

Development of Software Tool for Bathymetry Mapping Using Satellite Imagery

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Introduction

The following is the documentation for a application in which a Satellite Image of a particular Area of Interest (AoI) would be selected by the user and a bathymetric maps will be generated for the same. User can perform 2 types of operations in this software.

- 1) Water Column Correction to derive empirical representation of substrate types.
- 2) Depth Derivation for the Area of interest which would require some ground truth data in any one of the following forms: Georeferenced Survey Map or CSV file containing depths of points by UTM coordinates.

Language and libraries used

The application uses Python version 2.7.12, and it has dependencies in the libraries: NumPy, sklearn, SciPy, Matplotlib, Rasterio, GDAL.

IN THE PACKAGE

- 1) Sample datasets of Port Blair/ Ross Island region from LandSat8 for testing purpose in the folder "clipped datasets".
- 2) NHO maps (both original and georeferenced) along with "depths.csv" file containing data for all points in the map.
- 3) Results of Water Column Correction saved as "diigray.tif" and "diicolor.png", along with scaling information in "dii.log.txt" in folder "results" for the sample dataset.
- 4) Results of Depth Calculation saved as "depthgray.tif" and "depthcolor.png", along with scaling information in "depth.log.txt", regression info in "regression.png", validation info in "validation.png" in folder "results" for the sample dataset.
- 5) Executable of Bathymetry tool in folder "Executable of Bathymetry tool"

- 6) Executable of program to create CSV file of depths in folder “Executable of program to create CSV file of depths”.

NOTE: The executables need no dependencies on the system.

- 7) Source code of Bathymetry tool in “Code that works with Rasterio 0.36 & GDAL 1.1” & “Code that works with Rasterio 1.0 & GDAL 2.2 as bathymetryfinal.py.
- 8) Source code of Depth Points CSV creation tool in “Code that works with Rasterio 0.36 & GDAL 1.1” & “Code that works with Rasterio 1.0 & GDAL 2.2 as depthlabel.py.

NOTE: To run source code in Command Prompt, user needs to have all dependencies mentioned above with the version specificity of whichever folder the file comes from.

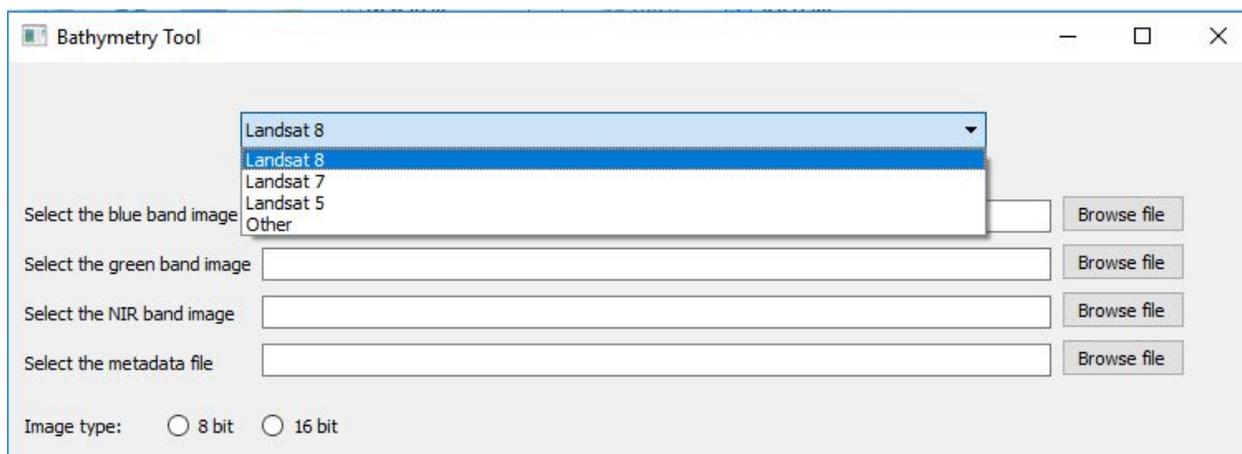
- 9) “Setup file to render Executable of Bathymetry tool.py”
- 10) “Setup file to render Executable of program to create CSV.py”

NOTE: These setup files will have to be run on Command Prompt with dependencies as above plus the cx_Freeze library which enables creation of exe files.

PROCEDURE - FOR EXECUTABLE USERS

BATHYMETRY TOOL

1. Open the folder “Executable of Bathymetry tool”. Next open the folder “exe.win-amd64-2.7”. Open BathymetryTool2.exe.
2. The following window will open. Input the red image, green image, NIR image.
3. Input the metadata file if the data is from Landsat 5,7 or 8. Select the respective satellite from the dropdown.



4. If it is from another satellite select Others in the dropdown. Enter the values of parameters asked.
5. Make sure that the image format is readable by Rasterio(Python Module) i.e. it is georeferenced and has coordinate data stored.
6. Select image datatype as 8-bit or 16 bit.

The screenshot shows the 'Bathymetry Tool' window with the dropdown menu set to 'Other'. It features three file selection fields: 'Select the blue band image', 'Select the green band image', and 'Select the NIR band image', each with a 'Browse file' button. Below these is the 'Image type' section with radio buttons for '8 bit' and '16 bit'. The 'Blue Band' section contains four input fields: 'Maximum Radiance value', 'Minimum Radiance value', 'Maximum Pixel value', and 'Minimum Pixel value'. The 'Green Band' section also contains four input fields: 'Maximum Radiance value', 'Minimum Radiance value', 'Maximum Pixel value', and 'Minimum Pixel value'. At the bottom, there are two buttons labeled 'WCC' and 'Depth'.

For any other dataset apart from Landsat 5,7 and 8

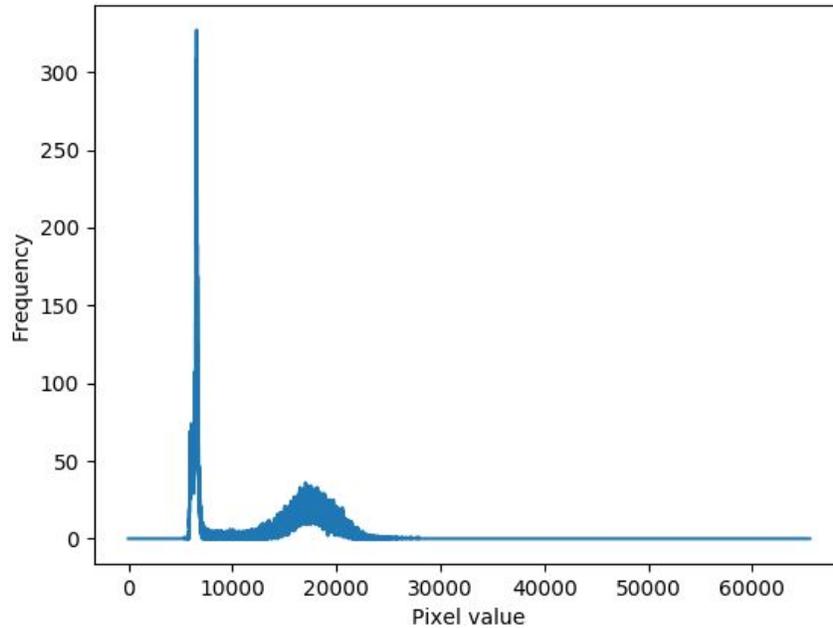
The screenshot shows the 'Bathymetry Tool' window with the dropdown menu set to 'Landsat 8'. It features four file selection fields: 'Select the blue band image', 'Select the green band image', 'Select the NIR band image', and 'Select the metadata file', each with a 'Browse file' button. Below these is the 'Image type' section with radio buttons for '8 bit' and '16 bit'.

For Landsat 8

7. Next click on WCC if you want to do water column correction and Depth for depth processing.

WATER COLUMN CORRECTION

1. Select the threshold for separating land and water using histogram. Select a point which is at a minima just after the biggest peak (provided your image has majority water). Generally for 16 bit data it is around 8000-10000 and for 8 bit data from 15-35.



Sample histogram

(ideal cut around 9000-11000)

2. The rest of the inputs are pretty straightforward. You have to input target directory and file names in order to save the output files where you desire.
3. Use the information in the logfile to convert pixel values to actual depth invariant indices.
4. The colour image does not have accurate values. It is just for visualization and to clearly mark the differences. The actual usable file which can be used in softwares like QGIS is the grayscale image.

Water Column Correction

Enter the threshold for separating land and water in IR band

Select target folder for output file

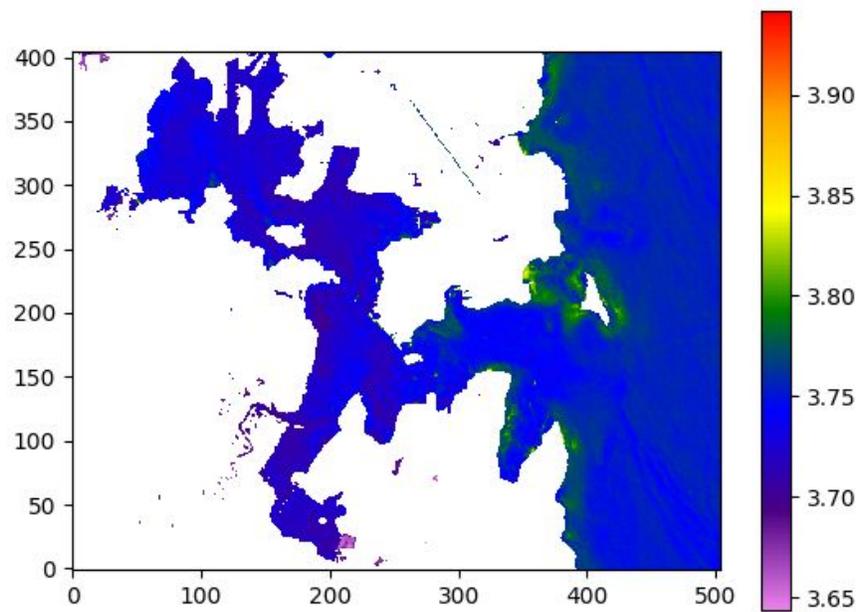
Output as: Grayscale map(original resolution) Colour map(less resolution)

Grayscale filename

Grayscale log filename

Colour filename

SAMPLE OUTPUT



Colour image

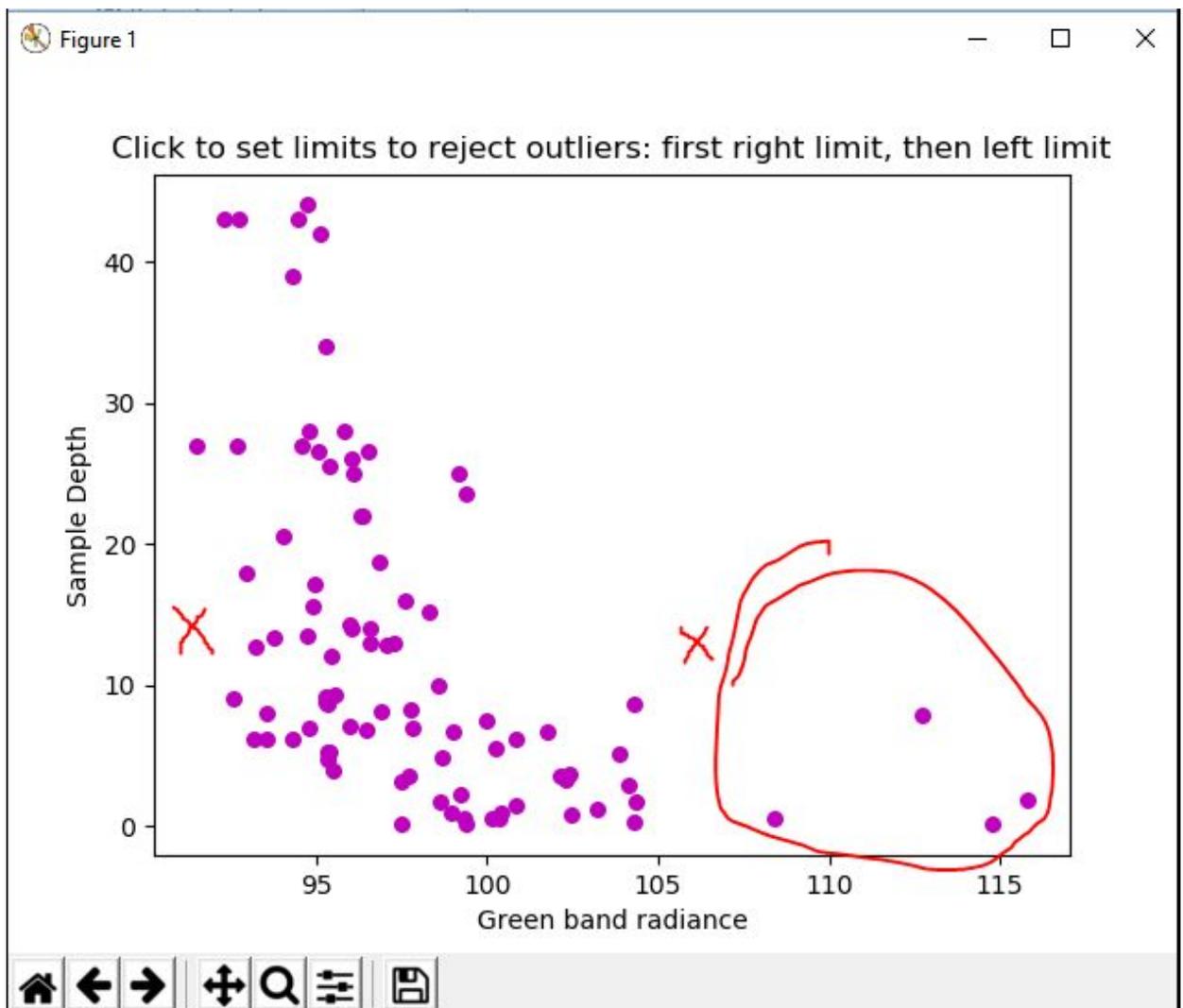


Grayscale image

DEPTH PROCESSING

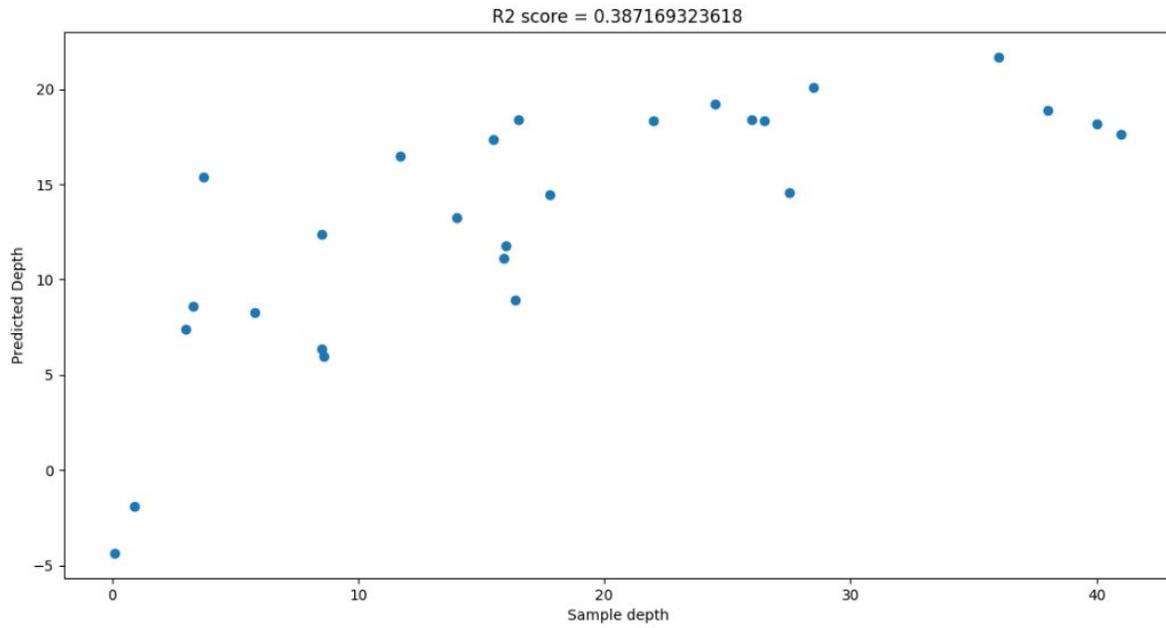
1. The window include all the inputs of Water column correction. Read the above to understand how to give input.
2. Additional inputs include georeferenced map having accurate depths marked on them.
3. After giving this input you have to select any one of the two: points file or picking ground truth points for depth manually..
4. If you select the option picking ground truth points and click on the button pick ground truth points, the georeferenced map image will be opened. You will need to click at any point that you need the depth and enter the depth. The image can be zoomed in so that the coordinates of that particular depth value can be accurately clicked.

5. WARNING : Do not press this button before entering the georeferenced image as it may cause an Error.
6. The preferred method is points file. This will ensure that you don't have to select the points manually again and again. You can use the other executable file to get points file. The points file is a .csv file having latitude, longitude and depth.
7. When scatter plot appears, user needs to click on 2 points, 1 left and 1 right of the cluster which visually seems to be the relevant part. This is to remove OUTLYING values which will cause a wrong regression to appear.



8. After the execution of the program a plot will be shown of the input depth values. Sample output plot is shown below. After closing this plot the window, the

window will close and the output files will be stored in the location according to the input.

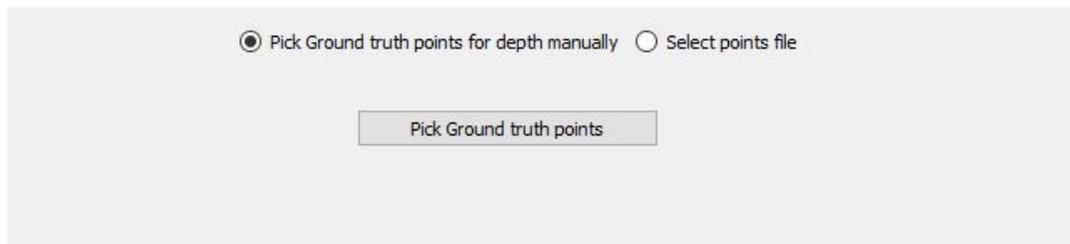


Sample plot

Select the georeferenced image

Pick Ground truth points for depth manually Select points file

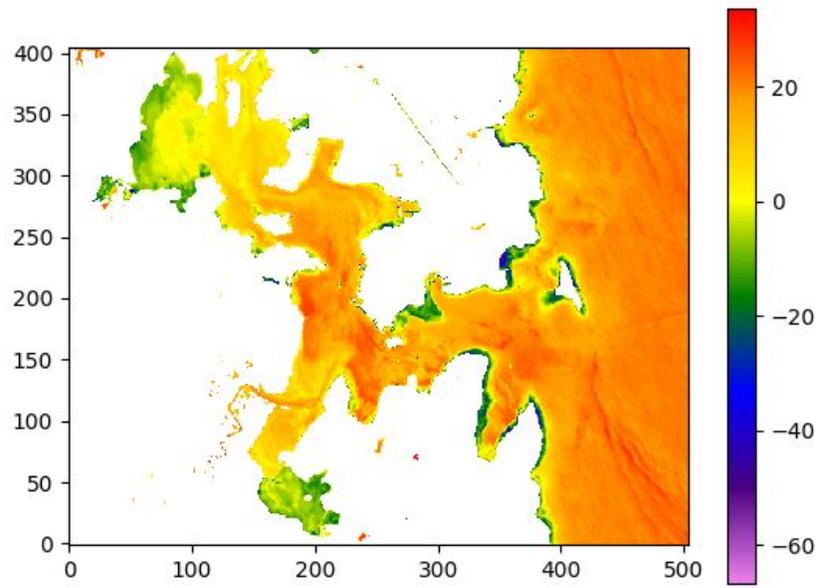
Select the points file(.csv file)



Suggestions for better results at depth processing:

1. Try taking a small area having similar physical properties and similar bottom type. This will ensure radiance values decrease linearly with depth. In case you have a large image, try picking ground truth values from a small area in the image where physical properties will be similar. The output image might not be accurate outside that area but within that area you will get accurate values.
2. Make sure that the georeferenced depth map is not covering a larger area than the satellite image. Even if it is, make sure the ground truth values selected don't lie outside the satellite image area as the final output will be the same as the input satellite image with different pixel values (according to depth). Use the information in the logfile to convert pixel values to depth as the values are scaled.
3. The colour image does not have accurate values. It is just for visualization and to clearly mark the differences. The actual usable file which can be used in softwares like QGIS is the grayscale image.

SAMPLE OUTPUT



Colour image

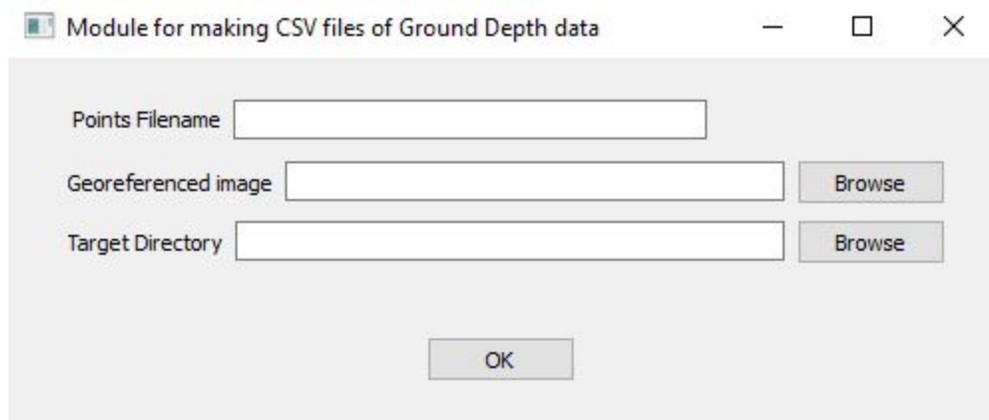


Grayscale image

PROCEDURE FOR POINTS FILE

1. Open the folder Executable for program to create CSV file. Then open the folder exe.win-amd64-2.7. Open the executable file Bathymetry_tool.exe.
2. A window will open asking for 3 inputs. The first is the georeferenced map of depth. The second and third are target folder and file name for output .csv file.
3. Clicking on OK will display the map. You will have to select the points as explained under depth processing procedure. The output .csv file can be used as input for depth processing in the other executable file.

NOTE: This is an accessory file for actual depth processing.



Module for making CSV files of Ground Depth data

Points Filename

Georeferenced image

Target Directory

PROCEDURE - FOR SOURCE CODE USERS & CONTRIBUTORS

- 1) Install Python ver \geq 2.7.12.
- 2) Install libraries as mentioned at the top of this file.
- 3) The functioning of the source code when run in Command Prompt is same as the executable except that the errors(if any) will appear in the Prompt instead of a Message box.
- 4) We think the source code is sufficiently commented to understand the processes and be able to make any changes you may so desire.

Contacts

If you run into any trouble, feel free to contact the following:

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