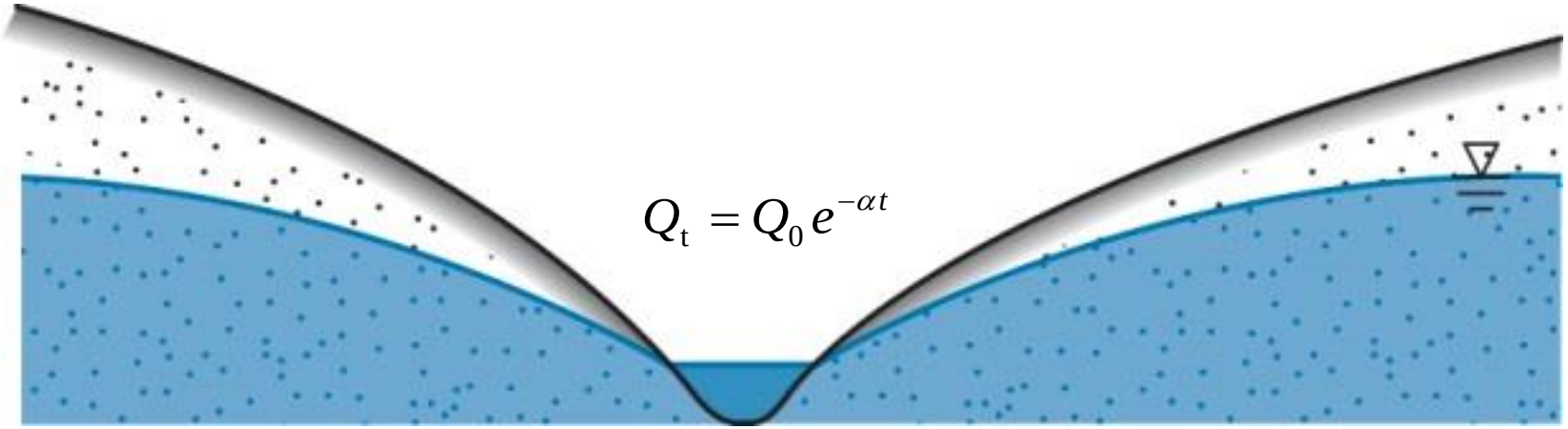
Linear reservoir model

https://www.youtube.com/user/MartinRHendriks/videos

$$S_t = \int_t^{\infty} Q_t \, dt$$



$$S_t = \int_t^{\infty} Q_0 e^{-\alpha t} dt = Q_0 \int_t^{\infty} e^{-\alpha t} dt = Q_0 \left[\frac{e^{-\alpha t}}{-\alpha} \right]_t^{\infty} = Q_0 \left(0 - \frac{e^{-\alpha t}}{-\alpha} \right) = \frac{Q_0 e^{-\alpha t}}{\alpha} = \frac{Q_t}{\alpha}$$

Linear reservoir model

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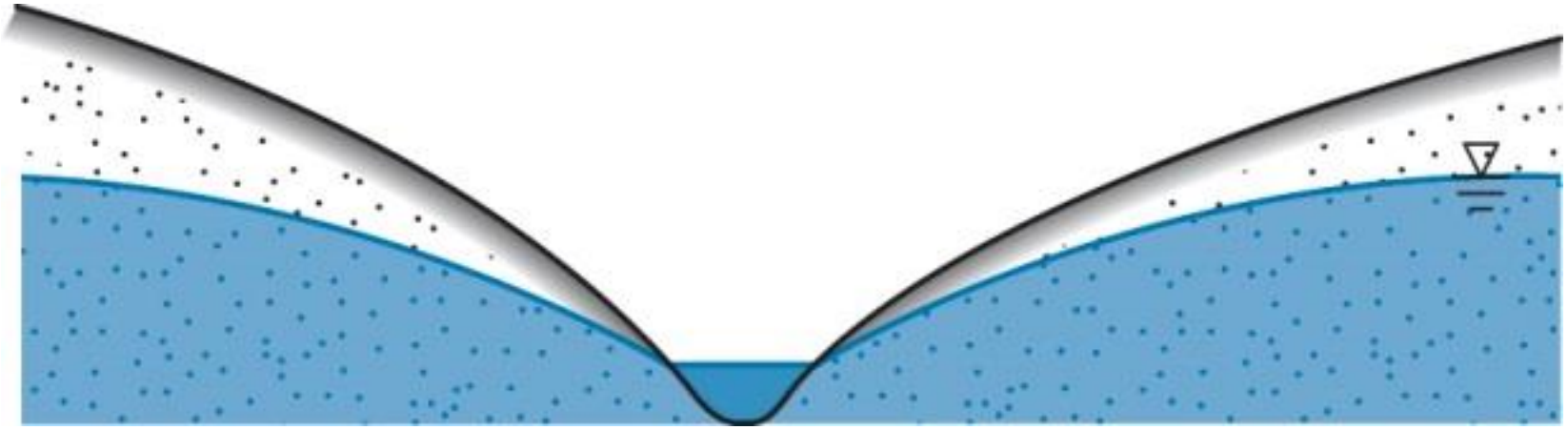
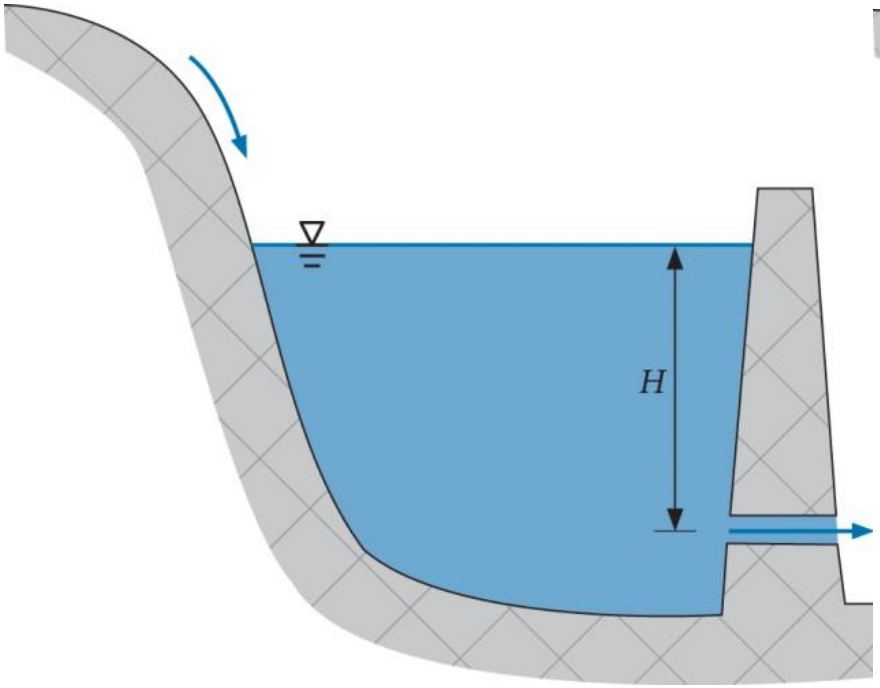
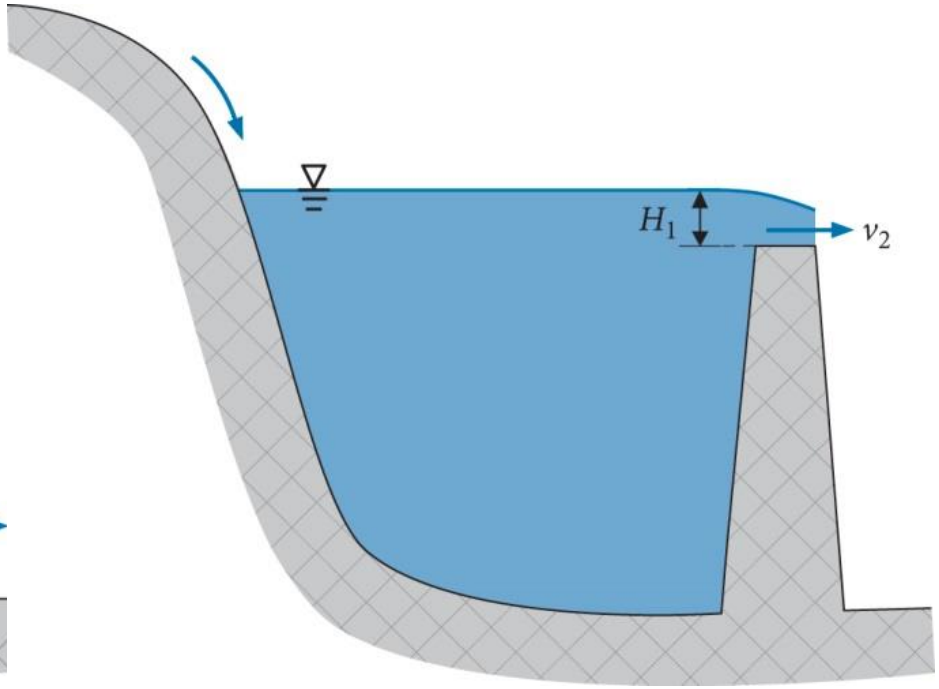


$$S = \frac{Q^n}{\alpha} \qquad n = 1$$

Outflow from a dam





$n = 2$ $\qquad S = \dfrac{Q^n}{\alpha} \qquad$ $n = 2/3$

Rainfall - groundwater runoff model

https://www.youtube.com/user/MartinRHendriks/videos

How to build a simulation model!

$$\frac{dS}{dt} = I - Q \qquad dS = \frac{dQ}{\alpha} \qquad \frac{dQ}{\alpha} = \left(I - Q\right) dt$$

$$dt \rightarrow \Delta t$$

$$dQ \rightarrow \Delta Q = Q_{t+\Delta t} - Q_t$$

$$Q \rightarrow \frac{Q_t + Q_{t+\Delta t}}{2}$$

$$I \rightarrow I_{\Delta t}$$

$$Q_{t+\Delta t} = \frac{2 - \alpha \Delta t}{2 + \alpha \Delta t} Q_t + \frac{2\alpha \Delta t}{2 + \alpha \Delta t} I_{\Delta t}$$

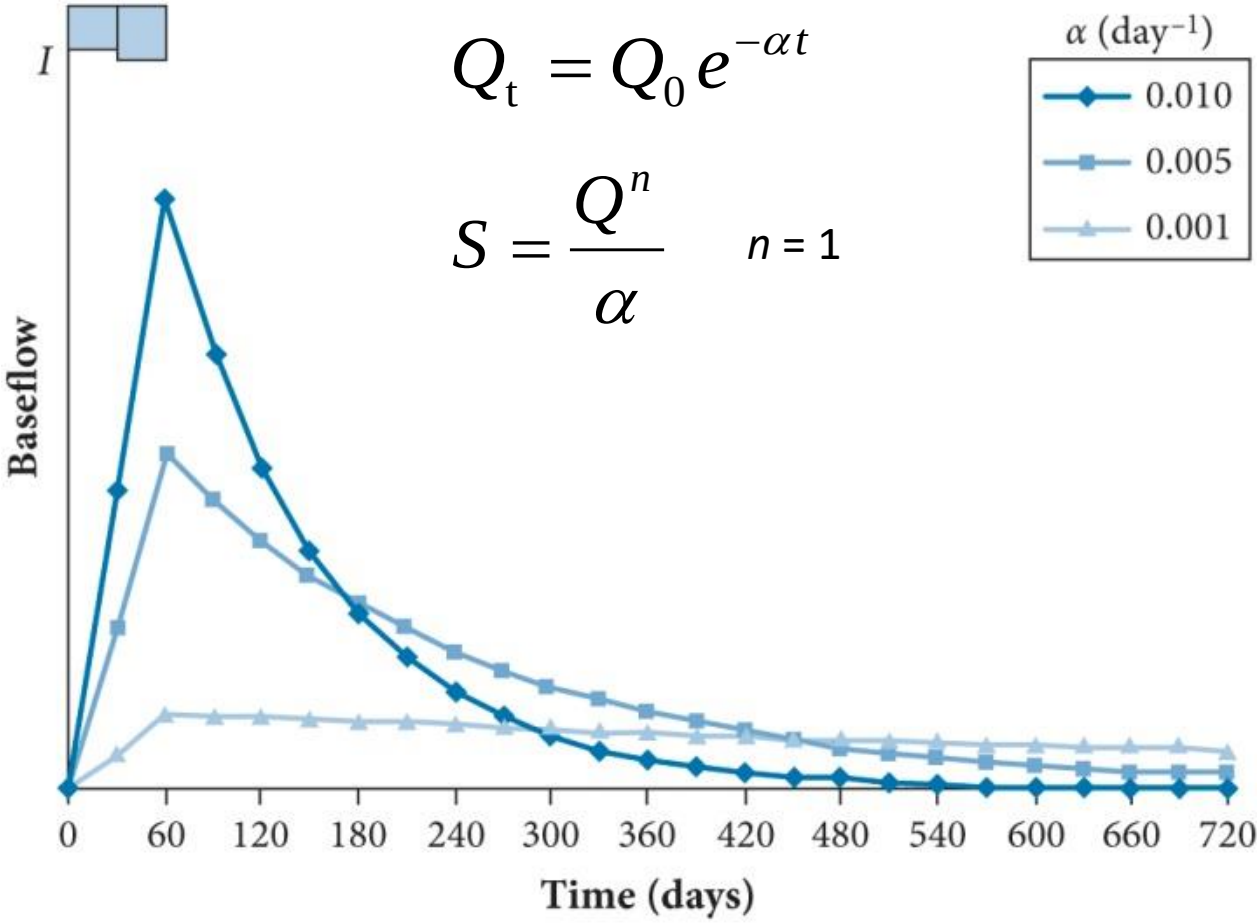
$$Q_{t+\Delta t} = \beta Q_t + \left(1 - \beta\right) I_{\Delta t}$$

Linear reservoir model

https://www.youtube.com/user/MartinRHendriks/videos

$$Q_t = Q_0 e^{-\alpha t}$$

$$S = \frac{Q^n}{\alpha} \qquad n = 1$$



Hydrological triggering of landslides

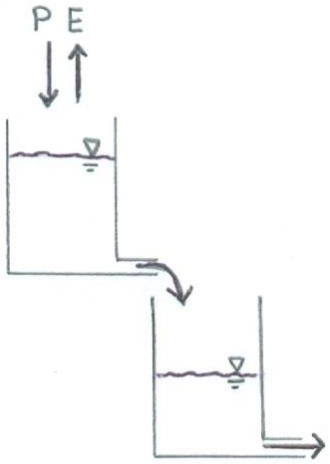
https://www.youtube.com/user/MartinRHendriks/videos

French Alps, northwest of Gap

Two linear reservoirs in series:

upper reservoir = colluvial layer

lower reservoir = varved clays



varved clays

Source: Van Asch et al. (1996)

Hydrological triggering of landslides

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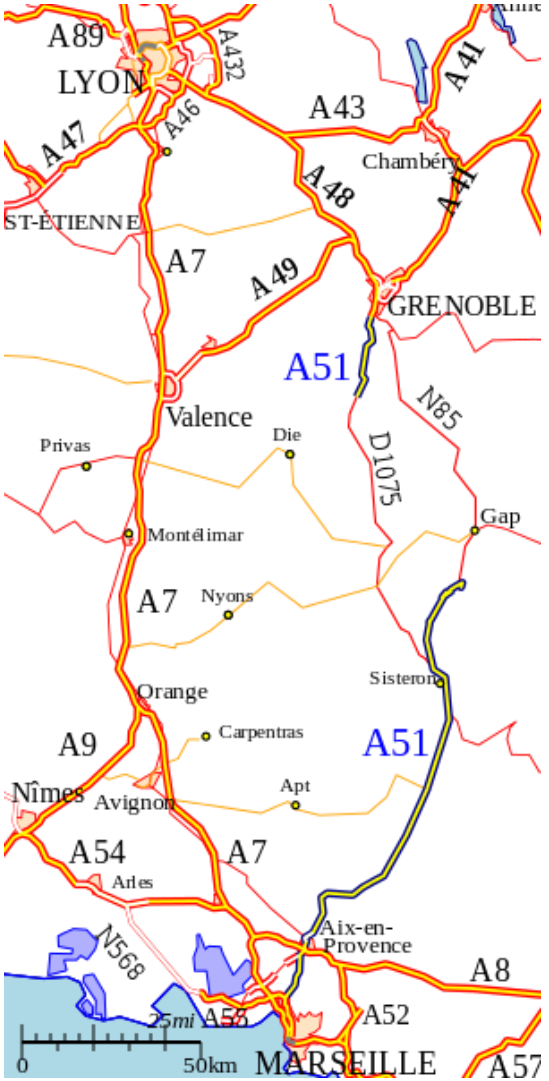
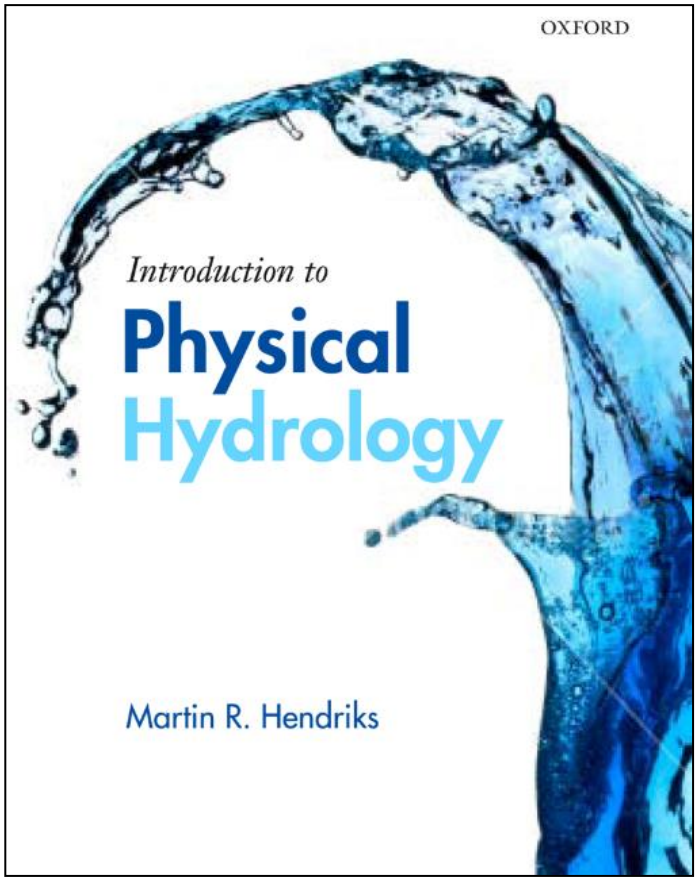
Landslide movements in varved clay areas northwest of Gap in the French Alps are mainly triggered by a maximum rise of water in vertical fissures in the clays. Complete saturation of the clays is not necessary!

Drainage of the shallow, more permeable colluvial cover overlying the varved clays is a very effective measure to stabilize the deeper landslides.

Source: Van Asch et al. (1996)



References



Van Asch, Th.W.J., Hendriks, M.R., Hessel, R., and Rappange, F.E. (1996). Hydrological triggering conditions of landslides in varved clays in the French Alps. Engineering Geology, 42, 239-251.

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