Human Impact on Erosion and Sedimentation (Proceedings of the Rabat Symposium, April 1997).
IAHS Publ. no. 245, 1997

The potential impact of neo-Castorization on sediment transport by the global network of rivers

CHARLES J. VÖRÖSMARTY
Institute for the Study of Earth, Oceans, and Space and Earth Sciences Department, University of New Hampshire, Durham, New Hampshire 03824, USA

MICHEL MEYBECK
Laboratoire de Géologie Appliquée, Université de Paris VI, Place Jussieu, F-75257 Paris, France

BALÁZS FEKETE & KESHAV SHARMA
Institute for the Study of Earth, Oceans, and Space and Earth Sciences Department, University of New Hampshire, Durham, New Hampshire 03824, USA

Abstract In this paper, we assess the potential impact of global reservoir construction on sediment transport from the continental land mass. Our study links information on 633 of the world's largest reservoirs (LRs) ($\geq$0.5 km^3 maximum storage capacity) to a digitized river network at 30-minute spatial resolution. A residence time change ($\Delta\tau_R$) is used in conjunction with a retention function to predict the proportion of incident sediment flux trapped within each impoundment. The discharge-weighted mean $\Delta\tau_R$ for individual LRs distributed across the globe is 0.21 years. We estimate that more than 40% of global river discharge is intercepted by the large impoundments we studied and that a significant proportion ($\approx$70%) of this discharge maintains a theoretical sediment trapping efficiency in excess of 50%. For regulated drainage basins the global, discharge-weighted residence time change is 0.16 years, representing a 30% potential sediment trapping. For all river systems, we estimate a 16% sediment trapping. From the standpoint of sediment retention, the most heavily regulated drainage basins are in Europe. North America, Africa, Australia/Oceania are also strongly affected.

INTRODUCTION

The transport of riverborne sediment from the continental land mass to the world's oceans is a fundamental feature of the geology and biogeochemistry of our planet. However, despite numerous attempts at its estimation, the magnitude of global suspended sediment flux to the ocean is still a matter of debate. Estimates range from 9.3 gigatons per year (Gt year^{-1}) (Judson 1968) to more than 58 Gt year^{-1} (Fournier 1960 as calculated by Holeman 1968) with more recent studies (e.g. Meybeck 1982, 1988; Walling & Webb 1983; Milliman & Meade 1983; Milliman & Syvitski, 1992) converging at 15-20 Gt year^{-1}.

This wide breadth of results has emerged from the admixture of assumptions, approaches, and uncertainties embedded within these global inventories. For example, the available data barely cover more than 50% of the continental land mass, necessitating significant extrapolation. The sampled rivers are also poorly checked for how representative they are of global patterns of runoff, relief, and climate. In addition, the manner in which exorheic and endorheic basins are distinguished is