Hungry water and sustainable management of sediment in regulated rivers

« Eau affamée » et gestion durable des sédiments dans un fleuve régulé

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RÉSUMÉ

La nécessité d'une gestion active des sédiments dans les réservoirs est de plus en plus reconnue, en raison de la perte de capacités de stockage précieuses dans les réservoirs, et du fait que les zones situées en aval souffrent du manque de sédiments et manifestent des problèmes tels que l'incision du chenal, l'accélération de l'érosion des deltas et la perte de graviers importants pour l'habitat naturel. Bien qu'il existe des possibilités de faire passer des sédiments à travers ou autour des réservoirs (pour préserver la capacité du réservoir et minimiser les impacts en aval), ces approches durables pour la gestion des sédiments ne sont pas appliquées dans de nombreuses situations où elles seraient pourtant efficaces. Lorsque la géométrie est favorable, il est souvent possible de faire contourner le réservoir aux sédiments (en évitant la sédimentation du réservoir et en fournissant des sédiments aux zones situées en aval) ou de les faire passer par des débouchés de grande capacité après les avoir fait circuler rapidement à travers le réservoir pour éviter la sédimentation. Dans les réservoirs étroits avec des pentes longitudinales très raides, les sédiments accumulés dans le réservoir peuvent souvent être remis en suspension et évacués lorsque le réservoir est vidé. Les courants de turbidité peuvent souvent être « évacués » à travers le barrage, avec l'avantage que le réservoir n'a pas besoin d'être vidé pour évacuer les sédiments.

ABSTRACT

The need to actively manage sediment in reservoirs is increasingly recognized, as valuable reservoir storage capacity is lost and downstream reaches suffer from sediment starvation, manifesting problems such as channel incision, accelerated erosion of deltas, and loss of gravels important for habitat. Despite the opportunities to pass sediment through or around reservoirs (to preserve reservoir capacity and to minimize downstream impacts), these sustainable approaches to managing sediment are not applied in many situations where they would be effective. Where geometry is favorable, sediment can often be bypassed around the reservoir (avoiding reservoir sedimentation and supplying sediment to downstream reaches) or sluiced through large-capacity outlets after flowing rapidly through the reservoir to avoid sedimentation. In narrow reservoirs with steep longitudinal gradients, sediments accumulated in the reservoir can often be re-suspended and flushed through when the reservoir is drawn down. Turbidity currents can often be 'vented' through the dam, with the advantage that the reservoir need not be drawn down to pass sediment.

KEYWORDS

Sustainable réservoir management, sediment starvation in regulated rivers, sediment transport

INTRODUCTION

By trapping sediment in reservoirs, dams interrupt the continuity of sediment transport through rivers, resulting in loss of reservoir storage and reduced usable life, and depriving downstream reaches of sediments essential for channel form and aquatic habitats. With the acceleration of new dam construction globally, these impacts are increasingly widespread, as reflected in decreasing sediment loads in major rivers worldwide. There are proven techniques to pass sediment through or around reservoirs, to preserve reservoir capacity and to minimize downstream impacts. Experience around the globe demonstrates that these approaches can work in many situations, but they are not applied in many situations where they could be effective (Kondolf et al. 2014).

1 PASSING SEDIMENT THROUGH/AROUND DAMS

The most sustainable approaches are sediment routing, which allow natural flows to transport sediment through or around dams, maintaining the natural pattern and magnitude of sediment transport (Morris and Fan 1998). Where geometry is favorable it is often possible to bypass sediment around the reservoir, which avoids reservoir sedimentation and supplies sediment to downstream reaches with rates and timing similar to pre-dam conditions. *Sluicing* (or drawdown routing) permits sediment to be transported through the reservoir rapidly to avoid sedimentation during high flows; it requires relatively large capacity outlets. Sluicing delivers sediment to downstream reaches at rates and timing essentially unchanged from the natural sediment transport, which is a significant environmental advantage. *Drawdown flushing* involves scouring and re-suspending sediment deposited in the reservoir and transporting it downstream through low-level gates in the dam; it works best in narrow reservoirs with steep longitudinal gradients and with flow velocities maintained above the threshold to transport sediment. If flushing is undertaken during high flows, the timing of sediment delivery downstream will be comparable to natural patterns, and higher flows are available to transport sediments downstream. *Turbidity currents* can often be vented through the dam, with the advantage that the reservoir need not be drawn down to pass sediment.

3. OTHER APPROACHES

Where it is not possible to pass sediment around or through dams, other approaches are possible. To reduce reservoir sedimentation, *land conservation* efforts may be undertaken in the river catchment (with multiple benefits such as retaining productive agricultural soils on-site, but little proven value in reducing sedimentation problems) and sediments may be *mechanically removed* from reservoirs. To compensate for sediment starvation below dams, *sediment augmentation* (usually coarse) to the channel downstream can be undertaken, most commonly for restoration of gravel habitats.

4. CONCLUSIONS

As water supply and dam safety concerns become more urgent, we can anticipate increased demand for sediment management approaches to sustain reservoir capacity and minimize environmental impacts of dams (Annandale 2013). For example, in response to the current drought and water storage capacity concerns, California State Senate passed SB1259, directing the Department of Water Resources to assess the state's reservoirs for sedimentation problems. Sediment management is most efficiently implemented in planning/designing dams, rather than by retrofitting existing structures.

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