Model

Vorster, 1984.

Reference

Vorster, Peter. A Water Balance Forecast Model for Mono Lake, California. Draft Master's thesis, Hayward State University, California, 1984.

Study Area

Mono Groundwater Basin.

Time Interval

Annual--water year, October 1-September 30.

Base Period

1937-1983. The base period was selected to: (1) to be as long as possible given available data; and (2) to allow the calibration and verification periods to include both wet and dry periods.

Water Balance Components

Precipitation-Vorster developed an isohyetal map based on precipitation and snow course information through 1983. This component was evaluated for (1) the Grant Lake surface, (2) Mono Lake surface, and (3) groundwater basin land surface.

The Grant Lake precipitation was included in its net evaporation.

Mono Lake precipitation was computed as the product of average lake precipitation (8"), an annual index based on the Cain Ranch record, and an annual lake area.

Average precipitation on the groundwater basin land surface was adjusted to account for evapotranspiration using a Thornthwaite balance; resulting unused precipitation was estimated at a constant 9000 AF/yr.

Runoff-Sierra Nevada gaged runoff was quantified using existing gage records.

Ungaged Sierra runoff was computed by applying the average rainfall/runoff relationship of the gaged Sierran watersheds to the ungaged areas. Annual variations were derived from an index based on the annual runoff of gaged Sierran streams.

Non-Sierran runoff was computed as 90% of the soil moisture surplus calculated through a Thornthwaite soil moisture balance. No annual variation was included.

Evaporation-Evaporation rates were computed for Mono Lake, Grant Lake, and bare ground.

The Mono Lake evaporation rate (45") was based on seasonal freshwater pan evaporation rates from the Simis station, corrected with a pan coefficient and adjusted to an annual rate. The rate was also adjusted for salinity.

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Evaporation at Grant Lake was computed for three periods: (1) 1945-1983, using LADWP records; (2) 1941-1944, extrapolating the 1945-1983 average rate; and (3) 1937-1941, applying the average evaporation rate to the average 1937-1941 lake surface area.

Bare ground evaporation was evaluated for lagoons, and for high water table areas above 6428 feet, between elevations 6428 and 6402 feet, and from 6402 feet to the shoreline. Estimates were based on depth to water table information, lake level data, and evaporation studies in nearby playas and valleys. Annual variations are based on lake levels, and concomitant acreages in the high water table zones.

Evapotranspiration-for xerophytic plant areas in the groundwater basin area, evapotranspiration was included in the net land surface precipitation. Evapotranspiration rates were estimated for riparian areas, irrigated areas, and high water table areas above and below elevation 6428 feet. Evapotranspiration rates were based on climate data from the Simis and Cain Ranch stations and on the Blaney-Criddle formula. Rates were applied to acreages derived from vegetation maps based on aerial photos, surveys, and other sources.

Diversions-diversions considered in Vorster's model include the Virginia Creek import, diversions into the groundwater basin for municipal and domestic use, Los Angeles' surface water and groundwater exports.

Virginia Creek imports were estimated at a constant 1000 AF/yr based on considerations of irrigation supply and demand, and observations of flows in the diversion ditch.

The net municipal and domestic diversion is based on examination of water supply, consumption, and disposal in the June Lake area, Lee Vining, Mono City, and other residential areas.

The evaluation of LADWP surface water exports is based on their records of flow to the West Portal.

The groundwater export is assumed to be 60% of the tunnel make.

Storage changes-storage changes are quantified for soil water, Grant Lake Reservoir, groundwater, and Mono Lake. Soil water storage changes are assumed negligible.

Evaluations of Grant Lake storage are based on LADWP records for the period 1940-1983, and on estimates of inflows and outflows for 1937-1940.

Soil water storage changes were assumed to be negligible.

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Groundwater storage changes are evaluated for the shallow aquifer zone adjacent to and influenced by the lake by estimating the total storage change over the entire study period using an approximate specific yield value. Estimates of annual groundwater storage change are based on storage changes in the lake.

Mono Lake storage changes are computed in the model as the residual, and for calibration purposes also are computed from lake level records and a stage/volume curve based on the Scholl bathymetry.

Calibration

The model was calibrated over the period 1957-1983, using a multiple regressions analysis. According to this analysis, almost half of the overall error could be attributed to errors in evaluating annual variations in Mono Lake evaporation and gaged Sierran runoff. Calibration of the model produced a good fit between computed and actual lake levels.

Verification

The model was verified over the period 1937-1956, and errors in the quantification of the components were assessed.

Purpose of Balance

To determine the effect of diversions on the size and salinity of the lake, and to identify systematic errors in the network of hydrometeorological sites.

Comments

Peter Vorster's model is the most rigorously developed and most complete hydrologic model developed for the Mono Basin.

The consideration of water balance components is detailed and well documented. Most of the components take annual variations into account; however, the evapotranspiration components, non-Sierran runoff and net land surface precipitation were based on average values, assumed constant.

The water balance is both calibrated and verified, and errors in the model are analyzed.