ACCELERATION OF EROSION BY DAMS

ACCELERATION DE L'ÉROSION DUE AUX BARRAGES

PROKOPOVICH N. P., U. S. Water and Power Resources Service (formerly U. S. Bureau of Reclamation), Sacramento, California, U. S. A.*

Summary

The construction of dams on a stream can, under certain conditions, contribute to acceleration of erosion in the tributaries of the streams located between the dams. A good example of such acceleration is the Putah Creek watershed between the 92.66 m high concrete arch Monticello Dam and the small, 8.9 m high Putah Diversion Dam. The watershed above Monticello Dam covers some 1,500 km² and lies in the eastern portion of the Coast Ranges, about 100 km northeast of San Francisco. The area has a Mediterranean climate with winter rains and dry summers.

Some post-construction acceleration of erosion in the downstream reaches of tributary channels occurred in all eight major tributaries entering the mountainous section of Putah Creek between the dams. The erosion is particularly notable in the relatively soft Cenozoic deposits and is less pronounced in channels underlain and "armoured" by harder Cretaceous sandstone and conglomerate.

Under existing climatic conditions, all tributary erosion occurs during winter storms and for most of the year the tributary creeks are dry. Due to its larger watershed, pre-dam floods on Putah Creek were more intense than in its tributaries. Data from the gauging station, located about 2.25 km below Monticello Dam, indicate that some pre-dam Putah Creek flood levels were more than 7.5 m above the creek's summer water level. These very large floods were eliminated by Monticello Dam.

Putah Creek pre-dam floods created the "temporary" base level of erosion for tributary creeks and, to a certain degree, checked their erosion during intensive storm runoffs. Controlled releases from Monticello Dam resulted in lower winter water levels in Putah Creek downstream of Monticello Dam and allowed an acceleration of erosion in the tributary creeks. Construction of retaining gabions and riprapping of the channels near the mouths of tributary valleys is now under consideration.

Résumé

La construction de barrages sur un cours d'eau peut, dans certaines conditions, contribuer à une accélération de l'érosion des affluents des cours situés entre les barrages. Un bon exemple en est la retenue de Putah Creek entre le grand barrage voûté en béton de 92,66 m de haut de Monticello et celui de Putah Diversion de 8,9 m de hauteur. La retenue s'étend sur quelques 1 500 km² et se situe dans la partie Est des Coast Ranges. à environ 100 km au Nord-Est de San Francisco. La région a un climat méditerranéen avec des pluies d'hiver et des étés secs.

Une accélération de l'érosion dans les biefs avals du cours des affluents s'est produite dans l'ensemble des huit principaux affluents pénétrant dans la partie montagneuse de Putah Creek entre les barrages. L'érosion est particulièrement notable dans les formations relativement meubles du Cénozoïque et est moins prononcée dans le lit des cours établis sur des grès et conglomerats crétaçés plus durs et armés par celui-ci.

Sous les conditions climatiques existantes, l'érosion de tous les affluents se produit durant les orages d'hiver et la plupart de l'année leurs lits sont secs. De par son plus grand débit, les inondations de Putah Creek avant la création du barrage étaient plus fortes que celles de ses affluents. Les données de la station de mesure, située à environ 2,25 km en dessous du barrage de Monticello, indiquent que certains niveaux ont dépassé de 7,5 m celui habituel de l'été. Ces très grandes inondations ont été éliminées par le barrage de Monticello.

Les inondations de Putah Creek avant le barrage ont créé le niveau de base temporaire de l'érosion du cours des affluents et, à un certain degré, contrôlé leur érosion durant les forts débits d'orages. Les libérations contrôlées du barrage de Monticello ont eu pour résultat d'abaisser les niveaux d'eau en hiver dans le cours de Putah Creek en aval du barrage et ont permis une accélération de l'érosion du cours des affluents. On envisage maintenant la construction de gabions de retenue et le déblaiement des cours près de la confluence des vallées des affluents.

Introduction

The construction of any man-made structure always has an impact on the original environmental conditions. This is particularly true for dams which affect preconstruction biological and hydraulic relationships in their basins. The impact of dams on geologic processes, including sedimentation and erosion, has been discussed in detail in the literature (Trask 1950; Vanoni 1975; etc.). It has been recognized, for example, that water releases from dams have a low sediment load and may cause an accelerated erosion downstream of a dam. A good example is the Nile River, downstream of Aswan Dam (Vanoni 1975; Simons and Şentürk 1977). It has also been known that the decrease of the flow below a dam may result in siltation in the main valley by material introduced from tributary valleys. Not much is written, however, about the possible increase of erosion in...
tributary streams below a dam due to controlled dam releases. Such an acceleration, which may occur under certain geomorphic and climatic conditions, is described in the following text based on the author's observations in the Solano Project, California (Fig. 1).

The original intent of the Solano Project (USBR 1961) was the delivery of agricultural irrigation water for which water turbidity was of no concern. However, rapid urbanization and industrialization in the area progressively increased the industrial-municipal water usage. Turbidity requirements for such water are more strict and several complaints have been raised about its high seasonal turbidity. A geological investigation of the problem was initiated in 1973 and is summarized in the following text.

Solano Project — general data

The Solano Project of the United States Water and Power Resources Service (Fig. 1) consists of: (1) Monticello Dam on Putah Creek, (2) the small Putah Diversion Dam, and (3) the concrete-lined Putah South Canal serving the Solano Irrigation District, nearby towns, and industries (USBR 1961).

Monticello Dam (Fig. 2A), located in the Coast Ranges about 56 km west of Sacramento, is the principal feature of the project. The 92.66 m high and 311.81 m long concrete arch dam with a 21.95 m diameter glory hole spillway was completed in 1957 (USBR 1959). The reservoir, known as Lake Berryessa, has a storage capacity of 1,976,437 m³.