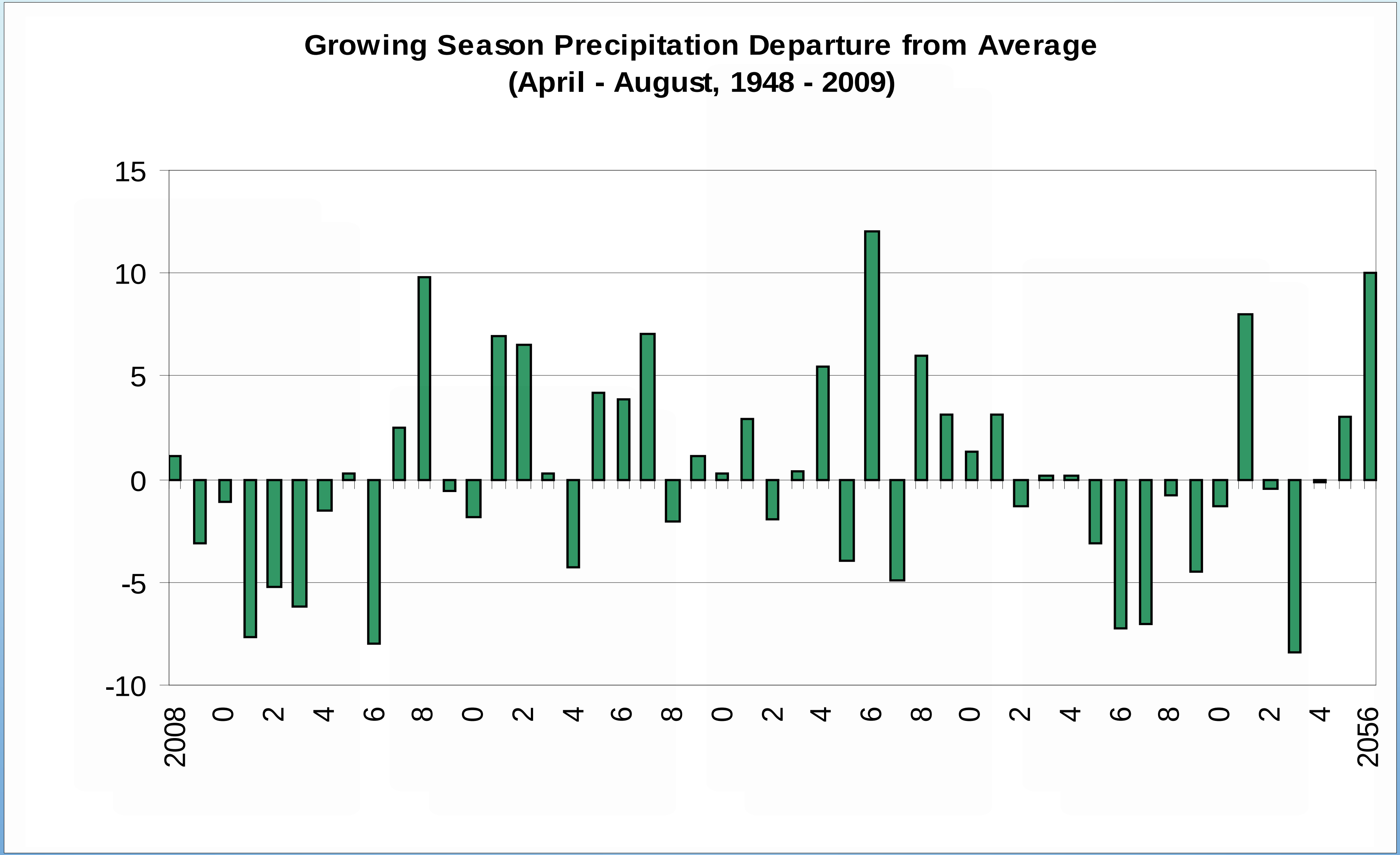
Climatological Variability-the driver



Using data and simulation techniques similar to those used in the catfish project, we are armed to hunt for solutions to this new question

Fox hunting

Tailwater Storage Pond

Tailwater Recovery Ditch

USE OF SURFACE WATER - RESERVOIRS

- **Example: 300 acre farm**
  - **10 acre reservoir**
  - **9 feet deep**
  - **90 acre feet of water**

USE OF SURFACE WATER - DITCHES

- Example: 3720’ ditch
  - 12’ wide x 6’ deep
  - 12 acre feet of water
  - From tailwater recovery and rain capture

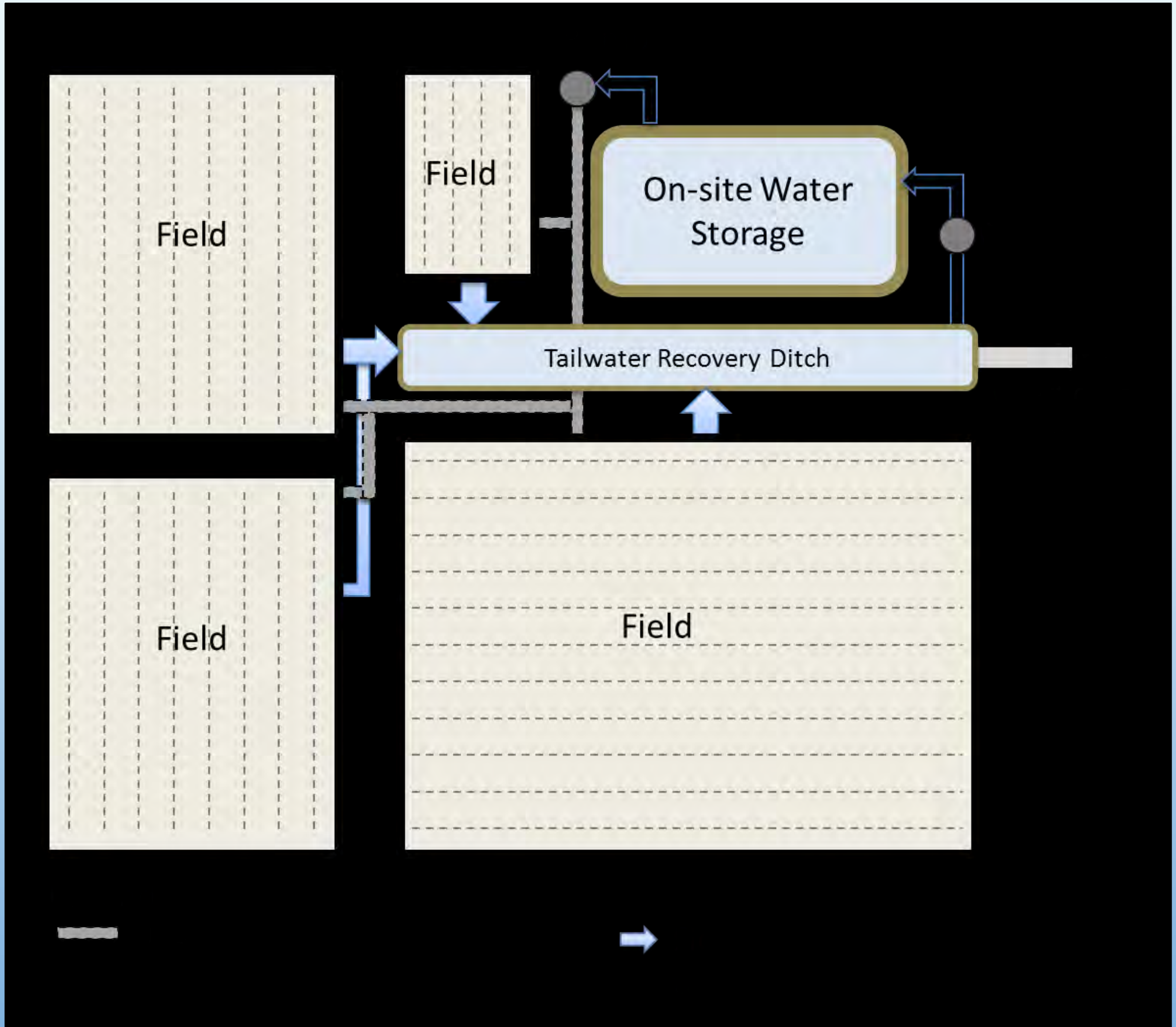
USE OF SURFACE WATER – DITCH TO RESERVOIR

Reservoir

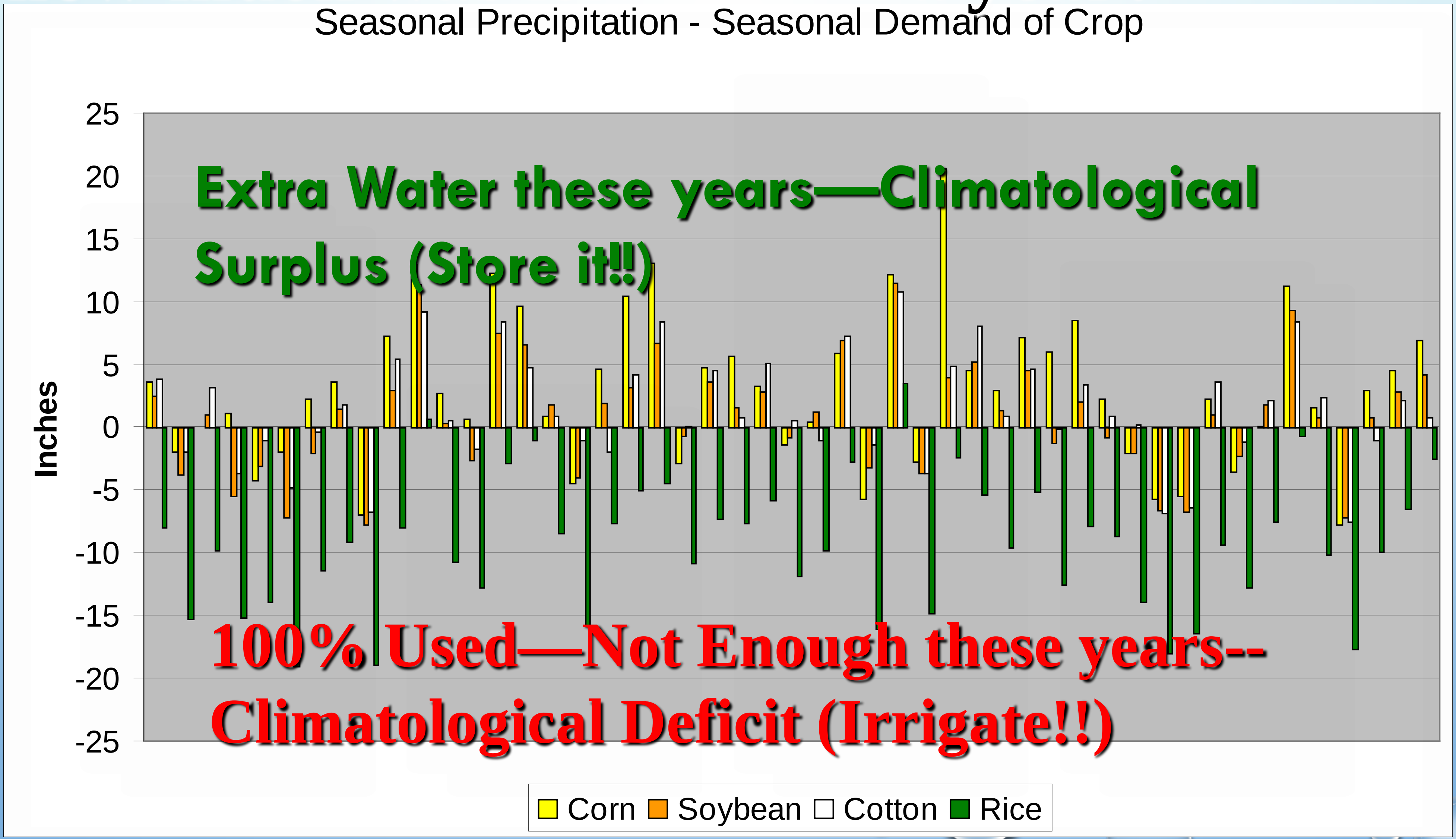
Ditch

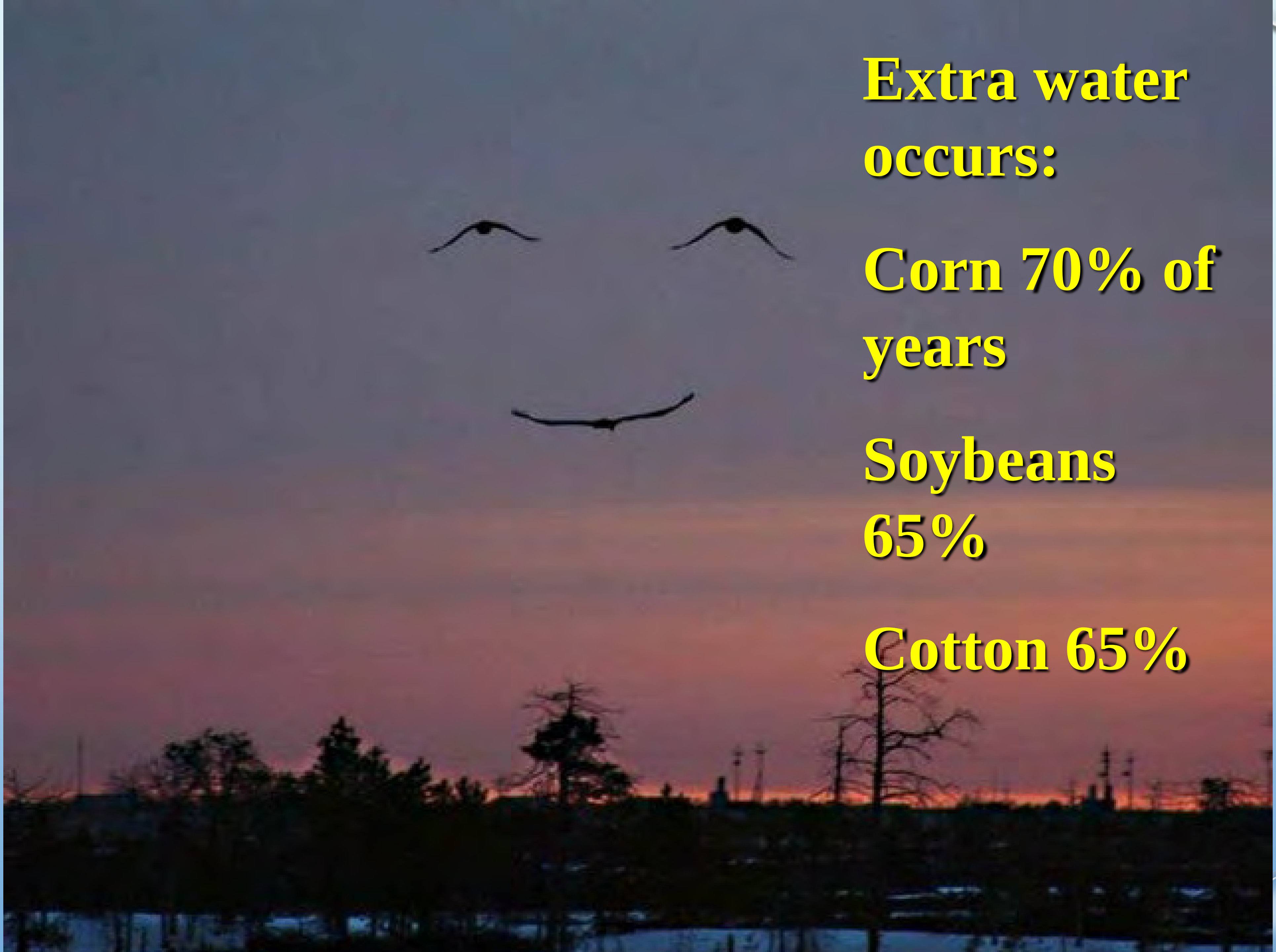
Pump

LAYOUT


Field
Field
On-site Water Storage
Tailwater Recovery Ditch
Field
Field

How much of the rain each season could the crops use, how much was left over in a year?





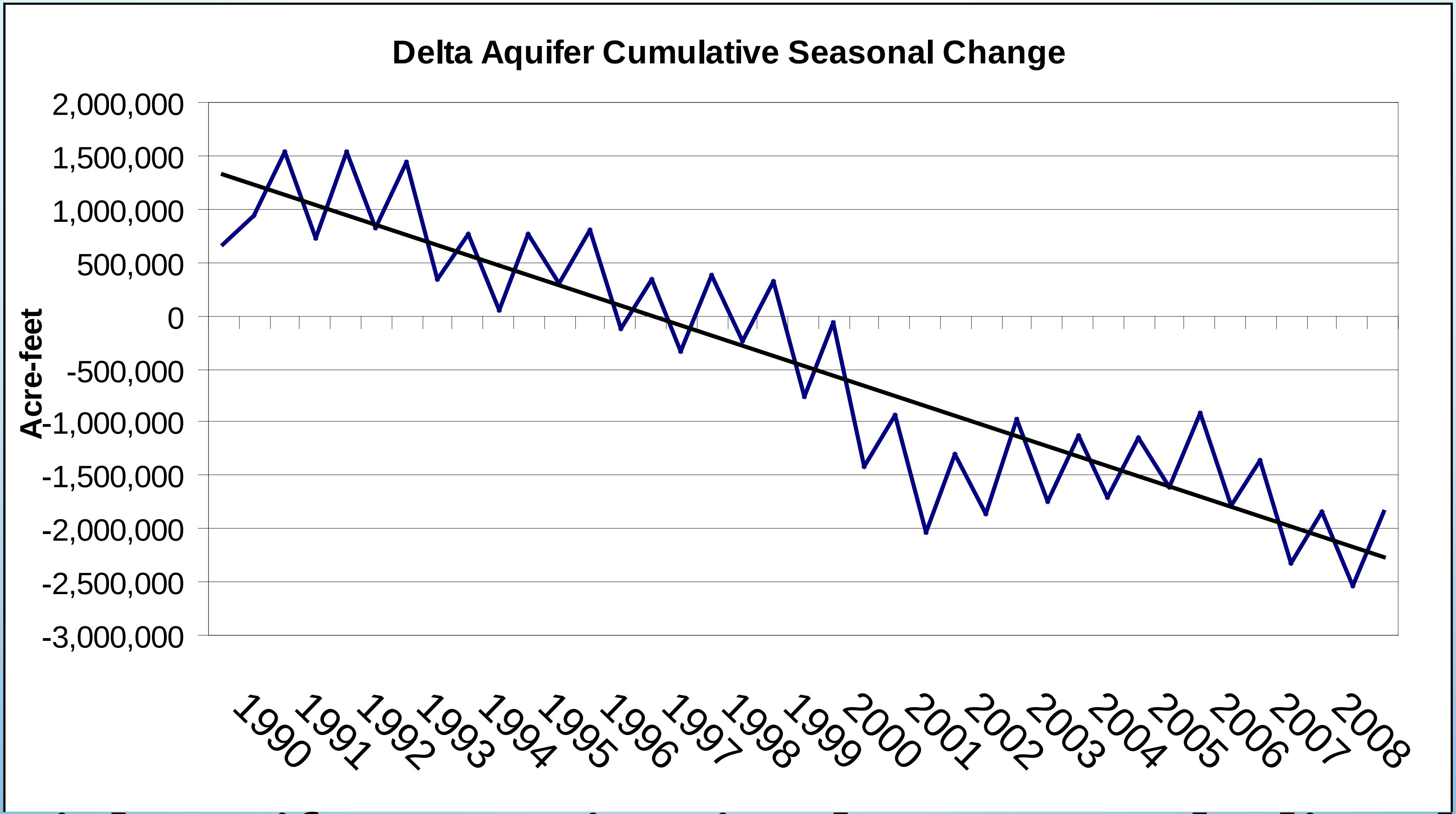
Extra water occurs:

Corn 70% of years

Soybeans 65%

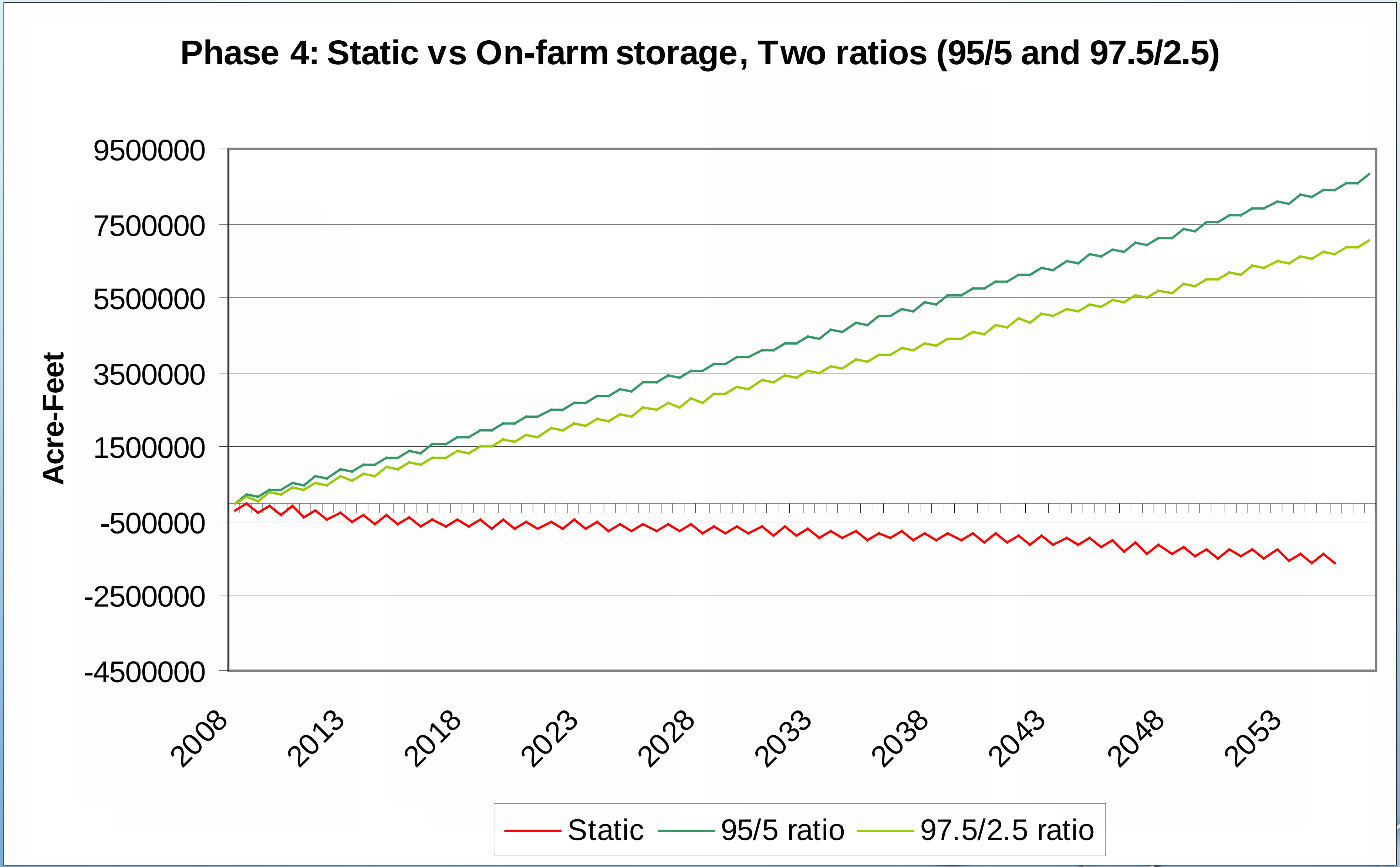
Cotton 65%

REMEMBER THIS PROBLEM?



- **Alluvial aquifer experiencing long-term decline due to the increasing demand for irrigation**

This is how well the on-farm capture of precipitation could work to save groundwater, reversing long-term decline

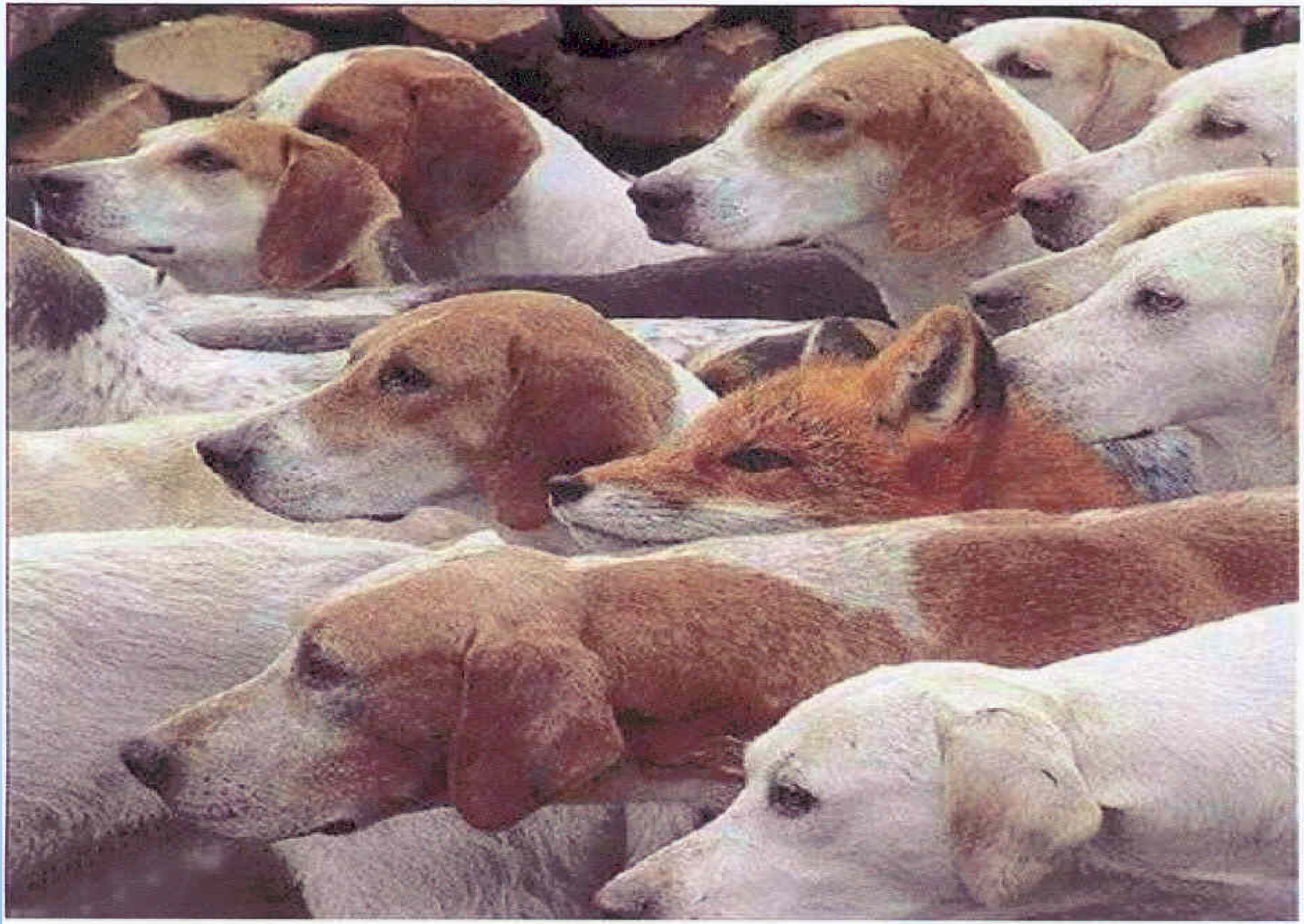


CONCLUSIONS

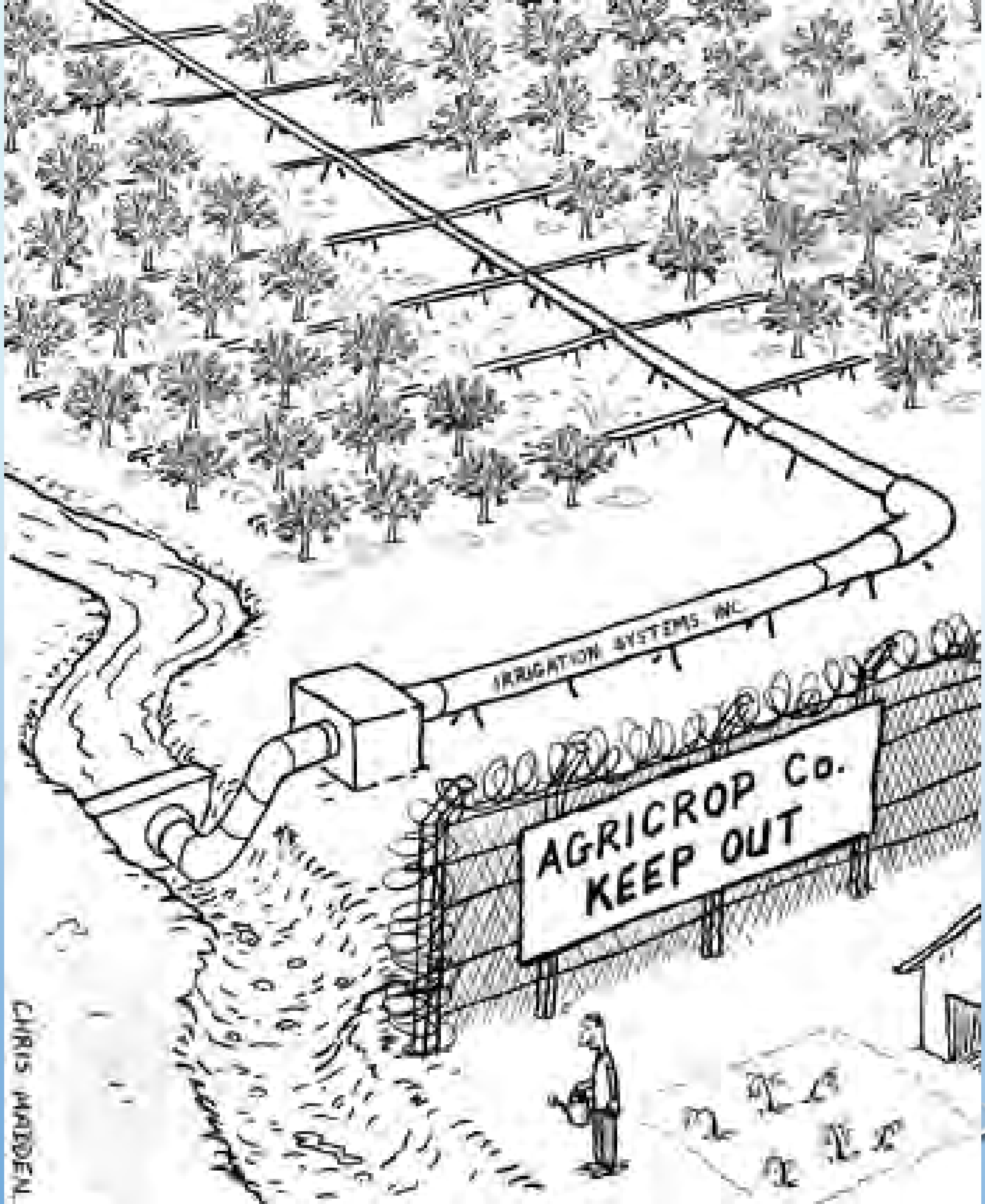
- **Minimal adoption of on-farm storage management system could potentially conserve 48-percent, 35-percent and 42-percent of groundwater for cotton, corn and soybeans, respectively**

(By capturing and storing excess precipitation!!)

If we're wrong about this…!



When you are in deep trouble,
say nothing, and try to look inconspicuous.



But, not all the surface water can be held for irrigation—some must be allowed to continue in the streams (new research??)

The river above the river—Magdeburg Water Bridge, Germany

River high, river low…..

Saw one farmer with a pump in a river (little sunflower)

Water was always too high or too low

So we realized we could capture the highest flow

VALUE OF WATER

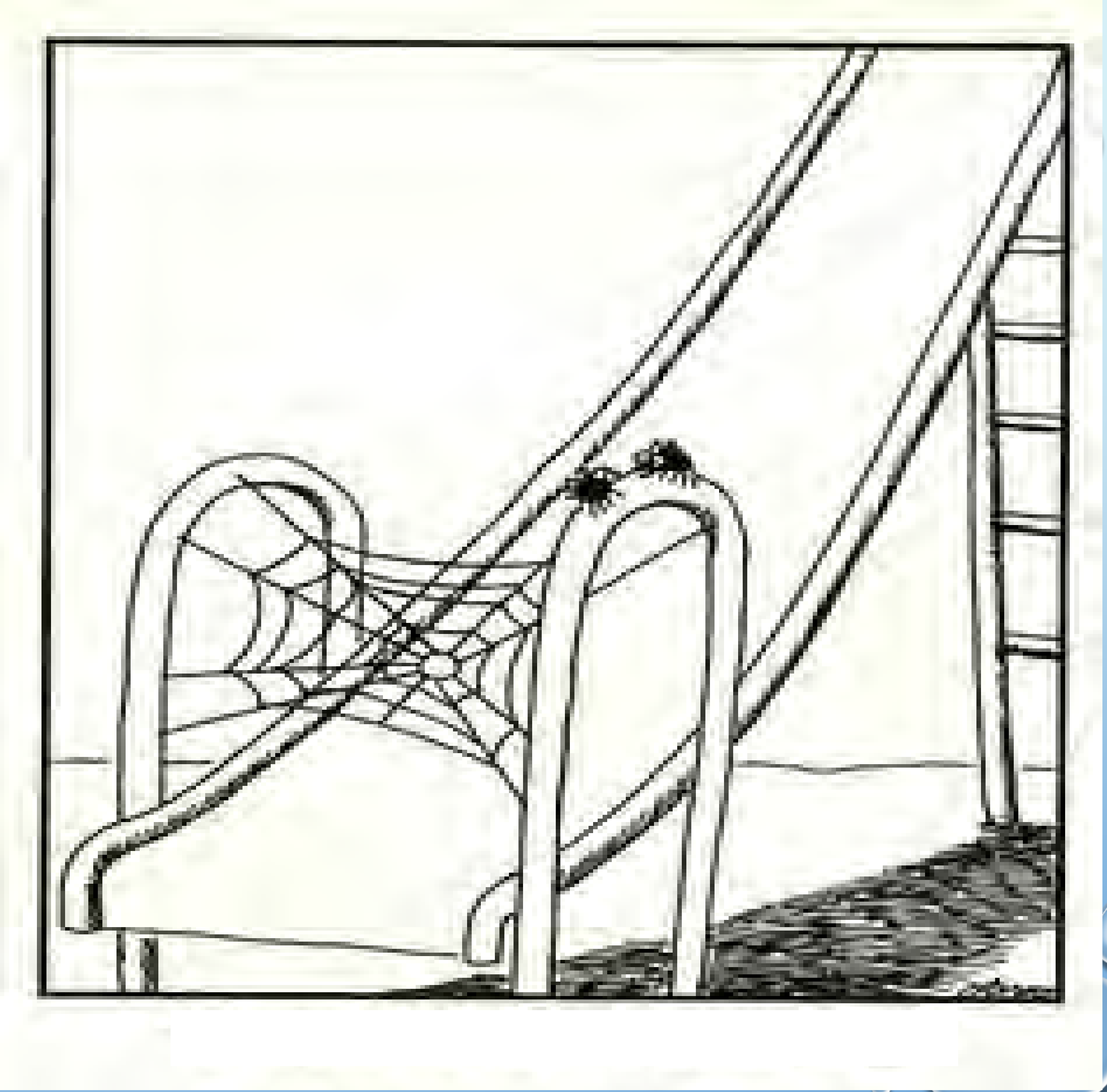
- **When river is low, competition between ecology and users increases the value of the water as it drops**
- **When river is high, plenty of water for all users, low value**
- **When river floods, value of water is negative**

Excess Water with Negative Value—Store it and make it positive!

VALUE OF WATER, Cont'd

- **Mississippi is blessed with a lot of water, <u>but it is not where we need it when we need it – "feast or famine"</u> (as compared to State of Washington, Columbia River)**
- **Many of our research projects are aimed at this problem – <u>capturing excess water when it is available for use when it is not available</u>**
- **If we can solve that, we will eat like kings!!**

“If we pull this off, we’ll eat like kings”



CONCEPT

- **Use a broad-crested weir and holding pond to capture high river discharge**
- **Note that the weir is not in the stream, but on the side**
- **It allows flow across it only at predetermined high stages**

SIDE DISCHARGE BROAD-CRESTED WEIR

DATA NEEDED FOR MODEL DEVELOPMENT

- Rainfall (Iuka plus Booneville)
- Evaporation (MSU)
- Stage of river (USGS Little Yellow Creek)
- Discharge of river (Little Yellow Creek)
- Use stage/discharge relationship for location to fill in missing data
- Daily for as long as possible (post TTWW, 1974 – 2010)

DATA NEEDED FOR MODEL DEVELOPMENT, con’t

- For 37 years of daily river discharge, rank every daily number (13,500) from highest to lowest
- Find 80th, 85th, and 90th percentile discharge and mark the corresponding gauge height
- Assume industry water use of .25mgd, .5mgd, and 1mgd

MODEL CREATION-37 YEARS OF DAILY RECORD

- 30 acre and 60 acre holding ponds 10 feet deep (300 and 600 a-f)
- Set weir at 80^{th}, 85^{th}, and 90^{th} percentile elevations
- Rainfall on pond directly increases pond depth and volume
- Rainfall on watershed mostly runs into the lake
- Evaporation reduces volume of lake
- Daily removal of industry water used
- If lake is above maximum, it does not increase
- If lake is below zero, it does not decrease, and none can be used

MODEL CREATION-37 YEARS OF DAILY RECORD, con't

- If river stage is below weir elevation, no water is captured
- If river stage is above weir height, calculate captured flow into pond for that day
- Remove water consumed by industry daily
- Repeat daily for entire period, and analyze by annual totals
- Note that analysis of river and weather data is separate

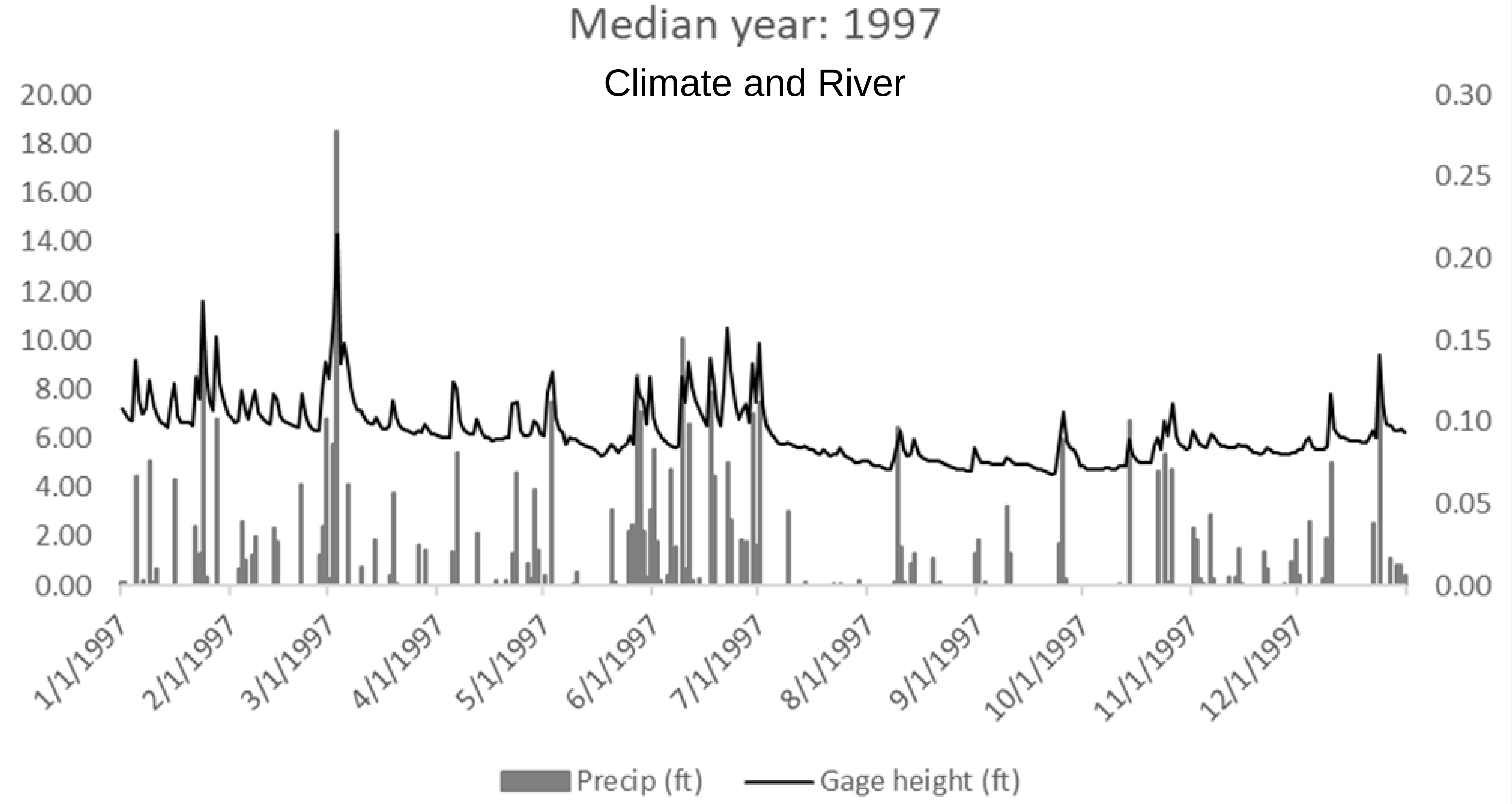
SPREADSHEET-example of model simulation

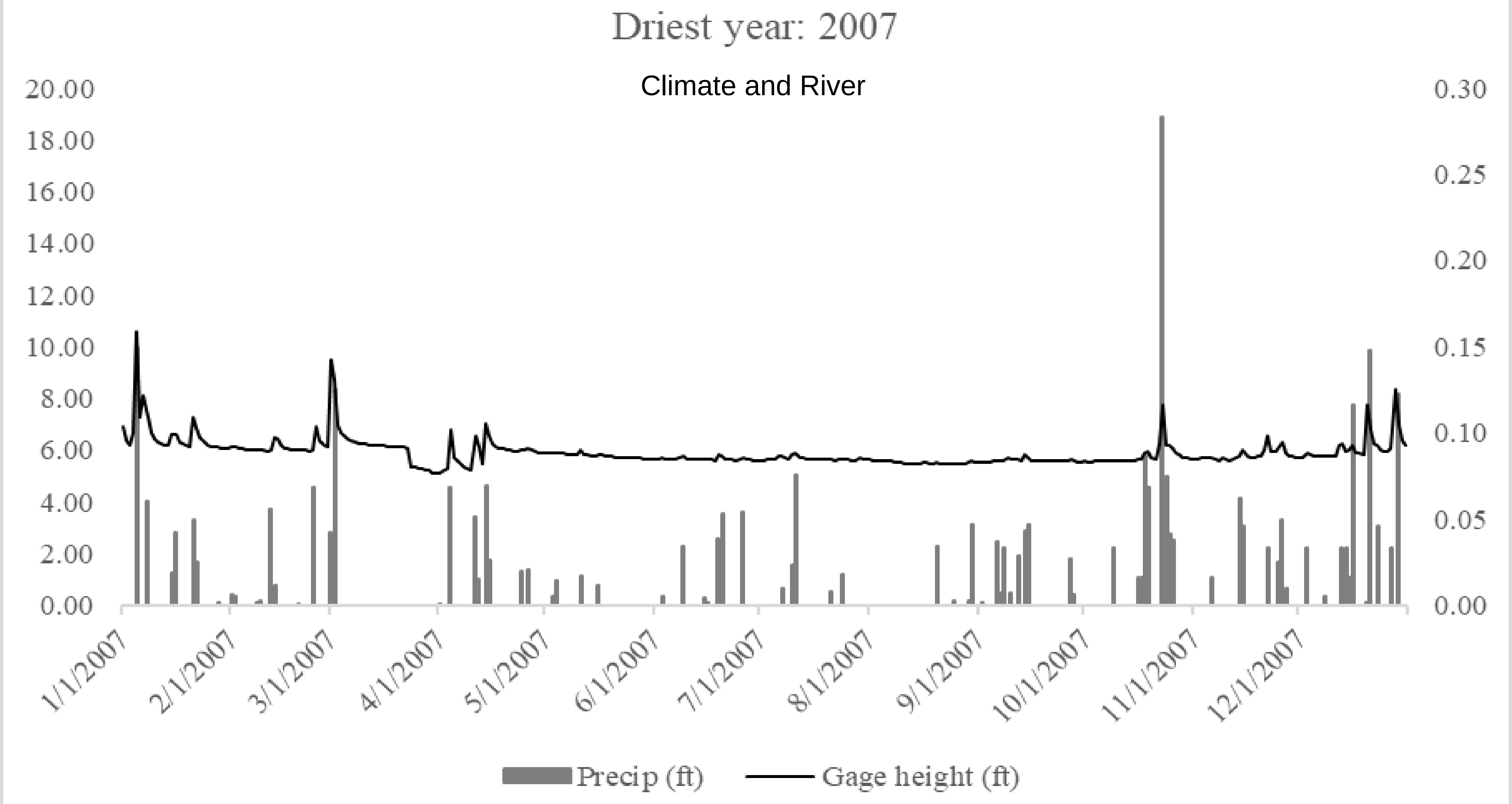
1974			Lake	Basin	Weir height		C = 1.6	Width = 2m (6.56ft)			Total	Total Lake
	Daily P-E	Gage height	(P-E*lake area)	P-E*basin*0.7	Above Weir	Above Weir	Weir Q	Weir Q	Daily Q	Daily Q	Daily Q	Volume
Day	(feet)	Ft	(A-F)	(A-F)	ft	m	cms	cfs	ft^3	a-f	a-f	a-f
1	-0.002	7.62	-0.06	0	0.810392646	0.247070929	0.39299086	13.86864745	1198251.14	27.51184617	27.45184617	326.6908343
2	-0.005333333	7.19	-0.16	0	0.379679431	0.115755924	0.126027354	4.447505316	384264.4593	8.822711986	8.662711986	334.5925345

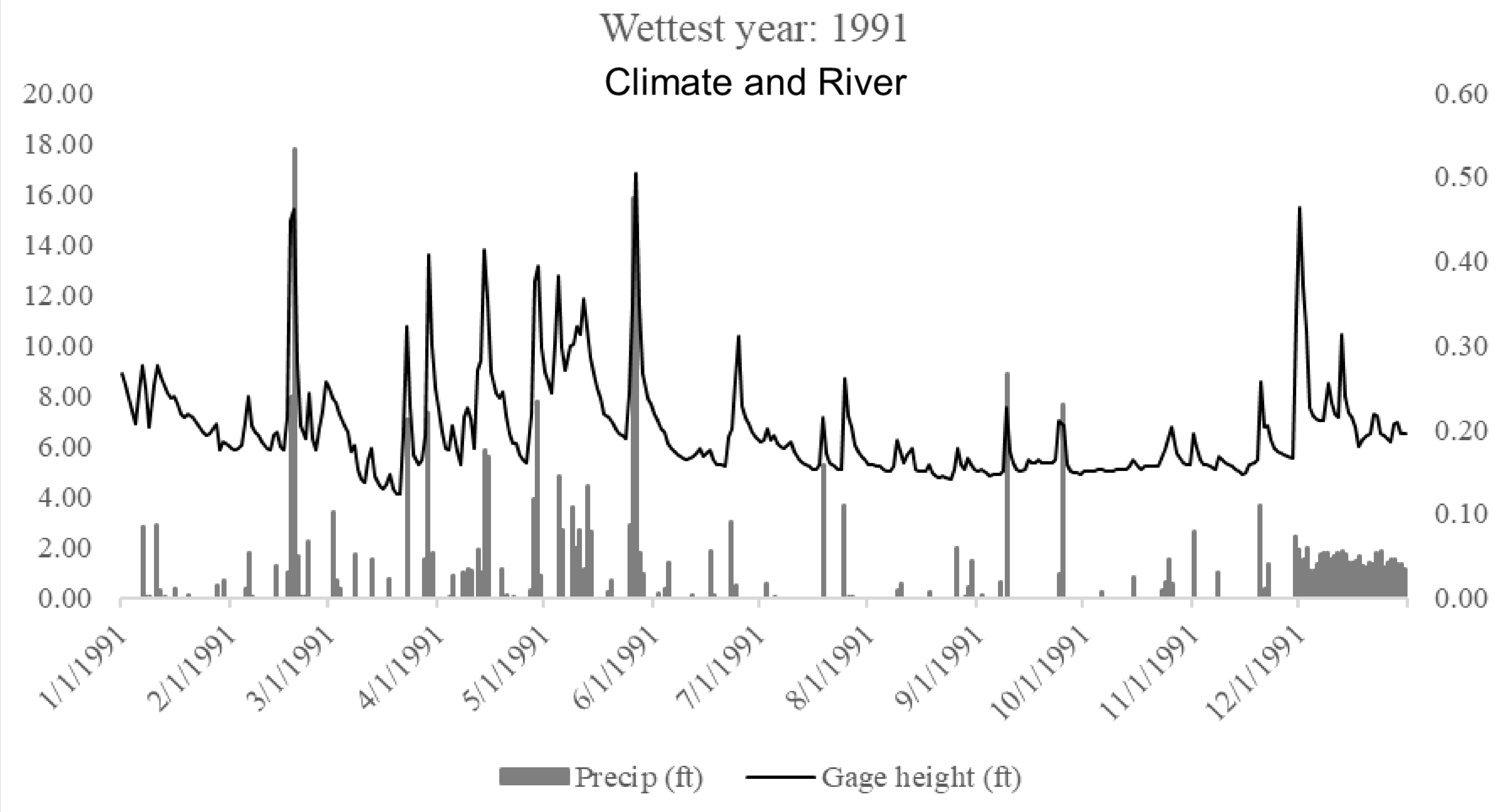
Light at the end of the tunnel

RESULTS

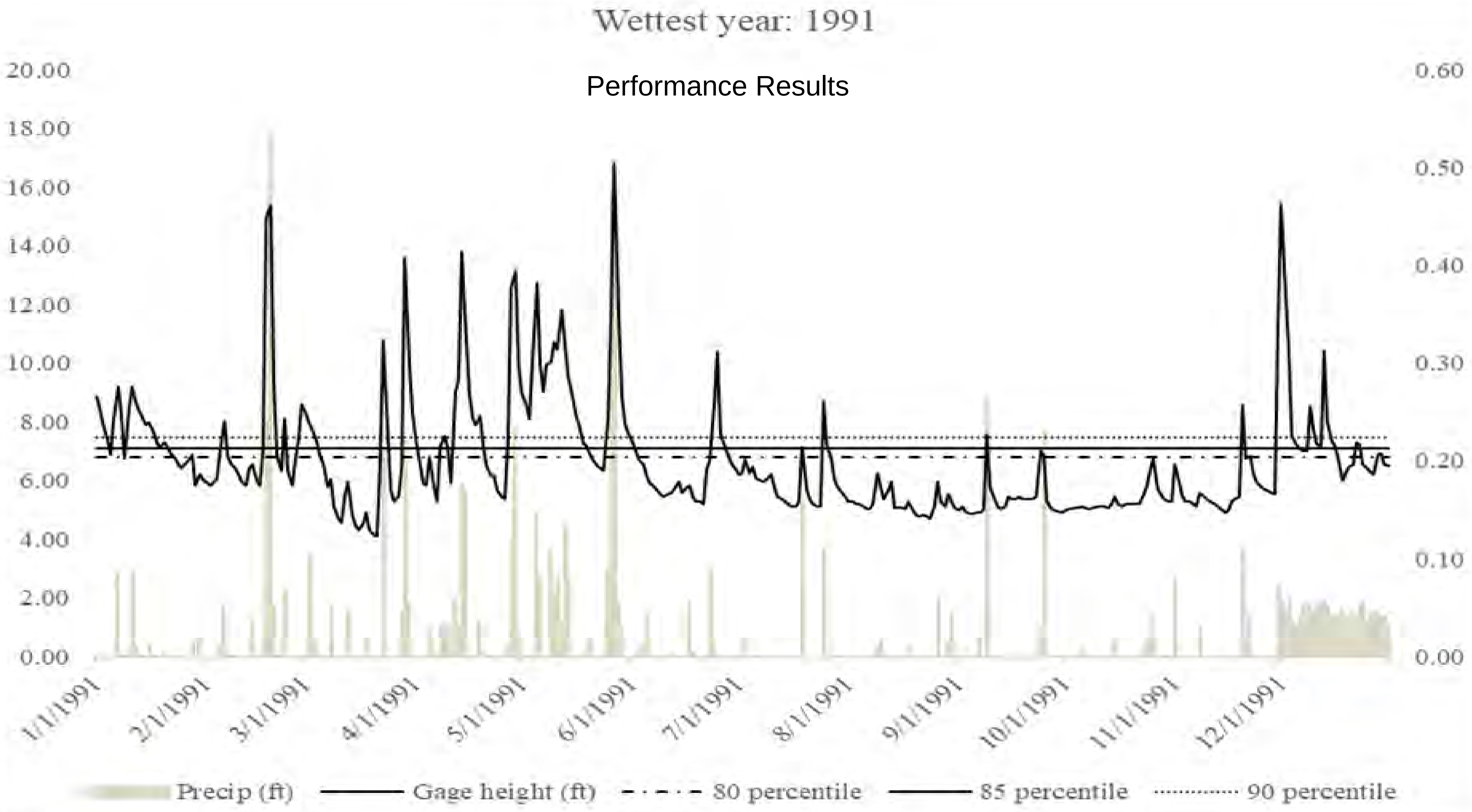
- Typical behavior of river and climate
- Performance of system


Median year: 1997
Climate and River
20.00
18.00
16.00
14.00
12.00
10.00
8.00
6.00
4.00
2.00
0.00
0.30
0.25
0.20
0.15
0.10
0.05
0.00
1/1/1997
2/1/1997
3/1/1997
4/1/1997
5/1/1997
6/1/1997
7/1/1997
8/1/1997
9/1/1997
10/1/1997
11/1/1997
12/1/1997
Precip (ft)
Gage height (ft)

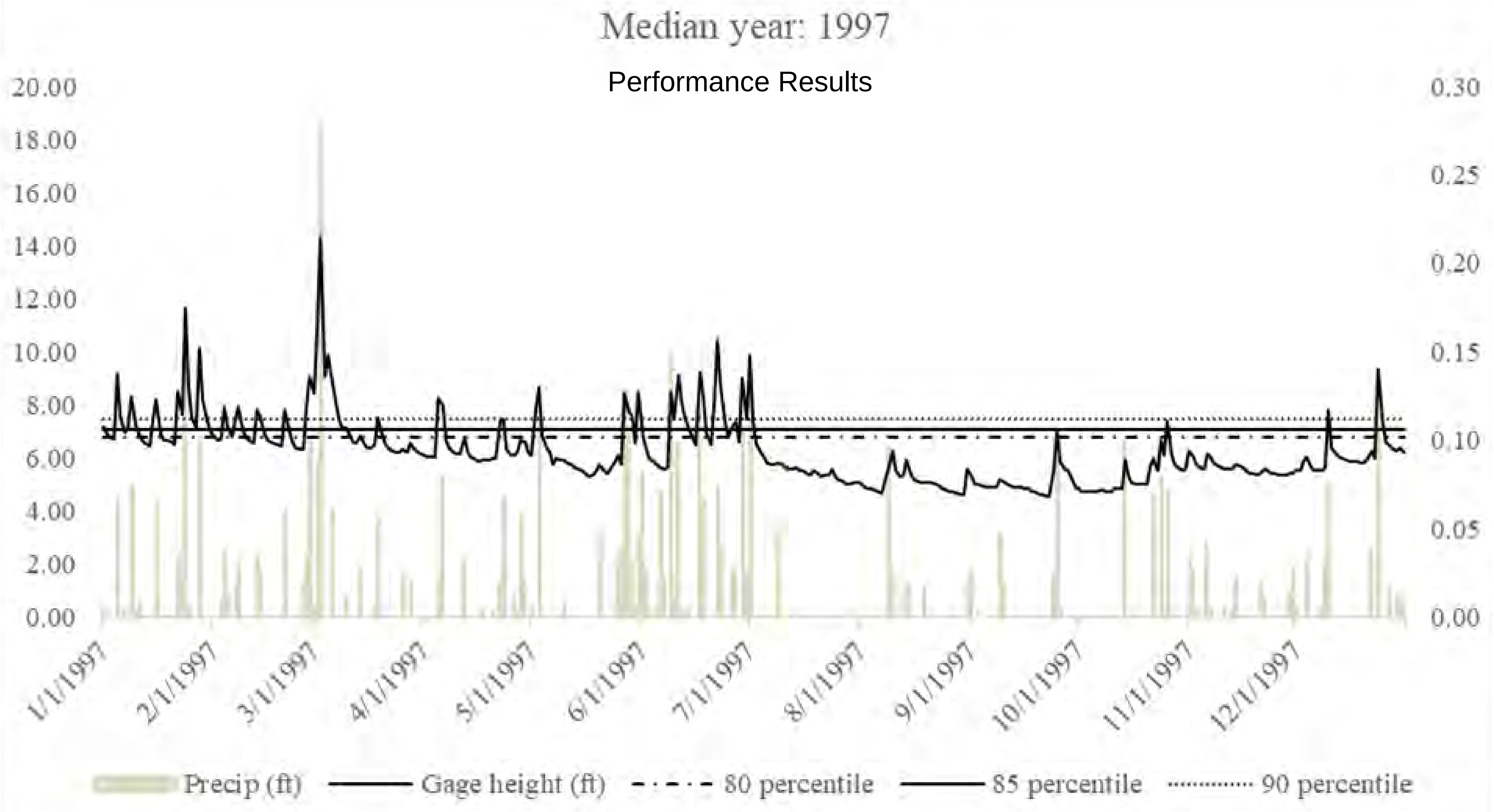

Driest year: 2007
Climate and River
20.00
18.00
16.00
14.00
12.00
10.00
8.00
6.00
4.00
2.00
0.00
0.30
0.25
0.20
0.15
0.10
0.05
0.00
1/1/2007
2/1/2007
3/1/2007
4/1/2007
5/1/2007
6/1/2007
7/1/2007
8/1/2007
9/1/2007
10/1/2007
11/1/2007
12/1/2007
Precip (ft)
Gage height (ft)


Wettest year: 1991
Climate and River
20.00
18.00
16.00
14.00
12.00
10.00
8.00
6.00
4.00
2.00
0.00
0.60
0.50
0.40
0.30
0.20
0.10
0.00
1/1/1991
2/1/1991
3/1/1991
4/1/1991
5/1/1991
6/1/1991
7/1/1991
8/1/1991
9/1/1991
10/1/1991
11/1/1991
12/1/1991
Precip (ft)
Gage height (ft)

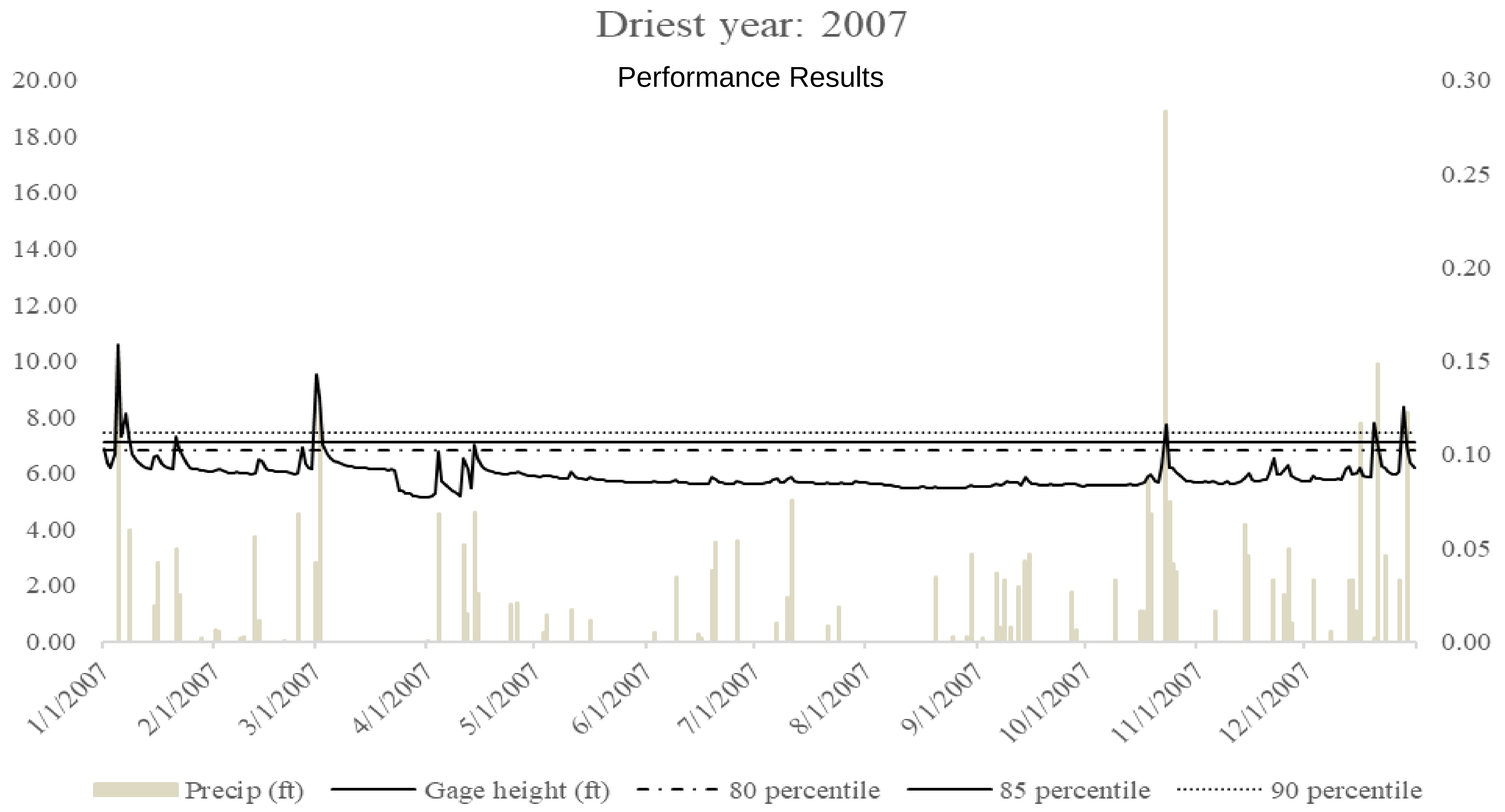
Performance Results

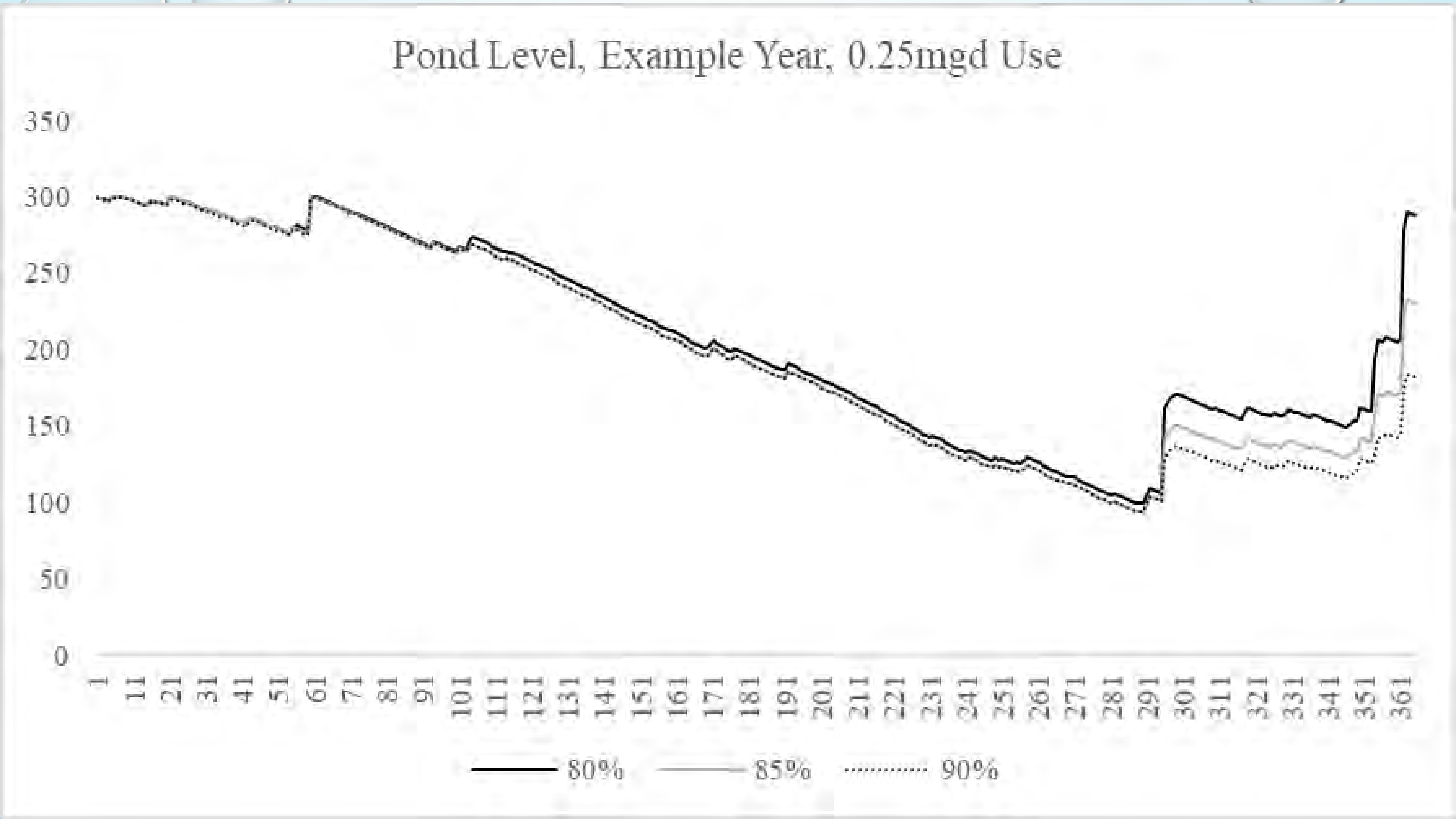


Performance Results



Performance Results





Pond Level, Example Year, 0.25mgd Use
350
300
250
200
150
100
50
0
1
11
21
31
41
51
61
71
81
91
101
111
121
131
141
151
161
171
181
191
201
211
221
231
241
251
261
271
281
291
301
311
321
331
341
351
361
80%
85%
90%

Table 1: Total lost days calculated using 0.25 mgd for the wettest, median and driest years.

	30 acres			60 acres		
Year	**80%**	**85%**	**90%**	**80%**	**85%**	**90%**
1991	0	0	0	0	0	0
1997	0	0	0	0	0	0
2007	0	0	0	0	0	0

Table 2: Total lost days calculated using 0.5 mgd for the wettest, median and driest years.

	30 acres			60 acres		
Year	**80%**	**85%**	**90%**	**80%**	**85%**	**90%**
1991	0	0	0	0	0	0
1997	0	3	0	0	0	0
2007	65	80	88	0	0	0

Table 3: Total lost days calculated using 1 mgd for the wettest, median and driest years.

	30 acres			60 acres		
Year	**80%**	**85%**	**90%**	**80%**	**85%**	**90%**
1991	2	10	23	0	0	0
1997	56	67	75	0	0	0
2007	176	182	190	78	86	90

CONCLUSIONS

- Driest year, 30 acre lake, 90^{th} percentile, .25 mgd (worst case scenario) :
- Total days when lake could not supply need = 3 days
- (less than 1% of days)
- Wettest year, 60 acre lake, 80^{th} percentile, 1mgd (best case scenario)
- Total days when lake could not supply need = 0 days (0%)

INTERESTING SIDE EFFECT

- Since the weir is skimming the top layer of the water, sediments are limited to organic detritus and smallest particulates
- Solids naturally sort in flowing water
- Is there a derivative of this that could be aimed at sediment selection?
- New Orleans