USE OF RAINWATER FOR WATER CONSERVATION IN MISSISSIPPI CATFISH PONDS

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INTRODUCTION

Water conservation in pond aquaculture has been a significant issue in the Mississippi Delta for some time due to lowering of water table levels. It is possible that, at some time in the future, producer access to groundwater may be limited or become significantly more expensive. It would be useful to have strategies available to decrease dependence upon groundwater should the above scenario occur.

Previous modeling work using historical rain data has suggested that ponds could be managed to use rainwater to reduce dependence upon groundwater (Wax and Pote 1990). Recent work along these lines appears to demonstrate that relatively minor modifications to existing ponds and pond management strategies may reduce ground water use even further. A corollary advantage to this approach is a potentially large decrease in the amount of water released to the environment from catfish ponds.

Typical catfish production ponds on the Mississippi Delta are levee-type, having surface areas of 5 to 7 ha and maximum depths of 1 to 1.1 m. The most significant determinant of maximum depth has been operator safety during harvesting: when depths much greater than 1.1m occur, water may fill the wading boots worn by workers and pull them under. The importance of operator safety on the farm has heretofore prevented serious consideration of increasing pond depths. As will be shown below, the elimination of this option may have been premature.

MODIFIED POND DESIGN AND MANAGEMENT

The approach described here is predicated upon the use of certain production ponds for water storage as well as production. By deepening the "storage" pond, additional volume becomes available to catch and hold rainwater. By opening a small culvert between the storage pond and adjacent production ponds, even a relatively modest rain event can substantially increase the amount of water "put into storage" (Figure 1). When production ponds require water, it is pumped first from the storage pond. Groundwater is used only when storage pond depth reaches the minimum required for production (~1m).

MODELING DESIGN AND MANAGEMENT CHANGES

A model was written and tested to explore the efficacy of the above approach to water conservation. Historical meteorological records were used for rain and evaporation (pond evaporation = 0.8 * *class A* pan evaporation). Percolation estimates were based upon typical infiltration rates in Mississippi Delta soils.

The model was implemented using *VisSim*, a block diagram graphical modeling package. Ponds were 5.6 ha, with the initial depth being 1.07 m. Minimum required depth for production was 1 m and overflow depth was 1.15 m. Two infiltration rates were used: 0 mm/day and 1 mm/day. Two pond configurations were tested (Figure 2):

1 production pond per production/storage pond; and
3 production ponds per production/storage pond.

Six management strategies were tested:

- Fill when 7.5 cm (3 inches) below full;
- Fill when 15 cm (6 inches) below full;
- Fill 7.5 cm when 15 cm below full (6/3 scheme, Wax and Pote 1990);
- 6/3 scheme plus 30 cm additional depth in production/storage pond;
- 6/3 scheme plus 60 cm additional depth in production/storage pond;
- 6/3 scheme plus 90 cm additional depth in production/storage pond.

Using the first 2 strategies, rain could be captured only when pond depth was between full and the fill depth. Using the third strategy, there was always 7.5 cm of available "storage." Using the latter 3 strategies, the available supplemental storage was augmented by the additional depth of the production/storage ponds.

RESULTS

The 6 management strategies were tested using the model and 26 years of historical meteorological data (1962-87) from Stoneville, Mississippi. The availability of supplemental storage capacity appreciably reduced the amount of groundwater required (Table 1). Depending upon the amount of supplemental storage provided (30 to 90 cm) and the soil infiltration (0 to 1 mm/day), the projected reduction in groundwater use was 36 to 80 percent relative to filling each time the water level drops 7.5 cm. A corollary advantage to the approach was a substantial reduction in the release of pond water to surface receiving streams. Within the same limits of supplemental storage and infiltration, projected reductions in release water were 54 to 88 percent relative to filling on a 7.5 cm drop.

Looking at yearly predictions of groundwater use and release of pond water, several other interesting consequences of using supplemental storage become apparent (Figures 3 and 4). First, there is virtually no release to surface waters during the warm months of the year. Release, when it occurs, is during times of the year when natural stream flows are high and temperatures are low. This suggests that the direct effects of nutrient release to the environment may be minimized by storing rainwater. Second, there are years when this approach results in the use of no groundwater and no release of pond water to the environment. Third, during most years, there will be many days (generally in the warmer months) when production/storage pond depth will be less than 1.15 m, making it possible to harvest these ponds without releasing stored water (Figure 5).

REFERENCE

Wax, C. L. and J. W. Pote. 1990. A climatological basis for conservation of groundwater in aquaculture in the Southern Region. MS Agr. & For. Exp. Stn. Tech. Bull. 169.

Table 1: Simulated groundwater use and release to surface waters for 1 production/storage pond per production pond and 2 infiltration rates using 26 years of meteorological data.

	Infiltration = 0				*Infiltration = 1 mm/day*			
Strategy	Groundwater Use (m^3)	% reduction	Release (m^3)	% reduction	Groundwater Use (m^3)	% reduction	Release (m^3)	% reduction
Fill on 7.5 cm drop	148,350		160,320		214,600		121,806	
Fill on 15 cm drop	126,120	15	138,090	14	187,930	12	95,800	21
6/3 Scheme	102,500	31	114,610	29	165,500	23	72,700	40
6/3 Scheme + 30 cm	61,910	58	74,030	54	131,780	36	38,980	68
6/3 Scheme + 60 cm	41,810	72	53,930	66	114,830	46	22,010	82
6/3 Scheme + 90 cm	29,730	80	41,840	74	107,190	50	14,380	88

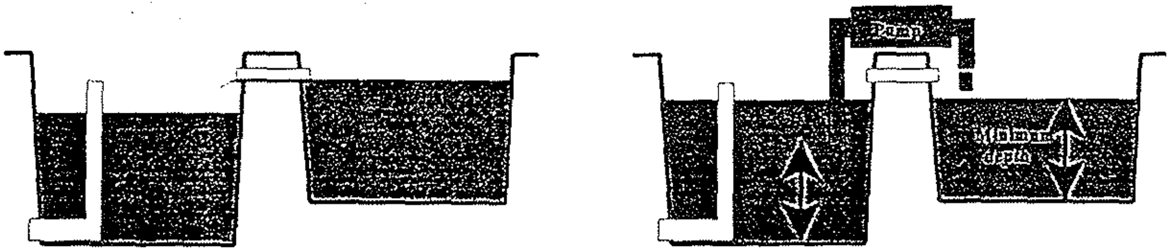

Figure 1. Ponds collecting (left) and using (right) rainwater.

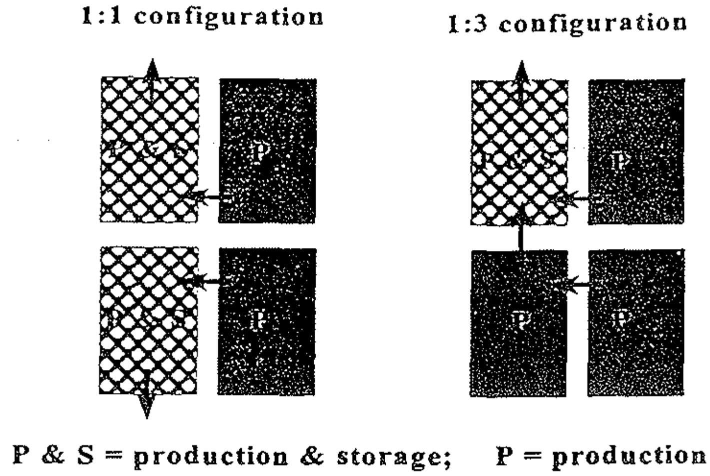

Figure 2. Configurations: 1 production/storage pond per production pond (left); 1 production/storage ponds per 3 production ponds (right).

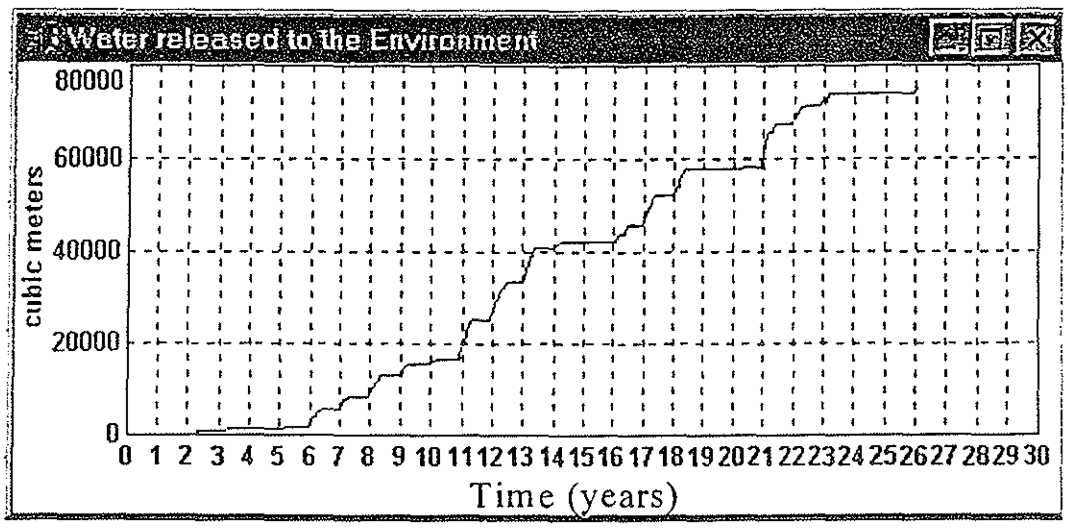

Figure 3. Predicted water release during the 26 year simulation (30 cm supplemental storage in the production/storage pond). Vertical lines represent the beginning/end of the calendar year.

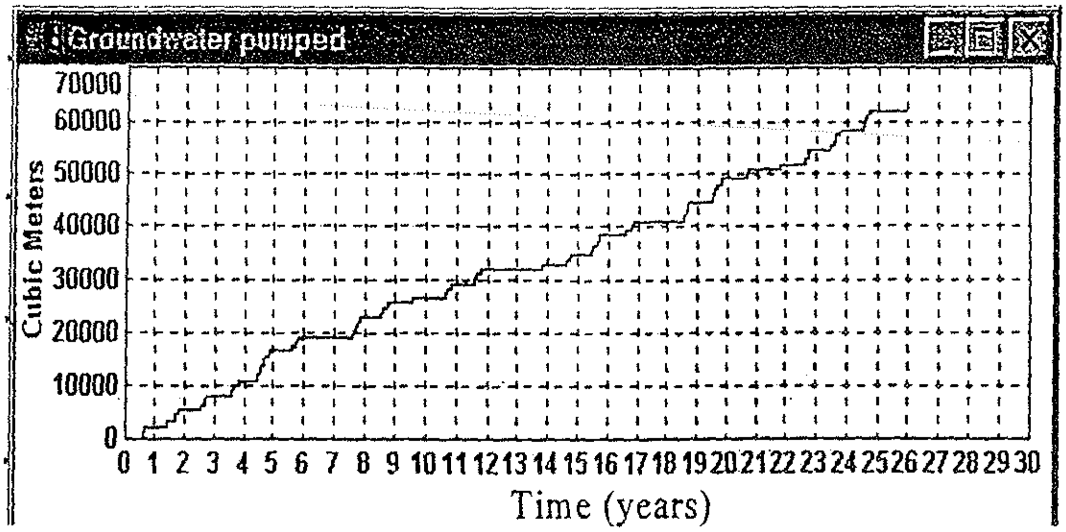

Figure 4. Predicted groundwater use during the 26 year simulation (30 cm supplemental storage in the production/storage pond). Vertical lines represent the beginning/end of the calendar year.

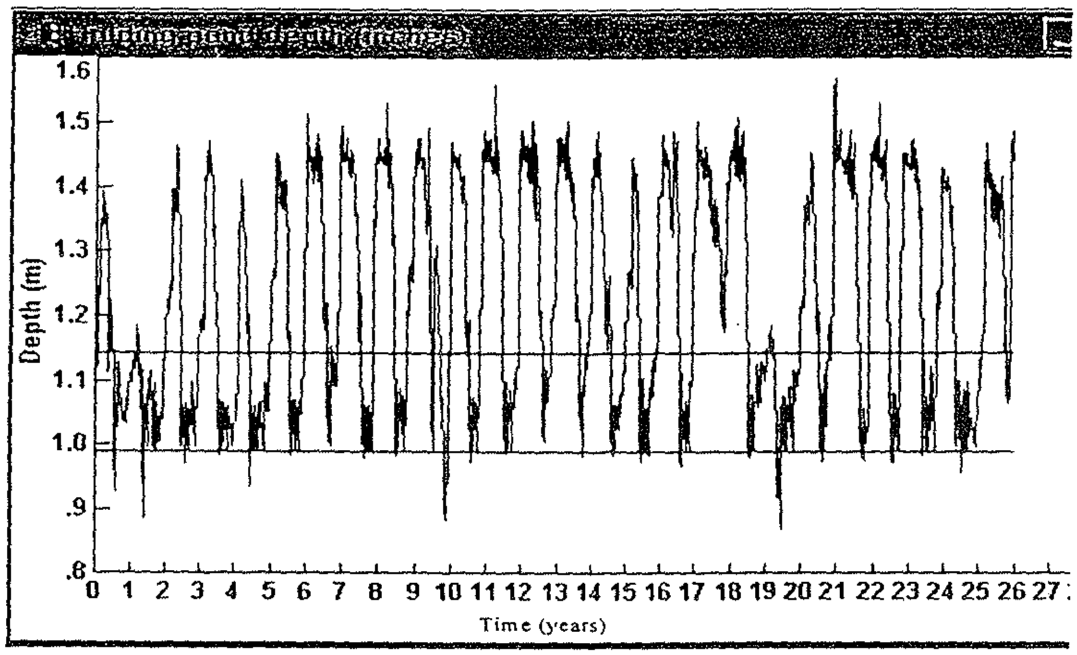

Figure 5. Production/storage pond depth during the simulation. Depths less than 1.15m (marked on the graph) represent days when harvesting is possible without release of stored water.