A DATA BASE SYSTEM FOR RIVER BASIN MANAGEMENT

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ABSTRACT

A data base system for the analysis of a large river basin was developed that permits users to retrieve and process a set of data elements to obtain the desired information pertaining to any gaging station, segment of a river, or a particular river in the basin. The data base management package is written in FORTRAN IV to operate under the NOS operating system. It uses a simple query language to direct the operations of various component programs. The command language specifications are also presented along with sample results of data retrieval and processing that show the usefulness of the data base system for large river basin management.

I. INTRODUCTION

The two most important problems that planners and/or project managers have to deal with in river basin management are the adequacy of information related to river basin evolution and the reliability of river system simulation models. A planning model can then be developed to assist users in the selection of an optimal strategy to optimize some pre-specified goals.

In this paper only a solution to the first problem is presented. The second problem has been discussed by the authors in a different paper (1); therefore, it will not be repeated here.

Large-scale analysis of river basin systems always requires a large amount of data. To minimize the "turn-around" time to acquire the desired information that must also be in some pre-specified formats to input directly to the river basin system simulation models, an efficient data storage and retrieval system is needed. Since the worth of historical data depends greatly on its quality and the way it is managed in order to give the maximum amount of useful information for solving some particular problems, data preprocessing and analysis capabilities are the two particularly desirable features of the data base management system (DBMS) to be developed.

In the following sections, the description of the characteristic features of YAZDB, a data base management system for the Yazoo River Basin, will be presented. Each sample result of data retrieval and processing will be accompanied by the corresponding command statements to show the simplicity of the query language and the usefulness of the data base system for river basin management.

II. CONCEPTUAL DESIGN OF THE YAZDB

The Yazoo data bank consists of magnetic tapes that store all data files of various data categories of the Yazoo River Basin. These data tapes are directed to be loaded to the computer system by the DBMS whenever required. The only data file needed to be stored permanently in the computer system is the river system descriptive data file (DESCRIP) that contains necessary information related to the status of various data categories at all the gaging stations in the Yazoo Basin and a node system describing the river system network. If a certain data category is expected to be used frequently in daily activities, a permanent file is created from the corresponding data tape to minimize the tape handling charge and accelerate the data retrieval and processing job. This concept offers a minimum operating cost to maintain a large data base, also assuring the continuity of service to users. The conceptual design of the Yazoo data storage and retrieval system is presented in Illustration 1.

The YAZDB consists of four overlay programs and a library of utility subroutines to manage the data. This overlay structure and modular concept aims at increasing the flexibility of the YAZDB in changing component elements and reducing computer memory requirements. The general structure of the YAZDB is given in Illustration 2 and the structure of the Yazoo data categories is given in Illustration 3.

III. CHARACTERISTIC FEATURES OF THE YAZDB

Storage:

(1) Coded files
(2) Magnetic tapes

Retrieval:

(1) Sequential access through keys, based on a node system that is developed according to the structure of the Yazoo River System.
(2) Data retrieval and processing is done through a simple query language. The command language specifications are presented in Table 1.

ILLUSTRATION 1

Conceptual Design of the Yazoo Data Storage and Retrieval System

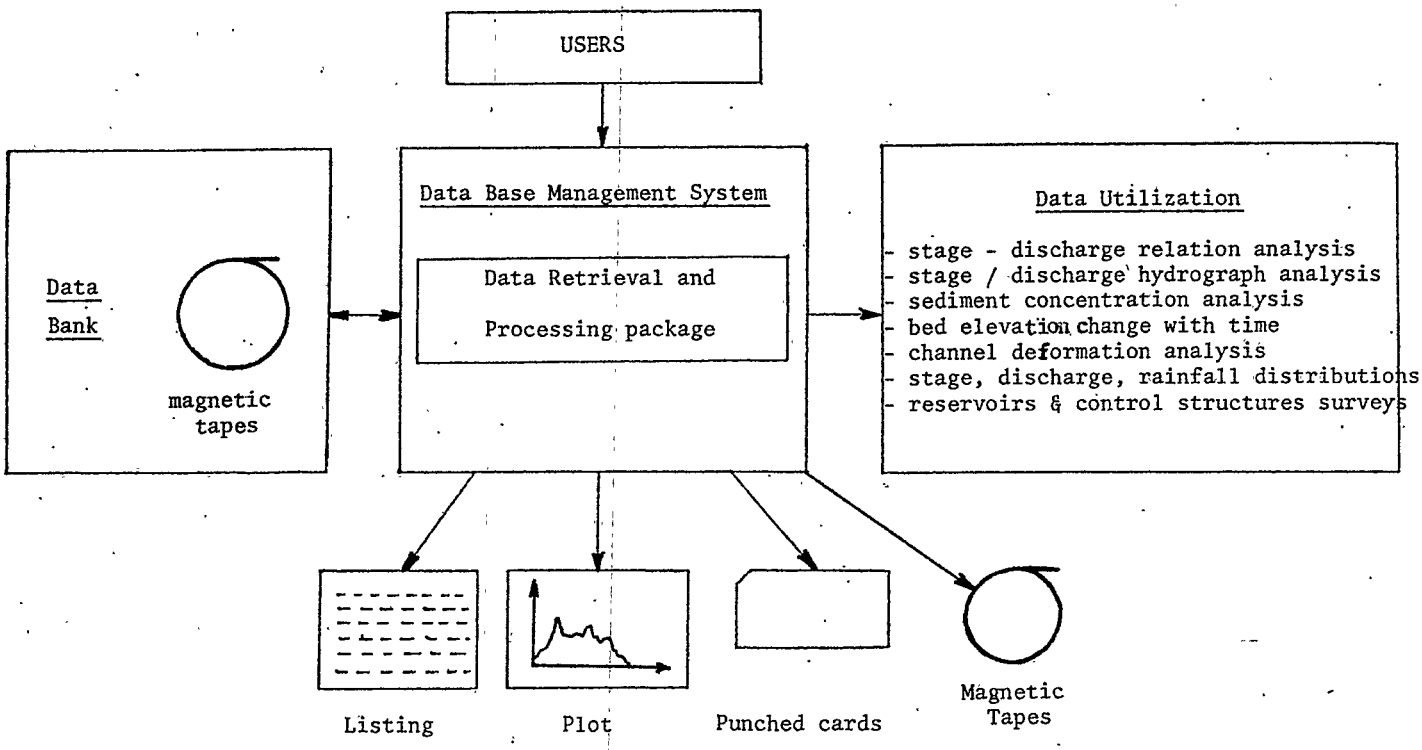
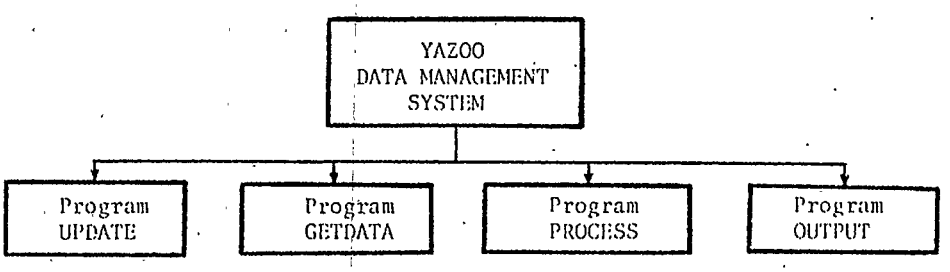


ILLUSTRATION 2

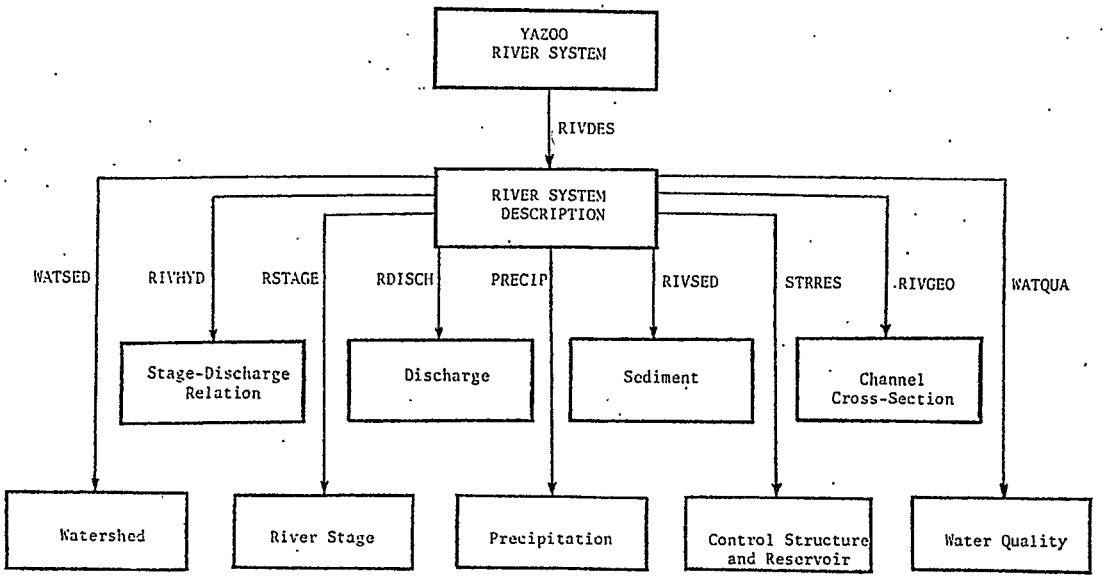
Overall Structure of the YAZDB



. Insert record	. Get data category	. Statistical analysis	. List
. Delete record	. Get location	. Data processing & generation	. Plot
. Change record	. Get time period	. Data reformating	. Display
	. Retrieve the desired data element		. Save

ILLUSTRATION 3

Structure of the Yazoo Data Categories



(3) Several input/output options are implemented in the YAZDB package:

- Three levels of information: the general gaging station information and data status, the data value, and all information available at a gaging station;
- Four types of location information: the basin, the river, a segment of river, or a gaging station;
- Five alternatives to locate a gaging station: by station name, station number, its geographical coordinates, a river name and a river-mile from a starting node, or a node number and a river-mile from that node;
- Six types of time information: a calendar year, a water year, a date, from a calendar year to another calendar year, from a water year to another water year, and from a date to another date.

(4) To date, several data processing options are available in the YAZDB for:

- Regression analysis;
- Correlation analysis;
- Frequency distribution analysis,
- Finding the minimum/maximum value within a given data set;
- Calculating the basic statistics (mean, standard deviation) of a given data set;
- Channel deformation analysis;
- Sediment concentration analysis;
- Cummulative rainfall analysis, and
- Reservoirs and control structures surveys.

The actual command statements for each specific data retrieval and processing operation are presented along with the corresponding results, in Illustrations 4 to 14. The utilization of the Yazoo data storage and retrieval system in the analysis of the Yazoo River Basin can be summarized by the block diagram in Illustration 15.

IV. CONCLUSIONS

This paper presented an approach that is efficient and quite economical to ensure the adequacy of providing useful information to planners or project managers in the analysis of large river basin systems. Sample test cases show the simplicity of the query language and the capability of YAZDB. The command language specifications and the types of data processing operations are designed to satisfy the majority of users who are not familiar with the computer system, but want to have some basic information about the evolution of the river basin system.

BIBLIOGRAPHY

1. Simons, D. B., Duong, N., and Li, R. M. "An Interactive Planning Model for River Basin Management." Second Lawrence Symposium on Systems and Decision Sciences, October 3-4, 1978.

TABLE 1

Command Language Specifications for the Yazoo Data Base

GET--command	Category--Type	Information--Type	Location	Time
	· all	· status	· all	· all
	· stage-discharge	· data	· basin: river name	· year (X)
	· stage	· all information	· River: river name	· date (X)
	· discharge			· from year (X) to (Y)
	· bed material			· from date (X) to (Y)
	· suspended sediment		· Segment (of river):	· water year (X)
	· cross section		· river name, from (XRM) to (YRM)	· from water year (X) to (Y)
	· control structure		· Node (X), from (XRM) to (YRM)	
	· reservoir	(rule, curve, spillway curve, capacity curve)	· Station:	
	· precipitation	(daily, hourly)	· located (at/nr) (station name)	
	· (water quality)		· number (station no.)	
	· (watershed)		· coordinates (lat., long.)	
			· on (river name) at (XRM)	
			· node (X) at (XRM)	
PROCESS--command	· min value			
	· max value			
	· basic statistics			
	· cum frequency			
	· histogram			
	· regression analysis			
	· stage-hydrograph generation			
	· discharge hydrograph generation			
	· changing stage for Q = (XCFS)			
	· thalweg level plot			
	· cum rainfall			
OUTPUT--command	· list			
	· plot			
	· display (list and plot)			
	· save			
UPDATE--command	· delete			
	· add			
	· change			

ILLUSTRATION 4

Stage-Discharge Plot

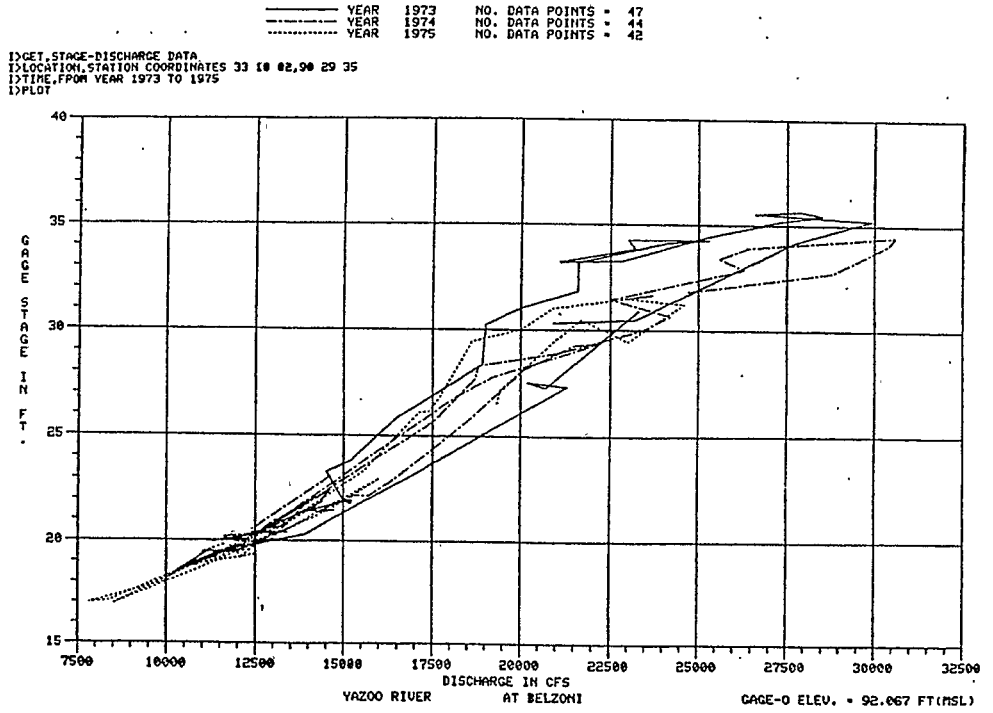


ILLUSTRATION 5

Changing Stage for Q = 5000.CFS
No. data points - 29

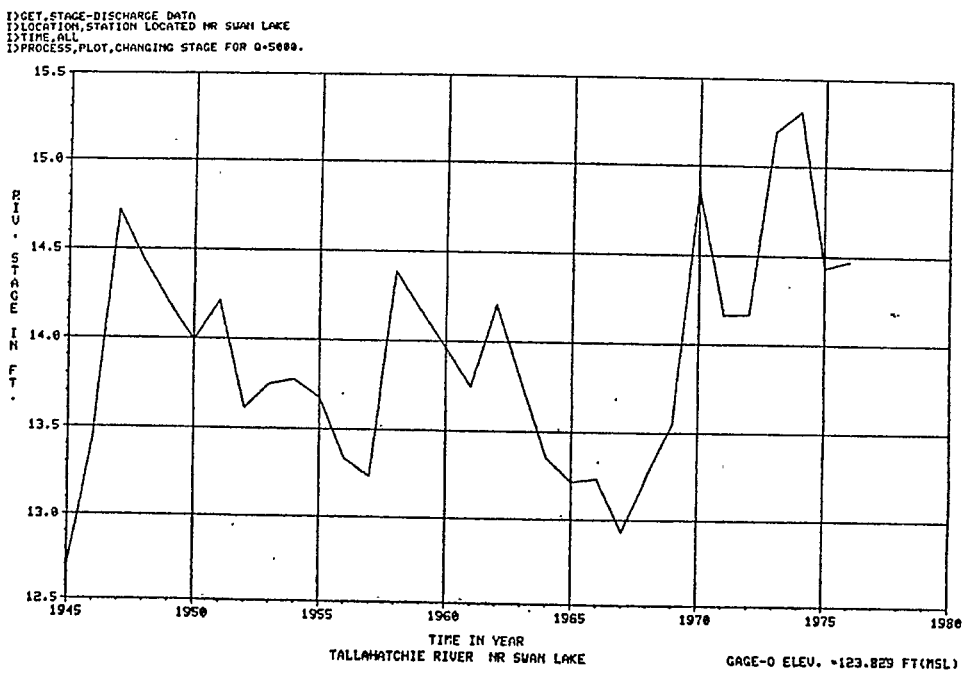


ILLUSTRATION 6

Stage-Hydrograph Plot

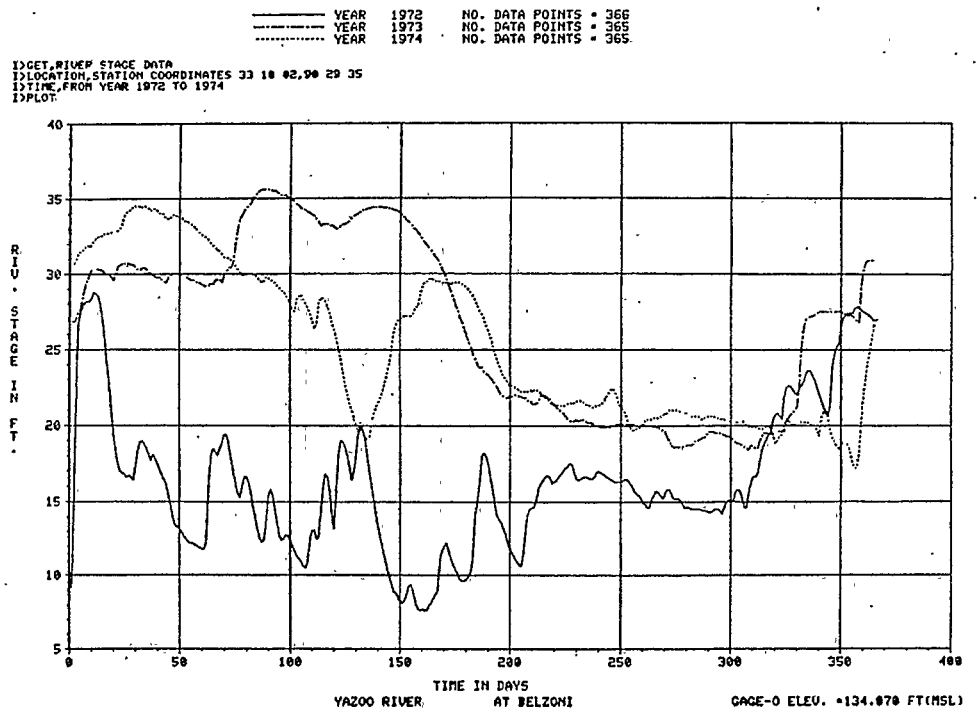


ILLUSTRATION 7

Cumulative Frequency Curve

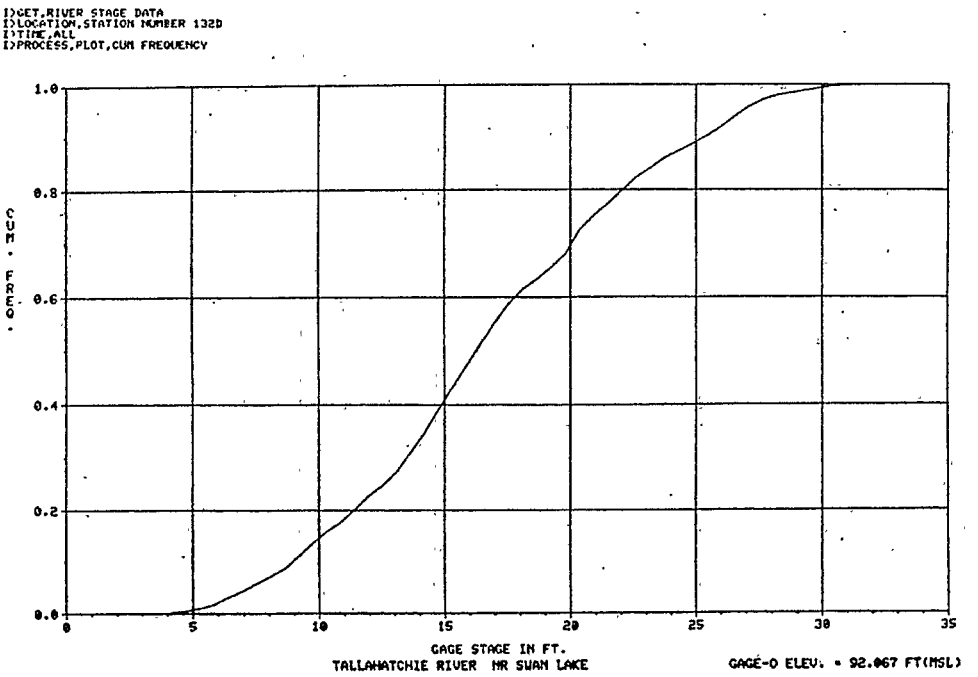


ILLUSTRATION 8

Relative Frequency Histogram

```
I)GET,RIVER STAGE DATA
I)LOCATION,STATION LOCATED NR SWAN LAKE
I)TIME,ALL
I)PROCESS,PLOT,HISTOGRAM
```

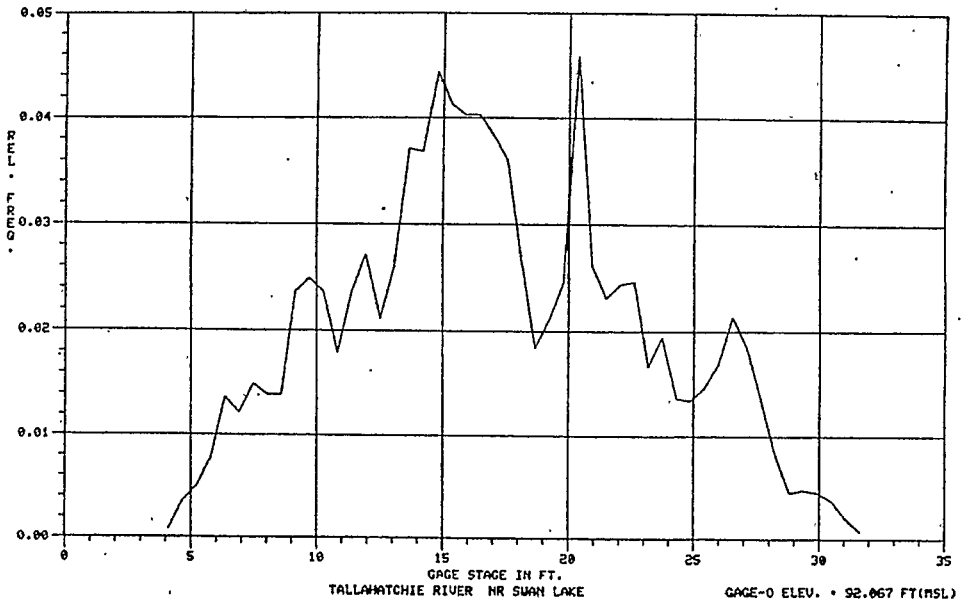


ILLUSTRATION 9

Gage-Stage Values (ft)

```
I)GET,RIVER STAGE DATA
I)LOCATION,STATION COORDINATES 33 31 17,90 11 03
I)TIME,FROM DATE 150673 TO 150773
I)LIST

                    GAGE-STAGE VALUES (FT) FOR THAT PERIOD ARE

      1973      31

      30.50     29.90     29.20     28.30     27.40     27.00     26.70     26.40     26.00     25.60
      25.30     25.00     24.70     24.40     24.20     24.10     23.90     23.80     23.80     23.70
      24.60     24.60     24.80     24.70     24.70     24.60     24.50     24.40     24.10     24.20
      23.20

I)PROCESS,LIST,MIN VALUE

                    THE MINIMUM VALUE IS     23.70  WHICH OCCURRED ON JUL  4,1973

I)PPOCESS,LIST,MAX VALUE

                    THE MAXIMUM VALUE IS     30.50  WHICH OCCURRED ON JUN 15,1973

I)GET,RIVER STAGE DATA
I)LOCATION,STATION ON YAZOO RIVER
 AT I)166.00
I)TIME,FROM DATE 150673 TO 301273
I)PROCESS,LIST,BASIC STAT

      MINIMUM VALUE =    19.20          MAXIMUM VALUE =    32.20
      MEAN VALUE =       23.73          STANDARD DEVIATION =    3.22
```

ILLUSTRATION 10

Yazoo River System Data Bank

```
? GET,RIVER STAGE,ALL INFORMATION
? LOCATION,STATION,LOCATED AT BELZONI          RIVER STAGE DATA CATEGORY
? TIME,WATER YEAR 1973
? DISPLAY
```

STATION NAME		STATN NO	DIST FR MOBE	LATITUDE	LONGITUDE	GAGE ZERO(MSL)	DATA TYPE	NO YEARS
YAZOO RIVER	AT BELZONI	353	116.20(MI)			76.02(FT)	CONTI	11

DAILY RIVER STAGE FOR WATER YEAR 1973

COMPUTED DAILY RIVER STAGE IN FEET ABOVE GAGE ZERO ELEVATION

DAY	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	18.60	18.70	27.10	30.80	34.50	32.60	29.60	25.70	27.20	28.70	22.20	22.22
2	18.60	18.60	27.20	30.70	34.40	32.50	29.50	25.10	27.20	28.50	22.10	22.33
3	18.60	18.50	27.20	31.00	34.50	32.40	29.40	24.40	27.20	28.20	21.90	22.40
4	18.60	18.40	27.30	31.40	34.40	32.20	29.20	23.60	27.20	27.90	21.80	22.50
5	18.60	18.70	27.40	31.50	34.30	32.00	29.10	22.70	27.40	27.50	21.70	21.92
6	18.60	18.60	27.50	31.60	34.20	31.90	28.90	22.00	27.80	27.30	21.50	21.40
7	18.70	18.50	27.50	31.80	34.30	31.70	28.80	21.40	27.80	26.50	21.40	21.20
8	18.70	18.50	27.50	31.90	34.30	31.60	28.50	21.00	28.60	26.50	21.40	21.00
9	18.70	18.90	27.50	31.80	34.10	31.50	28.30	20.40	29.10	26.10	21.40	20.80
10	18.80	19.30	27.50	32.00	34.00	31.30	28.00	20.00	29.40	25.80	21.30	20.30
26	19.30	21.20	30.30	34.10	33.60	29.70	28.20	24.90	29.40	22.20	21.20	20.70
27	19.20	22.80	30.20	34.20	32.90	29.60	27.80	26.10	29.30	22.20	21.30	20.80
28	19.10	25.30	30.90	34.30	32.70	29.40	27.40	26.60	29.20	22.30	21.30	20.80
29	18.90	26.50	30.50	34.50	0.00	29.60	26.80	26.90	29.10	22.20	21.40	21.00
30	18.80	27.80	30.50	34.50	0.00	29.80	26.30	27.00	28.90	22.30	21.50	21.00
31	18.80	0.00	30.80	34.50	0.00	29.70	0.00	27.10	0.00	22.30	21.80	0.00

MONTHLY STATISTICS

MEAN	32.66	33.80	33.74	28.08	22.57	28.89	24.33	21.50	28.75	19.86	22.27	26.88
MAX.	34.50	34.50	32.60	29.60	27.10	29.70	28.70	22.20	22.40	0.00	0.20	0.00
MIN.	30.70	32.70	29.40	26.30	19.00	27.20	22.20	21.20	19.70	0.00	0.00	30.90

MEAN RIVER STAGE FOR YEAR WAS 25.84

HIGHEST RIVER STAGE VALUE WAS 34.50FT. ABOVE GAGE ZERO ELEVATION, OCCURRED ON JAN 29
LOWEST RIVER STAGE VALUE WAS 18.40FT. ABOVE GAGE ZERO ELEVATION, OCCURRED ON NOV 4

ILLUSTRATION 11

River Cross Section

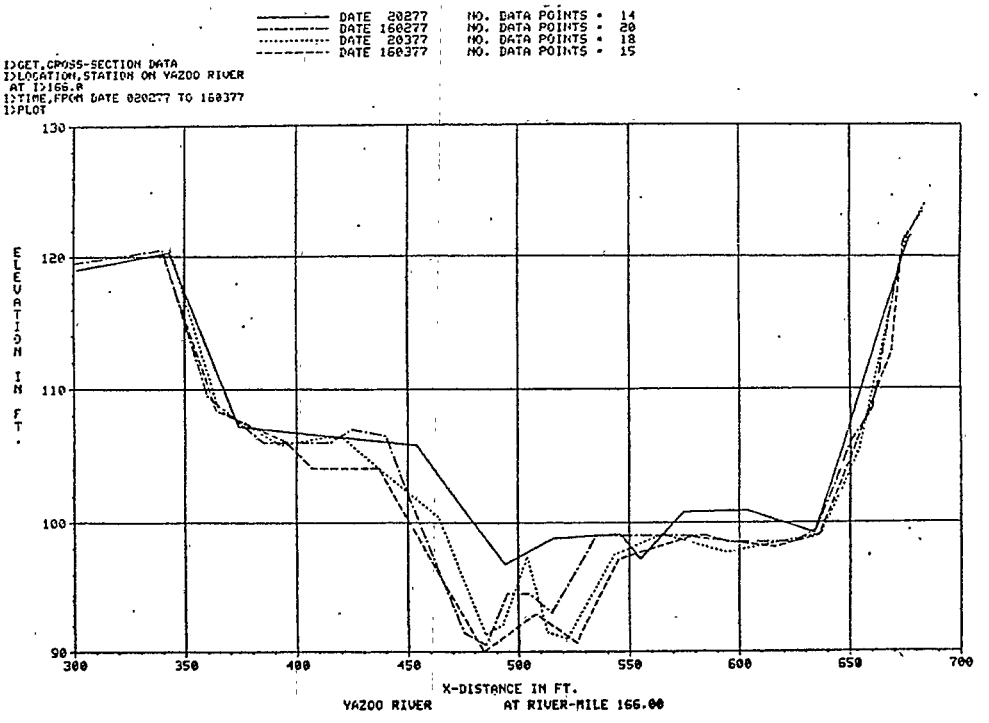


ILLUSTRATION 12

Thalweg Level Plot
No. data points-44

```
? GET,CROSS SECTION,DATA
? LOCATION,SEGMENT,YAZOO RIVER
 FROM ? 3.
 TO ? 100.
? TIME,FROM DATE 010862 TO 300862
? PROCESS,PLOT,THALWEG LEVEL
```

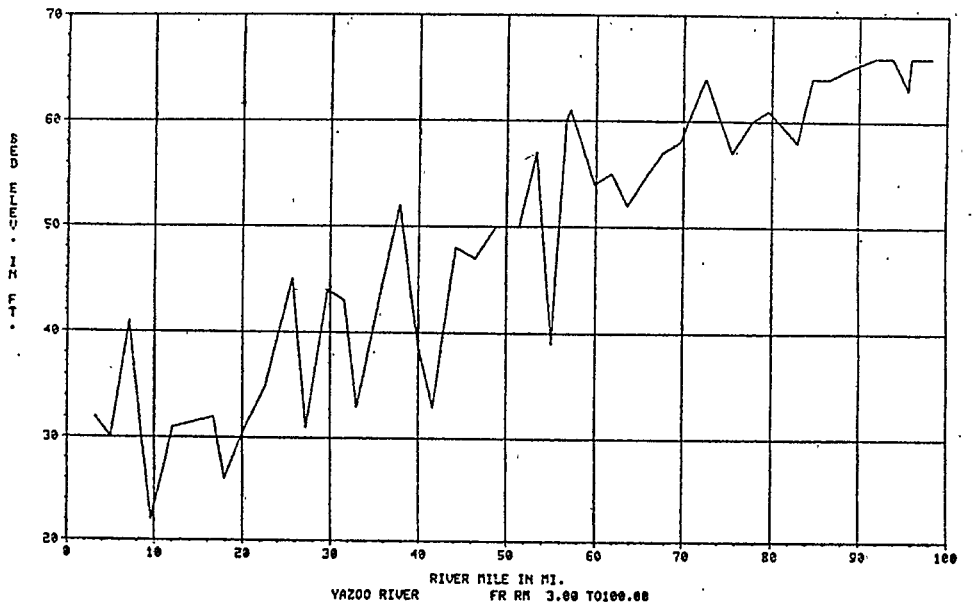


ILLUSTRATION 13

```
? GET,STAGE DISCHARGE,DATA
? LOCATION,STATION,LOCATED NR SUAN LAKE
? TIME,FROM YEAR 1972 TO 1974
? PROCESS,LIST,REGRESSION ANALYSIS
```

```
                              YEAR = 1972
                REGRESSION EQUATION IS     Q =  54.39603((S).EXP( 1.7053))
CORRELATION COEFFICIENT =   .9894                STANDARD ERROR =   .091329

                              YEAR = 1973
                REGRESSION EQUATION IS     Q =  13.98061((S).EXP( 2.1638))
CORRELATION COEFFICIENT =   .9524                STANDARD ERROR =   .141689

                              YEAR = 1974
                REGRESSION EQUATION IS     Q =  14.39231((S).EXP( 2.1442))
CORRELATION COEFFICIENT =   .9665                STANDARD ERROR =   .090748
```

ILLUSTRATION 14

Daily Cumulative Rainfall Plot
Year 1973 No. data points-365

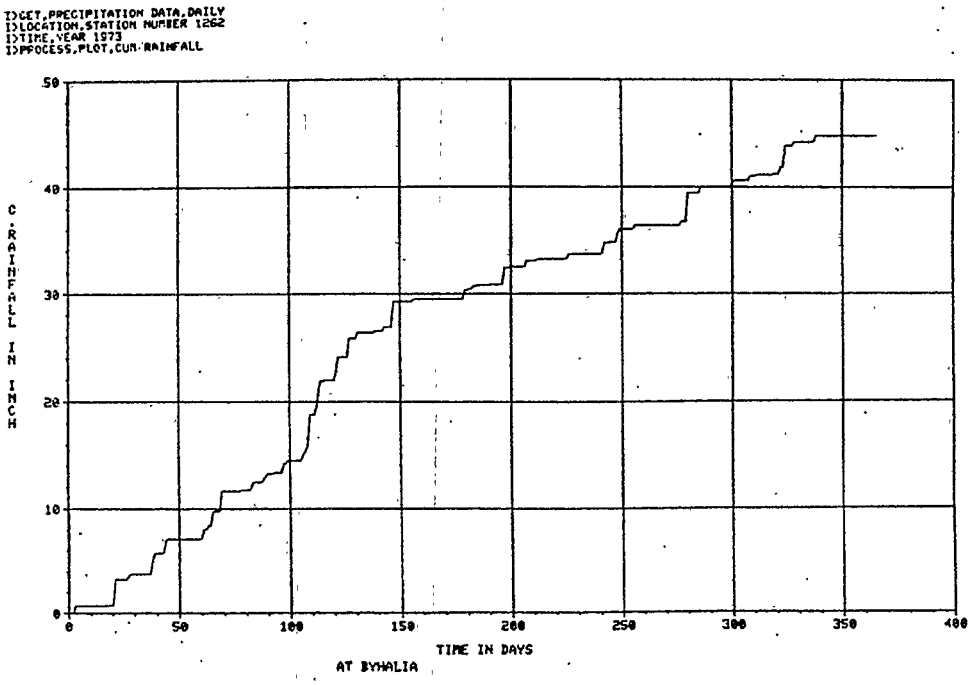


ILLUSTRATION 15

Utilization of the Yazoo Data Storage and Retrieval System