Universitat Politècnica de València

School of Engineering in Geodesy, Cartography and Surveying

PERSONAL ASSIGNMENT 1

Desarrollo de aplicaciones SIG

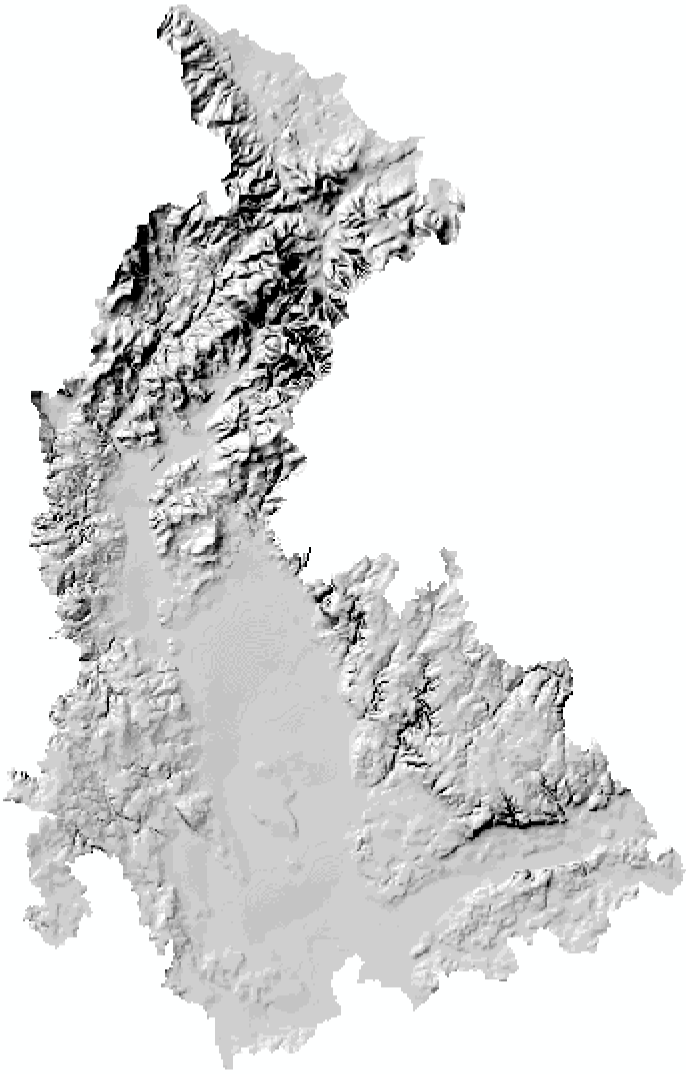
Eliška VLČKOVÁ

València 2017

INDEX

1 GOAL

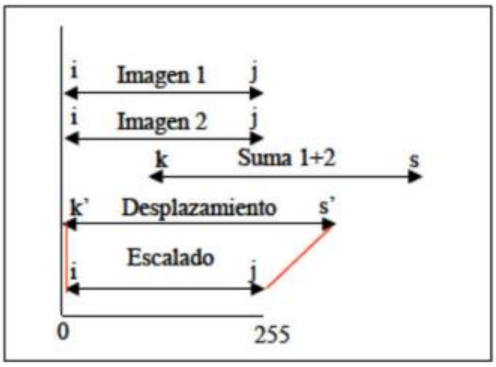
The goal of this personal assignment is to make a script in order to perform a combined hillshade of a DEM. This script allows to set both azimuth and elevation for both obtained hillshades.



2 DESCRIPTION

2.1 Assignment

Make a script to perform a combined hillshade of a DEM. This script will allow to set both azimuth and elevation for each single hillshade. Use ArctoolBox in order to create a new tool and link this tool with your script.

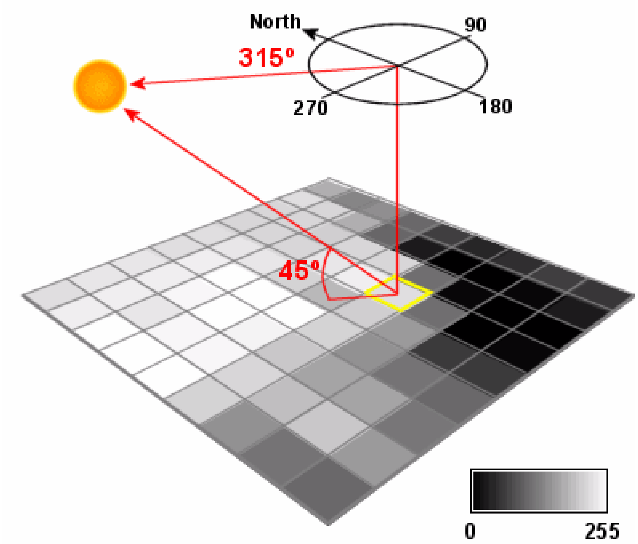


$$V = ((I1+I2)-k) * ((j-i) / (s'-k'))$$

2.2 Hillshade

2.2.1 Description

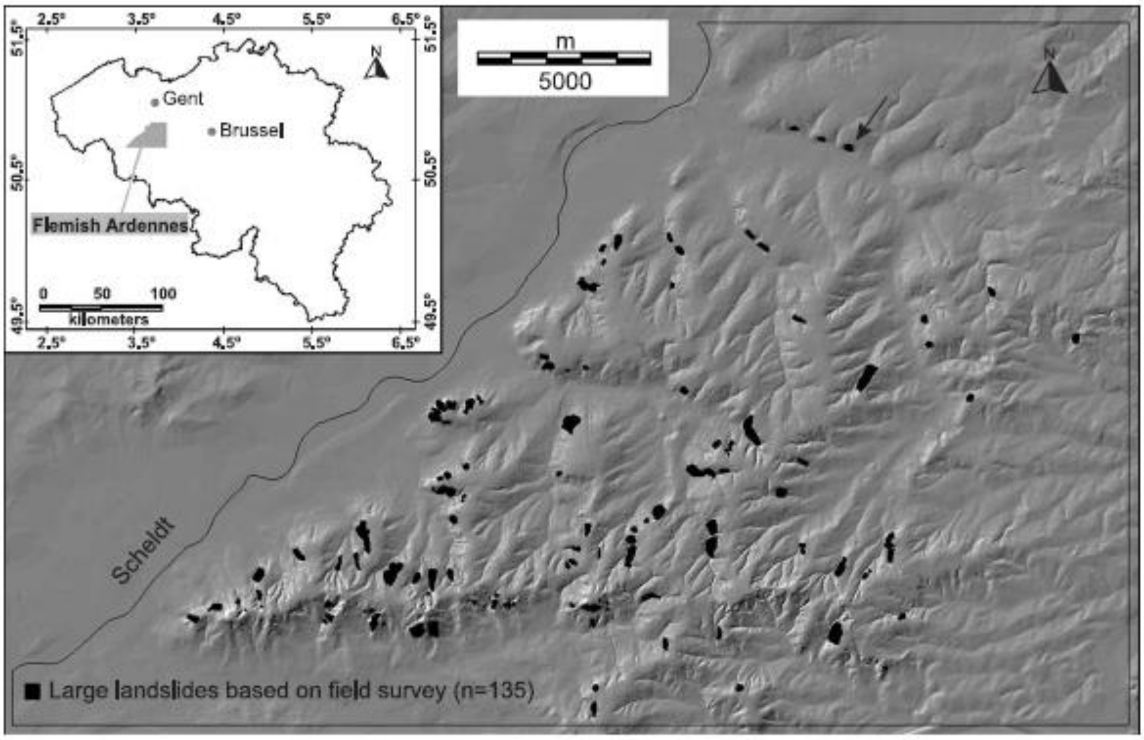
Hillshading is a technique used to create a realistic view of terrain by creating a three-dimensional surface from a two-dimensional display of it. Hillshading creates a hypothetical illumination of a surface by setting a position for a light source and calculating an illumination value for each cell based on the cell's relative orientation to the light, or based on the slope and aspect of the cell.



Hillshading computes surface illumination as values from 0 to 255 based on a given compass direction to the sun (azimuth) and a certain altitude above the horizon (altitude).

2.2.2 Use

Hillshades are often used to produce maps that are visually appealing. Used as a background, hillshades provide a relief over which you can draw raster data or vector data.



Location of the study area. The field survey-based landslides (N=135) are shown on the hillshade map with sun elevation angle of 308 and sun azimuth angle of 315. The black arrow indicates the landslide which was indicated to the experts as an example. (Van den Eeckhaut, 2005)

2.2.3 Availability

Besides ArcMap is hillshade function is available in R (R Documentation) with different arguments. An example of usage can be seen below:

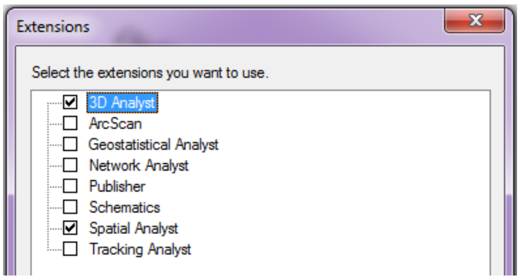
```
hillShade(slope, aspect, angle=45, direction=0, filename='', normalize=FALSE, ...)
```

Shaded relief can be also generated through GDAL library, where hillshade command outputs an 8-bit raster with a nice shaded relief effect. There can be optionally specify the azimuth and altitude of the light source, a vertical exaggeration factor and a scaling factor to account for differences between vertical and horizontal units (GDAL).

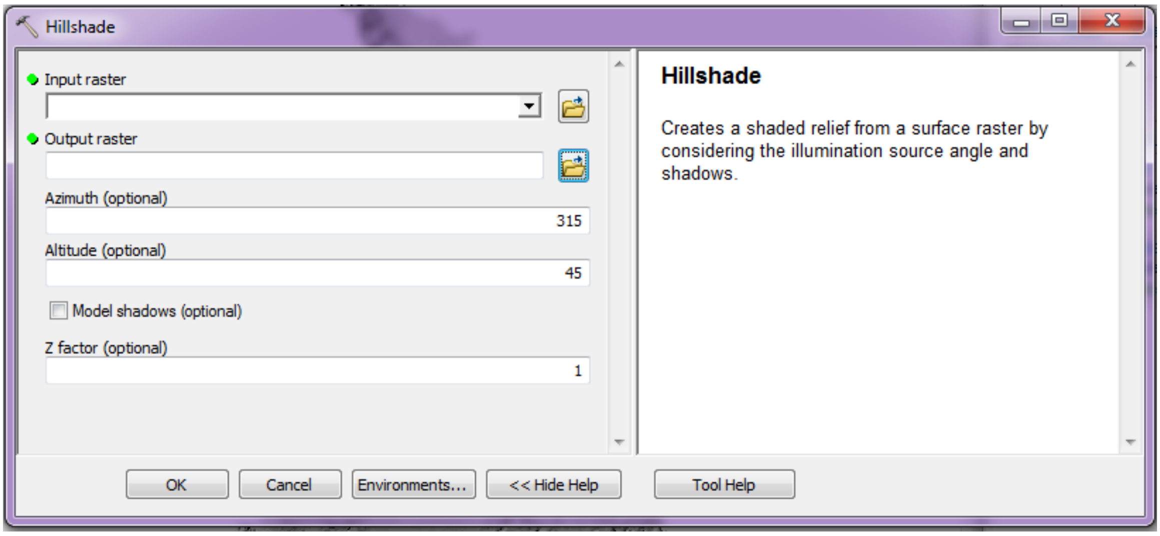
For our purpose was used ArcMap, where is hillshaded available in two extensions: 3D analyst and Spatial Analyst. In code was used hillshade from Spatial Analyst, because there is no need to obtain output during processes. Spatial Analyst is the extension ArcGIS uses to conduct analyses with raster data. 3D Analyst allows users to display and work with three-dimensional (x, y, z) data.

2.2.4 Hillshade in ArcMap

As it has been told, Hillshade funtion is available in 3D Analyst Extension and in Spatial Analyst Extension. In order to use any of these, is necessary to make sure that the Spatial Analyst or the 3D Analyst Extensions are turned on.



In our purpose, the next steps will consider only hillshade function in Spatial Analyst. Hillshade analysis is a way to see where light would fall on a landscape. The resulting grid will appear as a grayscale (black & white) image. Hillshade often has a photo-like quality to it. On the Spatial Analyst Toolbar, go to Spatial Analysis → Surface Analysis → Hillshade. This will bring up the Hillshade dialog box.



Two types of shaded relief rasters can be output. If the Model shadows option is disabled (unchecked), the output raster only considers local illumination angle. If it is enabled (checked), the output raster considers the effects of both local illumination angle and shadow. The hillshade raster has an integer value range of 0 to 255.

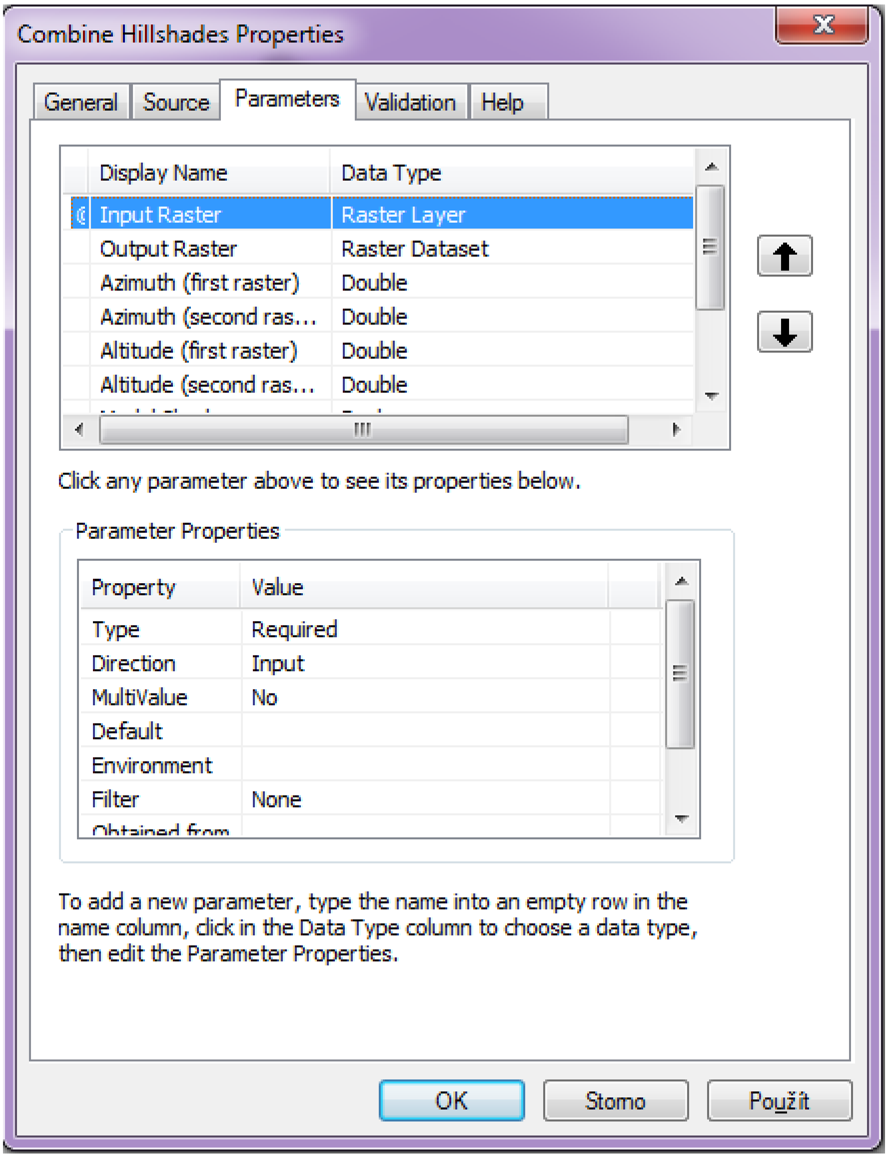
Syntax for using hillshade in ArcPy is following:

Hillshade_3d (in_raster, out_raster, {azimuth}, {altitude}, {model_shadows}, {z_factor})

PARAMETER	MEANING	DATA TYPE
in_raster	The input surface raster.	Raster Layer
out_raster	The output hillshade raster. The hillshade raster has an integer value range of 0 to 255.	Raster Dataset
azimuth (Optional)	Azimuth angle of the light source. The azimuth is expressed in positive degrees from 0 to 360, measured clockwise from north. The default is 315 degrees.	Double
altitude (Optional)	Altitude angle of the light source above the horizon. The altitude is expressed in positive degrees, with 0 degrees at the horizon and 90 degrees directly overhead. The default is 45 degrees.	Double
model_shadows (Optional)	Type of shaded relief to be generated. NO_SHADOWS —The output raster only considers local illumination angles; the effects of shadows are not considered.The output values can range from 0 to 255, with 0 representing the darkest areas, and 255 the brightest. This is the default. SHADOWS — The output shaded raster considers both local illumination angles and shadows.The output values range from 0 to 255, with 0 representing the shadow areas, and 255 the brightest.	Boolean
z_factor (Optional)	Number of ground x,y units in one surface z unit. The z-factor adjusts the units of measure for the z units when they are different from the x,y units of the input surface. The z-values of the input surface are multiplied by the z-factor when calculating the final output surface. If the x,y units and z units are in the same units of measure; the z-factor is 1. This is the default. If the x,y units and z units are in different units of measure; the z-factor must be set to the appropriate factor, or the results will be incorrect.	Double

2.3 Import of script to ArcMap

After creating toolbox, the script of combining hillshades was imported. The inputs were taken in the same order as they were in code itself. Data types of those parameters were typed the same as in the previous table.



As it was in hillshade function in AcrMap, the only obligatory fields were „Input“ and „Output“. The rest of parameters was optional, with set default values.

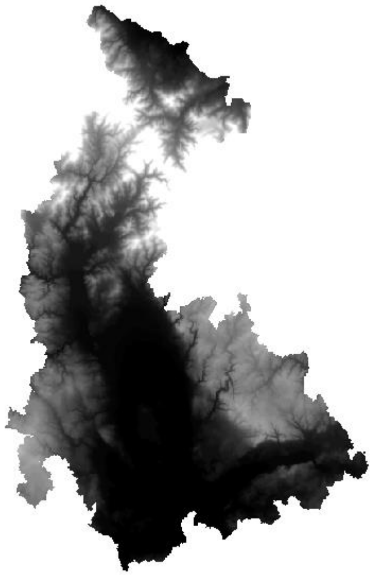
The code was written based on assignment, can be seen in following chapture. Rescaling back between values 0–255 was applied based on formula $V = (Is - k) + j/(s' - k')$

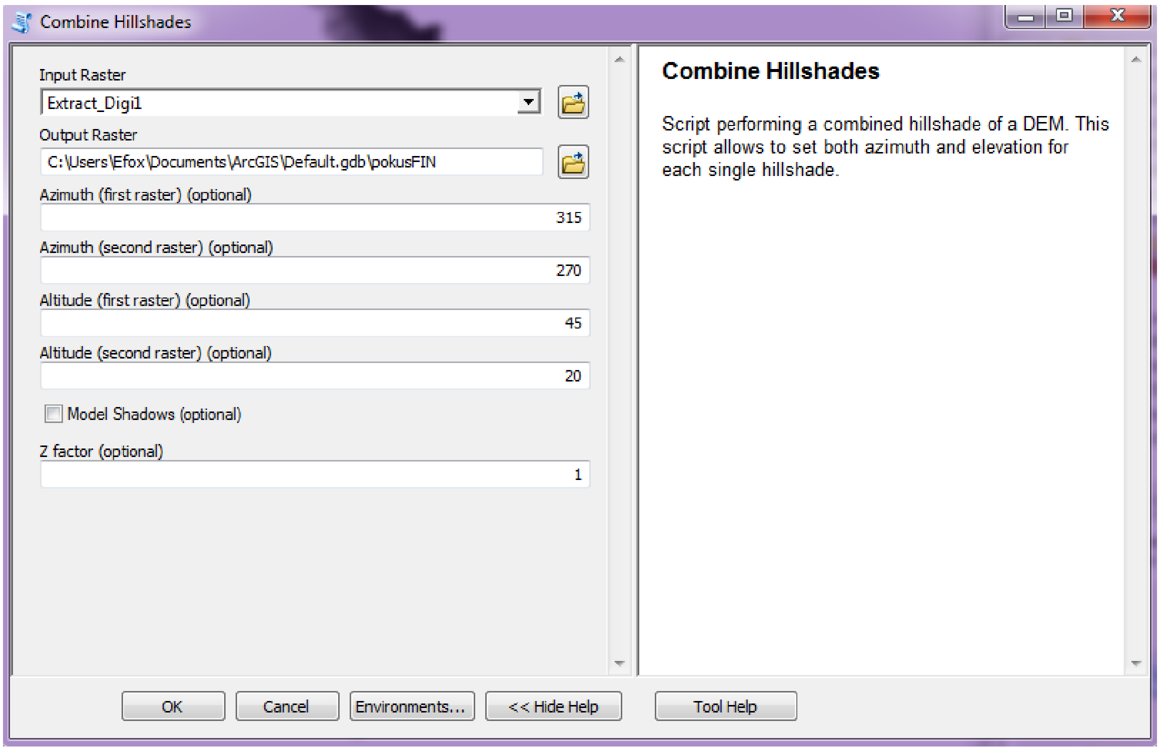
3 CODE

```
#creating class licencseError
class LicenseError(Exception):
    pass

#import libraries
import arcpy
from arcpy import env
from arcpy.sa import *

#allowance of overwite, setting current workspace
arcpy.env.overwriteOutput = True
arcpy.env.workspace = 'CURRENT'


try:
    #try if is Spatial Extension available
    if arcpy.CheckExtension('Spatial') == 'Available':
        arcpy.CheckOutExtension('Spatial')

        #setting inputs, outputs
        in_raster = arcpy.GetParameterAsText(0)
        out_raster = arcpy.GetParameterAsText(1)

        azimuth1 = arcpy.GetParameterAsText(2)
        azimuth2 = arcpy.GetParameterAsText(3)
        altitude1 = arcpy.GetParameterAsText(4)
        altitude2 = arcpy.GetParameterAsText(5)
        model_shadows = arcpy.GetParameterAsText(6)
        z_factor = arcpy.GetParameterAsText(7)

        #function for rescale rasters back to 0/255
        def rescaleHillshade ():
            s = int(sum.maximum)
            k = int(sum.minimum)
            V = (sum-k)*255/((s-k))
            return V.save(out_raster)
        #case, that user wants to model with shadows
        if model_shadows == True:
            hillshade1 = Hillshade (in_raster, azimuth1, altitude1, "SHADOWS", z_factor)
            hillshade2 = Hillshade (in_raster, azimuth2, altitude2, "SHADOWS", z_factor)
            sum = hillshade1 + hillshade2
            rescaleHillshade()

        #case without shadows /this is optional/
        else:
            hillshade1 = Hillshade (in_raster, azimuth1, altitude1, "NO_SHADOWS", z_factor)
            hillshade2 = Hillshade (in_raster, azimuth2, altitude2, "NO_SHADOWS", z_factor)
            sum = hillshade1 + hillshade2
            rescaleHillshade()
    else:
        raise LicenseError

except LicenseError:
    print("Spatial Analyst license is unavailable")
except arcpy.ExecuteError:
    print(arcpy.GetMessages(2))
finally:
    arcpy.CheckInExtension("Spatial")
```

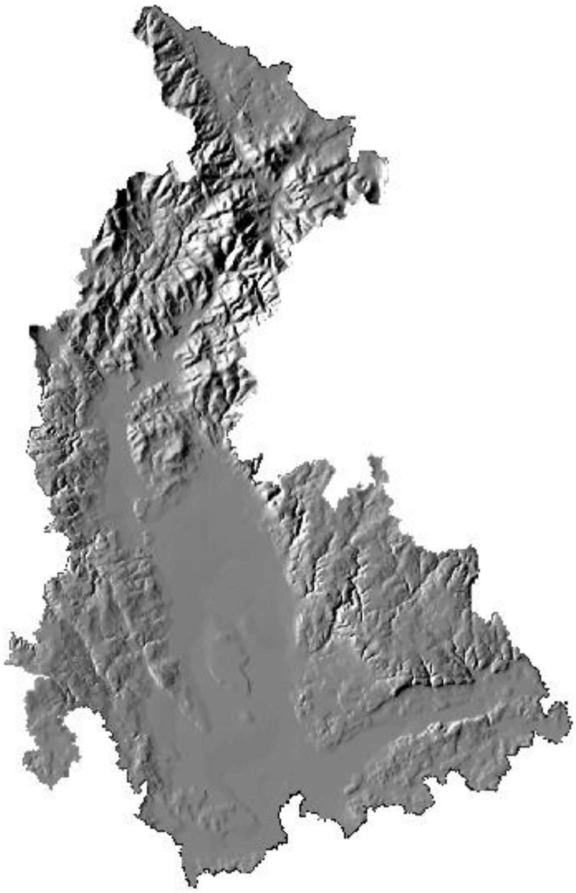
4 RESULTS

The script was tested on data from Czech Republic, concrete on geodatabase named ArcČR 500, what is distributed for free. All data are in scale 1 : 500 000 and except vector layers, Digital Model of Relief and also Shaded Relief are available in this datased (in precision 100 x 100 meters). In our purpose, DMR was clipped only for Olomoucký region.





Based of previos image, with setted parameters, the result is following:



5 BIBLIOGRAPHY

DIENER, Michael. *Python Geospatial Analysis Cookbook*. Packt Publishing Ltd. UK, 2015. ISBN 978-1-78355-507-9.

FERIC, Pavle, Snježana Mihalić ARBANAS a Martin KRKAC. Visual mapping of landslides from LiDAR imagery, Zagreb, Croatia. In: *Conference: 2nd Japanese-Croatian Project Workshop 'Monitoring and analyses for disaster mitigation of landslides, debris flow and floods', At Rijeka, Croatia*. 2011.

GDAL: gdaldem [online]. Available in: http://www.gdal.org/gdaldem.html

HENGL, Tomislav. a Hannes I. REUTER. *Geomorphometry: concepts, software, applications*. Boston [Mass.]: Elsevier, 2009. Developments in soil science, 33. ISBN 0123743451.

R Documentation: Hillshade [online]. Available in:
https://www.rdocumentation.org/packages/raster/versions/2.5-8/topics/hillShade

KÄÄB, A. Combination of SRTM3 and repeat ASTER data for deriving alpine glacier flow velocities in the Bhutan Himalaya. *Remote Sensing of Environment* [online]. 2005, **94**(4), 463-474 [cit. 2017-05-16]. DOI: 10.1016/j.rse.2004.11.003. ISSN 00344257.

LI, Ying-kui. Determining topographic shielding from digital elevation models for cosmogenic nuclide analysis: a GIS approach and field validation. *Journal of Mountain Science* [online]. 2013, **10**(3), 355-362 [cit. 2017-05-16]. DOI: 10.1007/s11629-013-2564-1. ISSN 1672-6316.

VAN DEN EECKHAUT, M., J. POESEN, G. VERSTRAETEN, V. VANACKER, J. MOEYERSONS, J. NYSSEN a L.P.H. VAN BEEK. The effectiveness of hillshade maps and expert knowledge in mapping old deep-seated landslides. *Geomorphology* [online]. 2005, **67**(3-4), 351-363 [cit. 2017-05-16]. DOI: 10.1016/j.geomorph.2004.11.001. ISSN 0169555x.