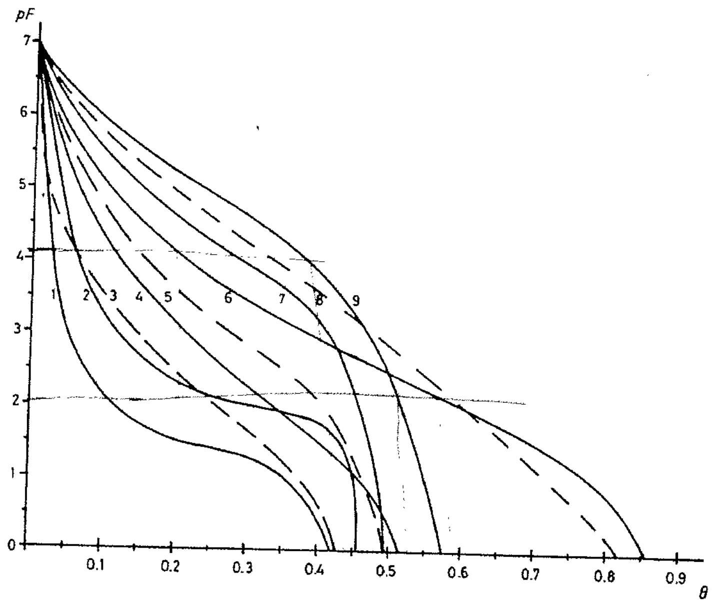
Exam Course GEO3-4304 Land Degradation
4 November 2008, 9 – 12 hr

Question 1:
The graph below shows soil water retention curves or soil pF curves.



1a. What is a soil water retention curve? Give a description/definition. Include in your description in words what the X- and Y axes in the graph represent.

1b. The numbers 1, 6 and 9 refer to a peat soil, river clay soil and dune sand soil. What number (1, 6, 9) belongs to what soil. Motivate your answer.

1c. Field capacity (veldcapaciteit) and wilting point (verwelkingspunt) are important characteristics of a water retention curve. What are pF values of field capacity and wilting point respectively? Copy/sketch the pF curves of soil 1, 6 and 9 on your exam paper and draw lines of the wilting point and of field capacity in this sketch. Estimate the fractional water availability for plants for these three soils.

Water repellent soils have quite particular water retention curves.
1d. What is soil water repellency? What are the negative effects of soil water repellency?

1e. Draw the water retention curve (pF curve) of a water repellent soil. Describe the special properties of this water retention curve of a water repellent soil.

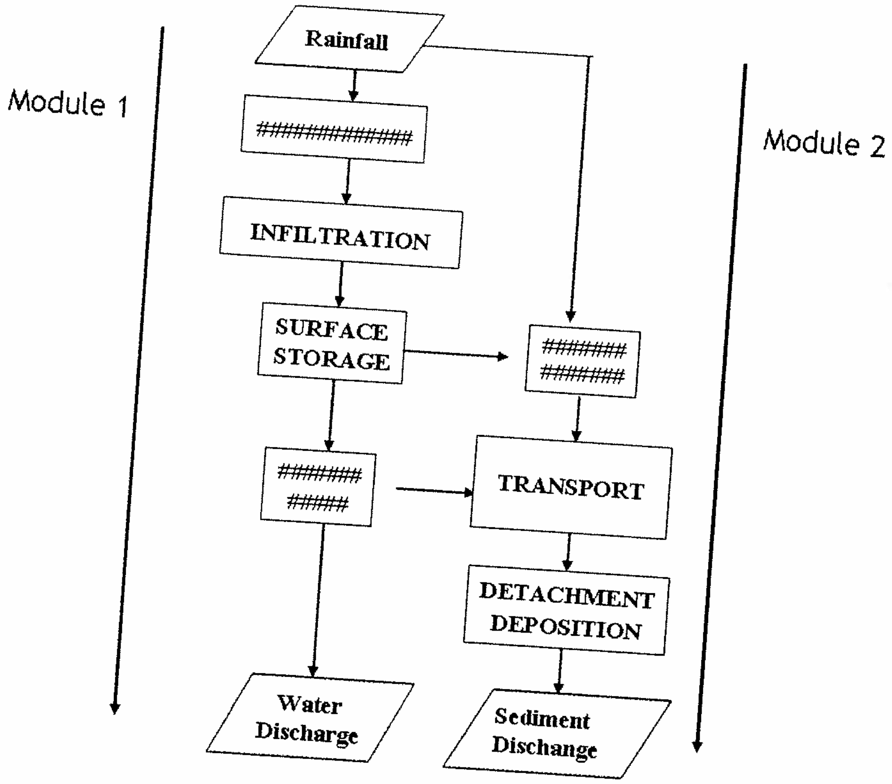
Question 2:
Given the definitions of land degradation as discussed during the first lecture of the course, argue why the following landscapes are degraded landscapes or not (make out a case for/against):

- The Dutch Flevopolders;
- A Mediterranean Maquis (shrub) area.
- The Sahel region

Motivate your answers.

Question 3:

The GIS based MMF soil erosion model was used during the computer exercises to simulate water induced soil erosion in the Nam Chun catchment. The model is built up of two modules as shown in the flow diagram.



3a. Name and describe the modules 1 and 2 used in the MMF soil erosion model?

3b. Give names for the processes / variables in the 3 boxes with '#####'. Describe the main parameters controlling the processes in these 3 boxes.

The splash detachment rate in the sediment phase of the model is computed by the following equation:

```
Ds = K * (KE_LD + KE_DT)*0.001
```

3c. Describe the process of splash detachment? What do the symbols K, KE_LD, KE_DT represent in this equation? What are the units of these variables?

3d. What are conceptual weak points in the MMF soil erosion model? Why?

3e. Suppose a farmer living in the southern, hilly part of The Netherlands (Limburg province) asks you how he can reduce soil erosion from his agricultural fields. Describe three examples of effective soil conservation measures that this farmer might apply on his fields and motivate why you think these measures will be effective.

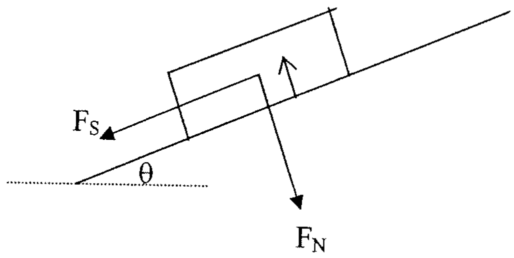
Question 4:

Suppose you are asked to study a possible unstable slope in the Meuse valley in the southern, hilly part of The Netherlands. A road is planned at the top of this slope. During a field visit you observe signs of creep and land slides.

4a) What is the role of soil moisture in mass movements?

4b) What are three ways that vegetation is important in slope stability?

You are using the infinite slope model to compute the safety factor F (stability) of this slope (see the concept below).



4c) At what values of F is a slope stable, unstable and quasi stable?

4d) Compute the safety factor for the given slope assuming (note equation sheet):

- the depth of the soil mass on the slope is 10.0 meters;
- a slope angle of 14 degrees;
- a soil cohesion 1100 N/m^2;
- an angle of internal friction of 15 degrees;
- density of soil material of 2200 kg/m^3;
- density of water of 1000 kg/m^3;
- unsaturated, dry conditions on the entire slope.
- acceleration due to gravity: 9.8 m/s^2;

Based on your computed factor of safety, is the slope safe, yes or no?

4e) Suppose you were mistaken and the soil angle of internal friction is 8 degrees? What is now the value of the safety factor?

List of Equations Land Degradation Course GEO3-4304

1. $F = 0.001K(Ee^{-aA})^b$
2. $q = -k(\theta)\frac{\delta H}{\delta s}$
3. $Ro = R / Rn$
4. $KE = a + b\log(I)$ a=11.87; b=8.73.
5. $G = 0.001CQ^d \sin(S)$
6. $SAVI = \frac{NIR - R}{NIR + R}(1 - L)$
7. $yl = \frac{Log(1-(1-g)\frac{R}{C}}{Log(g)} - 1$
8. $\cos(\theta) = \frac{\sigma_{sv} - \sigma_{sl}}{\sigma_{lv}}$
9. $\frac{F}{N} = \frac{W\sin(\alpha)}{W\cos(\alpha)} = \tan(\alpha)$
10. $\tau = \rho gRS$
11. $V = \sqrt{(g/a)RS} = CR^{0.5}S^{0.5}$
12. $V = \frac{R^{2/3}S^{1/2}}{n}$
13. $NDVI = R\frac{NIR - R}{NIR + R}$
14. $KE = KE_{\max}(1 - a\exp(-bI))$
15. $Ds = K_{i3} \cdot KE \cdot \exp(-bh)$
16. $F = \frac{c + (\rho_s gH\cos(\theta) - \rho_w gW)\tan(\varphi)}{\rho_s gH\sin(\theta)}$
17. $S_{\max} = 0.935 + 0.498LAI + 0.00575LAI^2$
18. $A = R \cdot K \cdot LS \cdot C \cdot P$