Written exam "Hydrology of Catchments, Rivers and Deltas" 1 November 2010.

1. About the articles that you studied.

According to Savenije (2003) the equation of Lacey can be written as:

$$Q_b = \frac{2 \tan \varphi}{\pi^2} B^2 U_b$$

1a. Explain the meaning of the parameters in the equation and give their dimension.

1b. The paper demonstrates that the width and the depth are directly proportional. If the depth *h*, the width *B* and the bank full velocity U_b are power functions of the bankfull discharge, then what should be the exponents of these power functions?

According to Savenije (2001), the equation for the relative amplification (or damping) of the tidal range is given by:

$$\frac{dy}{dx}\left(1 + \frac{1}{\alpha} y\right) = \frac{1}{\beta} y$$

or

$$\frac{dy}{dx} = \frac{\alpha}{\beta} \frac{y}{(\alpha + y)}$$

1d. Explain the meaning of the parameters in these equations and give their dimensions.

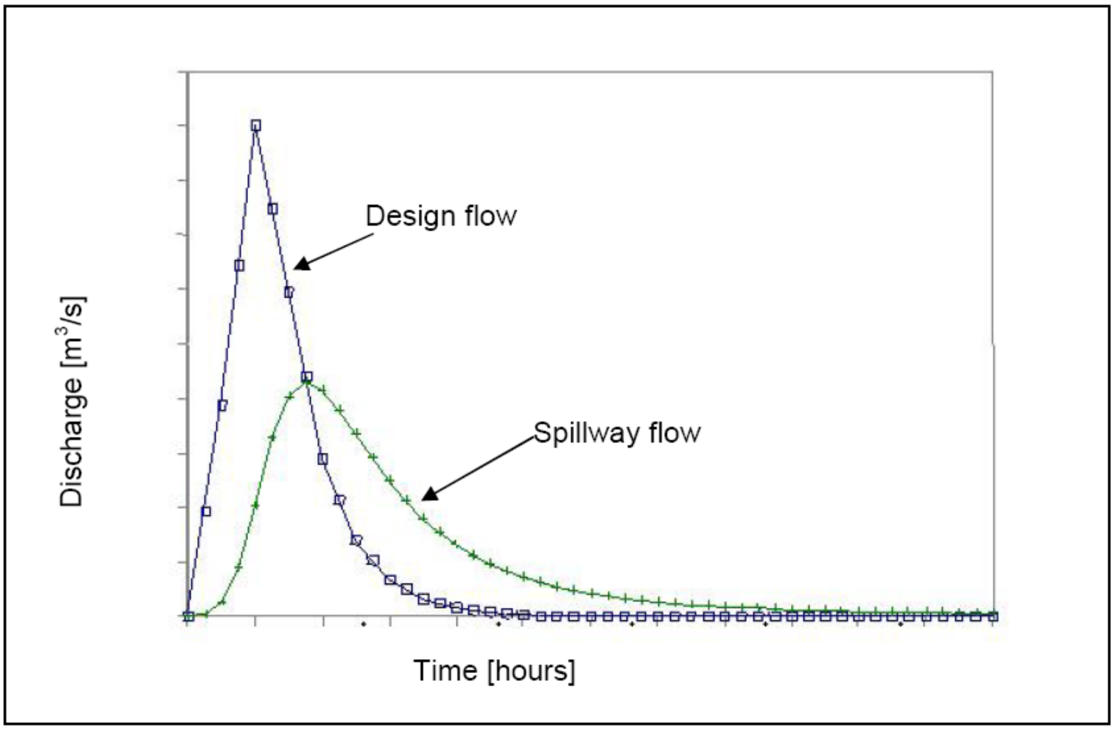
1e. Under which condition does the graph of y(x) approach a straight line?

1f. Under which condition does the graph of y(x) approach an exponential function?

1g. Sketch a graph of y(x) for selected values of α and β

2. Routing

In the graph below you see an inflow and an outflow hydrograph of a water body.



2a. What kind of water body is this and how can you conclude that?

2b. Write the water balance of the water body.

2c. What can you say about the water volumes depicted in the graph? Illustrate it with a sketch.

2d. What is particular about the intersection point of the two hydrographs? Explain why this is the case.

3. Evaporation

In a large climate room, free from draught, the relative humidity is 60% and the temperature 20 °C. Most of the time it is dark in the climate room.

To answer the question below you might want to use the following equations / information:

$$E_0 = \frac{\left\{ \frac{sR_N}{\rho\lambda} + \frac{c_p \rho_a}{\rho\lambda} \frac{(e_s - e_a)}{r_a} \right\}}{s + \gamma}$$

$$e_s = 0.61 \exp\left(\frac{17.3t}{237 + t} \right) \qquad s = \frac{4100 e_s}{(237 + t)^2} \qquad r_a = \frac{245}{(0.54u_2 + 0.5)}$$

$$e_w = e_a + \gamma (t - t_w)$$

Where:

R_N	net radiation on the earth's surface [Wm^{-2}]
λ	latent heat of vaporization [J/kg] (2.45 MJ/kg)
s	slope of the saturation vapour pressure-temperature curve [kPa/°C] (see Eq. [7.7])
c_p	specific heat of air at constant pressure [J kg^{-1} K^{-1}] (1004 J kg^{-1} K^{-1})
ρ_a	density of air [kg/m^3] (1.205 kg/m^3)
ρ	density of water [kg/m^3] (1000 kg/m^3)
e_a	actual vapour pressure in the air at 2 m height [kPa]
e_s	saturation vapour pressure for the air at 2 m height [kPa]
e_w	wet bulb vapour pressure [kPa]
t_w	wet bulb temperature [^{o}C]
γ	psychrometer constant [kPa/^{o}C] (0.066 kPa/^{o}C)
r_a	aerodynamic resistance [s/m]

Questions:

3a. What is the actual vapour pressure in the room. Show your calculations.

3b. In case the temperature rises in the room what will happen with the relative humidity ? Explain.

3c. We put a small saucer with 2 mm of water in the climate room. How long will it take before all the water in the saucer has evaporated? Show your calculations.

3d. Now we put a stone bottle in the room filled with water. The stone material is porous and allows water to evaporate. Explain how you can calculate the temperature of the water in the stone bottle? Make a sketch and show the formulas. (you don't have to calculate the resulting temperature)