Artificial Recharge of Groundwater in Israel

by J. Schwarz[1] and J. Bear[2] (10/4/2016)

Artificial recharge of groundwater aquifers (AR), performed through infiltration ponds and through recharge wells, has been practiced in Israel since the 1960's as an important component of the integrated management of surface and groundwater (Schwarz,1980) for the following objectives:

1. Seasonal storage of excess surface water in the National Water Supply (NWS) system, which carries water from the Jordan sources in the north to the central (coastal) regions.
2. Reclamation of over-exploited aquifers,
3. Utilization of rainwater runoff and flash floods, where surface storage is unavailable.
4. Soil – Aquifer Treatment (SAT) of sewage treatment effluents, aimed at the removal of residual contaminants by filtration and adsorption on the aquifer's solid skeleton, by upper soil aeration and by long retention time in the aquifer.

The NWS system, inaugurated in 1964, supplies water for domestic, industrial and agricultural purposes. It conducts and integrates Jordan River surface water, through Lake Kinneret, with groundwater from the coastal sandstone and mountain limestone aquifers, which are the major groundwater basins in Israel. Since 1964, AR has been implemented for seasonal storage, as part of the NWS's operation, to increase the yield during years of high demand and low rainfall. The water carried by the NWS is recharged both into the Coastal (sandstone) and Mountain (limestone) aquifers.

In the first years of the NWS system, AR was implemented also for the reclamation of the sandstone Coastal Aquifer, which had been heavily overpumped prior to 1964. In fact, already in 1958, while planning the NWS, AR experiments were conducted in order to establish the capacities of AR facilities and to investigate the fate of the recharged water as it spreads in the aquifer.

AR has been implemented within the framework of the NWS system through spreading grounds, by dedicated (single purpose) wells, and by dual purpose wells operating alternately for pumping water to the water supply system and for AR.

AR of flash floods started in the 1960's in two of the main coastal River Basins by diversion to specially constructed spreading basins.

SHAFDAN is the main Waste Water Treatment Plant (WWTP) in Israel. Presently, it is serving a population of 2 million people in the Greater Tel-Aviv Region. Within the framework of this project, effluents of a conventional secondary WWTP are delivered to SAT/AR facilities, composed of percolation ponds, in a dedicated portion of the Coastal Aquifer, These ponds are surrounded by pumping wells. The pumped water is delivered through a separate pipeline system for irrigation in most Southern Israel farms, replacing fresh water supply.

The evolving role of AR can be traced in the records of the Hydrological Service (Weinberger et al 2012). Recently, the role of AR as a storage procedure has declined due to the replacement of water from the NWS by reclaimed sewage as the main source of irrigation water and the introduction of sea-water desalination. In recent years, most of AR is of reclaimed sewage effluents. Table 1 shows the development of AR in Israel since 1960.

ARTIFICIAL RECHARGE OF GROUNDWATER IN ISRAEL [$10^6 m^3$/year]

Decade	Total	Wells		Spreading Grounds		
		Limestone	Sandstone	Sandstone		
		Water Supply System		Water Supply System	Floods	SAFDAN Reclaimed Sewage Effluents
1961-1970	87	18	36	14	20	
1971-1980	91	32	27	15	17	10
1981-1990	127	18	42	12	9	46
1991-2000	132	5	11	13	15	89
2001-2010	144	3	2	6	14	119
2011-2013	134	0	0	1	10	122

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Table 1: Artificial recharge in Israel since 1960 (in $10^6 m^3$/year)

AR operations have posed challenges which called for theoretical and field research (TAHAL, 1969, Schwarz *et al*, 2016). This research led to the development of planning tools. For example, research provided a better understanding of the process of mixing in the aquifer of water of different qualities (the Kinneret water being more saline than aquifer water), and produced tools for calculating the quality of pumped water (Bear and Jacobs, 1968). Another challenge was to overcome the clogging of soil beneath infiltration ponds and around screens of recharge wells (e.g. Rebhun and Schwarz, 1968).

The main challenges of AR that required intensive research and studies aimed at establishing diagnostic and remedial methodologies were:

1. The travel and mixing in the aquifer of recharged and indigenous water.

2. The impact of AR on the quality of pumped water in dual purpose wells and in nearby pumping wells.
3. Clogging and capacity degradation of recharge wells and spreading basins.
4. Contamination of AR wells.
5. Proper design and maintenance of AR facilities.
6. Cost allocation of AR operations within the National Water Supply System

At present, Israel's water economy is characterized by the introduction of large scale sea water desalination within the framework of the NWS system. AR of this water is required, but it raises new economic and technical challenges that are currently under intensive research.

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