Project 2: Phosphorous leaching in the Rönne å catchment

NGEA09; 17-29/1, 2017; Teacher: Cecilia Akselsson

Background

An officer at the county board in Skåne has seen a project report from the Department of Physical Geography and Ecosystem Science in Lund, where students on one of the GIS courses have calculated P leaching from different types of land use in the Rönne å catchment. They would like to have a more detailed mapping, and they have therefore hired you to map risk areas, to quantify phosphorous leaching with also slope and soil properties taken into account, and to give suggestions of a suitable location for a sedimentation dam.

Task

The county board wants a report where the following sections are included:

1. A physical geographical description of the Rönne å catchment, including the following: topography, land forms, geological history, bedrock, soil properties and land use.
2. A risk mapping for phosphorous leaching according the the Ekologigruppen methodology (i.e. identification of the 5% of the area that has the highest flow accumulation.
3. Quantification of phosphorous leaching from land use in the Rönne å catchment, based on leaching coefficients for different land use types.
4. Quantification of phosphorous leaching where the higher erosion in steeper slopes is taken into account.
5. Quantification of phosphorous leaching where both slopes and the effect of grain size distribution on erosion is taken into account.
6. Suggestion of a location of sedimentation dam, based e.g. on the mappings above. Quantification of phosphorous leaching after this measure.

Tools

- Matlab routine for calculation of flow accumulation (required for point 2 above) and for identification of the area that drains to a chosen point (required for point 2 and 6). The Matlab routine is more advanced than corresponding routines in ArcGIS, since the flow from a grid cell can go to more than one grid cell.
- ArcGIS for the other GIS operations.

Methods

1. Use litterature (e.g. from the litterature list) and maps (e.g. soil maps in GIS format and relevant maps from GET) for the physical geographical description.
2. Follow the methodology of Ekologgruppen (Alström and Wedding, 2013), with height data (50*50 m) as input. However, choose to fill sinks, in contrast to the Ekologgruppen methodology. Think about what the effect of that will be. Flow accumulation should be calculated using a Matlab routine (Appendix 1). With this routine you will also identify the Rönne å catchment, and you should use the resulting map as a basis for further work. The result should look very similar to the catchment layer you used in the hydrology exercise. Try to identify the 5% with the highest flow accumulation in ArcGIS, or other software if required
3. Use leaching coefficients from Appendix 2, in combination with the areas for the different land use classes, to estimate total phosphorous leaching.
4. Give coefficients to different slopes. Give the average slope the coefficient 1, and give higher coefficients at higher slopes and lower coefficients at lower slopes. You can use the coefficients in the Table in Appendix 2 for scaling, or try to find another way of scaling in the litterature.

5. Give different coefficients to different soils (jordarter). Two factors are important here. At higher grain sizes than 0.06 mm the erodibility increases with reduced grain size. At lower grain sizes than 0.06 mm there are cohesion forces that act in the opposite direction. In appendix 2 this is illustrated in a schematic figure. Use this figure, or other information that you find in litterature, together with the soil map, to weigh the effect of soil properties into the estimation of phosphorous leaching. Let the "average grain size" get the coefficient 1.
6. Choose an appropriate location for a sedimentation dam. Motivate your choice. Use the results from above, the report Jordbruksverket (2010), other litterature and information you find on Intenet, to make the choice. You can also test different alternatives. Use the Matlab routine (Appendix 1) to identify the area that drains to the location that you have chosen, and make a new calculation of the total phosphorous leaching in the Rönne å catchment, where the leaching from the area draining to the dam is subtracted (in ArcGIS), with the assumption that the dam takes up all phosphorous.

Geographical data that you will get at project start

- A digital elevation model (DEM), 50*50 m, covering the area, in ascii format (the required format for the Matlab routine).
- Columns.asc and Rows.asc – ascii-files that can be used to identify row and column numbers in the DEM (required in the Matlab routine).
- Land use map (the same as in the hydrology exercise)
- Soil maps

Written report and oral presentation
The report should include:

-Background (corresponding to point 1)
-Short methodology description
-Results
-Discussion (focusing on how land use, topography and soil texture affect the results, uncertainties in the methodology and possible ways to improve the mapping)
-Conclusions
-References

The report should be maximum 15 pages long, including everything (e.g. figures and references). Pretend that it is a report to the county board (i.e write in a way that makes it easy to see the results and understand what has been

You will present the results orally on Monday the 29th of February, between 9:15 and 12. Each group will have a presentation of 10-15 minutes. All groups don´t have to go through all questions. Choose some aspects that you want to focus on, and that you would like the rest of the group to discuss.

References
Alström, T. and Wedding, B., 2013. Enkelt verktyg för riskkartering av fosforförluster via ytavrinning. Test inom Edenbergaåns avrinningsområde i södra Halland. Ekologgruppen..

Jordbruksverket, 2010. Dammar som samlar fosfor. Jordbruksinformation 11-2010.

Bilaga 1 – Matlab routine for ”flow accumulation” and identification of catchments

The matlab routine is used to calculate “flow accumulation” (DA) and drainage area (trackup) to a specific point.

1. Unzip TFM2014.zip and put the files in the folder that you will use for the Matlab runs.
2. Put the file dem_ronne.asc in the same folder. This is the DEM for the area in ascii-format. Also put columns.asc and rows.asc in the same folder.
3. Open Matlab, and open the file Main_TFM_AH.m from Matlab.
4. “Run” (green arrow).
5. Enter the name of the DEM (dem_ronne.asc)
6. The routine starts. Choose not to ”connect the flow in culverts”, but to fill (remove) sinks. Then follow the instructions.
7. When you are asked to enter row- and column number for the point for which you want to calculate the drainage area: enter row 291 and column 64 the first time, when you want to derive the whole Rönne å cathcment. This point corresponds to the outlet of the Rönne å catchment (you can see that if you look at columns.asc and rows.asc in ArcGIS, together with the DEM). *If the questions about row and column come up on the same row, it is due to a problem in the Matlab version. Then press enter until you get out of the program. Mark row 180-207 in the code window, right click and choose “Evaluate selection”. If the question about row and column numbers does not come up after that, press enter and it will come up.* To get the drainage area to the location of the dam later on, enter the row and column number for the chosen location instead. Use rows.asc and columns.asc in ArcGIS to find the row and column numbers.
8. Choose to print ”DA”, ”, save with an appropriate name in the folder where you work. DA shows “flow accumulation”.
9. Choose to print also ”trackup”, save with an appropriate name in the folder where you work. Trackup identifies the area that drains to a specific point.
10. Open the result files in ArcGIS.
11. To get the drainage area to another point – fill in row and column numbers for that point. The numbers can be identified in the files columns.asc and rows.asc in ArcGIS.

Appendix 2 – Leaching coefficients and the importance of slope and grain size distribution

Leaching coefficients (from the GIS exercise)

Land use	Kg P per hektar och år
Agriculture	0.4
Forest	0.1
Town/village	0
Wetland	0.1
Lake	0

The S-factor (Slope) in the USLE equation, from an application in Ethiopia (Pilesjö, 1992). A recommendation is to give the average slope in the Rönne å catchment the value 1, and to use this table to put coefficients on areas with higher slope (coefficient>1) and lower slope (coefficient<1).

Slope (%)	5	10	15	20	30	40	50	60
Factor S	0.4	1.0	1.6	2.2	3.0	3.8	4.3	4.8

Schematic picture showing the importance of grain size distribution for the erodability (Pilesjö, 1992).

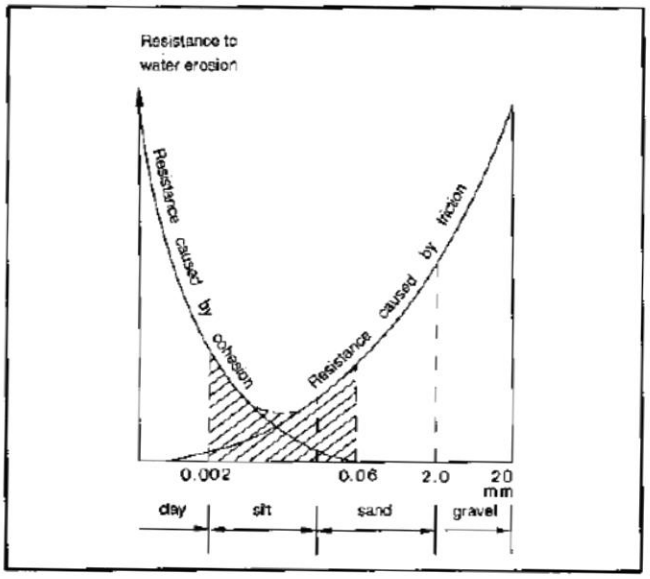

Figure 2.4. A schematic graphic presentation of the relative resistance of different grain sizes to erosion by water. The graph cannot be used for quantitative estimations (from Kihlbom 1970).

References

Pilesjö, P., 1992. GIS and Remote Sensing for Soil Erosion Studies in Semi-arid Environments. Estimation of Soil Erosion Parameters at Different Scales. Meddelanden från Lunds Universitets Geografiska Institutioner, avhandlingar 114.