VRIJE
UNIVERSITEIT
BRUSSEL

ENVIRONMENTAL PROGRAMMING

ASSIGNMENT 10

Environmental analysis using Remote Sensing data

TA: AXEL DEIJNS
PROF. DR. IR. ELGA SALVADORE

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1. INTRODUCTION

Remote sensing products can be valuable data products when analysing regional or local landscape trends. Multispectral satellites such as Sentinel-2 capture light from different wavelengths (red, green, blue, infrared etc.) and store these in maps (called bands) for every separate wavelength. One .tif file can contain multiple bands. These bands are essentially pictures with for every pixel an emittance value for designated wavelength. In this exercise we want to understand the regional vegetation patterns and relate them to land cover. For each Multispectral satellite image, we can calculate the amount of vegetation (from so-called vegetation indices) using the different bands. For example, a commonly used vegetation index is the Normalized Difference Vegetation Index (eq.1), which calculates the normalized difference of the near infrared band (NIR) and the red band (R).

$$NDVI = \frac{NIR - R}{NIR + R}$$

Vegetation emits significantly more near infrared light versus red light compared to bare soil. Meaning that NDVI is high for vegetation and low for bare soil. Additionally there is a vegetation index named Soil Adjusted Vegetation Index (SAVI) which is calculated from equation 2

$$SAVI = \frac{NIR - R}{NIR + R + 0.5} \times 1.5$$

Below are the satellite images of the locations for this exercise.

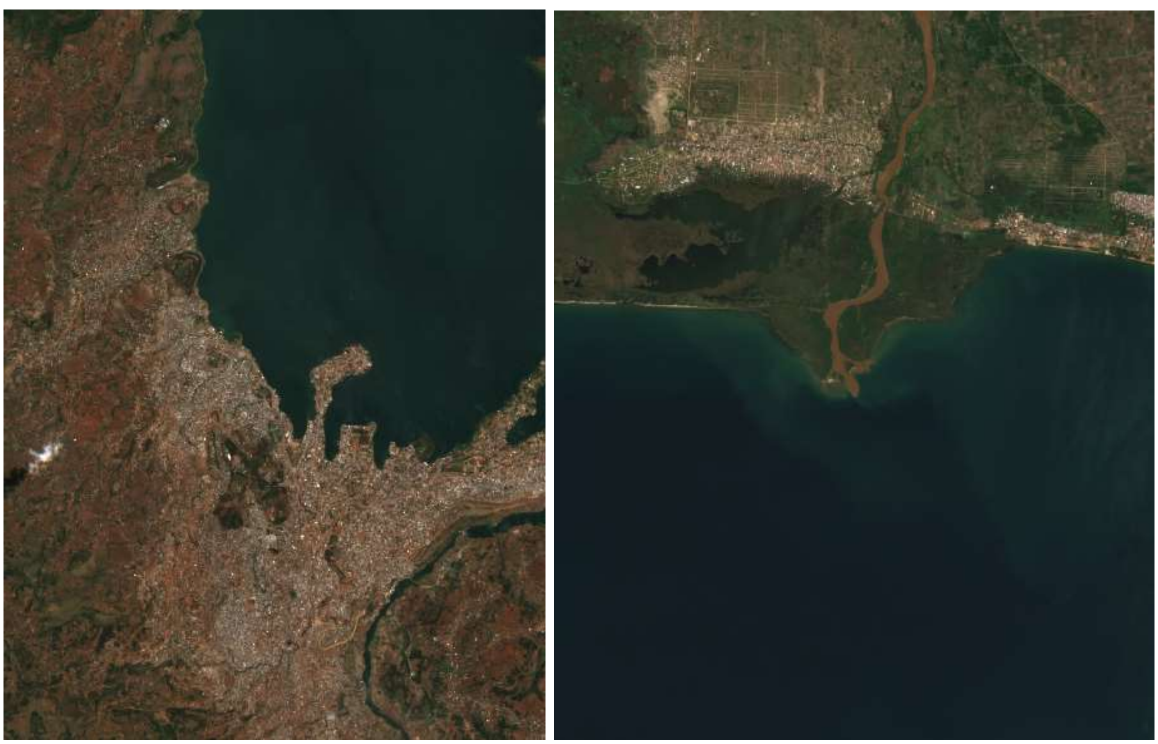

Figure 1: Sentinel-2 imagery of (a) Bukavu, Democratic Republic of the Congo and (b) the outflow of the Rusizi river into Lake Tangyanika, Burundi.

2. ASSIGNMENT

2.1. Dataset

In the directory "DATA" you can find the following data:

- "Land_Cover_images": A folder containing two land cover images (.tif files) for two locations (35MQS and 35MPT) derived from optical imagery in separate locations. The resolution of each pixel is 10 by 10 meter
- "Optical_images": A folder containing a time series of images for each location (35MQS and 35MPT). The date is given in the filename. The resolution of each pixel is 10 by 10 meter. Each image contains 2 bands:
  - Band 1: RED
  - Band 2: Near Infrared (NIR)

The GIS_functions.py provides multiple functions that can be used to read and create .tif files. Using it is highly recommended.

2.2. Tasks

1. Open the two land cover maps and visualize them. Export the figures in JPEG with 600dpi.
2. Calculate the area of each land cover (km2 and %) for each land cover map and store all the results in one multi-index pandas dataframe (index= location, land cover type). (Note, the land cover and optical images are of equal size and resolution)
3. Create one pie chart of the land cover area for each location. Export the figures in JPEG with 600dpi
4. Create a function that reads an image and calculates NDVI and create a function that reads an image and calculates SAVI
5. Create an NDVI and SAVI map per optical image and export them as tiff files.
6. Create an average NDVI and average SAVI map from all the images within the time series.
7. Calculate the average NDVI and SAVI for each land cover type for each of the two land cover maps. Add all the values as new columns in the multi-index table (made in Exercise 2)
8. Export the multi-index table as csv and xlsx

Optional?

9. Create a multi-index dataframe containing NDVI and SAVI time series (a value for each date) for each land cover and each location
10. Create 2 figures. For each location, the average values of NDVI and SAVI over time

2.3. Optional Task

Develop a simple graphical user interface (GUI) to interactively execute your code.
Tip: You are free to use any open access Python package and free to design and create the layout of the interface. I suggest you to try Tkinter (https://wiki.python.org/moin/TkInter) but this is just a suggestion, many other options are available.
Internet is an incredible source of information (docs, videos, tutorials…).
Just to list some websites and youtube videos…
https://www.youtube.com/watch?v=eJRLftYo9A0&list=PLQVvvaa0QuDclKx-QpC9wntnURXVJqLyk&index=8 http://sebsauvage.net/python/gui/
https://www.tutorialspoint.com/python/python_gui_programming.htm
https://docs.python.org/3/library/tkinter.html

http://www.tkdocs.com/tutorial/index.html

2.4. Libraries

Numpy, gdal, geopandas, matplotlib, …

3. SUBMISSION AND REPORT

Develop a software that solves the steps described in the previous section and submit this together with a short report describing your software (objective, software structure), user manual like (or you can present your code with a Jupyter Notebook) a week before the exam date. In the report also include a table that presents the different components of the software and names of the developers (who did what).

3.1. Do you need clarification on the assignment?

Please contact Axel Deijns and Elga Salvadore through the dedicated CANVAS forum. In the discussion forum you are able to post questions, share your code and request an appointment for an online session.

3.2. How is the assignment evaluated?

EVALUATION MATRIX Assignment	Point
1) Does your software perform the required tasks providing the correct result(s)?	10 points
2) Is your code readable?	± 1 point
3) Are the name of the variables\functions\modules meaningful?	± 1 point
4) Are the data types appropriate for values the hold?	± 0.5 point
5) Are there too many code repetitions?	± 0.5 point
6) Does your code have a coherent structure?	± 0.5 point
7) Is the report clear, to the point and complete?	± 1 point
8) Is your code easy to use?	± 1 point
9) Is there a good balance of comments and code in the scripts?	± 0.5 point
10) Code reuse: are existing codes used appropriately?	± 1 point
11) Code reuse: Did you forget to properly citing the source of codes you are reusing?	- 2 point
12) How flexible is your code? For example, if I use a different data set with a different file name, would it still be working?	± 1 point
13) How easy would be for the next user to adapt/modify your code?	± 1 point
14) Is there any documentation? Installation steps (if additional libraries are used), flow chart	± 0.5 point
15) Did you develop a GUI for your code?	Up to 2 points