THESIS

ANALYSIS AND MODELING OF EROSION HAZARDS AND SEDIMENT DELIVERY ON ST. JOHN, U.S. VIRGIN ISLANDS

Submitted by

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ABSTRACT OF THESIS

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More than half of St. John island and much of its offshore area is managed as Virgin Islands National Park by the U.S. National Park Service. St. John is a popular tourist destination because of its white sand beaches, coral reefs, and relatively undisturbed tropical forests. Increasing development on St. John has raised concerns that soil erosion and sediment delivery to the marine environment has accelerated. Since coral reefs are particularly sensitive to turbidity and fine sediment, this may be damaging the marine resources that were a primary reason for the establishment of the Park.

This study was undertaken on behalf of the U.S. Park Service to assess existing and potential erosion threats on St. John. The primary objectives were: (1) to identify and map areas of low, medium, and high erosion susceptibility; (2) to predict rates of sediment delivery to the marine environment; and (3) to recommend practices to minimize or reduce sediment delivery to the marine environment.

Historic rates of sediment delivery on the island were estimated by investigating sediment accumulation in depositional areas and erosional characteristics of upland areas. Present-day erosion and sediment delivery processes were assessed

by investigating land use activities, erosional evidence associated with these land uses, and particle characteristics of several major streambeds.

Two models were used to identify and map erosion hazard areas on St. John. First, an automated model (ROADMOD) was developed to predict average annual erosion and sediment delivery from unpaved road networks. Second, spatially-distributed data on soils and topography were interfaced with the Revised Universal Soil Loss Equation (RUSLE) to predict areas with greatest potental for surface erosion following removal of protecting cover vegetation.

Both RUSLE and ROADMOD were implemented using a geographic information system (GIS). In the case of RUSLE, a raster-based modeling approach was used. The slope-length (L) factor for RUSLE was derived from a three-dimensional analysis of terrain characteristics. In the case of ROADMOD, the model was interfaced with vector-formatted GIS data including road widths, lengths, surface character, gradient, and discharge locations. ROADMOD was applied to two test watersheds on St. John. Park Service turbidity measurements in the receiving bays are consistent with model predictions.

Field measurements indicate that the average natural sediment yield on St. John is on the order of 20 tonnes per km^2 per year. Field data and model predictions lead to the conclusion that present-day production and delivery of fine sediment on the island is dominated by erosion from unpaved road surfaces, and that roads probably increase sediment production rates two to ten times.

Eleven sediment control practices are recommended on St. John. Principle among these are: (1) wherever possible, no new roads should be constructed; (2) unnecessary roads should be eliminated; and (3) unpaved road surfaces should be paved.

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