PLATEFORME DE CONSTRUCTIONS HYDRAULIQUES

Water Resources Engineering and Management

Exercises Lecture 4: reservoir design and operation, domestic and agricultural water uses

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EPFL

Exercise 1: Reservoir design and operation

The yearly hydrologic regime of a river can be subdivided in 4 periods, with the duration and the average discharge summarized in the table below.

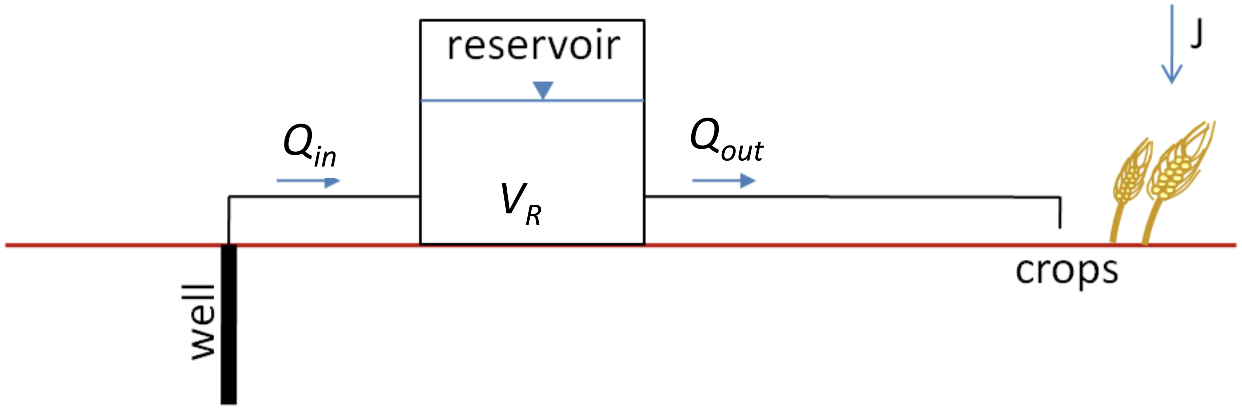
Period *i*	1	2	3	4
Duration ΔT_i [d]	60	60	180	60
Average flow rate Q_i [m³/d]	$3 \cdot 10^6$	$1 \cdot 10^6$	0	$2 \cdot 10^6$

<u>QUESTIONS</u>

- The reservoir capacity, V_R, needed to withdraw a firm yield (i.e. constant flow rate) equal to the average flow during the year
- The volume of water that must be stored in the reservoir at the beginning of the year, V_0, to obtain an annual steady state functioning of the reservoir
- The best regulation that approximates the average constant discharge supposing that after 20 years the reservoir has lost 50% of its initial volume because of deep sedimentation

Exercise 2. Irrigation need and reservoir design

An irrigation system is constituted by a groundwater well which supplies a constant discharge Q_{in} to a reservoir and a pipeline system which connects the water reservoir to a crop area. The yearly hydro-climatic and crop growth regimes of the irrigated area can be subdivided into three periods as illustrated in the table below.



Period	1	2	3
Duration ΔT [d]	100	65	200
Average crop evapotraspiration ET_0 [mm/d]	2.5	1	1.5
Crop factor K_c [-]	1.2	0.5	1
Average rainfall J [mm/h]	0.1	0.1	0.1

DATA and ASSUMPTIONS

- Crop Area → A = 1 Km^2
- Irrigation system efficiency → $\eta = 0.6$
- Effective rainfall to crop → $K_p = 0.5$
- Evaporation from the reservoir can be neglected

QUESTIONS

- The constant flow rate Q_{in} that must be pumped throughout the year to meet the irrigation water demand
- The design storage of the reservoir, V_R
- The initial volume , $V_{R,\,0}$, that must be stored in the reservoir at the beginning of the year.

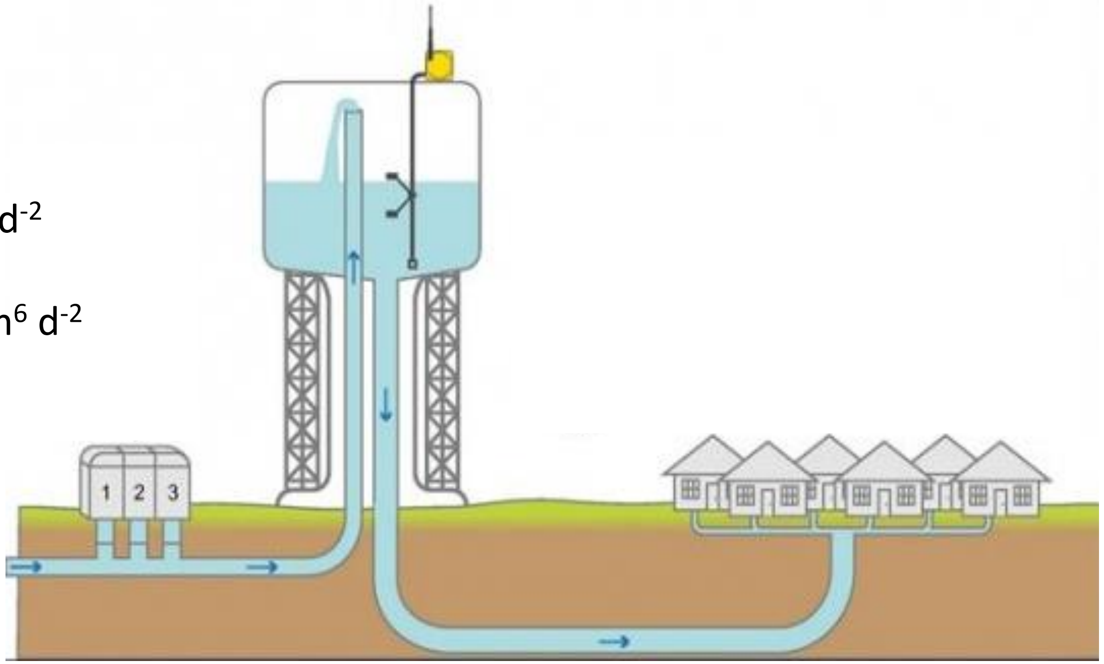
Exercise 3. Probabilistic design of water reservoir

An existing reservoir has been designed to function at a null failure rate for a certain return period.
The corresponding empirical variance of the inflow data corresponding to the assumed return period is known.

The community is considering to increase the size of the reservoir that may work for a longer period.
The characteristic properties of the process behind the reservoir design are known.

DATA and ASSUMPTIONS

- Initial reservoir volume → V_1 = 200 m^3
- Initial return period → T_1 = 50 years
- Empirical variance of inflow data, first design process → S_1^2 = 3320 $m^6 d^{-2}$
- Future return period → T_2 = 80 years
- Empirical variance of inflow data, future design process → S_2^2 = 3450 $m^6 d^{-2}$
- Hurst exponent → 0.56
- Failure rate does not change



QUESTIONS

- The reservoir volume, V_2, in the future scenario