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The flow mechanism of the recharge water and exploitation issues- Example from Maagan Michael Fishpond area- Israel

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Understanding of the flow mechanism and monitoring after the spreading water is one of the main challenges during performing an artificial recharge through spreading ponds or wells.
The conventional and the simple way are by using one of the "conservative" anion such as chloride. This tool is good in places where the differential in the concentration of the chloride in the recharge water and in the aquifer water is large. In places where the chloride concentration of the recharge water and the aquifer are quite similar, difference tools are required.
Such an area is the Maagan Michael Fishpond that is located close to the Mediterranean Sea shore and about 30 km southward to Haifa (Israel). The ponds are located on the top of two sandstone ridges. The thickness of the sandstone aquifer (Pleistocene age) beneath the ponds is between 30- 40 m and the saturated thickness is about 30 m.
Spring water (about 15 MCM/year with salinity of about 1800 mg/lit Cl) is the source water for filling up the ponds. The losses are evaporation and downward leakage to the sandstone layers and recharging the aquifer.
The fishponds undergo strong evaporation, which enriches the residual water in the stable isotopes like Deuterium and Oxygen-18 in compare to the natural groundwater. This contrast allows us to use the heavier isotopes of the fishpond water as a monitoring tool after the movement of the water that leak from the fishponds into the aquifer.
Nearby the ponds, several wells were drilled in order to exploit the recharge water and to reuse it for re-filling the pond and for desalination plant. From technical reasons (leaving enough space for drawdown), most of the wells were constructed in a way that they are exploiting the water from the lower part of the aquifer.
The water in many of these wells have light isotopic composition that indicates that they are not pumping the "leaked" water from the fishpond and of course do not fulfill their original purposes.
The questions are: Which part of the aquifer section contains the leaked water? Where the recharged water "disappear"?
To answer to theses quandaries an isotopic profile was carried out in an observation well. It was found that the recharged water from the fishpond is "concentrated" in the upper part of the saturated zone. The transition zone from heavier (fishpond water) to lighter (aquifer water) isotopes is thin and sharp.
The depth and the shape of the transition zone depend on the lithology of the layers, the permeability, the anisotropic proportion and the flow regime.
The permeability of the sandstone aquifer below the fishponds is quite high and varies between 50-400 m/day. The absence of the recharge water in the lower part of the aquifer (the total saturated zone is around 30 m' only) lead that the permeability in the upper part of the saturated zone is much higher than in the lower part. It seems that the high horizontal flow in the upper part of the saturated zone coerced the recharge water from the ponds to change its flow regime from vertical direction to horizontal direction. In this case the abstraction of the recharge water can be done only by very shallow wells that should be drilled to the middle part of the aquifer section.