The Processes Surrounding Channel Evolution following a Partial Dam Removal on the Coastal Plain of Virginia

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Abstract

The physical changes to a newly forming river in a slow draining reservoir following partial dam removal are the focus of this investigation. Past research on the effects of dam removal have focused on changes to the morphology of the downstream channel. This research evaluates the independent parameters controlling channel evolution in the draining reservoir. This research uses a case study to determine the controlling parameters in the channel evolution post dam removal and to develop a conceptual model that is applicable to draining reservoirs on the coastal plain where there is high cohesive sediment content. A partial dam breach on tributary of the James River (VA) has led to slow draining of the reservoir. Data collection included suspended and bedload sediment, discharge rates, bank material samples, and cross sections at twenty-meter increments every four months for two years. A complete documentation of channel adjustments was performed, including the identification and classification of forms and processes observed and the quantification of the dominant processes of channel formation. Data from the study site is to test the accuracy of current methods of predicting channel behavior following a dam break and to develop a conceptual model describing channel formation in draining reservoirs in the coastal plain.

Field Site

Kimages Creek is a tributary of the James River, located south of Richmond, Virginia. The site is on the coastal plain. The confluence between Kimages Creek and the James River was dammed in 1927 to create a lake for fishing and recreation. In September of 2006, the earthen dam was partially breached in a storm and the reservoir left to slowly drain.

Cross sectional surveys have been conducted on a quarterly basis since July, 2007 at the 10 sites shown with white hatches. Discharge entering the site is monitored and correlated to a nearby USGS gage. Sediment samples were taken from the left bank, right bank, and channel center at each cross section. Bedload was measured using a Hely-Smith meter. Suspended sediments were sampled using a DH-48 sampler at each cross section.

Results

From the field data, we develop a conceptual model predicting morphological changes associated with channel evolution in a reservoir following partial dam removal on the coastal plain.

Discussion

The HEC-RAS, DREAM, Fluvial 12, and Cantelli analytical models were evaluated for their ability to predict the observed changes in reservoir and channel forms as the new path of Kimages Creek emerged in the former reservoir area. However, these programs model changes occurring with flood events, and are not designed for large time scale changes occurring with daily flows. A further limitation of these models is their focus on non-cohesive sediments. The coastal plain and Kimagus Creek contain a high proportion of fine and cohesive sediment, limiting model applicability.

Summary and Conclusions

Existing computational models are not able to reproduce the changes following dam removal in the coastal area where reservoirs drain slowly and sediments have a high cohesive content. A new conceptual model is presented to describe and predict the pattern of channel evolution in the coastal plain. The evolution of a channel in a formerly impounded reservoir is dependent on the flow regime and frequency of high flows.

Contributions

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References