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

1. About the articles that you studied.

The equation for monthly interception reads:

$$I = P\left[1 - \exp\left(-\frac{n_r D_d}{P}\right)\right]$$

1a. Explain the meaning of the parameters in the equation and give their dimension.
1b. What is the maximum amount of interception that you can have in a month?
1c. How can you calculate the time scale of the interception process?

The equation fro moisture recycling can be written as:

$$\frac{W}{W_0} = \frac{P}{P_0} = \exp\left(-\frac{x}{\lambda}\right)$$

where

$$\lambda = \frac{u}{p\alpha}$$

1d. Explain the meaning of the parameters in these equations and give their dimensions.
1e. Sketch a graph for the equation of P(x)
1f. In the same figure, sketch a graph of P(x) for the situation where their is no runoff, bit all rainfall evaporates.

About the predictive model for salt intrusion

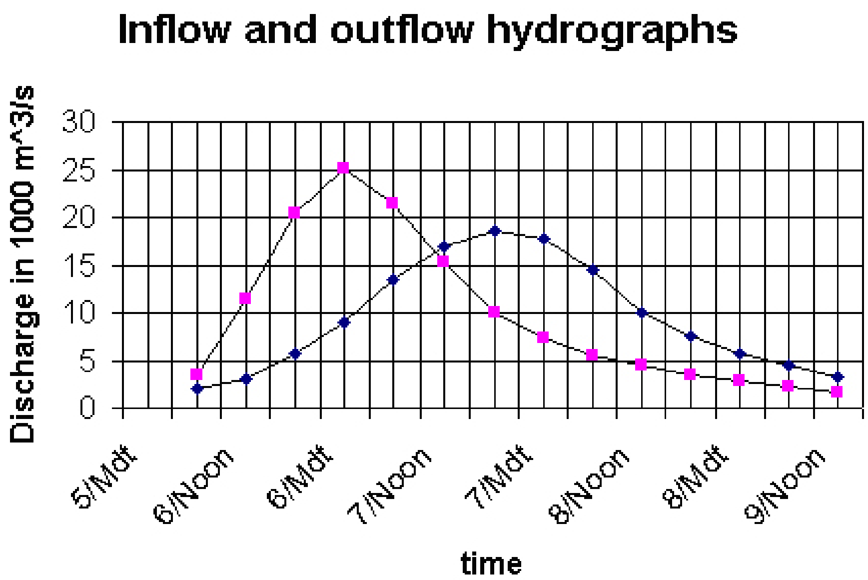
The predictive equation for the salt intrusion length reads:

$$L^{HWS} = a \ln\left(-220\frac{h_0 E_0 v_0}{K a^2 u_0} \mathrm{F}^{-0.5} \mathrm{N}^{0.5} + 1\right)$$

1g. Explain the meaning of the parameters in this equation and give their dimensions.
1h. What is the main difference between this equation and the more traditional equations presented by e.g. Rigter, Fischer, Van Os, or Van der Burgh?

2. Flood Routing

In the graph below you see an inflow and an outflow hydrograph of a river reach of 60 km length.



The method of Muskingum provides a relationship between inflow, outflow and the storage in the river reach.

$$S = K\left[xI + (1-x)Q\right]$$

2a. Explain the meaning of the parameters in the equation and give their dimension.
2b. How can the parameter K be estimated on the basis of this graph? Calculate the value of K.
2c. How can the parameter x be estimated on the basis of this graph? Calculate the value of x.
2d. How can the average flow velocity v of the river during the flood peak be derived from this graph? Calculate the value of v.

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:

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

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

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

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)