Land Degradation (GEO3-4304)

First Exam - answers

4 October 2017
09.00 – 12.00 h

Name: :.....

Registration number :.....

Study programme :.....

- Answers should be given in English
- Read all questions first
- Start answering the easier questions first
- Use the empty space between the questions to write down your answer
- Continue with your answer on the back side of the page if necessary
- Formulate your answers briefly and to the point
- Write neatly
- Think twice before you write down your answer (avoid making later corrections)
- Good luck!

Question 1 Mark:
Question 2 Mark:
Question 3 Mark:
Question 4 Mark:
Question 5 Mark:
Question 6 Mark:

Final score:

1a. A field on a hillslope loses annually 35 ton ha^{-1}. What is approximately the average soil depth lost during 10 years? Show your calculation!
1b. What is meant with tolerable soil loss?
1c. Explain the difference between the terms <u>erosivity</u> and <u>erodibility</u>.

1a. (3 pts)
35 ton/ha = 35000/10000 kg/m^2 = 3.5 kg/m^2
Dry bulk density = ~1100 kg/m^3
Annual soil loss = ~3.5/1100 = 3.18 x 10^{-3} m
In ten years: 10 x 3.18 x 10^{-3} m = 0.0318 m

1b. (3 pts)
Tolerable soil loss is a term used in soil conservation efforts, when the annual soil loss is tried to reduce to an presumably acceptable level of soil loss. This acceptable level is the tolerable soil loss and usually in the order of 5 – 10 ton per ha per year.

1c. (4 pts)
Erosivity: the energy of the eroding fluid (wind, raindrops, overland flow).
Erodibility: a measure of resistance of the soil against the erosive forces of wind or water.

2a. What are the two classes of a fluid?
2b. The density of water is for most practical purposes equal to 1000 kg m^{-3}. In reality, the water density varies with temperature. Describe how the density of water varies when the temperature rises from 0^o to 20^o C.
2c. What is indicated by the dynamic or molecular viscosity of a fluid?

2a. (2 pts)
Liquids and gases (or Newtonian and non-Newtonian fluids)

2b (4 pts)
The water density increases from 0 to ~4 ^{o}C to a maximum of and decreases with temperatures exceeding 4 ^{o}C.

2c. (4 pts)
The degree of resistance to deformation of the fluid.

3. Fluid flow can be characterized by the streamline pattern, which indicates the flow direction.
a. The streamline pattern also provides information about flow strength or velocity, why?
b. The energy along a streamline is constant and can be expressed by the Bernouilli equation:

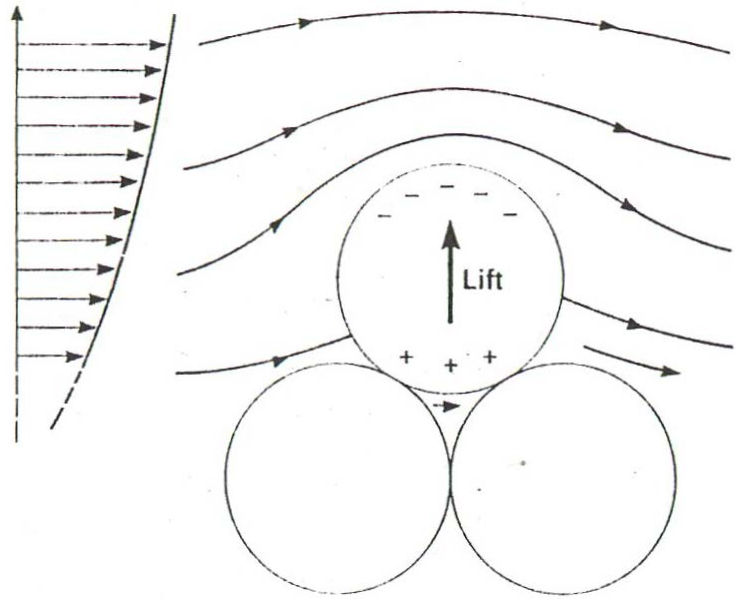
$$\frac{1}{2}\rho u^2 + \rho g y + p + E_{loss} = constant$$

What are the four energy terms on the left hand side, when going from left to right?
c. Show why the Bernouilli equation explains a lift force on a spherical soil particle that lies on top of a bed with similar spherical particles (use a drawing).

3a. (1 pt)
The distance between streamlines gives an indication of the flow velocity: when close to each other the flow speed is relatively high; when the streamlines are further apart, the flow speed is lower.

3b. (4 pts)
1. kinetic energy; 2. Potential energy; 3. Pressure energy; 4. Frictional heath loss

3c. (5 pts)
One streamline goes just over the particle and has a high kinetic energy and a low pressure. The other streamline goes underneath the particle and has a low kinetic energy and a high pressure. The pressure difference creates a lift force.



4a. What is the general mechanism for dust-size particles to be entrained in the air?
4b. How is the dust concentration in a dust storm related to the height above the surface?
4c. What are the two main forces acting on a dust particle that is travelling in the atmosphere?

4a. (4 pts)
Saltation, which breaks down aggregates and the impacting sand grains cause emission of fine, dust-size particles.

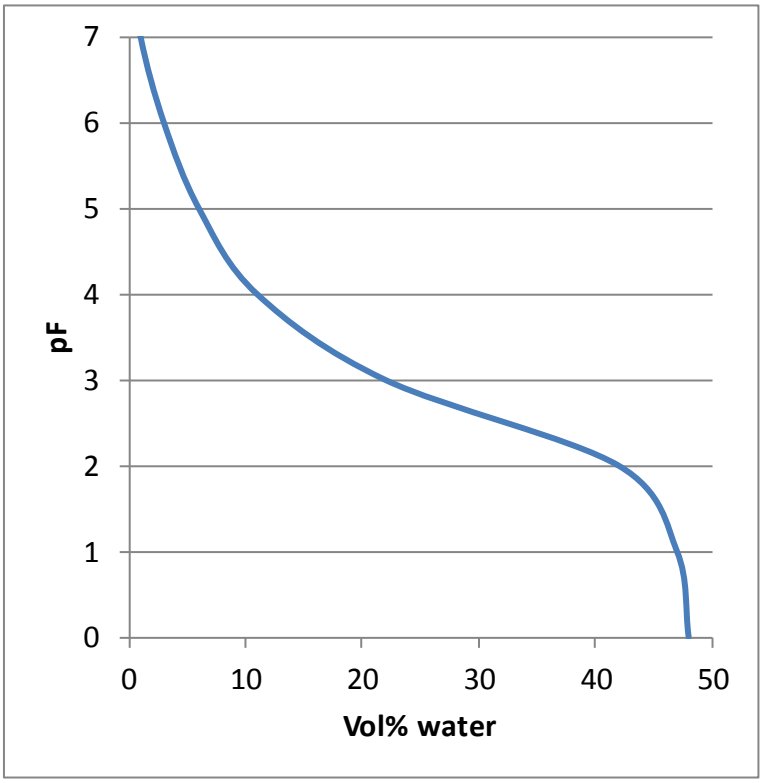
4b. (4 pts)
Exponential decrease of dust concentration with height

4c (2 pts)
Gravity force and turbulent lift force.

5a. Why does non-saturated soil have a negative pressure potential ψ_p ?

5b. At what depth in a soil is the pressure potential equal to zero?

5c. In the figure below the pF curve of a loamy soil is given. Calculate the amount of rainfall (in mm) required to wet a root zone of 0.30 m from permanent wilting point to field capacity.

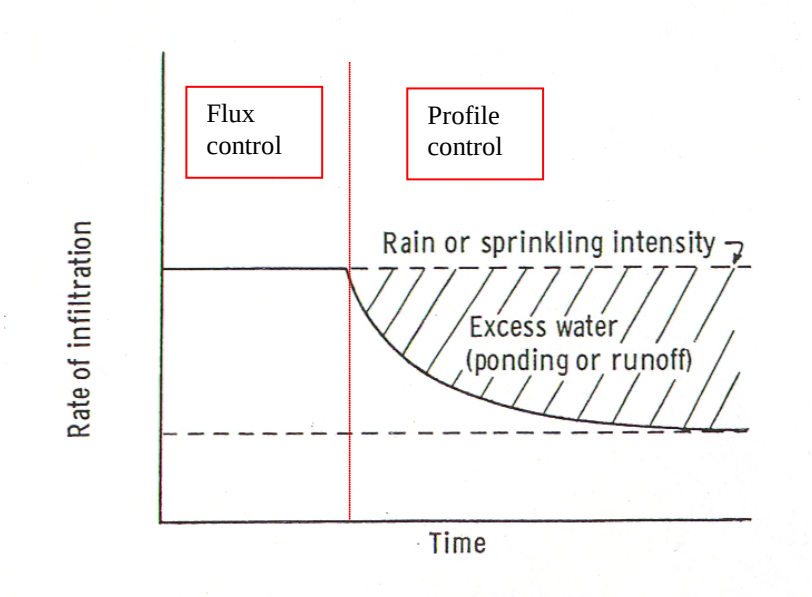


5a. (4 pts)
Due to capillary suction the water is raised into the soil and bound to the soil particles. The pressure potential is zero at the phreatic level and positive below, so the pressure potential of the moisture in the non-saturated soil has to be negative.

5b. (2 pts)
At the phreatic level.

5c. (4 pts)
Moisture content at pF=4.2 (permanent wilting point) = 10%
Moisture content at pF=2.0 (field capacity) = 42%
Difference is 32%
To wet a soil layer of 0.30 m depth from pF 4.2 to pF 2.0 requires 300 x 0.32 = 96 mm of rain.

6a. What is infiltrability?
6b. In the figure below, indicate where the infiltration process is flux controlled and where it is profile controlled.



6c. To what value becomes the infiltration rate more or less equal when the process becomes steady?

6a. (4 pts)
The maximum infiltration rate into a soil when water is supplied in a thin layer at atmospheric pressure.

6b. (4 pts)
See figure.

6c. (2 pts)
The saturated hydraulic conductivity.