

Project 1: Weathering and sustainable forestry

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Background

A forest company with large forest areas in the county of Västra Götaland is interested in the sustainability of the forestry in the county, and if branches and tops can be harvested to replace fossil fuels, without significantly negative effects on acidification. As a first step, they want a pilot study on one site, to determine the methodology. The catchment F1 at Gårdsjön is chosen. The catchment has been used for environmental monitoring for many years, thus there are a lot of data from the catchment, which makes it suitable for a pilot study.

Task

The forest company would like to get a report including:

1. A physical geographical description of the F1 catchment, including the following: topography, land forms, geological history, bedrock, soil properties and land use.
2. A calculation showing if the weathering in Gårdsjön is high enough for (a) stems and (b) stems, branches and tops, without exceeding the “critical base cation harvesting”.
3. A calculation showing how increased temperatures, according to an existing climate scenario, would affect weathering rates and exceedance of critical base cation harvesting.
4. An investigation about which minerals that contributes the most to the weathering rates.
5. An investigation about how the grain size distribution affects weathering rates.
6. A discussion where the results from the modelling are connected to the physical geographical conditions in the region, and concluding remarks.

Tools

The geochemical soil model PROFILE is used for weathering modelling.

Methodology

1. For the physical geographical description, literature (e.g. according to suggestions in the literature list) and maps (e.g. relevant maps from GET, and a soil map in GIS format) should be used.
2. Weathering should be calculated with the PROFILE model (Appendix 1). Download projekt1_2017.zip. There you will find PROFILE and all data required. Data on soil properties, forest properties, atmospheric deposition and climate can be found in the file data_projekt1_2017.xlsx. Grain sizes from clay to gravel are given as input to PROFILE, which means that the modelled weathering applies to those fractions. In field there are also stones and boulders, which means a reduction of the calculated weathering rates, since it reduces the weatherable volume. That should be accounted for in the PROFILE calculations. Data on fractions of stones and boulders can be found in data_projekt1_2017.xlsx. Think about the units!! Equivalent (also called molar charges) have to be used! Note that some data are given in mEq per m² and year, whereas others are given in kEq per hectare and year.

Critical biomass harvesting and exceedance can be calculated according to Equation 1 and 2. Deposition of sulphur, chloride and base cations (calcium, magnesium, potassium and sodium) can be found in data_projekt1_2017.xlsx, as well as leaching of NH₄-N and NO₃-N.

Equation 1. Critical BC harvesting = $BC_{\text{weath}} + BC_{\text{dep}} + NH_4\text{-N}_{\text{leach}} - S_{\text{dep}} - Cl_{\text{dep}} - NO_3\text{-N}_{\text{leach}}$

Equation 2. Exceedance = BC harvesting – Critical BC harvesting

3. Find a climate projection that shows how the temperature will change in the Gårdsjön region. There are many different projections, describe which one you use. Hint: Look at the SMHI homepage.
4. There is an output sheet where weathering per mineral is given. You can test the effect of changing the content of different minerals, one at a time. Quartz is not included in the input data sheet, but it is always “the rest”, so that the sum of the minerals become 100%.
5. Test the grain size distribution systematically. Make sure that it always sums up to 100%.
6. In the discussion and conclusions the physical geographical description should be connected with the results. The tests about how different minerals and grain size distributions affect weathering rates can be helpful here. Also include a discussion about potential effects of climate change. The conclusions should be short, maximum 1/3 page.

Report and presentation

The report should include:

- Background (corresponding to point 1)
- Short description of methodology
- Results
- Discussion (focusing on the connection between the results and the physical geographical conditions)
- Conclusions
- References

The report should be maximum 15 pages long, including everything (e.g. figures and references). The text should be built up logically, and the different parts should be connected. For example, how are the soil properties connected to the geological history, and how does that affect the weathering rates and the conditions for forestry?

You will present the results orally on Tuesday the 6th of March between 9:15 and 12. Each group will be given a specific question to present (maximum 10 minutes), as an introduction for a discussion where different results and methodologies among the groups are compared and discussed.

Appendix 1. The PROFILE model – to get started

-Start the program safeui.exe

-Open the file “testforest.txt” in the data folder with the button “Open data” in the main sheet.

-Use the button “Read mineraldata” in the main sheet to open the file “mineraldata.txt”. This file contains information about the minerals on the site. Select all minerals.

-Look at the different sheets. You will only do changes in the PROFILE sheet and the four layers. Find the places where you can change e.g. temperature, soil water content, minerals and surface area.

-Before you run the model, save the data with the save data button in the main sheet. This is important to do before all runs, in order for the data to update correctly. The first time you run you can overwrite the original file, but later, when you have done changes, you should use other names, preferably indicating the changes you have done.

-Run the model from the main sheet. Save with the same name. After running a new window will become active. Close that (choose not to save changes in input/output). Change to the original PROFILE window (e.g. using the bar in the bottom of the screen). Answer “yes” on the question “Calculation ready?”

-You will now see an output window. Click “show results”. Note that date and time for the run is given in the upper right corner. It can be good to check, to see that you actually look at the right results. You can change output sheets with the arrows. Output sheet 4 is the one with weathering results.

-Look at the weathering rates for Ca, Mg and K (totals) and save data in the main sheet (same name).

-When you make changes to test things, save a new file for each change. It is a bit messy to save output files. The best way is to save the input files with logical names, and rerun whenever you want to get the outputs again.

-Now it is time to set up the Gårdsjö site! Open “spruceforest.txt” and make changes in the PROFILE sheet and the four layers, according to data_projekt1.xlsx.