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The combined water system as approach for tackling water scarcity in Permilovo groundwater basin

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The water scarcity accepts now global scales. The depletion of water resources is especially significant for the small stream basins where the water demand is higher than the low-water flow. The application of combined water use is one of the ways to solve this problem.
The combined water system (CWS) is a complex technology comprising two separate wells, major catchment-zone wells and compensation pumping wells, located inside a single stream basin. The pumping rate of a major well in a CWS is determined by the difference between the current stream flow and the minimum permissible stream flow (stream flow required for maintenance water budget and for normal living of aquatic and terrestrial ecosystems).
The deficiency of the stream flow in dry seasons can be compensated for by the short-term pumping of groundwater. The pumping rate of a compensation well (CW) is determined by the difference between water demand and the permissible water withdrawal of the major well. The source for the compensation well is the aquifer storage. Short-term groundwater pumping allows the use of aquifer storage instead of stream flow until drawdowns of groundwater levels do reach the edge of the stream.
Some hydrogeological problems exist in the determination of the best location for the compensation well: 1) The delayed stream depletion produced by the CW; 2) The draining of storage recovery due to natural processes or artificial recharge; 3) The delayed effects of CW pumping that cause stream flow depletion, which occurs after pumping during high water level periods.
Three typical hydraulic cases of combined water systems were classified depending on their the relationship between surface water and groundwater: (a) perfect hydraulic connection between the stream and aquifer; (b) imperfect hydraulic connection between the stream and aquifer; and (c) essentially imperfect hydraulic connection between the stream and the underlying confined aquifer.
The numerical model of Permilovo groundwater basin (PGB) was developed to illustrate the application of CWS. PGB is located in northwest of the Northern Dvina Artesian Basin, Russia. The principle aquifer is in the Carboniferous fissured and karstified rocks. The aquifer has a good hydraulic connection to the stream.
The basin was explored but not used due to impermissible stream depletion. The organization of CWS is offered as approach for tackling environmental problem. The major well is located on the bank of river Vaymuga and induces infiltration from the stream. The deficiency of the stream flow in dry seasons (from November to April) is compensated for by the pumping aquifer storage. The aquifer system under consideration belongs to the first hydraulic case (a), where distance between CW and the stream should be sufficient enough to prevent the groundwater drawdown levels from reaching the stream edge during the pumping period.
The developed PGB model showed the efficiency of compensation pumping. Application of the combined water system in PGB allows of meet water demands during water-limited periods and of avoid the environmental problems.