

DISSERTATION

MEASURING AND PREDICTING EROSION AND SEDIMENT YIELDS  
ON ST. JOHN, U.S. VIRGIN ISLANDS

Submitted by

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WE HEREBY RECOMMEND THAT THE DISSERTATION PREPARED UNDER OUR  
SUPERVISION BY CARLOS E. RAMOS-SCHARRÓN ENTITLED MEASURING AND  
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BE ACCEPTED AS FULFILLING IN PART REQUIREMENTS FOR THE DEGREE OF  
DOCTOR OF PHILOSOPHY.

Committee on Graduate Work

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Chair

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## ABSTRACT OF DISSERTATION

### MEASURING AND PREDICTING EROSION AND SEDIMENT YIELDS ON ST. JOHN, U.S. VIRGIN ISLANDS

Increased sediment delivery rates are believed to be causing adverse effects on the nearshore coral reef communities of St. John, U.S. Virgin Islands. The objectives of this study were to: (1) measure runoff and sediment yields from undisturbed hillslopes and a road segment; (2) measure and predict sediment production rates from natural sources and unpaved roads; and (3) develop and apply a GIS-based sediment yield model.

Runoff on undisturbed hillslopes only occurred when storm precipitation exceeded 2-3 cm, while only 0.3 cm was needed to generate runoff from unpaved roads. Runoff coefficients for the undisturbed hillslopes averaged 3% and had a maximum of 8%, while the road segment had a mean runoff coefficient of 6% and a maximum of 70%. The road segment data were used to develop runoff models that combined the Green-Ampt infiltration with either an empirical unit hydrograph or a kinematic wave routing component. Both models underestimated runoff for storms with less than 1 cm of rainfall, but predictions improved when rainfall exceeded 1 cm.

Streambanks produced sediment at a rate of  $10 \text{ kg m}^{-2} \text{ yr}^{-1}$ , and treethrow produced 0.17 tons per kilometer of stream per year. Annual sediment production rates from undisturbed hillslope plots ranged from  $1\text{-}27 \text{ g m}^{-2}$ , while mean rates from undisturbed zero- and first-order catchments were 1 and  $8 \text{ g m}^{-2}$ , respectively. Sediment production rates from unpaved road segments averaged  $7.4 \text{ kg m}^{-2} \text{ yr}^{-1}$  and were significantly related to total precipitation and slope. After normalizing by precipitation and slope, the mean annual sediment production rate for roads graded within the last two years was  $0.96 \text{ kg m}^{-2} \text{ cm}^{-1} \text{ m m}^{-1}$ , while rates for ungraded and abandoned roads were 0.56 and  $0.071 \text{ kg m}^{-2} \text{ cm}^{-1} \text{ m m}^{-1}$ , respectively. Cutslopes were responsible for only 9% of road-segment scale sediment yields.

STJ-EROS is a GIS-based system that uses empirical sediment production functions and delivery ratios to estimate watershed-scale sediment yields. STJ-EROS indicated that unpaved

roads are increasing sediment yields by 5-40 times above undisturbed conditions. Predicted values were within the range of estimated sediment yields and bay sedimentation rates. The results indicate that road improvements are needed to protect the marine resources of St. John.

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## DEDICATION

This work is an offering to Olofi, God the Creator.  
She/He who knows the true value  
of all the processes that I have  
measured, modeled, and described in this dissertation.  
Processes that are naturally divine, as they are as much  
an expression of Him/Her as my breath and my heartbeat.  
To You I dedicate this work.

Any mountain stream is dangerous to ford,  
even the shallowest of them,  
chiefly because of the way the bed shifts.  
It's like a kaleidoscope, changing every day  
with the force of the current,  
and where there is a rock one day,  
there will be a hole the next.

Mikhail Lermontov  
*A Hero of Our Time*

¡Rio Grande de Loíza!... Azul. Moreno. Rojo.  
Espejo azul, caído pedazo azul de cielo;  
desnuda carne blanca que se te vuelve negra  
cada vez que la noche se te mete en el lecho;  
roja franja de sangre, cuando bajo la lluvia  
a torrentes su barro te vomitan los cerros.

Julia de Burgos  
*Río Grande de Loíza*

How he loved this river...  
Yes, he wanted to learn from it, he wanted to listen to it.  
It seemed to him that whoever understood this river  
and its secrets,  
would understand much more, many secrets, all secrets.

Hermann Hesse  
*Siddhartha*

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