GeoInfo (MIE_2.02)
Final Assignment SS 2020

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Read this document carefully as it contains the guidelines for your report!

MOTIVATION

Germany suffered from a **severe drought in 2018**. According to the German Drought Monitor [1] operated by the "Helmholtz-Centre for Environmental Research" (UFZ) the soil moisture in the upmost 180 cm of soil has still not recovered. Particularly in Eastern Germany as well as Bavaria the drought index yet reveals exceptional droughts until today.

Your task is to analyse the drought in 2018 in comparison to the years 2016 and 2017 utilising different data sources and tools. The underlying **hypotheses**[2] are:

1. The drought affects vegetation and the Normalized Difference Vegetation Index (NDVI) shows the effects on vegetation.
2. The drought is related to the cumulative precipitation CP (i.e. the precipitation sum) over the last year. There is a correlation between CP and NDVI.
3. The drought is related to the average temperature AT over the last year. There is a correlation between AT and NDVI as well as AT and CP.

ORGANISATION

Groups

You can work in groups with 1 to 3 (max) students. Form groups in Moodle if not having done so yet.

Due Date

The results of the given practical task shall be comprised of a scientific report. You have to submit the assignment via Moodle latest by the **16th of August 2020 at 23:59 CET** (Central European Time Zone, German local time).

Files to Upload

Each group has to upload **one single archive** (such as zip, 7z or any other common archive format) to the relevant upload area in the Moodle course. Any other file format but the common archive extensions will be rejected by Moodle! **Name the archive after your group name**, e.g. groupX.zip. Have a look at Moodle upload area early. Only one group member has to upload the group archive. The archive has to contain:

1. Scientific project report as **PDF**(!),
2. any **Python code** used to download, convert, aggregate or otherwise process data.

Do not include large data files! Do not include any QGIS project requiring large data. Other files can be added optionally.

[1] https://www.ufz.de/index.php?en=37937

[2] Hypotheses (pl., hypothesis sg.) are assumptions which seem to make sense at a first glance. We do not know whether the assumption is substantial or not. Your investigation is meant to verify or falsify the hypotheses.

TASKS

Overview

Investigate whether there is a correlation between calculated spectral indices, temperature, and precipitation **of specific areas in the region of Neunburg vorm Wald**. Your research aims to contribute to a better understanding of the effects (if any) of these climatological observations in the vegetation indices derived from satellite imagery during the summer periods between 2016 and 2018. You are given a research question: Is the NDVI correlated with temperature and/or precipitation? **Additional research questions or hypotheses by you are welcome!**

The tasks will be performed using the tools learned during your Geoinformatics course to retrieve, manipulate and display the data needed for this investigation. You will use Python to download and pre-process temperature and precipitation data from German Weather Service (DWD). Additionally, you will acquire the required datasets for your research, such as multispectral imagery, from reliable sources. Finally, you will use QGIS to load, process, and produce the results needed for your analysis.

The determination of NDVI is restricted to certain predefined regions of interests (ROIs) given as a polygon vector layer. **Each student working group will work on its own subset of ROIs**. Each student group (group 1 to N) is assigned a particular subset of ROIs to, i.e. a predefined set of polygons in the Neunburg vorm Wald area. The assignment between group ID and ROI polygon IDs is provided through a file the GitLab repository.

1. Clone or pull the GitLab repository of the course.

Clone or pull the Geoinformatics GitLab repository:
https://gitlab.spectors.eu/rolf/MIE_2.02_GeoInfo_WS2019.
The folder `gi0000_Final_Assignment` contains additional information and data for the task.

2. Identify the regions of interest assigned to your group.

As stated before you have to analyse the NDVI only for a subset of all regions of interest (ROI). The folder `./data/original/regions_of_interest/` provides a shapefile with all numbered ROIs as well as the file `ROI_assignment.csv` containing the list of selected polygon numbers for each student working group.

Open the shapefile with all predefined ROIs in QGIS.

Select only the polygons assigned to your team. Use the above mentioned CSV file with the polygon IDs for your group. Generate a new layer containing only the features that your group has to use.

Get a general overview about your ROI subset. Describe the land use.

3. Download Sentinel-2 multispectral imagery.

You have to analyse the NDVI in the summer periods (May-June) of each year between 2016 and 2018 in the region of Neunburg vorm Wald. Put emphasis on your subset of ROIs. The areas (polygons) of concern may encompass more than one NDVI pixel. Think about how to deal with it.

Consider the processing requirements of your data for the kind of analysis that you want to perform. If you need to further process level 1C granules from Sentinel-2 you can use the *Sen2Cor* tool.

In order to save time we identified six appropriate sensing dates with low cloud coverage: (a) 2016-05-09, (b) 2016-07-08, (c) 2017-05-17, (d) 2017-07-06, (e) 2018-05-22, (f) 2018-07-01.
Select **at least three appropriate satellite scenes** you want to analyse from the list **to cover all three years** 2016, 2017, and 2018. Download and store them in an appropriate folder.

4. Download and process climate data.

In order to analyse the relationship (if any) between NDVI, precipitation, and temperature for the selected dates you have to retrieve appropriate data from the German Weather Service DWD.

Starting from the Python code we developed in class and provided in the GitLab repository modify the code in order to retrieve temperature and precipitation measurements that correspond to the sensing dates of your satellite imagery. Which climate stations would you use? Justify.

Consider to aggregate the measurements for a **one-year-period before and up to the sensing dates**. Use daily time series to **derive average temperature and cumulative precipitation**. Annual data would not work directly, because they are covering a period from January 1st to December 31st whereas the sensing dates of your images are sometime between May and June of each year. Therefore, you have to aggregate the annual data yourself from daily measurements. Hourly measurements would result in a large amount of data to be processed without providing additional information after aggregation.

Notice that the amount of stations where temperature data is available is different from the number of stations where precipitation data is available. Makes sure that you download both separately (do not rely only on the total precipitation offered by the temperature stations).

You may want to shape your data in such a way that it is readable in QGIS. Thus, you can make better comparisons with your NDVI layers or other spectral indices.

The climate stations are not exactly at the regions of interest. What do you do? Do you select a particular station or interpolate climate data spatially? Justify your approach. How strong are the differences? There are at least two interpolation tools that you can use in QGIS.

5. Download soil moisture index data for Germany.

You should use the soil moisture index data provided by UFZ Drought Monitor / Helmholtz Centre for Environmental Research. We already pre-processed and transform this dataset for you from Netcdf format to Geotiff, so you should not have problems opening it in QGIS. The dataset comprehends soil moisture index values for the uppermost 25cm and 180cm of soil for the time period Jan 2016 until December 2018.

Identify the resolution of the datasets, how should you represent the soil moisture? You should reference your datasets in the report.

6. Analyse the data and compare.

After this preparation you can perform the core analysis with respect to the hypotheses / research questions. Write an appropriate report according to the guidelines of scientific writing. Always think about the intention of your investigation and the reader! The text has to be well structured and formulated.

But be aware: **Content and quality matter but neither quantity nor fancy style!**

Add maps, graphs and tables, **whenever appropriate.** Do not try to fill pages with rubbish. Keep it clean. Avoid useless, boring or trivial information. Use references whenever needed. Concentrate and focus fully on the scientific investigation! Do not write a how-to or a software manual!

Write the report for educated laypersons interested in climate change.

HELPFUL LINKS

This section contains some links that might be helpful for your investigation. You can assess them yourself and decide whether to use them.

CORINE Land Cover: It is a European project which provides land cover and land use information of different countries (between 28 and 39). They distinguish more than 40 classes (European Environment Agency, 2018):

https://land.copernicus.eu/pan-european/corine-land-cover.

German Weather Service (DWD): Link to the http and ftp servers of the German Weather Service. You will find the data under /observations_germany/climate/. (DWD Climate Data Centre, 2018)

https://opendata.dwd.de/climate_environment/CDC/
ftp://opendata.dwd.de/climate_environment/CDC/

Germany Administrative Areas 1:250000 (Verwaltungsgebiete 1:250000 Ebenen): Data repository of Administrative Areas in Germany. It contains the boundaries of all administrative units according to their hierarchy. (GeoBasis-DE, BKG Federal Agency for Cartography and Geodesy, 2019) You might be interested in getting the administrative boundaries of Neunburg vorm Wald:

https://gdz.bkg.bund.de/index.php/default/digitale-geodaten/verwaltungsgebiete.html?___store=default

Sentinel Imagery: This directs you to the Copernicus open access hub. You can retrieve Sentinel-2 data from here:

https://scihub.copernicus.eu/

Sen2Cor: The European Space Agency develops different toolboxes to enhance the scientific potential of its satellite data. Sen2Cor is a third-party standalone software that performs atmospheric correction on Sentinel-2 level 1-C data. (Sen2Cor)

https://step.esa.int/main/third-party-plugins-2/sen2cor/

Manual Atmospheric Correction: There are different algorithms and approaches to perform atmospheric correction. If you want to learn some known simple methods, you can refer to this website. However, I recommend reading the original papers to avoid interpretation mistakes. (GIS Ag Maps, 2011a) (GIS Ag Maps, 2011b)

http://www.gisagmaps.com/s2-atmospheric-correction

Moodle course: Link to the Geoinformatics course MIE_2.02. You will need the skills learned during the course to develop your report. Please refer to this if need to refresh your knowledge.

https://moodle.hochschule-rhein-waal.de/course/view.php?id=10688#section-2

Geoinformatics GitLab repository:

https://gitlab.spectors.eu/rolf/MIE_2.02_GeoInfo_WS2019.

Scientific writing:
This link contains the official scientific writing manual of our faculty. You need to log in to Moodle in order to access it:

https://moodle.hochschule-rhein waal.de/pluginfile.php/183209/mod_resource/content/1/Academic%20Writing%20Manual.pdf

Link to Prof. Rolf Becker's notes on scientific writing:

https://www.teawiki.net/teaching/doku.php?id=supp:scientific_writing:start

Another inspiration: Link to a presentation on scientific term paper requirements by Prof. Franca Ruhwedel (for Business and Psychology program):

https://www.hochschule-rhein-waal.de/sites/default/files/documents/2015/03/13/formal_requirements_for_thesis_and_term_paper_0.pdf

BRIEF GUIDELINES ON REPORT

You have to add a description who in the group is responsible for which section! Grading will be individual.

Your investigation is meant to verify or falsify the hypotheses if possible. It is mandatory to follow best practice of structured scientific writing! Structure the text logically. Justify and explain each step. Discuss the findings critically, e.g. are data and methods sufficient to give evidence? Do not write in a 'how-to-style'! Design the text such that the reader can fluently follow your story without being interrupted with unnecessary or locally inappropriate information, e.g. larger code segments can be listed in the appendix if necessary.

Your report should contain the following elements:

- **Title Page:** It has contain the following: Meaningful title (and subtitle if applicable) of the project, name and faculty of the university, study program and course name, name (and title if applicable) of the supervisor(s), working group name, authors' complete names and matriculation numbers and date of submission.
- **Introduction:** This section provides motivation and context: Why are you performing this investigation? Why is it important? What is its context, i.e. how is it embedded in the scientific domain and how does it compare to others' work? Use citations to show the interrelation. Formulate a research question or hypothesis you want to investigate and describe your approach in brief. Describe shortly how the paper is structured.
- **Material and Methods:** This section is used to explain the approach in detail: How are you performing the investigation? Where is your data coming from? Which tools and methods are you using? How are you doing the aggregations? Explain your assumptions and decisions. Explain what you are doing with your data.[3]

[3] Consider which level of information is appropriate in the section ‚Methods and Materials'. Example: Describing exhaustively what a GIS is would not be acceptable. This is common sense and does not support the reader in understanding your message. You can give a short explanation in the text and a substantial reference to further information.

- **Results:** Limit yourself to describe your results. What are you observing? Do not add any aspect which is not resulting from your very own investigation. Remember that tables and figures must be correctly labelled. If you are using maps (and you probably should) take care of the captions, labels and scale. Drive the reader's attention to the specific features you are representing with your results.

- **Discussion:** Interpret your results. Refer to the research question or hypotheses. Are your results appropriate to verify or falsify the hypotheses? Give a clear answer to your hypotheses (If you can't then explain why). Be critical. What are the limitations of your approach? Is it scalable? Compare your results with other investigations (other groups). Are they in accordance? You must not be biased with an 'intended outcome'. Limit yourself to discuss your results objectively and scientifically.

- **Conclusions and Outlook:** Summarize what you did and your findings. What are the lessons learned? If you conducted the research again, what would you do differently? What should be done by you or others in future to continue this investigation? Which are the open questions?

  Do not add any new aspects in this section. The conclusions are about what you investigated in your work and nothing else!

- **List of references:** Only use sources that you are referring to in your text. Use primary literature. You are writing a scientific report, so use a professional citation style.

- **Annex:** You should have at least an annex with your python notebook which should be commented.

- **Statement of authorship:** Each group member should add a signed statement of authorship to the final report. You can use something like this:

  "I, <name>, hereby declare that my contribution to the work presented herein is my own work completed without the use of any aids other than those listed. Any material from other sources or works done by others has been given due acknowledgment and listed in the reference section. Sentences or parts of sentences quoted literally are marked as quotations; identification of other references regarding the statement and scope of the work is quoted. The work presented herein has not been published or submitted elsewhere for assessment in the same or a similar form. I will retain a copy of this assignment until after the Board of Examiners has published the results, which I will make available on request."

  Notice that you will have to clearly state which parts belong to your contribution.

Even if your report does not need to specifically divide the text into the above elements, the elements shall be easy to distinguish while reading the document. Your report will be graded according to the criteria mentioned in the following section.

RULES AND REGULATIONS

- As discussed during the lectures, good grammar, spelling and technical writing are expected for this report. Reports showing very poor language skills or largely incomprehensible text passages will fail immediately. The supervisors are not willing waste time with bad text.
- Severe deficits in fundamental requirements such as incomplete title page, missing figure captions, unbearable maps, or inacceptable citation style will lead to fail. The supervisors are not willing waste time with bad structure.
- You will fail if plagiarism is found for the first time (see next section). Further actions will be taken if the behavior is recurrent.
- Late submissions are NOT possible.

SUSPECTED CHEATING AND PLAGIARISM

You will be marked with 0 points in the module if cheating or plagiarism is found out. This will be assessed according to the faculty´s Academic Writing Manual section 1.5 Scientific Misconduct on which plagiarism, fabrication, and falsification are stated as misconduct and will be considered cheating. (HSRW Faculty of Communication and Environment, 2013)

When a student presents the work of someone else as their work is considered plagiarism and this can be intentional or accidental. Plagiarism includes:

- Paraphrasing ideas or work of other authors and presenting them as your own. In other words, you are not referencing the author(s).
- Presenting work that has been purchased from any source as if it was yours.
- Copying and pasting material from the internet and presenting it as own work.

REFERENCES

DWD Climate Data Centre. (2018). Historical daily station observations (temperature, pressure, precipitation, sunshine duration, etc.) for Germany, version v006, 2018.

ESA European Space Agency. (2000-2019). Copernicus Sentinel Data. Available online at https://scihub.copernicus.eu/dhus/#/home (Accessed Dec20, 2019).

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Sen2Cor. (n.d.). Courtesy of the European Space Agency. Available online at http://step.esa.int/main/third-party-plugins-2/sen2cor/ (Accessed Dec20, 2019).

U.S. Geological Survey. (2000). Earth Explorer: U.S. Geological Survey database available online at https://earthexplorer.usgs.gov/. (Accessed Dec 20, 2019).