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APPLICATION OF NCCHE'S SEDIMENT TRANSPORT MODELS TO MEXICO RIVERS

Guillermo Cardoso Landa[1]

Abstract: *The 39 main rivers of Mexico and the 667 large dams to operate in the country of Mexico, moves a significant amount of sediment, which have not quantified accurately in our country and causing major problems of flooding, disasters and in general, hydraulic, and hydrological problems, which requiring resolved taking as data, among others, through sediment transport. This paper discusses the different current sediment transport models and select models developed by the National Center for Computational Hydroscience and Engineering (NCCHE) of the University of Mississippi, in the United States, to be applied in rivers and Mexico dams for sediment transport. The governing equations, model closures, empirical functions and numerical methods of sediment transport models in NCCHE are briefly reviewed in this paper. Several verification and application examples are selected to demonstrate the capabilities of NCCHE's models.*

Keywords: *sediment transport; Mexico Rivers; models; dams.*

INTRODUCTION

In the rivers in the country of Mexico drain approximately 400 cubic kilometers of water annually, including waters that fall from neighboring countries and discounting departing towards them. Approximately 87 % of this runoff occurs in 39 major rivers whose basins occupy nearly 58 % of the continental territorial extension. Rivers that account for 65 % of runoff are Grijalva-Usumacinta, Papaloapan, Coatzacoalcos, Balsas, Pánuco, Santiago, and Tonalá (whose basins together totaled 22 % of the national territory). The Rivers Balsas and Santiago belong to the Pacific slope and the other five to the slope of the Gulf of Mexico. For its length highlight the Bravo and Grijalva-Usumacinta rivers.

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Fig. 1 Major rivers of México

Some of the water that drains by rivers is currently stored in dams and used, between other purposes, for the production of food, the generation of electric power, flood control, and industrial and domestic uses water supply. Major dams in the country of Mexico began to build before 1920 and had a growth accelerated between 1940 and 1970. Of 4000 existing dams, 667 are classified as large dams in accordance with the criteria of the International Commission of Large Dams. Storage capacity provided is 150 cubic kilometers of water and together would be 37 % of the annual average runoff from the country. However, the average volume storage in 51 major dams in the country between 1990 and 2004 was 61 cubic kilometers.

Fig. 2 Major dams in México

Recorded the largest average volume storage dams (considering the years 1990, 1995, 2000, 2003 and 2004) were La Angostura and Malpaso (both in the State of Chiapas, with 10,500 and 8,500 cubic hectometers per annum, respectively), Infiernillo (Michoacán State, 7,600 cubic hectometers) and Temascal (Oaxaca State, with nearly 5,000 cubic hectometers).

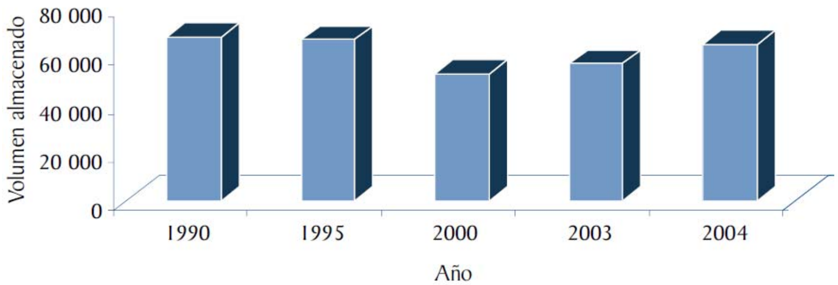

Fig. 3 Average volume storage dams in Mexico

PURPOSE

Of these 39 main rivers of Mexico and the 667 large dams to operate in the country of Mexico, moves a significant amount of sediment, which have not quantified accurately in our country and causing major problems of flooding, disasters and in general, hydraulic, and hydrological problems, which requiring resolved taking as data, among others, through sediment transport.

This paper discusses the different current sediment transport models and select models developed by the National Center for Computational Hydroscience and Engineering (NCCHE) of the University of Mississippi, in the United States, to be applied in rivers and Mexico dams for sediment transport.

RESEARCH ON SEDIMENT TRANSPORT BY NCCHE

Fundamental research on sediment transport has been conducted at NCCHE in past years. NCCHE researchers proposed formulas for determining the fractional transport capacities of bed load and suspended load, which take into account the hiding and exposure effects among different size classes. In addition, formulas for the calculations of sediment deposit porosity, settling velocity, movable bed roughness and sediment transport over steep slopes were also developed. These formulas were calibrated using a large data set that included experimental and field measurements.

The newly proposed Wu et al (2000) sediment transport capacity formulas were tested independently against many different experiment and field data, including Brownlie (1981) data sets, and Toffaleti (1968) data sets. Wu et al. formulas were also compared with some existing formulas, such as Ackers and White (1973) formula and its modification by Proffit and Sutherland (1983), Engelund and Hansen (1967) formula, Yang (1973) formula, and the SEDTRA module (Garbrecht, et al. 1995) Wu et al. formulas can provide reliable predictions for the fractional discharges of bed load, suspended load, and bed-material load.

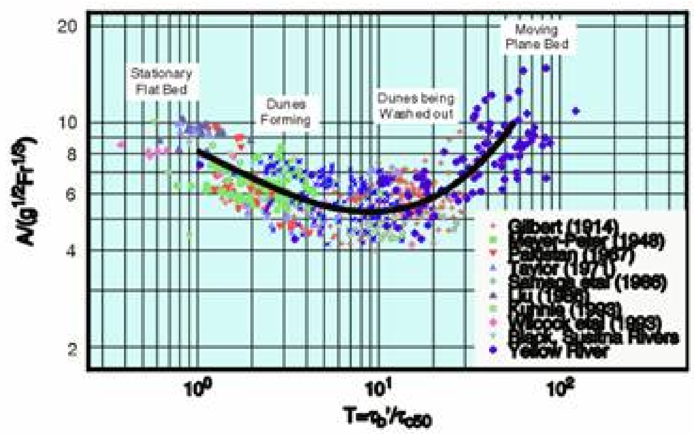

Fig. 4 Formulas for movable bed roughness, (Wu and Wang)

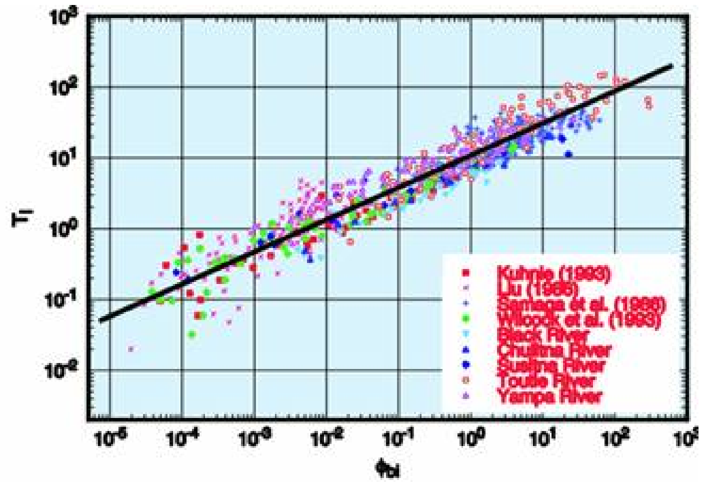

Fig. 5 Formulas for fractional bed-load discharge (Wu, Wang and Jia)

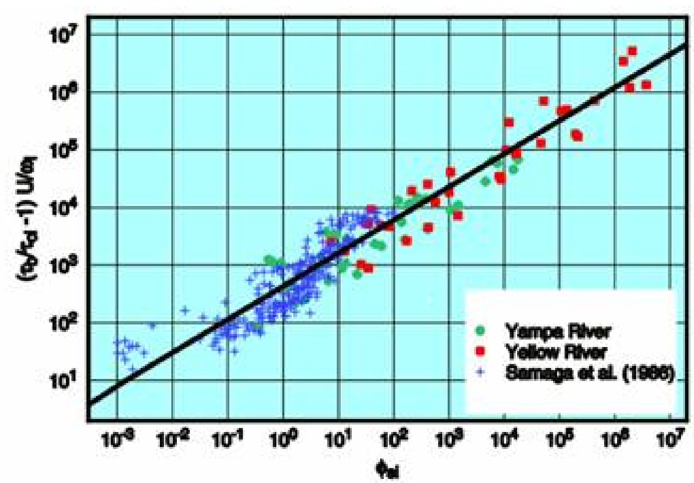

Fig. 6 Formulas for fractional suspended-load discharge (Wu, Wang and Jia)

Table 1 Comparison of bed-load transport capacity formulas using Brownlie uniform

bed load data

Error ranges	Percentages (%) of calculated transport rates in error ranges				
	Van Rijn	Engelund & Freds	Bagnold	Meyer-Peter & Mueller	Wu et al.
$0.8 \le r \le 1.25$	14.8	21.4	21.4	21.3	38.7
$0.667 \le r \le 1.5$	25.3	37.4	38.9	39.4	59.3
$0.5 \le r \le 2$	44.0	54.1	57.2	66.2	80.1

Table 2 Comparison of bed-material load transport capacity formulas using Brownlie uniform bed-material load data

Error ranges	Percentages (%) of calculated transport rates in error ranges				
	Ackers & White	Yang	Engelund & Hansen	SEDTRA	Wu et al.
$0.8 \le r \le 1.25$	37.3	33.4	33.6	36.6	40.4
$0.667 \le r \le 1.5$	57.9	56.6	55.4	59.1	62.7
$0.5 \le r \le 2$	82.4	76.6	77.0	78.1	81.3

Note: r = calculation / measurement.

Table 3 Comparison of bed-material load transport capacity formulas using Toffaleti nonuniform bed-material load data

Error ranges	Percentages (%) of calculated transport rates in error ranges				
	Modified Ackers-W.	Modified Engelund-H.	Karim	SEDTRA	Wu et al.
$0.5 \le r \le 2$	5.6	27.8	42.7	56.9	57.9
$0.333 \le r \le 3$	11.1	40.3	63.5	73.1	76.1
$0.25 \le r \le 4$	20.8	49.0	73.3	80.9	85.2

CONCLUSIONS

After to revise some sediment transport models and the characteristics of the 39 main rivers of Mexico and the 667 large dams that operate in the country of Mexico, it concludes that the best sediment transport models to apply to Mexican rivers are the models developed by the National Center for Com putational Hydr oscience and Engineering (NCC HE) of the University of Mississippi, in the United States, which apply the next diagram.

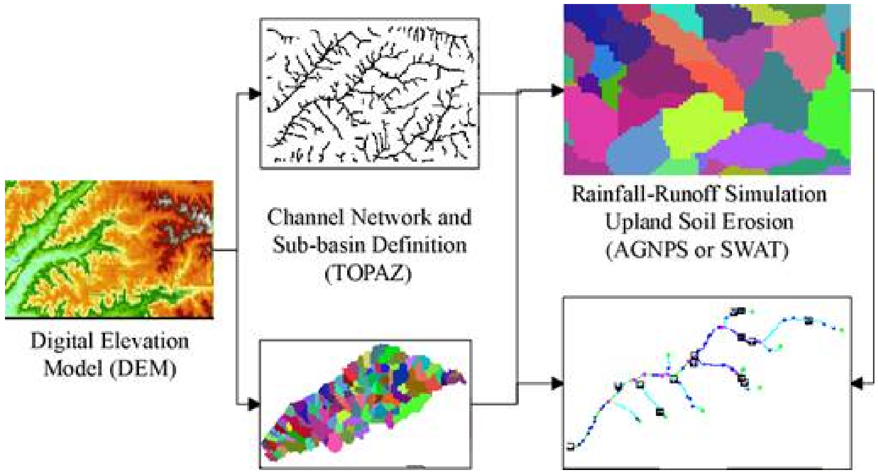

Fig. 7 Process used by the NCCHE's models

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Wu et al. 2000. Nonuniform sediment transport in alluvial rivers. *J. of Hydraulic Research*, 38 (6), 427-434.