AN EVALUATION OF THE RESPONSE OF THE APALACHICOLA-CHATTAHOOCHEE-FLINT RIVER BASIN'S RESERVOIR MANAGEMENT OPERATIONS TO ALTERNATE STATIONARY CLIMATE SCENARIOS

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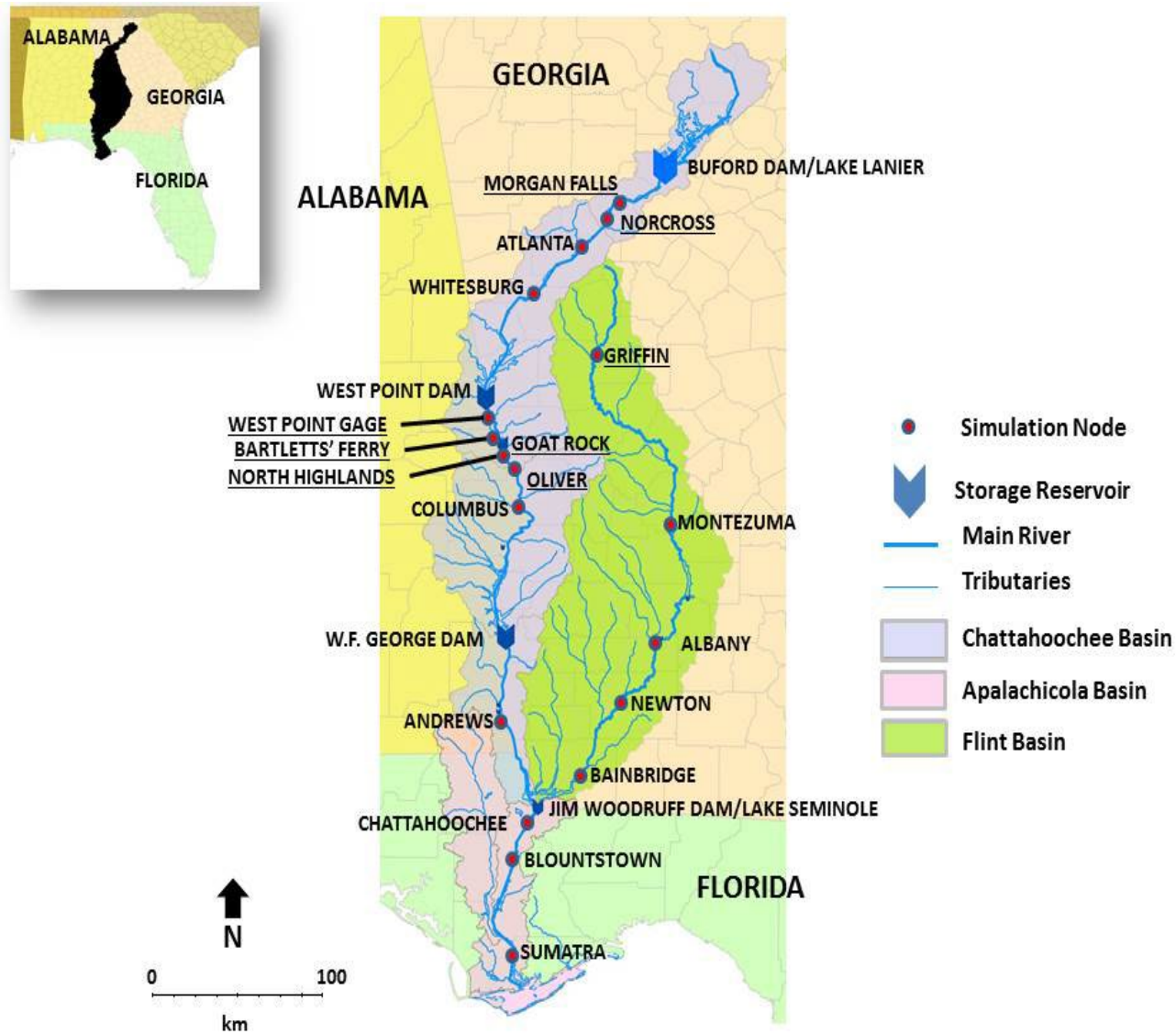
INTRODUCTION

- In 2017 the U.S. Army Corps of Engineers adopted a new Water Control Manual for the Apalachicola-Chattahoochee-Flint basin.
- The computer modeling to evaluate the new operations for the basin's storage reservoirs was based on historical climate (1939 – 2012).
- It is quite likely that in the future climatic events which are more extreme than those experienced in the historical record will occur both in terms of drought and flood events.
- Our concern should be how to best manage the watershed in the future, not what would have been the best way to manage in the past.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GRIFFIN
WEST POINT DAM
WEST POINT GAGE
BARTLETTS' FERRY
NORTH HIGHLANDS
GOAT ROCK
OLIVER
COLUMBUS
MONTEZUMA
W.F. GEORGE DAM
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NEWTON
ANDREWS
BAINBRIDGE
JIM WOODRUFF DAM/LAKE SEMINOLE
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Simulation Node
Storage Reservoir
Main River
Tributaries
Chattahoochee Basin
Apalachicola Basin
Flint Basin

RESEARCH QUESTION

Whether the operating rules for a managed river system developed for historically observed climate conditions will also perform as well under an array of future stationary climate conditions (i.e., comparable mean, but greater extremes) with a revised range of variability in terms of the magnitude, duration and frequency of floods and droughts.

METRICS

The USACE manages the ACF reservoir for: Navigation, flood control, hydropower, environment, recreation, and water supply

Two major objectives in the management of the ACF Basin are:

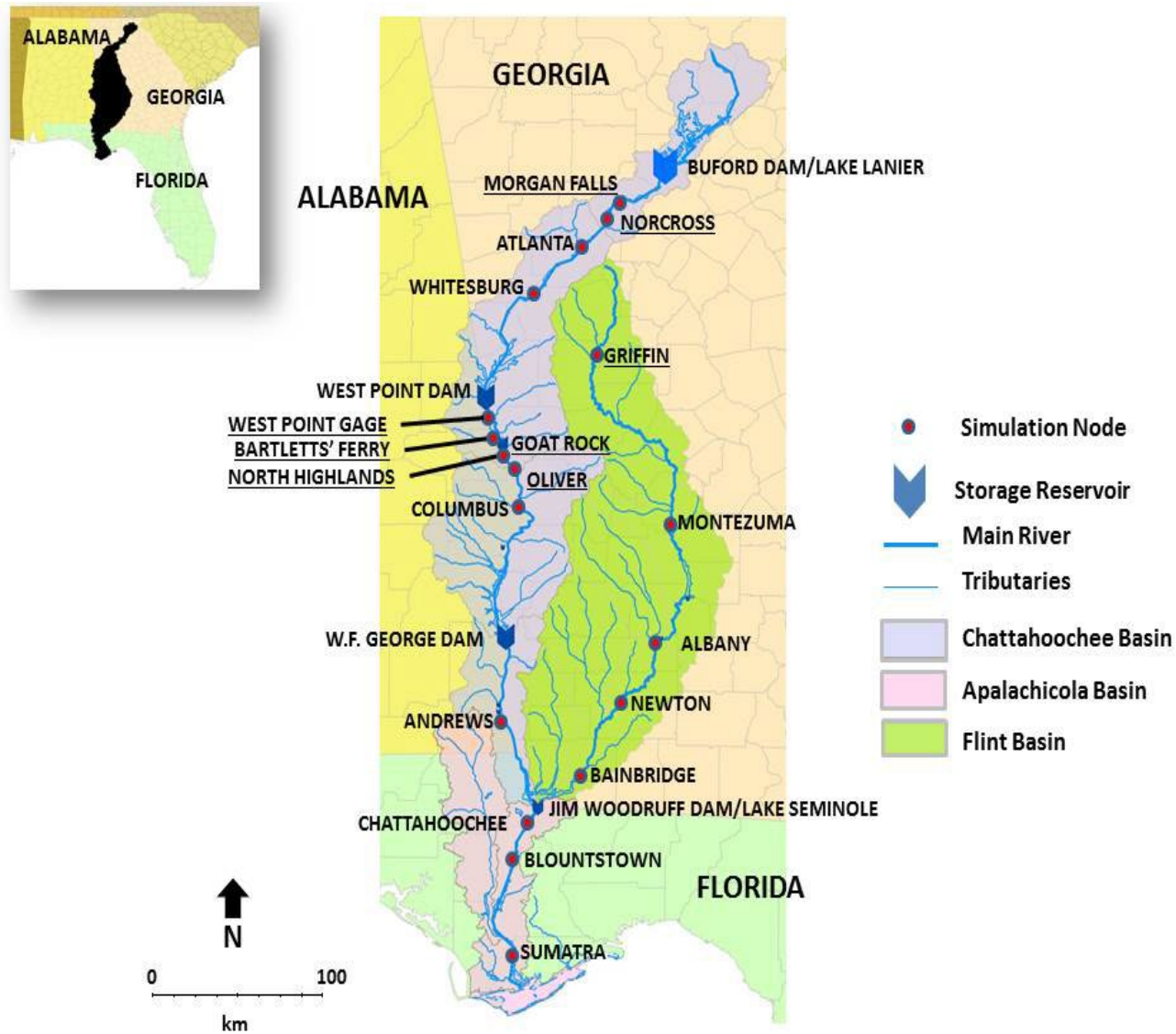
1) protecting volume of storage in Lake Lanier since the reservoir serves as a major contributor for the water supply of Metro Atlanta and recreational opportunities at the reservoir make an important contribution to North Georgia's regional economy.
2) freshwater inflow into the Apalachicola River and the occurrence of sustained periods of extreme low-flows into the Apalachicola estuary and the inundation of the Apalachicola River's floodplain and their concomitant environmental effects.

METRICS

- Although there are many other metrics which would need to be taken into consideration when deciding upon the best management approach for the watershed, if either of these metrics are not adequately met, then a proposed management approach should be considered unacceptable regardless of how well the other metrics perform.

METHODOLOGY

- We can expand the range of climate conditions considered by developing alternative realizations of historic streamflow using synthetic hydrology.
- 100 alternate realizations were developed using a program called PRSim.
- These realizations in turn were used as water inflow in the ACF STELLA model and evaluated relative to the metrics discussed earlier.
- The alternative realizations were developed using an existing unimpaired flow set which divides the basin into reaches.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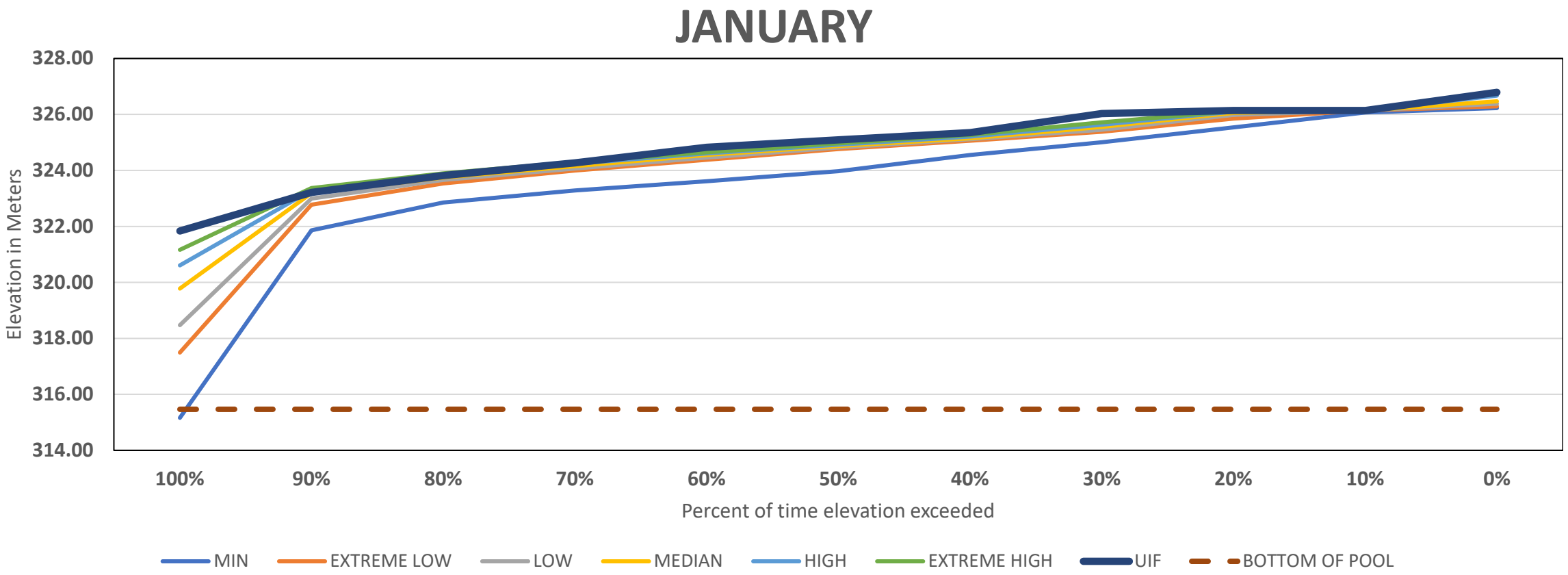
RESULTS – LAKE LANIER ELEVATION



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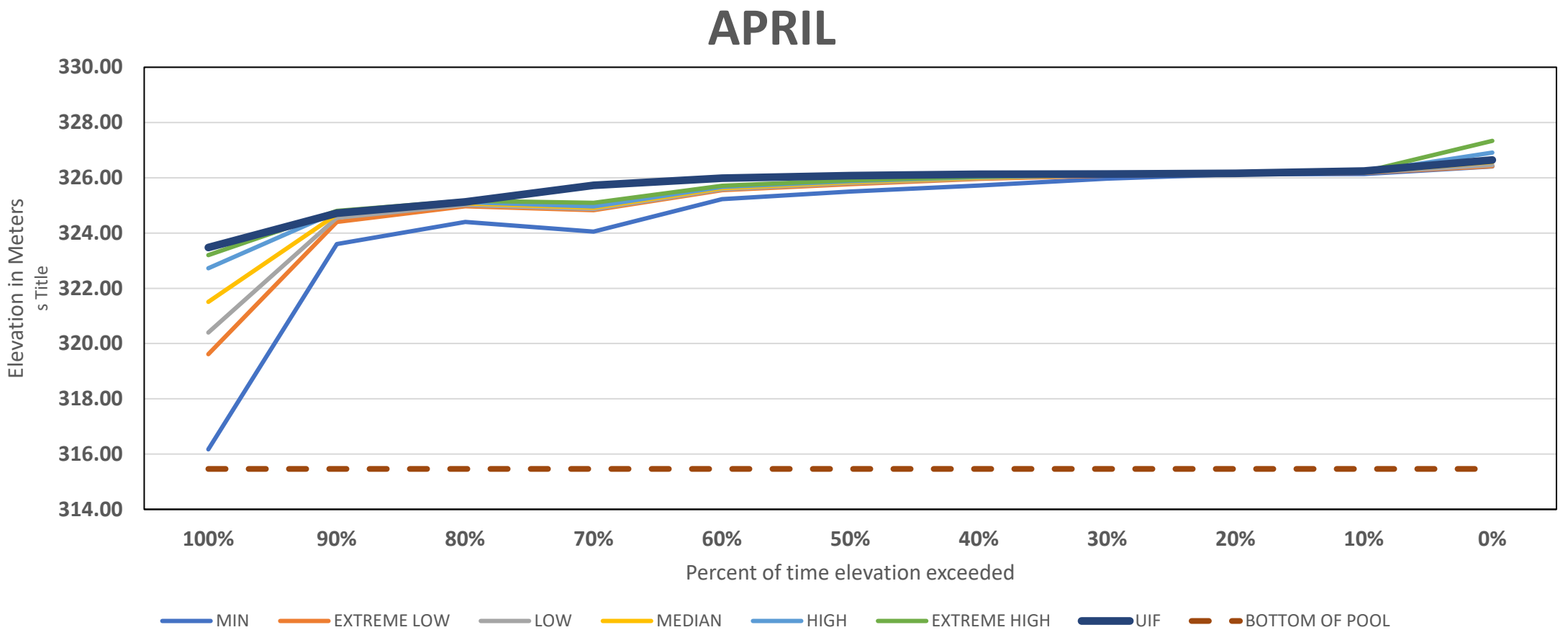

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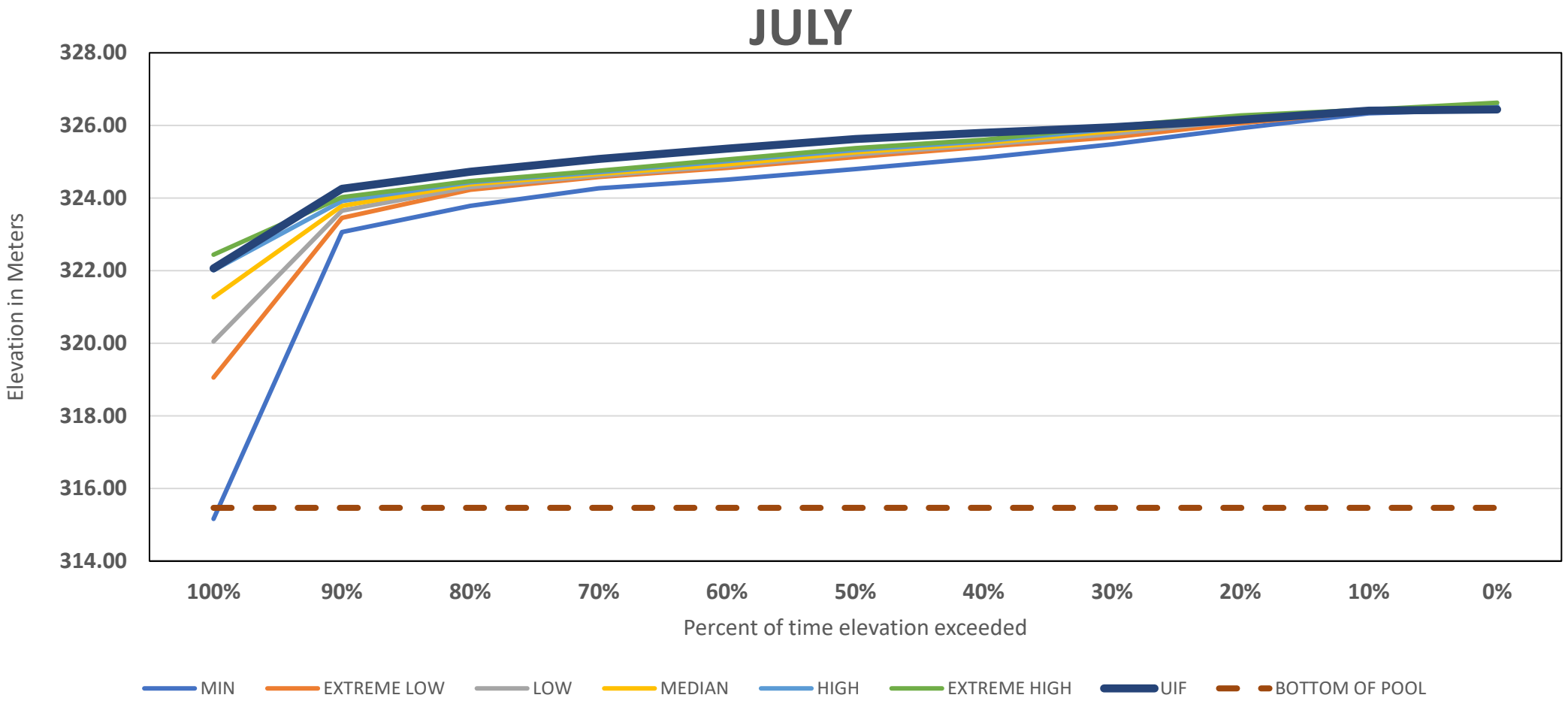

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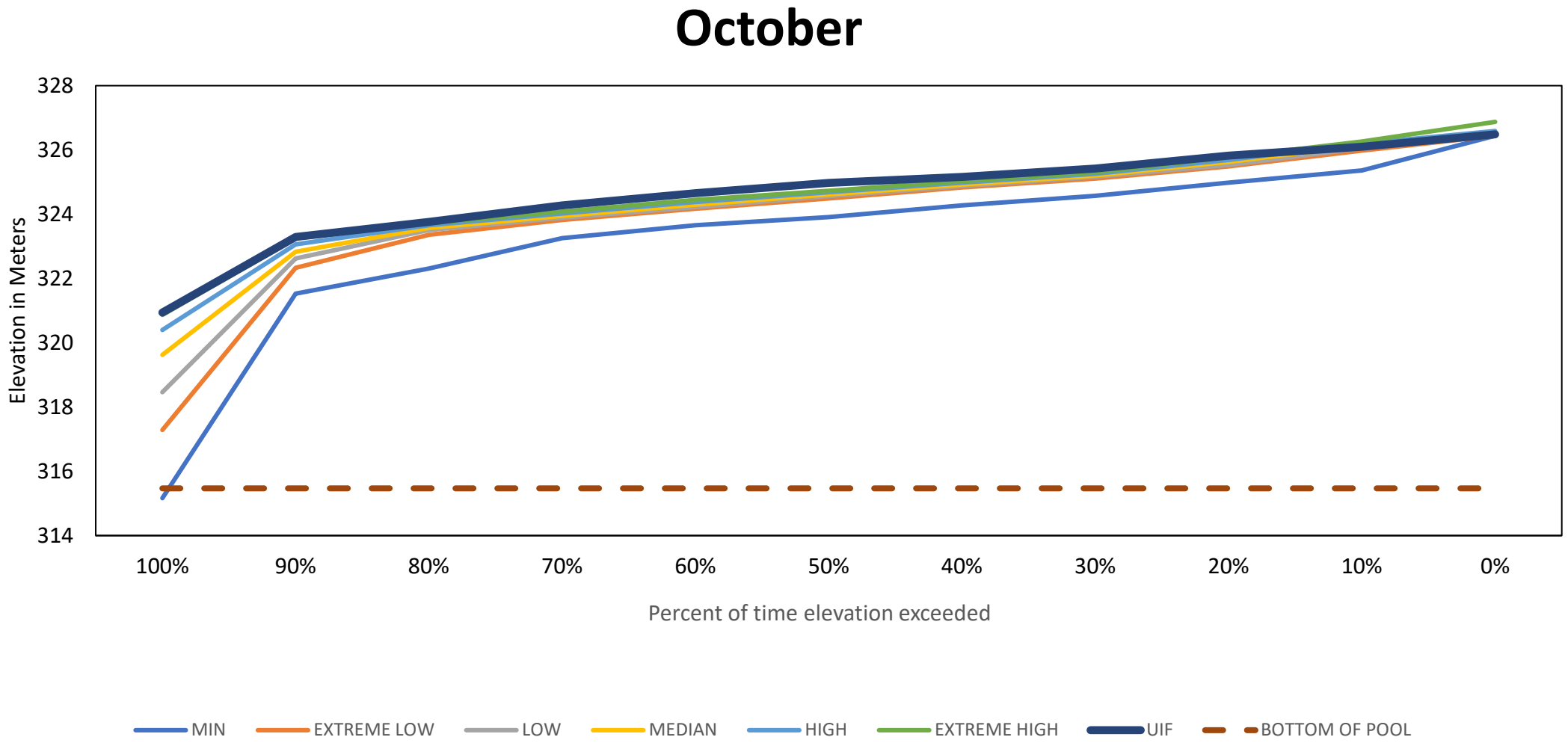

RESULTS – INFLOW TO THE APALACHICOLA RIVER

MONTHS	COMPOSITE CONSERVATION STORAGE	BASIN INFLOW (BI) (m3/s)	MIN RELEASES FROM JW LOCK AND DAM (m3/s)	BASIN INFLOW AVAILABLE FOR STORAGE
MARCH TO MAY	ZONES 1 AND 2	>= 962.88	708.00	UP TO 100% > 708
		>= 453.12, < 962.88	453.12	453.12 + 50% BI > 453.12
		>= 141.6, < 453.12	BI	
		< 141.6	141.60	
	ZONE 3	>= 1104.48	708.00	UP TO 100% > 708
		>= 311.52, < 1104.48	311.52 + 50% > 1104.48	UP TO 50% > 311.52
		141.6 - 311.52	BI	
		< 141.6	141.6	
JUNE TO NOVEMBER	ZONES 1, 2 AND 3	>= 623.04	453.12	UP TO 100% > 453.12
		>= 283.2, < 623.04	283.2 + 50% > 283.2	UP TO 50% > 283.2
		< 141.6	141.60	
DECEMBER TO FEBRUARY	ZONES 1, 2 AND 3	>= 141.6	141.60	UP TO 100% > 141.6
		< 141.6	141.60	
IF DROUGHT TRIGGERED	ZONE 3	NA	141.60	UP TO 100% > 141.6
AT ALL TIMES	ZONE 4		141.60	UP TO 100% > 141.6
AT ALL TIMES	DROUGHT ZONE	NA	127.44	UP TO 100% > 127.44

RESULTS – INFLOW TO THE APALACHICOLA RIVER

Percent of time the composite storage in the ACF basin was in the various zone designations

	ZONE 1	ZONE 2	ZONE 3	ZONE 4	ZONE 5
UNIMPAIRED FLOW SET	69.86%	19.42%	8.01%	2.70%	0.00%
AVERAGE OF 100 REALIZATIONS	58.07%	24.27%	11.02%	4.33%	1.31%

RESULTS – INFLOW TO THE APALACHICOLA RIVER

AVERAGE DAYS/MONTH				
	UNIMPAIRED FLOW		REALIZATIONS	
	< 141.60	< 169.92	< 141.60	< 169.92
JAN	0.00	0.15	0.02	0.64
FEB	0.00	0.03	0.00	0.42
MAR	0.00	0.01	0.00	0.05
APR	0.00	0.09	0.00	0.14
MAY	0.00	0.96	0.05	1.45
JUN	0.00	2.93	0.11	4.33
JUL	0.00	2.95	0.19	5.04
AUG	0.00	3.08	0.00	5.60
SEP	0.00	3.09	0.00	5.19
OCT	0.00	2.61	0.00	5.71
NOV	0.00	1.77	0.00	4.20
DEC	0.00	1.05	0.00	2.54

141.6 = MINIMUM RELEASE UNDER WCM, 169.92 = FLOW USED BY FLORIDA IN SUPREME COURT LAWSUIT

RESULTS – INFLOW TO THE APALACHICOLA RIVER

PERCENT OF TIME DROUGHT TRIGGERS AND EMERGENCY DROUGHT TRIGGERS WERE IN EFFECT		
DROUGHT TRIGGER	**UIF**	**REALIZATIONS**
MAX		31.84%
AVG	17.44%	27.83%
MIN		23.29%
EMERGENCY DROUGHT TRIGGER	**UIF**	**REALIZATIONS**
MAX		5.07%
AVG	0.00%	1.30%
MIN		0.00%

PERCENT OF TIME JW OUTFLOW IS LESS THAN CERTAIN FLOWS WHEN DROUGHT OPERATIONS ARE IN EFFECT

	FLOW(cfs)			
	< 6000	28.4%		
	< 7000	40.3%		
	< 7500	43.9%		
	< 10000	61.7%		
	< 15000	82.1%		
	<20000	93.1%		

RESULTS – INFLOW TO THE APALACHICOLA RIVER

UIF AVG		REALIZATIONS		
		MAX	MIN	AVG
29.57	MARCH	29.80	27.49	28.91
27.85	APRIL	28.22	25.32	26.91
24.00	MAY	24.18	20.82	22.26
12.16	JUNE	12.95	10.51	11.67
12.69	JULY	13.18	10.97	12.09
10.61	AUGUST	11.88	9.41	10.51
6.93	SEPTEMBER	8.42	6.34	7.46
7.57	OCTOBER	9.04	7.23	8.21

CONCLUSIONS

- The intent in revising a Water Control Manual should be to define operations for the future, since it is very unlikely that historic climate will be repeated in the future. Therefore flows outside the range of what was experienced in the historical record should be considered.
- In analyzing the effects of using 100 stochastically developed alternate realizations of historical climate, it was found the Water Control Manual did not perform well against two major metrics: elevations at Lake Lanier and inflow to the Apalachicola River.

CONCLUSIONS

- Consequently, I conclude that there is a need to revise the existing Water Control Manual using a fuller picture of plausible hydrologic conditions that these reservoirs may face in the future. In doing these revisions, I recommend that:
  - A set of performance metrics that define acceptable conditions in the ACF basin relative to flow be developed.
  - The operations defined by the Water Control Manual should consider a broader array of hydrologic regimes than those experienced in the historical streamflow record.

CONCLUSIONS

- The update should define additional research necessary to better understand the relationship between management of the watershed and the performance metrics developed to define acceptable conditions.
- This study focused solely on the streamflow variability. The impact of the variability of other factors such as soil moisture, which can trigger droughts, and their dependencies with the streamflow, should be studied along to provide a fuller picture of alternate stationary scenarios and the response of reservoir operations.

CONCLUSIONS

- An adaptive management program should be developed to implement the research program and allow for the management approach for the ACF basin to evolve over time.

ACKNOWLEDGEMENTS

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