American Water Resources Association
2017 International Conference: Cutting-Edge Solutions to Wicked Water Problems
September 10-11, 2017
Tel Aviv University, Tel Aviv, Israel

Monday, Sept. 11
15:30 – 17:00
SESSION 11: Management of Lakes and Other Water Bodies

Preserving Lake Kinneret as a Strategic Water Source Considering the Climate Change - Doron Markel, Israel Water Authority, Rosh Pina, Israel

Lake Kinneret (the Sea of Galilee) is the only freshwater lake in Israel, supplying about 20-25% of the country's potable water. Israel also supplies 50 million cubic meters per year (MCM/y) from the Lake to the Hashemite Kingdom of Jordan. There are plans to increase the supply to100 MCM/y by 2020, according to recent agreement between the countries. The Lake also sustains commercial fishery and serves as a touristic attraction. In order to control water quantity and quality an intensive and sophisticated monitoring system in the lake and its watershed has been developed since the 1970s.In the last 40 years, the Lake has exhibited a clear decrease in net inflows from an average of 500 MCM/y in the1970s to an average of 300 MCM/y since the 2000s. This is mainly due to regional climatic change and a long-term decrease of the precipitation in northern Israel. As a consequence, there is increased variability in water-level fluctuations and progressive deterioration of water quality. The latter is mainly due to salinity increase and the occurrence of cyanobacteria blooms. According to long term climate forecast models, net inflows into Lake Kinneret are about to decrease even more to an average of 200-250 MCM/y until 2050. Currently, the intensive desalination by the shore of the Mediterranean Sea enables flexible pumping policy from Lake Kinneret and stabilizing the lake water level. However, operation of the lake with low water exchange (low amount of water inflow and outflow) may lead to increase salinity and cyanobacteria blooms. The Israel Water Authority has executed a strategic management plan to overcome the consequences of the low water exchange in Lake Kinneret. The plan includes increased removal of saline inflows, fisheries management, intensified prevention of pollution in the watershed and increase water inflow and water exchange by various means.

The Next Generation of Evaporation Pans - Jake Collison, University of New Mexico, Albuquerque, NM, USA (co-author: D. Llewellyn)

Accurate tracking of open-water evaporative losses, one of the largest consumptive uses of water in arid regions, will become increasingly important in the future with the anticipated climate shifts toward longer, more-severe droughts. The current methods for estimating evaporation on reservoirs are known to have uncertainties ranging from ± 20 to 70 percent. This uncertainty in evaporation rates needs to be reduced in order to give water-resource managers a better understanding of current and future water supplies. This study will investigate an improved method for determining open-water evaporation rates by deploying a patent-pending Floating Evaporation Pan (FEP) with built-in wave-guard and adjustable freeboard that will measure continuous, real-time, evaporation rates at a fixed location within a reservoir. The FEP will be semi-submerged to minimize the difference in water temperature between the FEP and the reservoir. In addition, a goal of the FEP design is to have minimal influence on the atmospheric boundary layer overlying the FEP relative to the reservoir. Establishing these two conditions will provide a more accurate quantification of evaporation. The accuracy of the FEP will be verified through the use of a hemispherical evaporation chamber, designed to measure the actual evaporation rate adjacent to the FEP. Implementation of the FEP will occur during summer 2017 at Cochiti Reservoir in New Mexico, U.S., where a Class A evaporation pan has been in operation since 1975. This Class A evaporation pan, like many others, utilizes an annual pan coefficient of 0.7, which has never been verified to be accurate or precise for this location. The overarching goal of this project is to bring certainty to an uncertain estimation method, Class A pans. The accuracy of Class A pans has been questioned countless times, but due to the longevity of data sets (100+ years) the replacement of these simple devices is problematic. The FEP used in this study will provide real-time evaporation data allowing for precise pan coefficients to be applied to the Class A pan on site, allowing for the replacement/verification of the standard 0.7 pan coefficient. The longevity of Class A pan data is an important tool in understanding the effects of climate change, but their inaccuracies of estimating reservoir and lake evaporation rates make it difficult for accurate management of limited water resources. Preliminary evaporation comparison results between the FEP and onsite Class A pan will be available fall 2017. Additionally, comparisons among the FEP and the following common evaporation equations will be conducted: Priestley-Taylor, Penman, Bowen ratio energy-budget, Hamon, Hargreaves, and bulk-aerodynamic. Through innovative design and extensive field measurements, this study aims to develop a more accurate, robust, automated, and real-time technique for measuring near-actual reservoir or lake evaporation, leading to effective long-term monitoring and management of reservoir and lake water resources.

Trophic State Evaluations for Selected Lakes in Yellowstone National Park, USA - Woodruff Miller,
Brigham Young University, Provo, UT, USA

My presentation will document our monitoring and management of some 40 lakes in Yellowstone National Park, USA, over the past 18 years. I will discuss the evaluations and the updated trophic state classifications for these lakes. The presentation will also establish that monitoring methods and perspectives used in these analyses meet current acceptable practices. The key components of our work are goals, sampling parameters, sampling techniques, modeling, and human use implications and recommendations. I will present some 'cutting edge solutions to (slightly) wicked water problems. 'For selected lakes in Yellowstone Park, phosphorus, nitrogen, chlorophyll-a and other lake characteristics are studied to identify lake behavior and classify the annual average trophic states of the lakes. The four main trophic states are oligotrophic, mesotrophic, eutrophic and hyper-eutrophic. The trophic state of a lake is a measurement of where the lake is along the eutrophication process. Eutrophication is the natural aging of a lake as it progresses from clear and pristine water to more shallow, turbid, and nutrient rich water where plant life and algae are more abundant. Human interaction tends to speed up eutrophication by introducing accelerated loadings of phosphorus and nitrogen into aquatic systems. As lakes advance in the eutrophication process, water quality generally decreases. Data on algae growth can explain variations in lake nutrient levels and productivity. I will present the five models we use to classify the trophic state of the lakes: Carlson Trophic State Index, Burns Trophic Level Index, Vollenweider Model, Larsen-Mercier Model and the Nitrogen-Phosphorus Ratio. Simple models are commonly used where steady-state conditions and lake homogeneity are assumed. Water samples are taken mainly in the summer which is the season of most tourism and is crucial in terms of public concern and impacts. The major goal of this study is to determine if human activity is causing accelerated eutrophication in selected Yellowstone lakes. There is concern that human activity on and around the lakes, along with natural processes, are causing the water quality to decline. Other goals are monitoring of trends, documentation of current trophic conditions, identification of possible areas of concern, and implementation of corrective solutions. There have been significant efforts made to monitor lakes in the

USA. I will discuss how the costs and benefits of these efforts are appropriate for highly visible lakes where concerns are justified, and where problems may be unnoticed. This is certainly the case of the low to moderate eutrophication of lakes in Yellowstone Park. We were unable to find any previous literature that defined the trophic states of the Yellowstone lakes. So another objective of our study is to develop a nutrient data and trophic state classification baseline to which future evaluations can be compared. We are publishing our results in an open access hydrologic data information system developed by CUAHSI. Data are loaded into a HydroServer web site which exposes the data to the broader water resources community for direct retrieval.