Challenges, impacts, and management opportunities for sediment in large river basins

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Introduction: Dams have arguably the largest single impact on sediment budgets on most rivers worldwide, resulting in the decreased sediment yields recorded on most major rivers despite increasing extent of land-use change that would be expected to increase sediment yields. Sediment trapping by dams results in twin problems of loss of reservoir storage capacity and erosion of downstream channels and deltas by sediment-starved flows.

Cumulative Sediment Starvation on the Mekong: In the absence of proactive sediment management in reservoirs, cumulative sediment trapping at the river basin scale can have substantial impacts. In the Mekong River basin, construction of all 140 planned large mainstem and tributary dams would result in cumulative trapping of 96% of the river's suspended load (Kondolf et al. 2014a). The downstream effects of this sediment starvation will vary from bedrock to alluvial reaches, but ultimately such a reduction in sediment load will deprive the delta of its essential sediment supply, threatening its long-term sustainability (Rubin et al. 2014). The delta faces threats from other drivers as well, such as sediment starvation from intensive in-channel sand mining, accelerated subsidence from groundwater pumping, and accelerated sea level rise, but ultimately all deltas depend on a supply of sediment from the river basin to balance subsidence and coastal erosion (Schmitt et al. 2017).

Sustainable Sediment Management: Sediment starvation can be reduced through implementation of sustainable sediment management practices, such as sediment bypassing around dams, sluicing sediment through large low-level outlets in dams during floods, draw-down flushing through dams, and venting density currents through dams (Morris and Fan 1998, Annadale 2013, Kondolf et al. 2014b). While these approaches cannot be implemented at all dams, they can be used at far more dams than is currently the case.

Optimizing Dam Placement at Network Scale: Some dams, such as large mainstem dams, have greater impact on sediment loads and fish migration per MW generated. Our analysis (based on data available from the Mekong River Commission database and application of the CASCADE model) shows that an optimal portfolio of only dams on upper reaches of tributary rivers could generate 80% of the power with a fraction of the impact. However, such an optimization analysis does not currently guide dam development at the river basin scale in the Mekong or other river basins. However, in river basins where hydroelectric development is still being planned, it could potentially reduce environmental impacts while still generating significant hydropower.

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