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The Negative Water Balance of the Dead Sea; its Impact and the Future of the Lake

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The Dead Sea is one of the most saline lakes in the world (total dissolved salts ≈ 278 g/kg; density ≈ 1.240 g/ml) and forms the lowest exposed surface on Earth (-421 m, 2008). The lake is the last of a series of precursor lakes that evolved in the Dead Sea Rift valley since seawater first transgressed into the valley and formed the Sedom lagoon in the late Neogene. The unique Ca-chloride composition of these terminal lakes evolved through seawater evaporation, salt precipitation, water rock interaction and freshwater inflow. The Dead Sea came into existence in the early Holocene after the desiccation of its immediate precursor, Lake Lisan, in the late Pleistocene. Since then, its water level has been fluctuating in response to climatic changes. However, as of the middle of the 20th century, the Dead Sea experiences an "anthropogenic negative water balance", resulting in rapid water level decline of nearly 30 m, with increased rate of 1 m/yr over the last decade (Figure 1). This water level decline is mainly due to the diversion of water from the drainage basin for domestic and agricultural usages. The chemical industries at the shores of the lake contribute their share by pumping brines and evaporating them in evaporation ponds. The continuous

drop in water level has resulted in the drying of the Dead Sea southern basin, overturn of the water column which was meromictic for at least 400 years, onset of halite precipitation, retreat of shorelines and exposure of large mudflats, subsidence and development of sinkholes along its shore and collapse of the surrounding infrastructure. In order to stop the decline in water level plans are being considered to convey seawater from the Red Sea to the Dead Sea, while utilizing the > 400 m elevation difference between the seas to desalinize seawater. Yet, the mixing of seawater and/or desalination reject brine with Dead Sea brine will result in changes in the limnology of the Dead Sea that over the long run may change its characteristics and uniqueness. Initial one-dimensional model runs, in which water level is stabilized or raised by increasing inflow volumes, demonstrate the re-establishment of meromictic conditions, with continuous decrease in the density of the mixed layer, reaching values lower than those of the mid 20th century within 20-30 years of operation. It is thus important to quantify the mixing processes and verify that the benefits from the proposed project would not be outweighed by undesired environmental impacts.

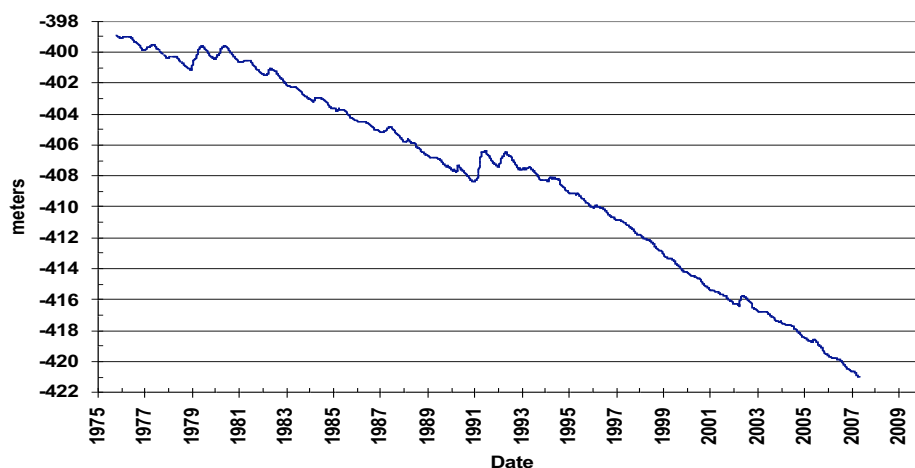


Figure 1—The Dead Sea water level, 1975–2008. Note the 2 meters rise in water level following massive runoff from the otherwise dammed Lake Kinneret (Sea of Galilee) and the Yarmouk River during the rainy winter of 1991–1992. The rise in water level resulted in dilution of the surface water and development of stratification which lasted only 3 years and was eroded by the continuous negative water balance of the lake. Data from the Israel Hydrological Service.