A guide to obtaining the amount of developable land in the USA*

October 15, 2014

Data files used in the estimation of developable land

1. National Land Cover Database (NLCD). This would be a source of data on developed land. We would look for 2011 edition on 2001 NLCD data. Can be downloaded here: `http://www.mrlc.gov/nlcd01_data.php`
2. National Elevation Dataset (NED). This would be a source of data on slope. Data will be obtained by this method: `http://www.usgs.gov/faq/categories/9865/5171%20`
3. The tracts/MSAs/counties or any other desirable geography level shape file obtained from the Census Bureau.

The algorithm for obtaining the amount of developable land

Step 1. Import the data

The first file which a user should import if he works in ArcGIS is the NLCD raster data file. This will set the default environment units to meters. Then NED raster data should be added to the current map. While importing a NED file for the first time, ArcGIS would offer a user to create pyramids (see figure 1). A user should click `Yes` keeping all the existing settings. This should be done only once. Building pyramids improves the display performance of raster datasets. The Census shape file of the desired geography should also be imported.

Note: if the shape file is too big (e.g., nationwide tracts coverage), it can be imported after step 6 is done to save memory and not slow down the performance.

*The guide was generated October 15, 2014. Authors: I. Kudko, S. DeSarkar

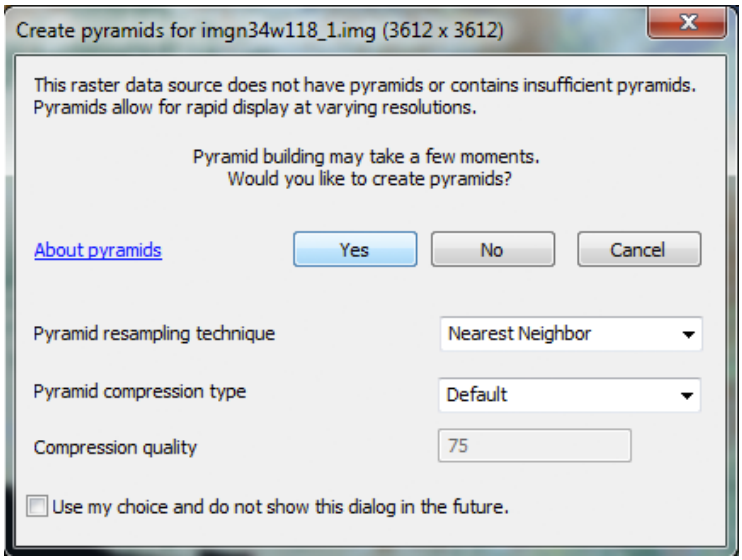


Figure 1: The default "Create pyramids" suggestion by ArcGIS.

Step 2. Project the data

A user has to project the raw data into new coordinate system and resize the cell-size to 30x30 meters. This is done so that two files have the same cell size and further analysis could be preformed. **Project Raster** tool from the **Data Management** toolbox should be used. User should select his NED raster data file in the **Input File** filed. After this is done, the output file name should be specified and the default output path to the own geodatabase name should be set. `Albers Conical Equal Area` coordinate system should be specified in the **Output Coordinate System Field**. The value of the **Output Cell Size** should be changed to `30` meters (!). See figure 2 for the details about the parameter values, which should be used in the tool.

To make sure that the tool was completed successfully and the new file is ready for further analysis, a user should check the NED file layer properties. Layer properties can be accessed by making a right click on the corresponding file name in the **Table of contents** and then changing to the **Source** tab. The original NED file was defined in degrees (e.i., X-coordinate and Y-coordinate are not 30m size, see figure 3a for detailes). But layer properties of the new (projected) NED raster file should have the cell-size 30 by 30 meters (see figure 3b).

Step 3. Calculate the slope

The primary goal of the NED file is to provide a user with the information on the slope of each cell of a raster file. To calculate the slope a user should use the **Slope** tool from the **Spatial Analyst** toolbox. The projected NED raster file from the step 2 should be specified as an Input raster. User should also specify a name for the new output raster file and its location path. Output measurement should be changed to the `"PERCENT_RISE"` to get the value of output slope in

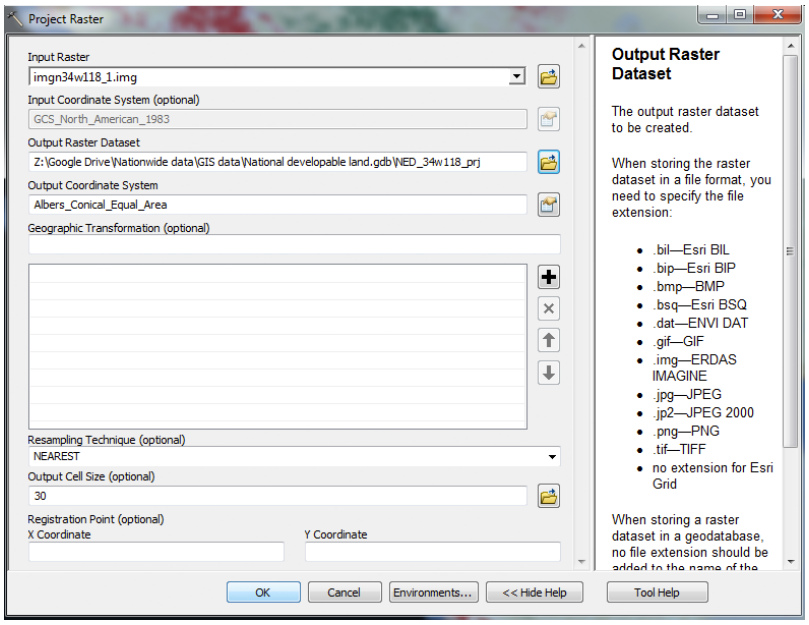
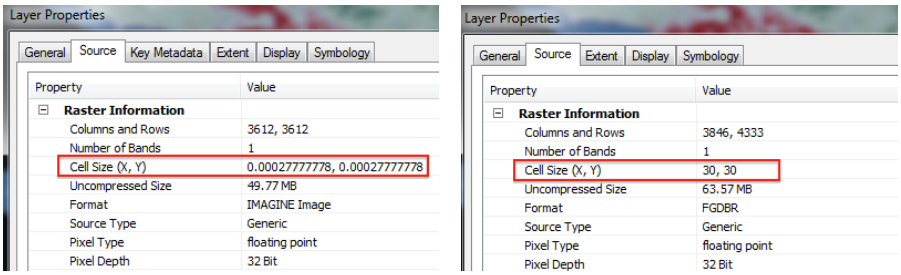


Figure 2: The parameters, which should be applied to the **Project Raster** tool.



(a) Original NED file (b) Projcted NED file

Figure 3: Layer properties of the original and projected NED files.

percentage points. The **Z factor**, which adjusts the units of measure for the z units should be left unchanged (equal to 1). See figure 4 for the details.

Step 4. Change the data pixel type from floating to integer

The pixel type of the NLCD raster file is an `unsigned integer`. In order to combine the two files (NED with NLCD) together, a user has to make sure they both have the same pixel type, otherwise the operation will be crashed. Changing the pixel type from floating to integer can be preformed using the tool **Raster Calculation** from the toolset **Map Algebra** in the **Spatial Analyst** toolbox. A user should type `Int("name_of_the_raster_file_which_should_be_changed")` in the expression box and then change the output path and the corresponding output file name. See figure 5 for the details.

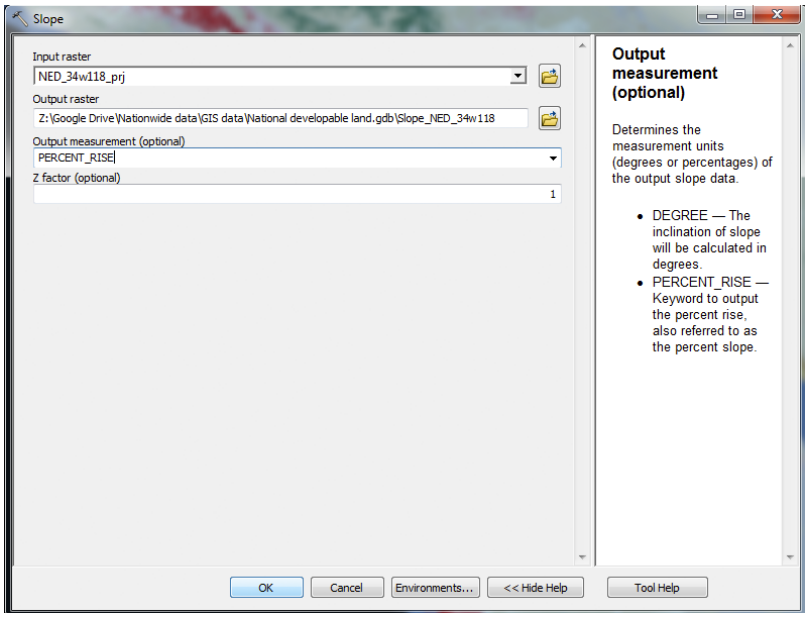


Figure 4: The parameters, which should be applied to the **Slope** tool.

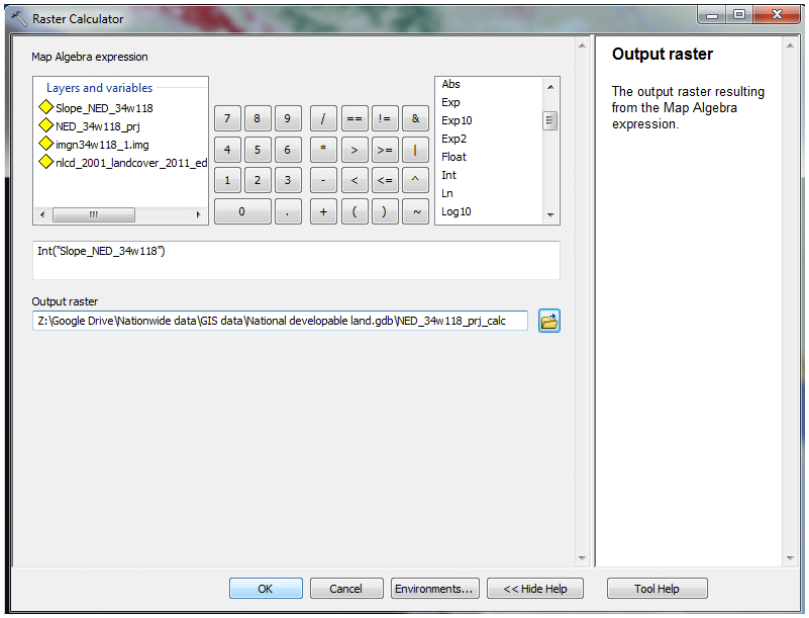


Figure 5: The parameters, which should be applied to the **Raster Calculation** tool.

Step 5. Combine the NLCD data with NED data

After the integer NED data file is obtained, two files are ready to me merged. To combine them a user should use **Combine** tool from the **Spatial Analyst** toolbox. Both raster files should be specified as the inputs and a path with the

corresponding file name should be given to the output file. The obtained output file should contain attribute table, which would have Cartesian product of all possible land classifications from NLCD and corresponding to them slope values from NED. See figure 6 for the details of what parameters should be specified in the **Combine** tool and figure 7 for the result.

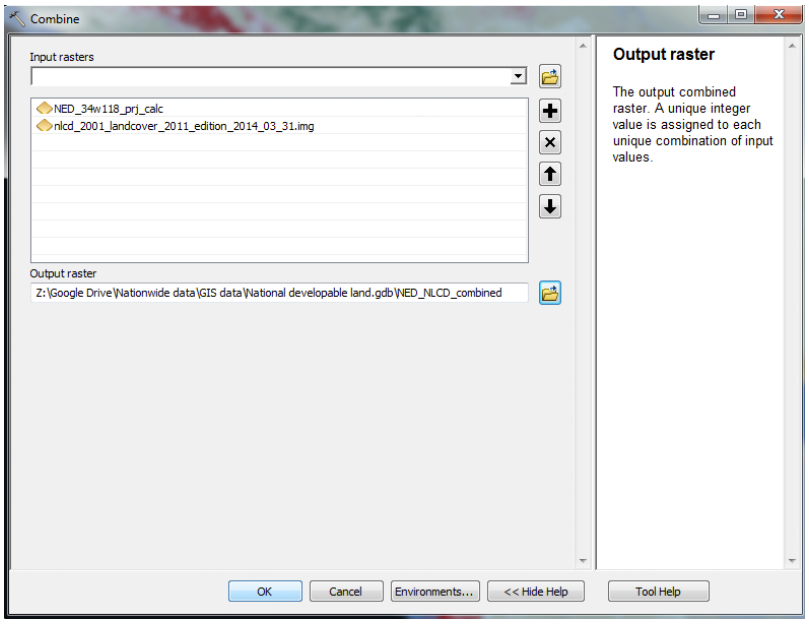
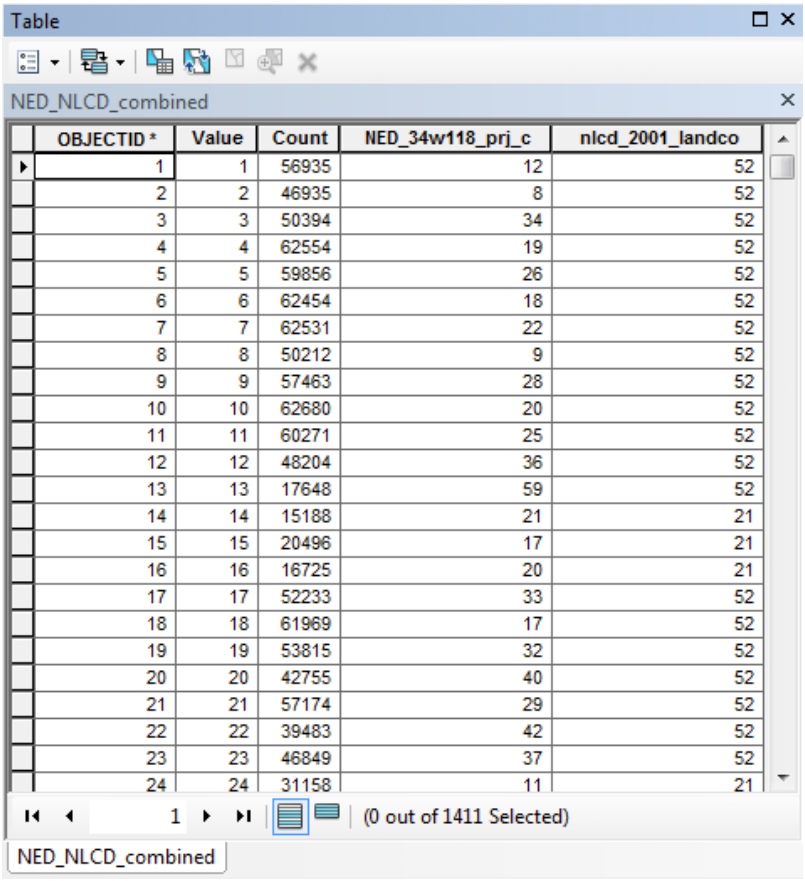


Figure 6: The parameters, which should be applied to the **Combine** tool.

Step 6. Extract the cells suitable for the developable land

A user should specify certain criteria, which he believes a developable land must suit. For example, one might believe that the land is developable if its slope is less than 15% and if it is not water, ice or land, which has already been developed. According to the NLCD legend the land, which is neither water nor ice nor already developed, has classification values ranging from 31 to 82. Thus, a user should apply the **Extract by Attributes** tool from the **Extraction** toolset of the **Spatial Analyst** toolbox. This tool allows extracting the cells of a raster based on a logical query. A combined raster file obtained on the step 5 should be used as the source for an input file. The **Where clause** might be different, but it should look like this: `"NED_34w118_prj_c" <= 15 AND "nlcd_2001_landco" IN ( 31, 41, 42, 43, 52, 71, 81, 82 )`. User should also specify the path and the name for the output raster file. This file will contain only those cells, which suit the developable land criteria. See figure 8 for the details of what parameters should be specified in the **Extract by Attributes** tool and figure 9 for the result.



OBJECTID *	Value	Count	NED_34w118_prj_c	nlcd_2001_landco
1	1	56935	12	52
2	2	46935	8	52
3	3	50394	34	52
4	4	62554	19	52
5	5	59856	26	52
6	6	62454	18	52
7	7	62531	22	52
8	8	50212	9	52
9	9	57463	28	52
10	10	62680	20	52
11	11	60271	25	52
12	12	48204	36	52
13	13	17648	59	52
14	14	15188	21	21
15	15	20496	17	21
16	16	16725	20	21
17	17	52233	33	52
18	18	61969	17	52
19	19	53815	32	52
20	20	42755	40	52
21	21	57174	29	52
22	22	39483	42	52
23	23	46849	37	52
24	24	31158	11	21

Figure 7: The resulting attribute table obtained from the **Combine** tool.

Step 7. Obtain the developable land by the desired geography level

The ultimate goal is to get the amount of developable land by the desirable level of geography, which can be tracts, counties, MSAs or States (or any other level of geography required by a user). This could be done using the **Zonal Statistics as Table** tool from the **Zonal** toolset of the **Spatial Analyst** toolbox. This tool might use a feature or a raster file as an input. The input file is used to define zones, which will be used for further statistics. After the input file is selected, a user should specify a **Zone field**, which can be a name or an ID of the feature, for which the observations are grouped and statistics is preformed. In the **Input value raster** field a user should specify a name of the raster file with the cells on which to calculate the statistics. A user also has to specify the path and the name for the output file in the **Output table** field and the type of statistics to be calculated in the **Statistics type** field. The statistics a user is looking for is a `SUM`, which calculates the total number of developable cells in each zone. See figure 10 for the details of what parameters should be specified in the **Zonal Statistics as Table** tool and figure 11 for the results. Output table produced on this step will contain the amount of developable land given

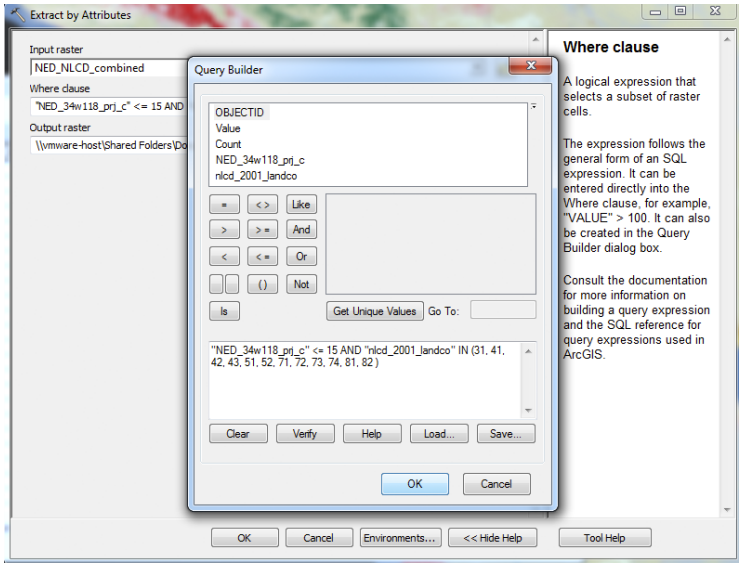


Figure 8: The parameters, which should be applied to the **Extract by Attributes** tool.

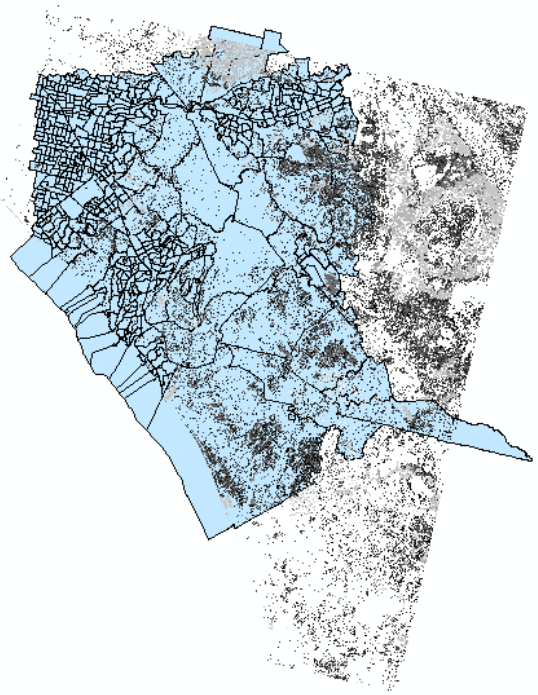


Figure 9: The resulting raster file obtained by **Extract by Attributes** tool.

for each observation of the desirable geography level (e.g. for each census tract).

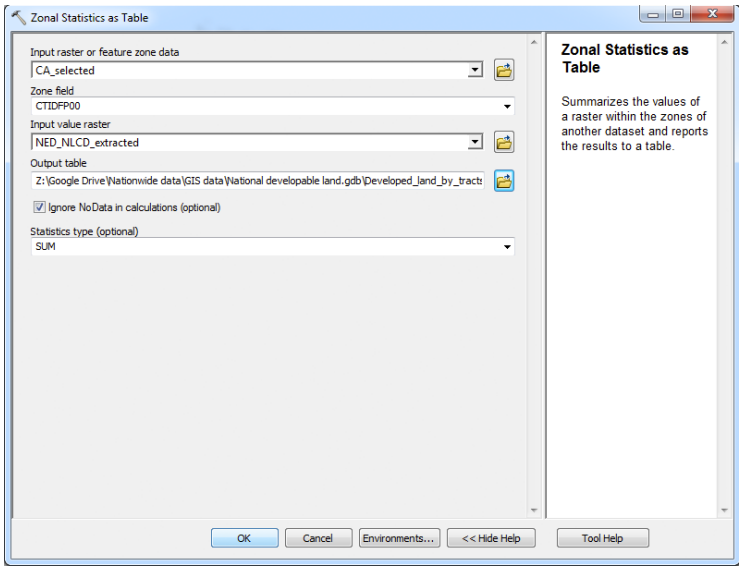


Figure 10: The parameters, which should be applied to the **Zonal Statistics as Table** tool.

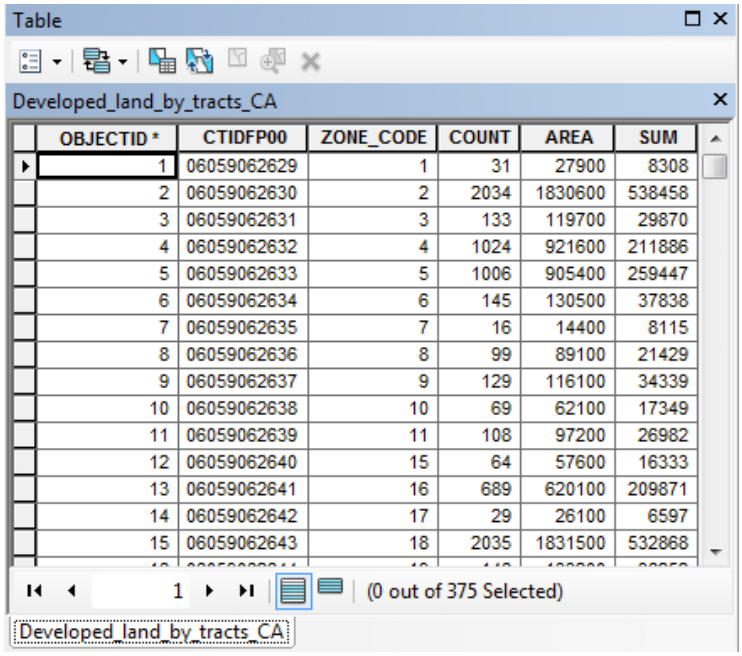


Figure 11: The resulting attribute table obtained from the **Zonal Statistics as Table** tool.