Seminar 2

- Overview on hydraulic characteristics
- Intro to pedotransfer functions
- Program Rosetta
- The task

Retention curve

- Characterizes soil pore space from the perspective of filling and draining
- Dependence of suction pressure *h* and moisture content θ
- Mainly dependent on solid phase structure. Also depends on properties of other phases.

- Obtained through laboratory measurements – measured points are fitted by parametric functions (**van Genuchten** 1980, Brooks and Corey 1964)
- hysteresis

http://euclid.ucc.ie/appliedmath/soilhyst/node17.htm

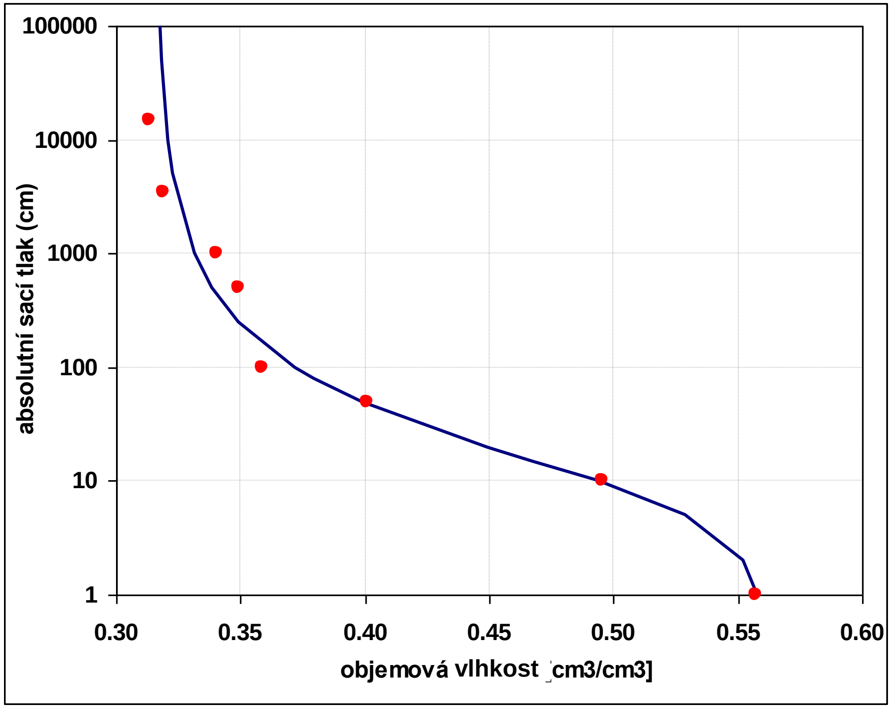
$$\theta_E = \frac{1}{\left(1 + \left(\alpha |h|\right)^n\right)^m}$$

h [L] is capillary pressure, α[L^{-1}], *n* and *m* are optimization parameters

$$\theta_E = \frac{\theta - \theta_r}{\theta_S - \theta_r}$$

θ_E ... Effective moisture cont.
θ ... Moisture cont.
θ_s ... Saturated moisture
θ_r ... Residual moisture

$$m = 1 - \frac{1}{n} \qquad n>1$$

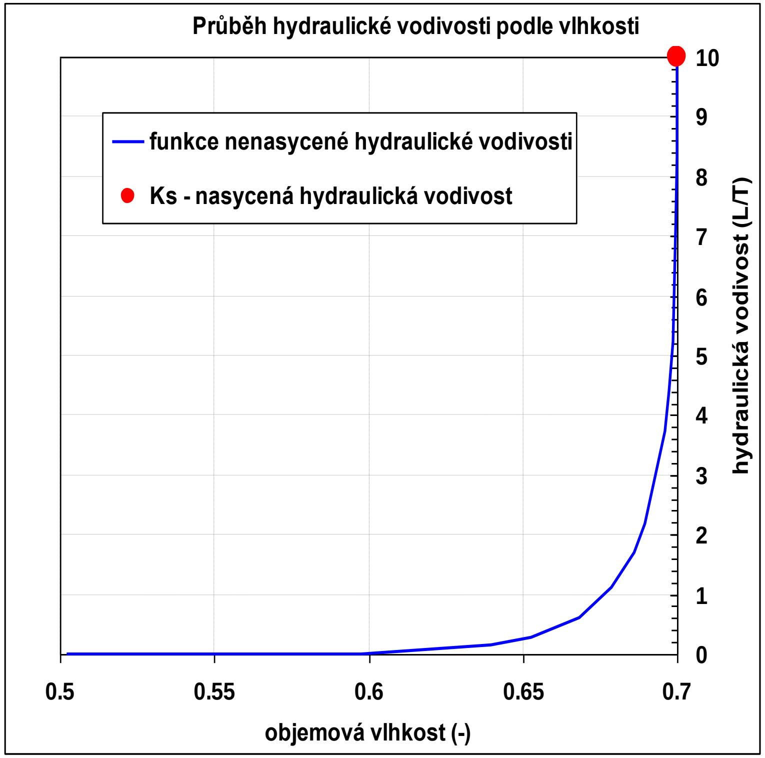


Hydraulic conductivity function

•Dependence of the unsaturated hydraulic conductivity on suction pressure

•Technically difficult to measure, time consuming – > we usually derive it from the retention curve (by means of the theory of capillary models)

•Introduction of relative capillary conductivity – predicted according to Mualem's or Burdine's capillary model



Conclusion:

Knowledge of hydraulic characteristics is esential to study movement of liquids in porous media. Measurements of the characteristics cost quite a lot of effort, time and money.

Might be useful : $\log_{10} x = a$

$10^a = x$

In case of van Genuchten's function of retention curve mostly Mualems capillary model is used.

Relative hydraulic conductivity function is predicted by the expression:

$$K_r(h) = \begin{cases} \dfrac{\left\{1-(-\alpha h)^{mn}\left[1+(-\alpha h)^n\right]^{-m}\right\}^2}{\left[1+(-\alpha h)^n\right]^{m/2}} & h < 0 \\ 1 & h \geq 0 \end{cases}$$

or inversely

$$K_r(\theta_e) = \theta_e^{1/2}[1-(1-\theta_e^{1/m})^m]^2$$

Pedotransfer functions

Indirect methods for determination of hydraulic functions are often called pedotransfer functions. Based on known or easily obtainable properties of the soil (i.e. particle size distribution, bulk density of soil, organic matter, …), we can estimate hydraulic characteristics.

Although predictions by PTFs are not as accurate as measurements, they provide a way to obtain soil hydraulic characteristics that would otherwise not have been available.

Program Rosetta

Based on neuron network prediction, useful for estimation of:

•Retention curve parameters according to van Genuchten

•Saturated hydraulic conductivity

•Unsaturated hydraulic conductivity function (Mualem - van Genuchten)

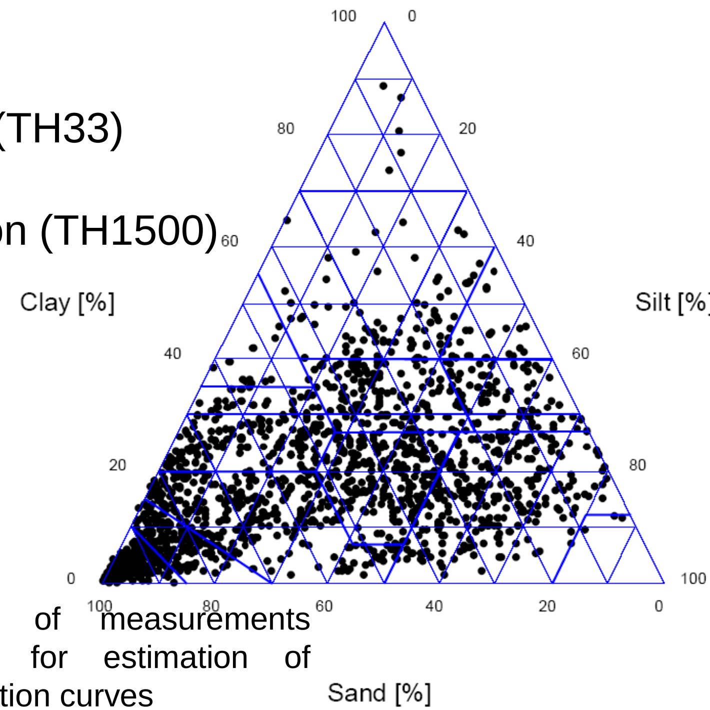
Shareware, downloadable (with user manual) from webpages of US Salinity Lab http://www.ussl.ars.usda.gov/MODELS/rosetta/rosetta.HTM

Program Rosetta

predicts van Genuchten (1980) water retention parameters and the saturated hydraulic conductivity (Ks) from soil textural class information, the soil textural distribution, bulk density and one or two water retention points as input.

Model 1 (TXT):
Soil textural classes (USDA classification: sand, silty loam, clay loam, etc)
Model 2 (SSC):
Texture percentages (%sand, %silt, %clay)
Model 3 (SSCBD):
Textural percentages and bulk density (BD)
Model 4 (SSCBDTH33):
As model 3, but with water content at 33 kPa suction (TH33)
Model 5 (SSCBDTH331500):
As model 4, but with water content at 1500 kPa suction (TH1500)

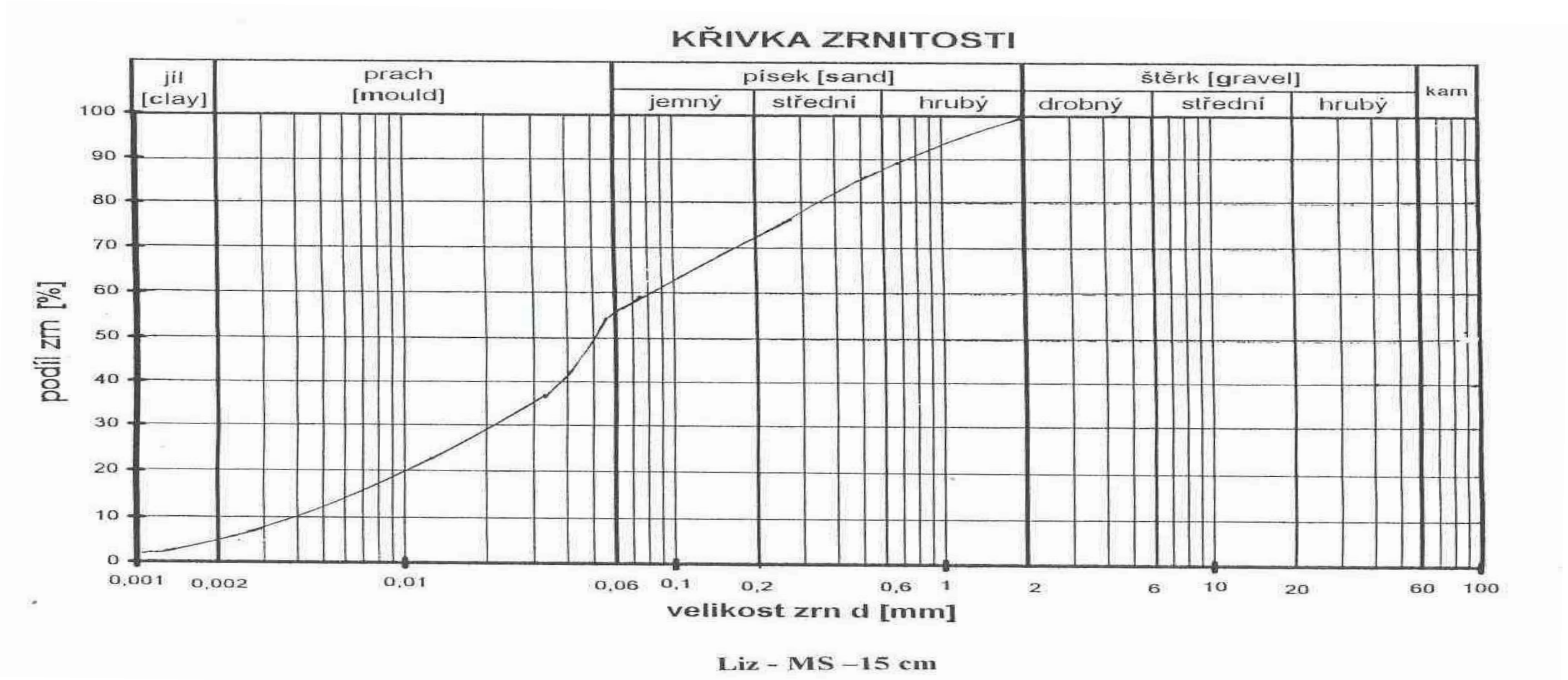
The calibration data set contained 2134 samples for water retention and 1306 samples for Ks (Schaap and Leij, 1998). The samples were obtained from a large number of sources in temperate climate zones of the northern hemisphere (mainly from the USA and some from Europe). Usage of Rosetta for other climate zones, and hence other pedogenic processes, could lead to inaccurate predictions.



Field of measurements used for estimation of retention curves

The task

Based on known particle size distribution function and bulk density of soil sample, estimate saturated hydraulic conductivity and parameters of retention curve. Plot the retention curve and hydraulic conductivity function. Bulk density of soil is 1,95 g/cm^3.



References

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