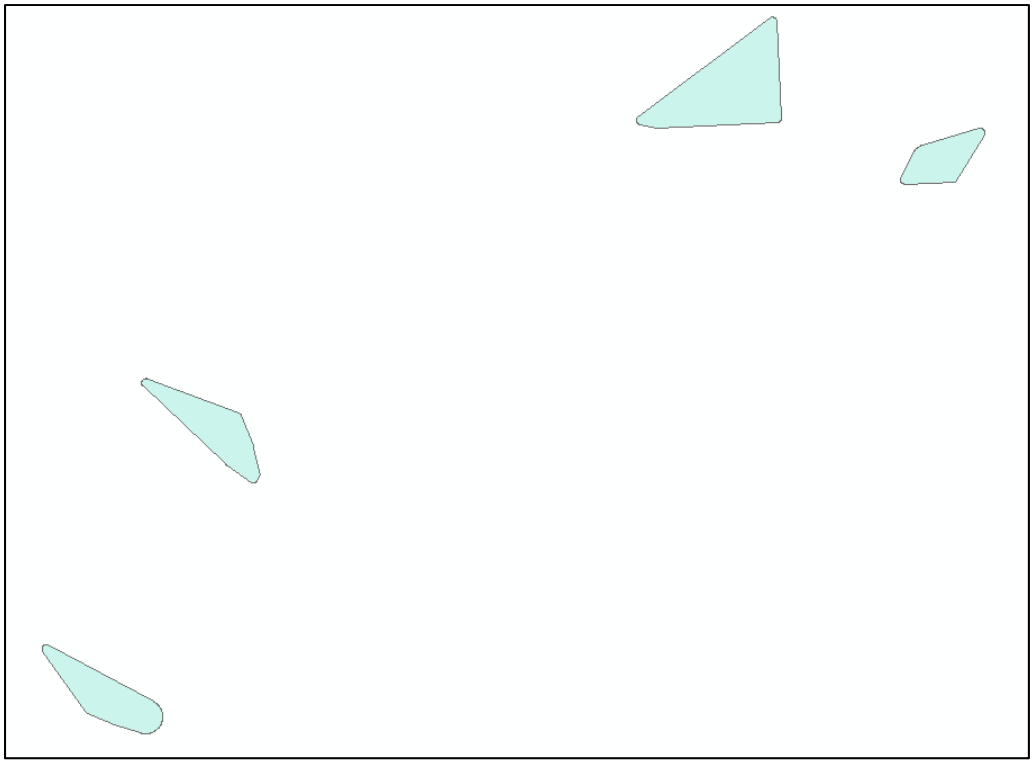

Figure 6. HRM results.

Please note that you can refer to (Hasanzadeh et al., 2017) if you are interested in learning more about the theories behind IREM.

3. Individualized residential exposure modeling tool (IREModeler)

Open the toolbox and double click on the tool "Individualized residential exposure modeling tool" as in Figure 7.

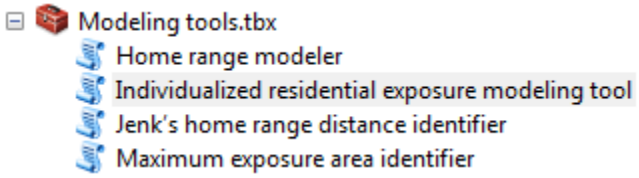

Figure 7. IREModeler in toolbox.

Now you should see the window shown in Figure 8. Provide the path to the home points, activity points, and travel routes in the first three rows respectively. If you are using the example data, these will be 'home.shp', 'dep.shp', and 'routes.shp' respectively. In the fourth row, choose the name and path of the output home range file. In the next two steps provide the D1 and D2 parameters as desired or use the default values. You can skip these three steps if you already

have the home range boundaries created. You need to also provide a path for saving the IREM output raster files. The path should be to a folder or geodatabase which will contain the output files. It is strongly recommended to use a file or personal geodatabase for storing output raster files.

One of the criteria used in estimation of the exposures, is the frequency of visits to each location. Alternatively, this can be replaced with the time spent at each location. The value entered in the field 'Maximum frequency/time' indicates the time/frequency that will be assigned to an individual's home. The value itself is not important. However, it's ratio to other time/frequencies specified in the dataset can affect the results. For example in the provided example data, frequencies for each activity point are presented as times per month in 'dep' dataset. Accordingly, in this example we have specified 30 as the maximum number of visits per month. Use of a bigger maximum value will decrease the effect of activity points with lower frequencies/time on the overall exposure estimation.

Another example: if time spent at each activity place is used instead of frequency for estimation exposure, the maximum duration of study duration should be used in this field. For example if we have collected data for a duration of 7 days, and time is presented in hours in our dataset, this field can be filled with 168 as the total number of hours per week.

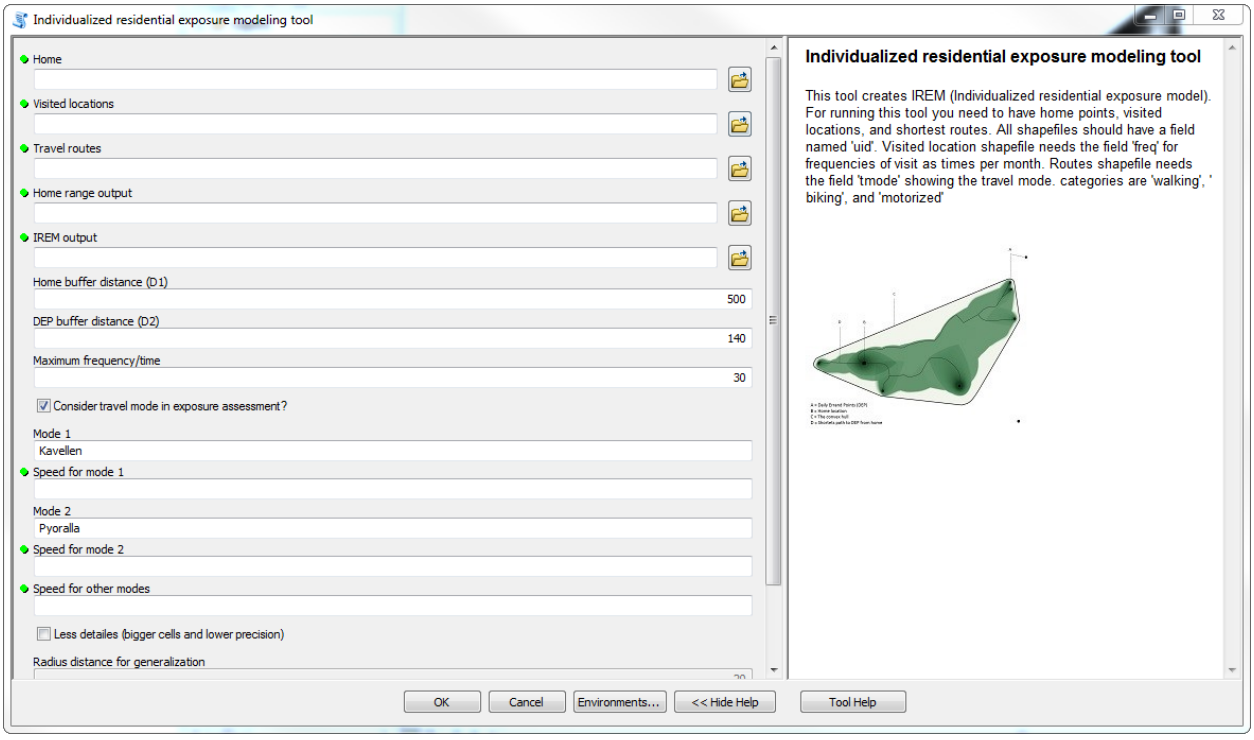

Figure 8. IREModeler interface.

‘Consider travel mode…’ is activated by default in the tool. You can turn this off if you don’t have information of travel modes in your dataset or you do not want them to affect the exposure estimation. If this feature is left activated, in the next rows you need to provide information on travel modes. In mode 1 and 2, you should enter the name that is used for referring to these modes in your dataset and provide their average speed in the next step. Please note that this interface is designed to work with a maximum of three travel modes. Please consider using the scripts directly if you have more than three travel modes. In case you have less than three modes, random values can be specified to the fields and this will not affect the results.

In the next step you are asked if you want to simplify the raster output. If activated, the tool will use a circular Block Statistics to average the cell values within the provided radius.

Finally, if you have already created the home range boundary files, you can check’ I already have…’ option and provide the path to the shape file in the next step. This will skip home range modeling step of analysis and save you some time.

Once completed, click on OK and wait a few moments until the process is completed. This waiting time can vary from a few seconds to hours depending on the size of dataset. Once completed you must be able to see the results (Figure 9) on the map. If the output is not mapped automatically upon completion, please add the output file manually to your ArcMap environment.

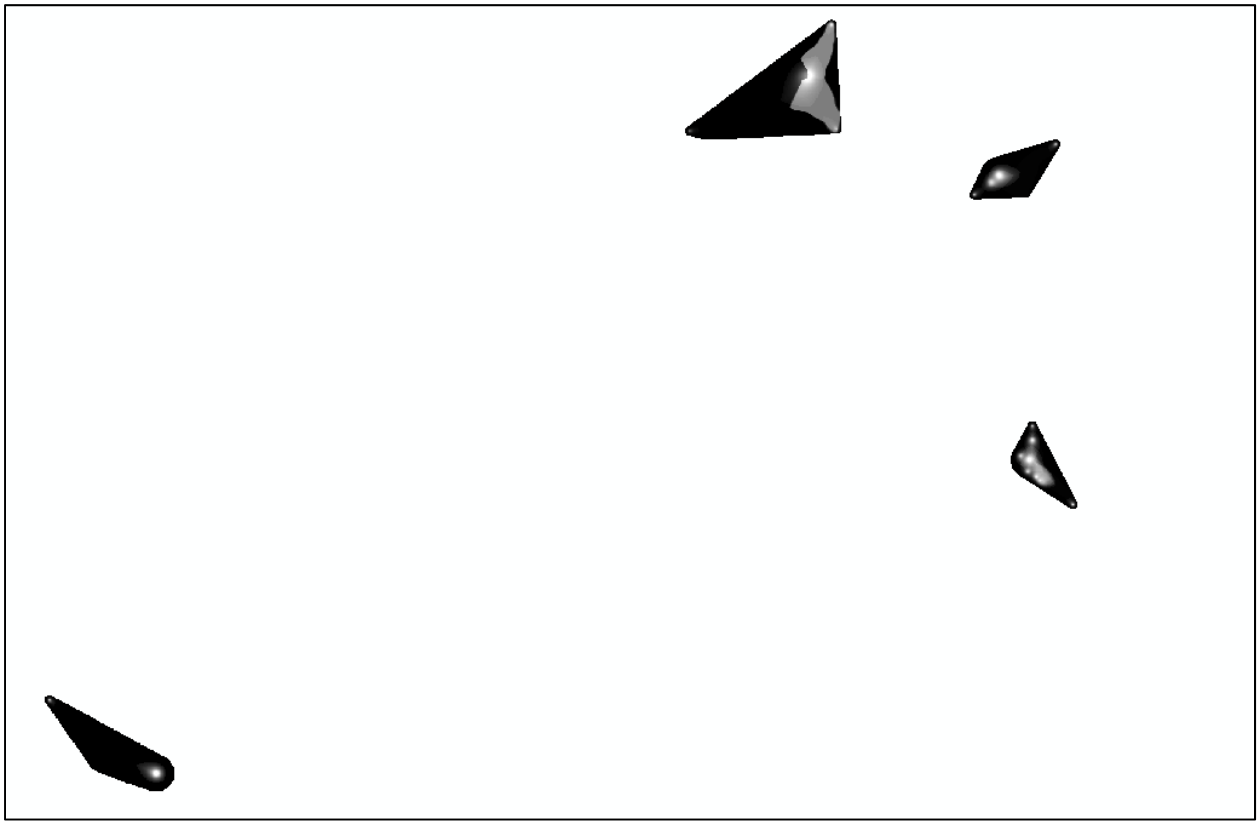

Figure 9. IREModeler results.

Please note that you can refer to (Hasanzadeh, Laatikainen, & Kyttä, 2018) if you are interested in learning more about the theories behind IREM.

4. Maximum exposure area estimator (MEAE)

This tool works with individualized exposure estimations –Such as IREM created in the tool described above. You need to already have these raster files in order to use this tool.

Open the toolbox and double click on the tool "Maximum exposure area identifier" as in Figure 10.

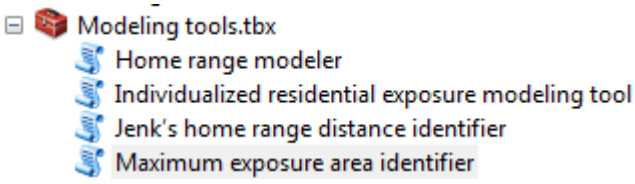

Figure 10. MEAE in toolbox.

Now you should see the window shown in Figure 11. In the first field, provide the path to the folder containing the exposure raster files. The files in this folder must be raster files with one

band (preferably .tiff format). The files must be named in a valid format for the tool to work properly. A valid format includes a unique numerical identifier followed by an underscore '_'. For example: nb_1333, where 1333 is a unique identifier referring to an individual. If you have used IREModeler for creating the exposure estimations, the files are already in the right format for this tool.

Please note that you should not have any other files but your exposure raster files in the indicated folder. Otherwise, you may encounter errors toward the end of the processing.

If you are using the example data to test this tool, you can use the raster files in Results > IREM as the input.

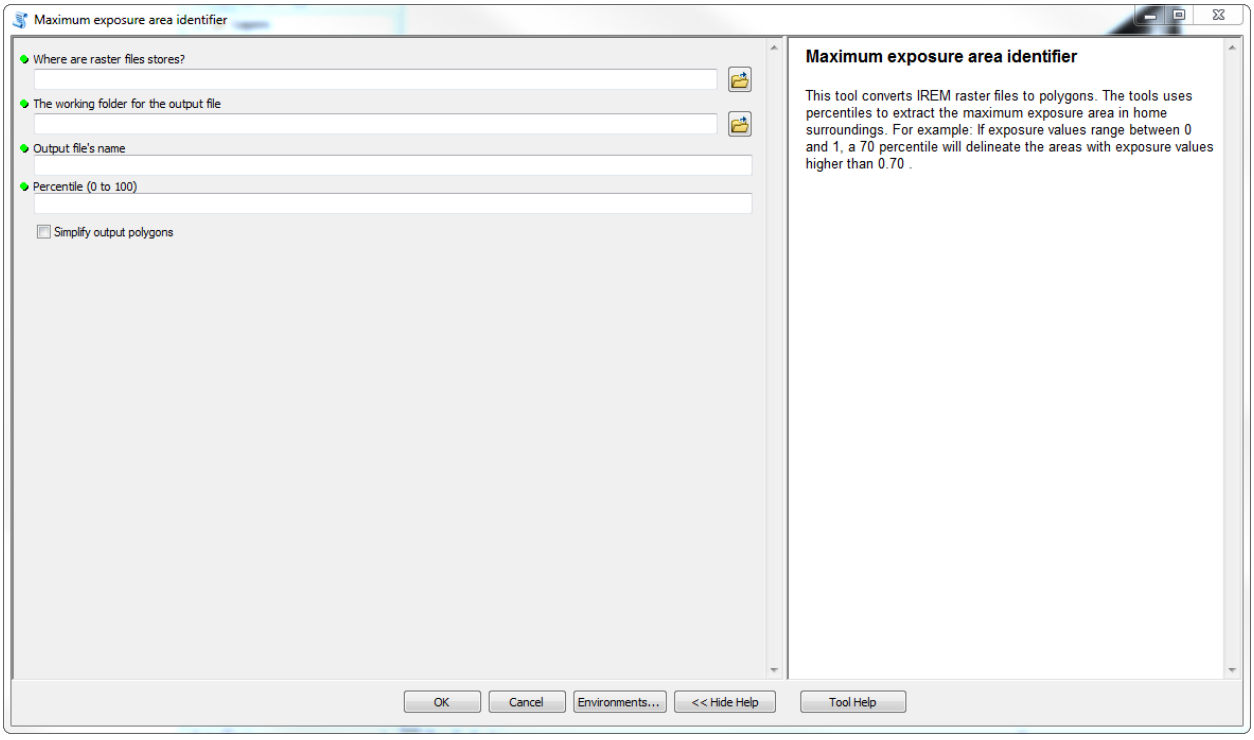

Figure 11. MEAE interface.

In the second step provide a working folder for the tool. This is also where the output will be saved. During the process the tool will create some temporary files in this folder which will be deleted automatically upon completion of the task. It is strongly recommended to use a path that does not contain any spaces. Failing to do so may incur errors.

This tool identifies the areas which have an exposure value of bigger than a minimum defined by the user. The extracted areas will be enclosed with a polygon for each individual and saved to a shapefile as the output. Since the exposure values estimated in IREM tool do no have an upper limit, the minimum exposure value is specified by the user in terms of percentiles in the last field. For example a value of 70 set by the user, will extract all the areas which have exposure values of higher than 70% of the maximum exposure value for the individual.

Finally, if you want smother polygons in the output, activate 'Simplify output polygons'. This is not recommended since it will lower the accuracy.

Once completed, click on OK and wait a few moments until the process is completed. This waiting time can vary from a few seconds to hours depending on the size of dataset. Once completed you must be able to see the results (Figure 12) on the map. If the output is not mapped automatically upon completion, please add the output file manually to your ArcMap environment.

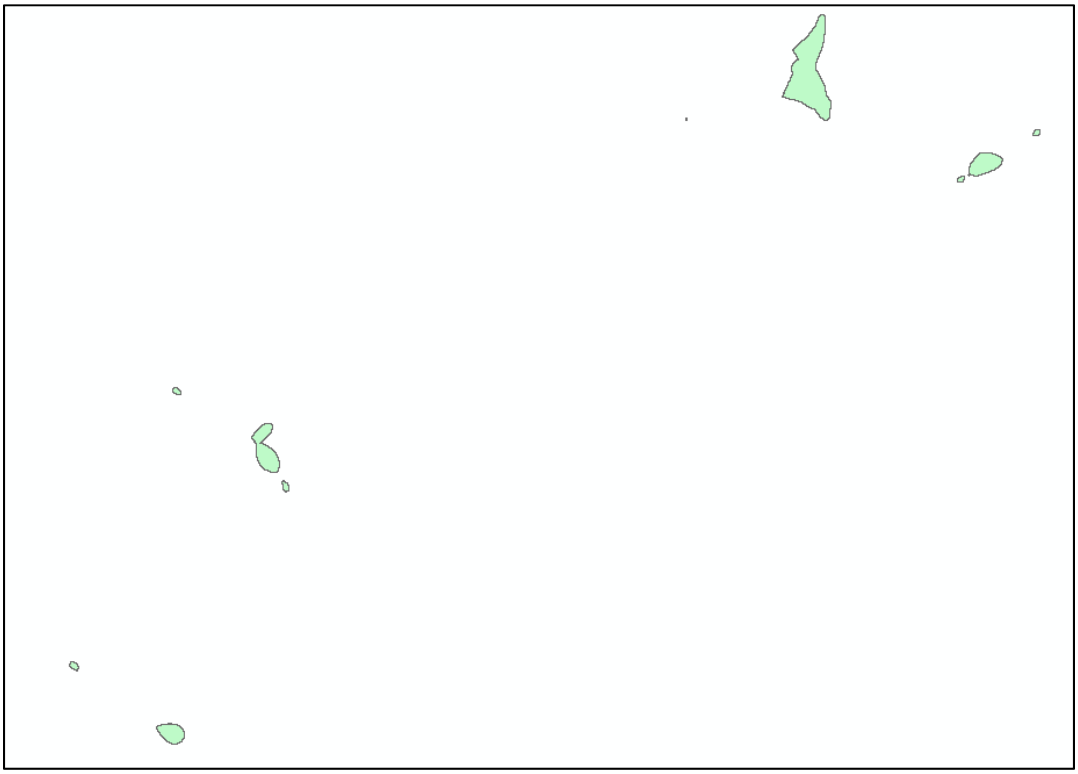

Figure 12. MEAE results.

Troubleshooting

Table 3 shows some of the most common errors that you might encounter when sing this toolbox. In the last column you can see workaround for the problem.

Table 3. Most common errors.

Tool	Error	Cause/Solution
IREModeler	999999 error: Failed to perform clip analysis	You are using a folder for saving output raster files.

		Please consider saving files in a Geodatabase instead.
MEAE	Object: Error in executing tool 'union'	There is a space in the path to the working folder. Choose a different path that does not include a space.

General tips:

- The toolbox works fastest when all files are stored on a local storage. Using files stored on a remote storage device (e.g. network files) may slow down the process depending on the transfer speed.
- The toolbox uses RAM to speed up processes. When running the tool for large files, please make sure you have enough free memory available on your device.
- Working with files stored in geodatabases (as both input and output) can significantly speed up the processes and lower the chance of unexpected errors.
- Using very long paths or paths that include spaces may cause errors in some devices.

References

Hasanzadeh, K., Broberg, A., & Kyttä, M. (2017). Where is my neighborhood? A dynamic individual-based definition of Home zones. *Applied Geography*, *84*(C), 1–10. https://doi.org/10.1016/j.apgeog.2017.04.006

Hasanzadeh, K., Laatikainen, T., & Kyttä, M. (2018). A place-based model of local activity spaces: individual place exposure and characteristics. *Journal of Geographical Systems*. https://doi.org/10.1007/s10109-017-0264-z

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