Salt & Verde River
Paleoflood Studies
1985

HYDRO LIBRARY

126.903

Salt River Project
WATER ◆ POWER

P.O. BOX 1980
PHOENIX, ARIZONA 85001

NEWS RELEASE

PUBLIC INFORMATION SECTION: 236-8240

George Poteet: 236-8239

FOR IMMEDIATE RELEASE

February 19, 1985

Preliminary results of research on the Salt and Verde rivers indicate some historic floods were large enough to create a safety hazard for Salt River Project-operated dams if they occurred today. The information confirms the need to proceed promptly with flood control measures.

The flows in the past were greater than those experienced in modern time. Though less severe than the maximum flood predicted by theoretical studies, the identified historical flows would create significant downstream damage today.

SRP remains in total support of Plan 6 and is in hopes that the research will help in the final designs of dams on the Salt and Verde rivers.

-more-

#0210

A University of Arizona professor leading the research told representatives of the SRP board of governors and management today the studies involved inspection of flood-deposited evidence datable back almost 2,000 years. Recent theoretical studies calculated the worst-case event that could ever happen.

According to paleoflood studies (investigations of ancient river activity), historic flows are estimated as high as 240,000 cubic feet per second (cfs) on the Salt River. About 200,000 cfs traveled down the Verde River.

By comparison, the largest upstream flow this century occurred on the Salt River in March 1978, with 170,000 cfs recorded above Roosevelt Dam.

Computer-generated theoretical flood studies estimate peak flows of 678,000 cfs on the Salt River and 764,000 cfs on the Verde River.

In 1983, the Salt River Project supported Dr. Victor Baker, University of Arizona professor of geosciences, in his effort to conduct the initial paleoflood studies, which were performed through 1984. Final reports will be prepared after follow-up studies are performed this year.

-more-

"Historic floods which traveled down the Salt and Verde rivers left an abundance of evidence behind," Baker said.

The high-water mark of the largest floods scored the sides of canyon walls. With paleoflood analysis, river sections were surveyed and high-water marks were used to measure the depth and width of the flow. With the aid of a water-surface-profile computer program, Baker was able to calculate the size of the flood.

In addition, flood-deposited materials--sand, silt and even Indian artifacts--were found along the high-water marks. The materials, through radiocarbon (Carbon-14) analysis, helped establish dates for the flows.

According to Robert Mason, SRP's director of Water Group Management Staff, the studies were initiated to provide additional information to the approximately 90-year record of gaged water runoff. Results also will provide assistance in establishing the likelihood of floods of various sizes.

"Paleoflood analysis is a relatively untested science," Mason said. "SRP encourages the technical community to begin the process to validate the study, including peer review of Baker's methodology and academic analysis of the findings.

"Also proposed is a National Academy of Sciences review of the role of paleohydrology in flood-frequency analysis and the development of a probable maximum flood," Mason said.

"SRP recognizes that the paleoflood studies are limited by availability of datable materials (unlike theoretical studies which exam an indefinite time period)," Mason said. "But, Dr. Baker's studies do provide another piece to the flood puzzle."

If the research is validated, the U.S. Bureau of Reclamation proposes to include the results among information being analyzed in federal Safety of Dams studies. Baker's follow-up studies on the two rivers this year will enhance the validity of the results.

The USBR agrees with the study concept and welcomes information to augment previous study findings.

-30-

#0210

SALT & VERDE RIVER PALEOFLOOD STUDIES

Introduction

With specific geologic evidence available, it's possible through paleohydrology to reconstruct large-magnitude floods which occurred hundreds of years ago. While limited by the availability of datable materials, the information can be used to extend floodwater records beyond about 90 years of gaged records on the Salt and Verde rivers. This increased knowledge has important implications for all those concerned with dam structure design, reservoir capacity and flood frequency.

How SRP Got Involved

Paleoflood analysis was brought to the attention of Salt River Project through participation in a review committee for federal water-research project funding. In spring 1983, the committee was unable to fully fund a Southwest-region paleoflood study proposed by Dr. Victor Baker of the University of Arizona. The committee favored other "higher priority" proposals--mostly water-quality related. Baker proposed to SRP staff an independent investigation of the Salt and Verde rivers alone. In addition to providing additional information beyond gaged river records, it was determined the research:

* would provide assistance in establishing various sizes of floods. The information could be useful concerning federally mandated Safety of Dams Act construction activities; and

* if validated, would provide geologic evidence to augment theoretical information concerning flood frequency. Safety of Dams modications recommended to cope with the Maximum Credible Earthquake (MCE) are unaffected by this study.

The paleoflood study was authorized in September 1983. Research was conducted during 1984 and follow-up studies will be performed during 1985.

Method of Investigation

Approximately 30 days were spent investigating study sites along the Salt and Verde rivers. Initial field work concentrated on selecting sites most useful in providing evidence of past floods, either because of preserved slackwater sediments in side canyons and canyon walls, or evident high-water marks on layers of rock. Subsequent study involved detailed sediment sampling and rock-

layer analysis with the aim of comparing flood deposits from site to site.

Physical samples were collected for radiocarbon analysis to aid in matching information among study sites, as well as provide age comparisons. Radiometric analysis was performed at the Balcones Research Center at the University of Texas, Austin.

Numerous slackwater sedimentation sites were found at tributary mouths, upstream or downstream of channel constrictions, and in natural shelters along canyon walls. The overwhelming majority of deposits were found in the form of beds of fine-grained sand and silt. This material was extracted and the individual layers were studied. Artifacts discovered above geologic zones also were analyzed. Radiometric dating for this project focused on establishing the age of the various flood events.

Another high-water indicator for past floods involved analysis of prominent flood scars on the channel walls. At places the scars represented a stripping of modern vegetation, elsewhere cuts into thin soil levels developed on the bedrock walls. Scars of this type are preserved for hundreds, perhaps thousands of years, and provide evidence of the largest water flows experienced in prehistoric time. Organic debris is common along the river channel and identifies high-flow stages.

Slackwater sites and other high-water indicators were incorporated in a detailed survey of each river cross-section. An abundance of material along study areas made it possible to reconstruct water surface profiles.

A water surface profile computer program--common in examining streamflow characteristics--was used at the University of Arizona to determine volume and velocity of the historic flows. In general terms, given a starting water surface elevation and discharge at one study site, the program computes the water surface elevation at the next survey section. At each stage, the program accounts for flow changes between cross-sections due to contrasting geology or channel configuration. Nearby streamflow gaging stations operated by the Salt River Project provided a useful tool in comparing gaged and calculated river flows.

Findings

Slackwater deposits on the Salt and Verde rivers are excellent sites for extending stream records using paleohydrologic methods. Stream gages are in close proximity to paleoflood survey sites and recent flood deposits can be correlated with gage records.

Flood dating not only can be accomplished through radiocarbon dating of sediment materials, but also through datable Indian artifacts incorporated within the deposits.

Through these techniques, physical evidence indicates that the largest flood in the past 1,000 to 2,000 years on either river is significantly less than the theoretical worst-case flood. It's important to note, however, that theoretical flow studies were not limited to datable evidence within a specific time frame. Computer-generated flows calculate the worst-case event possible. Paleoflood study results indicate peak river flows still were larger than those experienced in modern times.

The largest flows recorded are approximately one-fourth to one-third the magnitude of theoretical calculations recorded in the Plan 6 (1) hydrology studies. The following information compares maximum flows according to theoretical studies and results of paleoflood analysis at nearby study sites:

-- PEAK FLOW (cubic feet per second) --

Locations	Theoretical	PALEOFLOOD	RATIO
Gage, Salt River near Roosevelt	460,000	162,000	3:1
Roosevelt Dam	678,000	240,000	3:1
Gage, Verde River below Tangle Creek, above Horseshoe Dam	742,000	191,000	4:1
Horseshoe Dam	764,000	196,000	4:1

(The largest upstream flow recorded in the past 90 years occurred on the Salt River in March 1978, with 170,000 cfs recorded above Roosevelt Dam.)

(1) Plan 6 was judged the best of nine alternatives to Orme Dam for Central Arizona Project water storage, central Arizona flood control and mandated Safety of Dams Act changes affecting some dams owned by the federal government.

Plan 6 proposes a New Waddell Dam to impound Lake Pleasant on the Agua Fria River, a new Cliff Dam to replace Horseshoe Dam on the

Verde River, new spillways at Stewart Mountain Dam and a higher Roosevelt Dam on the Salt River. Construction costs are estimated to total about $1.1 billion in 1984 funds, of which Safety of Dams changes are estimated to encompass about $270 million.

INVESTIGATOR QUALIFICATIONS

SALT & VERDE RIVER PALEOFLOOD STUDIES

Dr. Victor R. Baker, 40, is Professor of Geosciences, and Professor of Planetary Sciences and the Lunar and Planetary Laboratory, University of Arizona, Tucson, AZ 85721.

Baker received a B.S. in Geology from Rensselaer Polytechnic Institute (Troy, N.Y.) in 1967 and a Ph.D. in Geology from the University of Colorado (Boulder) in 1971. He worked as a hydrologist/geophysicist for the U.S. Geological Survey (1966-1969); as the City Geologist of Boulder, Colo. (1969-1971); and as Research Scientist for the Bureau of Economic Geology, the University of Texas at Austin (1973). From 1971-1981 he was on the faculty of the University of Texas. From 1979-1980 he was a Visiting Fellow at Australian National University, Australia. He accepted his present position at the University of Arizona in 1981.

He has published more than 80 research papers, plus numerous technical reports, reviews, abstracts and encyclopedia articles. His books include The Channels of Mars, Catastrophic Flooding (edited), Surfical Geology (co-authored with John E. Costa) and The Channeled Scabland (co-edited with Dag Nummedal).

Baker has served on numerous technical and advisory committees, study groups and panels. These include several advisory groups for the National Aeronautics and Space Administration, committees and panels of the National Research Council, and committees of the American Geophysical Union and the Geological Society of America. He is a member of 11 professional societies. Baker recently was named to a special committee reporting on the Tucson Flood of October 1983 for the Committee on Natural Disasters, National Research Council.

SRP'S POSITION

SALT & VERDE RIVER PALEOFLOOD STUDIES

Central Arizona Project Plan 6 will require several years to complete at a cost estimated to exceed $1 billion. Construction activities in large part will help determine Central Arizona's water future. Owing to the magnitude of the undertaking, it's necessary to investigate all information sources available which might affect the design. It's SRP's position that paleoflood analysis should be validated, expanded where possible locally and in other areas of the Southwest, and included among other Safety of Dams design information.

Though listed in a federal register of Safety of Dams study criteria*, paleohydrology is a fairly new and untested methodology. Attempts should be made to validate the results. Salt River Project invites the technical community to undertake a peer review of Dr. Victor Baker's research methods and encourages an academic investigation of the findings. SRP also will propose a National Academy of Sciences review of the role of paleohydrology in flood-frequency analysis and the development of a probable maximum flood. SRP will attempt to enhance the validity of the study results by expanding investigations. New paleoflood information will be analyzed to enlarge the number of historic floods identified and refine the known frequency through additional datable materials. Through these steps, the percentage of error, inherent in any scientific effort, will be reduced.

Additionally, if paleoflood studies were conducted on watersheds throughout the Southwest, a correlation between historic flooding and predicted floods could be developed. Such a study might indicate the value of paleoflood analysis as an additional tool in determining probable maximum floods.

Once paleoflood results are finalized, the information developed about historical floods should be added to a period of record information source. New flood frequency curves should be developed incorporating statistical analysis. Provisions for doing so are required by "Guidelines for Determining Flood Flow Frequency" by the U.S. Water Research Council of the National Academy of Sciences. Impact on future central Arizona dam designs, in turn, should be determined by managing federal, state and local agencies.

* National Academy Press, 1985. Safety of Dams Flood and Earthquake Criteria, p. 278.