WATERLINE RECESSION IN FARM PONDS

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In regions of limited rainfall or in areas where geological formations do not favor the absorption of water, farm ponds are an important source of water for livestock. The severe drouths of 1934 and 1936 have stimulated the construction of farm ponds to provide a more adequate water supply than was previously available. During the past four years more than twenty-three thousand farm ponds have been constructed in Oklahoma.

Evaporation of water from reservoirs is an important problem in areas where water is used for irrigation. Some of the earlier investigations on this subject were reported by Bigelow (1908) who made an attempt to correlate the evaporation of water from reservoirs with evaporation of water from open metal tanks. During the past thirty years different investigators have studied this particular problem and some general recommendations have been made concerning the probable loss of water from reservoirs as a result of evaporation. Experiments conducted by Sleight (1917) and by Rohwer (1931) indicate that evaporation from reservoirs is much less than the evaporation of water placed in small open metal tanks. A rather complete bibliography on evaporation from land and water surfaces has been assembled by Thornthwaite and Holzman (1942). Follansbee (1933) compiled evaporation data from a large number of reservoirs and compared this information with Weather Bureau records with varying results. He also reported that variations in humidity, low wind velocity, and temperatures do not affect the ratio between water loss from Class-A pans and reservoirs. This information does not agree with results obtained by other investigators who have found that each of these three factors has an important influence on rate of evaporation when the other two factors are constant.

Rohwer (1931) found that a standard evaporation pan as used by the U. S. Weather Bureau gives results which are approximately 42 percent higher and a buried tank three feet square gave results 26.6 percent greater than loss of water from a large reservoir. Metal tanks six feet in diameter have been buried in the soil at all of the Dry Land Field Stations in the Great Plains area. The temperature of the water in these pans is lower than the temperature of water in a Class-A Weather Bureau pan during the summer months when rapid evaporation occurs; consequently, there is less evaporation under such conditions.

Several investigators have devised mathematical formulae which can be used to calculate the loss of water from reservoirs under different climatic conditions. One of the difficult problems in using a formula is to obtain experimental data on the variations in temperature, wind velocity, and humidity for a particular locality.

One of the important problems of comparing the evaporation from an open metal tank with loss of water from a reservoir is the location of the tank. Experiments by Harding (1933) indicate that a 25 percent variation in evaporation will be obtained from open metal tanks in exposed areas as compared with similar installations protected from the wind.

EXPERIMENTAL RESULTS

Rainfall in central Oklahoma was relatively low from June to September, 1943. Excessive rainfall occurred in May; consequently, all farm ponds were filled and ample opportunity occurred to saturate the banks, which would reduce seepage to a minimum. During the summer of 1943 there was practically no runoff except in limited areas from local thunder showers. Rainfall occurring at the Red Plains Conservation Experiment Station near Guthrie, Oklahoma, did not produce any runoff from the bare fallow control plot, which loses more water by surface movement than any other plot, from June 8 to October 2, 1943, a period of 115 days. Although the temperature of the summer months was not high when compared with that of 1934 or 1936, the water level in farm ponds was reduced because of the rather long period of drouth to a very low point, many of them being dry in September 1943. This condition provided an opportunity to obtain measurements on some of these ponds to determine the relationship between recession of waterline in farm ponds and evaporation data from Class-A Weather Bureau tanks.

Measurements were made on 32 farm ponds on September 16, 1943. Data on the reduction of the waterline in these ponds are given in Table I. It will be observed that the average reduction in waterline from these different ponds was 27 inches. The average evaporation of water from open metal tanks located at Lake Carl Blackwell, six miles west of Stillwater, Oklahoma, and at Norman, Oklahoma, was 37.44 and 35.72 inches, respectively, for these four months. The average rainfall for twelve different Weather Bureau stations located in north central Oklahoma for the four-months period from June to September 1943 was 6.74 inches, which is 49 percent of the normal rainfall for these stations. More rain occurred in the northern part of the area than in the southern part; consequently, some of the variations in waterline recession may be due to local runoff. Seepage was responsible for the higher value in one location (No. 27).

Since the average pond in Oklahoma is excavated where the subsurface soil contains a high percentage of montmorillonite-type clay, the downward movement of water would be very slow under such conditions. When the average rainfall is added to the average reduction in the waterline of these farm ponds, a total of 33.74 inches is obtained. This total would represent the total quantity of water evaporated during the four-months period if no rain had occurred. Some loss of water occurred from most of these ponds as the result of consumption by livestock but the quantity of water in most cases is very low as compared with total quantity of water evaporated. The average evaporation from open metal tanks at the two stations mentioned was 36.58 inches. The value of 33.74 inches for total evaporation from the ponds and 36.58 inches as the average evaporation from open metal tanks being used, it is observed that the evaporation from open metal tanks was 8.1 percent higher than the average loss of water from the farm ponds. According to these estimates it would be necessary to allow approximately the same depth in the average farm pond for the evaporation of water during periods of limited rainfall as is obtained from Class-A Weather Bureau tanks to insure a factor of safety which would be adequate to offset water loss by evaporation during drought periods.

TABLE I

A study of farm-pond waterline recession, due to severe summer drought, in north central Oklahoma (data collected on September 16, 1943) [a]

No.	Location	County	Muddy or clear	Approximate area in acres	Recession of waterline from spillway level in feet
1	4.8 mi. north of Stillwater	Payne	Muddy	1.0	2.64
2	4.6 mi. west, 3 mi. south of Morrison	Noble	"	0.5	2.29
3	3.0 mi. west, 1.5 mi. south of Morrison	"	"	2.0	2.86
4	3.2 mi. west of Morrison	"	"	7.0	2.38
5	3.0 mi. west, 2 mi. north of Morrison	"	"	0.5	2.13
6	3.5 mi. east, 4.5 mi. north of Sumner	"	"	1.5	2.34
7	6.0 mi. east, 2.4 mi. south of Redrock	"	Clear	2.0	1.80
8	6.0 mi. east, 1.0 mi. south of Redrock	"	Muddy	15.0	1.96
9	4.0 mi. east, 2.0 mi. south of Marland	"	"	1.0	2.37
10	4.0 mi. east, 0.5 mi. south of Marland	"	"	2.0	2.40
11	1.5 mi. north, 1.0 mi. east of Ponca City	Kay	"	2.5	2.22
12	4.0 mi. north, 3.5 mi. east of Ponca City	"	"	3.0	2.00
13	2.5 mi. west of Uncas	"	"	0.5	2.09
14	5.5 mi. north, 1.0 mi. east of Ponca City	"	"	1.0	1.79
15	5.0 mi. south, 2.5 mi. west, of Newkirk	"	Clear	1.5	1.88
16	1.0 mi. west of Nardin	"	"	5.0	2.02
17	4.0 mi. east, 2 mi. north of Hunter	Garfield	Muddy	0.5	1.66
18	4.0 mi. east, 1 mi. south of Hunter	"	Clear	0.5	1.60
19	4.0 mi. east, 1.5 mi. south of Hunter	"	Turbid	1.5	1.72

TABLE I (Continued)

A study of farm-pond waterline recession, due to severe summer drought, in north central Oklahoma (data collected on September 16, 1943) [a]

No.	Location	County	Muddy or clear	Approximate area in acres	Recession of waterline from spillway level in feet
20	4.2 mi. north of Garber	"	Muddy	3.0	2.64
21	0.7 mi. north of Garber	"	Clear	2.0	2.99 [c]
22	0.5 mi. north of Garber	"	Clear [b]	3.5	1.77
23	2.5 mi. north, 0.5 mi. west of Covington	"	Clear	4.0	2.47
24	1.7 mi. north of Covington	"	Muddy	2.0	1.97
25	2.3 mi. south of Covington	"	"	1.0	2.10
26	5.7 mi. south of Covington	"	"	1.0	2.32
27	3.5 mi. south of Marshall	Logan	"	4.0	3.47 [c]
28	7.0 mi. west of Guthrie	"	Clear	0.5	3.04 [d]
29	4.0 mi. east, 1.0 mi. north of Guthrie	"	"	3.0	2.26
30	7.5 mi. south, 0.5 mi. west of Stillwater	Payne	"	3.0	2.49
31	3.3 mi. south of Stillwater	"	"	1.5	2.26
32	2.8 mi. south of Stillwater	"	Muddy	1.5	2.36

[a] Livestock had access to all of these ponds. Some of them were in stream valleys and seepage was probably greater under these conditions. Rainfall in the northern part of north central Oklahoma may have raised the water level in some of the ponds, which offset loss by evaporation.

[b] Dense growth of vegetation in this lake.

[c] In stream valley.

[d] In sandstone formation.

Since stock-water ponds should be designed for maximum evaporation losses rather than average losses, evaporation losses during periods when runoff from rainfall is not likely to occur should be considered rather than total annual evaporation. Normally, runoff occurs during the spring months. Consequently, the ponds are full at the beginning of the warm weather season and the greatest quantity of water is lost at a time when conditions are most favorable for evaporation.

Evaporation records obtained at Stillwater for a ten-year period from 1932 to 1941 indicate that the evaporation in 1943 was below the average for this locality. In 1934, the total evaporation for June, July, August, and September was 54.6 inches. Heavy rainfall during the latter part of August 1934, replenished the water supply in farm ponds. In 1936 the evaporation for the same period was 50.5 inches but no rains occurred in the fall. Since rainfall in central and western Oklahoma is relatively low during the fall and winter months, runoff water may not collect in farm ponds until spring; therefore it may be necessary to use an evaporation value which will include losses during the fall and winter. Since loss of water in the winter is relatively low, total evaporation for an eight-month period would not increase appreciably over the four-month value. Many farm ponds are entirely too shallow, and cover rather broad, flat areas rather than deep, narrow channels where evaporation losses would be low as compared with the total volume of water in the ponds. The Agricultural Adjustment Agency has paid farmers for building over 16,000 farm ponds during the past four years. No requirements concerning an adequate allowance for loss of water by evaporation during critical drought periods have been made.

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