Land-based Sources of Threat to Coral Reefs in the US Virgin Islands

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A collaborative data product coordinated by

WORLD RESOURCES INSTITUTE

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Project Goal

With support from the U.S. National Oceanic and Atmospheric Administration (NOAA), The "Reefs at Risk" project of the World Resources Institute (WRI) teamed with NOAA's "Summit to Sea" project to develop and implement analysis of land-based threats to coral reefs in the U.S. Virgin Islands (USVI) and Puerto Rico. The goal of the collaboration is to support improved management of coastal ecosystems by developing and making available extensive information on watershed-based threats to these ecosystems, including identification of watersheds which are highly erosive and those watersheds contributing elevated levels of sediment and pollution to coastal waters. Data assembled or developed under this collaboration, including analysis results, are published on the *Coastal Data CD for the U.S. Caribbean*[1]. The data CD also serves as a GIS data sampler for both the USVI and Puerto Rico, allowing users to do their own analysis of land-based sources of threat. This atlas provides a summary of some of the spatial indicators developed under the project.

Collaboration

The project was implemented by the World Resources Institute and the U.S. National Oceanic and Atmospheric Administration, in collaboration with many local institutions and other partners. Collaborating institutions were vital sources of information, provided guidance on the analytical approach, and offered critical review of analysis results. Groups which contributed data or provided guidance on the project include:

- University of the Virgin Islands / Caribbean Data Center (UVI / CDC)
- USVI Department of Planning and Natural Resources (DPNR)
- Puerto Rico Department of Natural and Environmental Resources (DNER)
- U.S. Department of Agriculture
- U.S. National Park Service
- U.S. National Fish and Wildlife Service
- U.S. Geological Survey
- The Nature Conservancy
- Island Resources Foundation
- The Ocean Conservancy
- International Coral Reef Action Network (ICRAN)

[1] World Resources Institute (WRI) and U.S. National Oceanic and Atmospheric Administration (NOAA), *Coastal Data CD for the U.S. Caribbean*, (Washington, DC: WRI / NOAA, 2005)

Analysis Approach

Alteration of the natural landscape for development, road construction, or agriculture can have adverse impacts on coral reefs through increased delivery of sediment and pollution to coastal waters. The threat associated with land clearing is higher in areas of steep relief, intense precipitation, and where soils are erosive in nature. This threat is often evaluated through application of the Revised Universal Soil Loss Equation (RUSLE) developed by the U.S. Department of Agriculture (USDA). RUSLE is useful for examining erosion in many agricultural areas, but is less well suited to the very steep and rutted environments of the U.S. Virgin Islands where road construction accounts for most erosion.

This study uses several spatial and statistical techniques to characterize watersheds across the USVI with regard to relative erosion rates and the threat of land-based sources of sediment and pollutant delivery to coastal waters. A simplified version of RUSLE (using slope, land-cover, precipitation, and soil characteristics) is applied, as well as indicators of road density and erosivity by watershed. Watersheds are an essential unit for analysis, since they link land areas with their point of discharge to the sea. The atlas presents a comparison of estimated watershed-based threat to coral reefs from both land cover change and road development.

Note on watershed boundaries:
In the USVI, official watershed boundaries have been derived and are available from the USVI Department of Planning and Natural Resources (DPNR) and the University of the Virgin Islands – Conservation Data Center (UVI-CDC). These "official" watersheds reflect large areas discharging to a single bay, and are relevant for coastal planning and land management. Most maps in this atlas use these watersheds for reference. The "Reefs at Risk" project, however, has an interest in hydrologic modeling of "basins" where land areas are associated with a single point of discharge to the sea. In order to estimate sediment delivery to coastal waters, we also present these smaller hydrologic units, called "basins" within this atlas.

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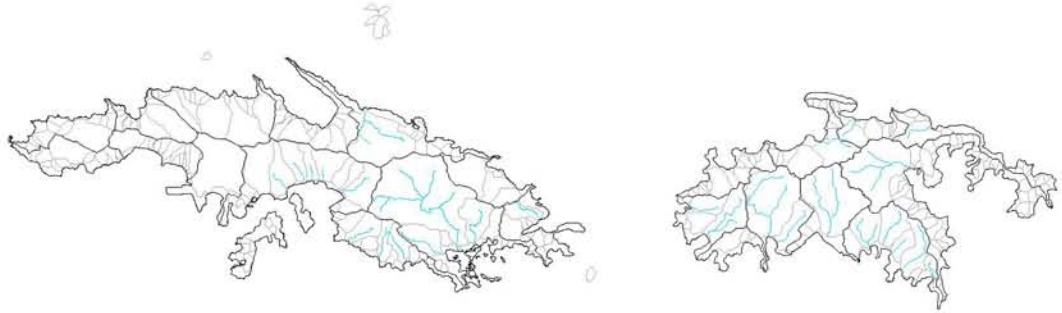
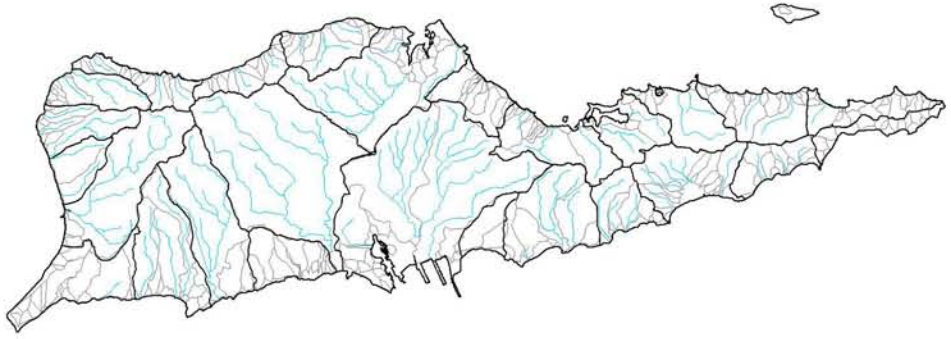
Hydrology in the US Virgin Islands



St. Thomas and St. John



St. Croix

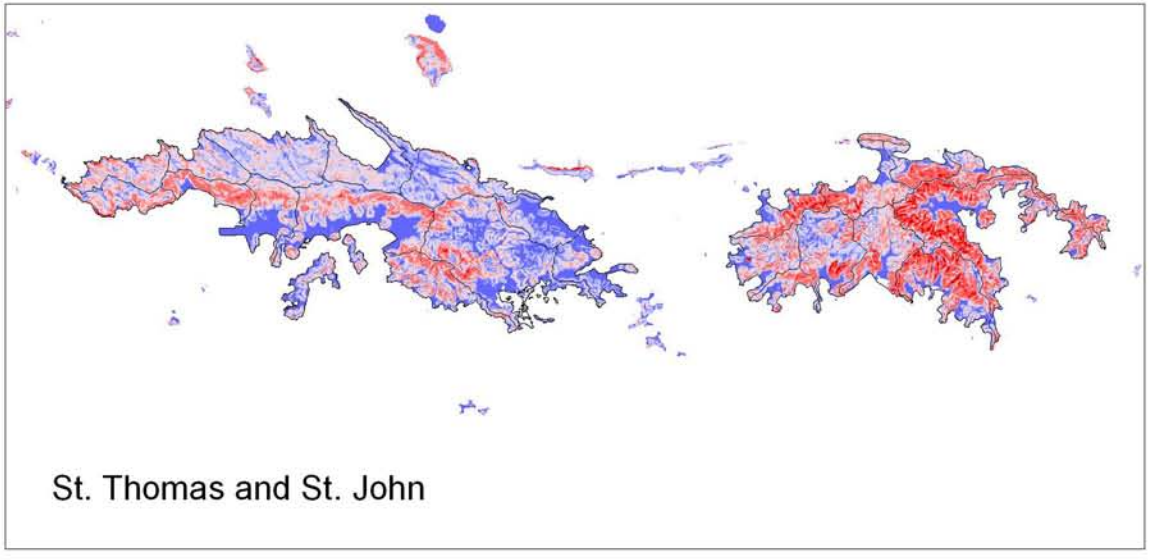
This map presents two approaches to watershed mapping. The USVI has mapped "official" watersheds reflecting large areas discharging to a single bay. These 53 "watersheds" are relevant for coastal planning and land management.
The "Reefs at Risk" project has an interest in hydrologic modeling of "basins" where land areas are associated with a single point of discharge to the sea. Over 400 basins with a minimum area of 6 ha. are presented.

River Guts (Sttj_river_guts.shp)
Watersheds (Sttj_ws_uwi.shp)
Basins (derived) (Sttj_basins.shp)

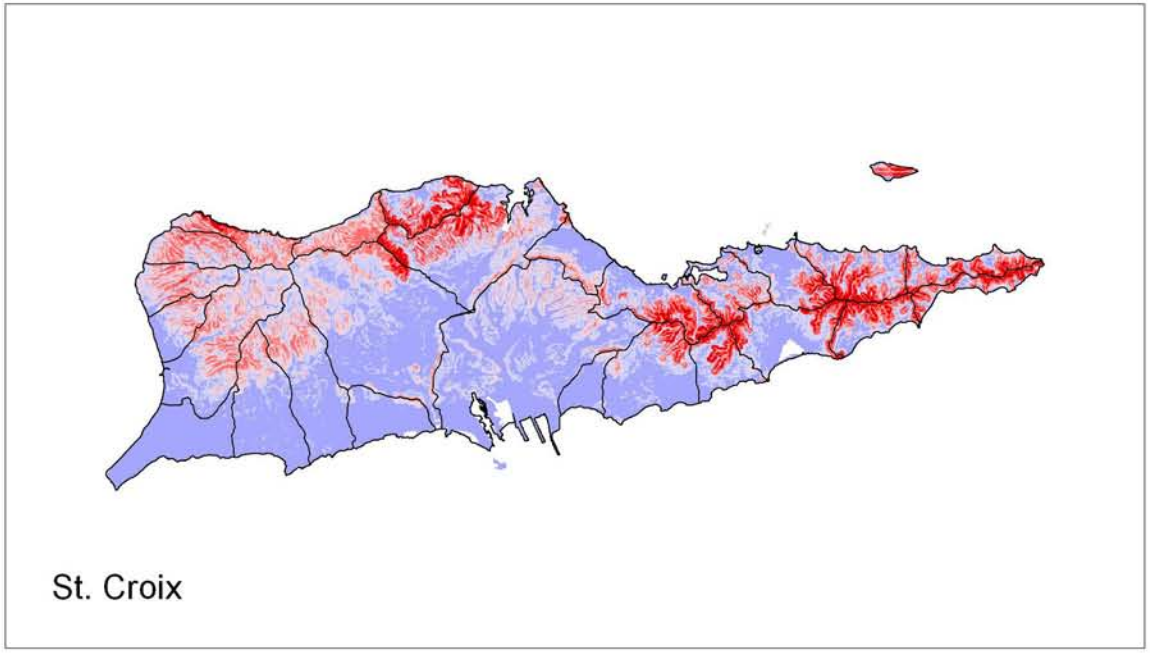
Source:
Watershed boundaries provided by the USVI Department of Planning and Natural Resources (DPNR) and the University of the Virgin Islands (UVI/CDC).
Basins were derived by WRI and NOAA, 2005, under the Reefs at Risk Project.

5 0 5 Kilometers

Relative Vulnerability of Land to Erosion

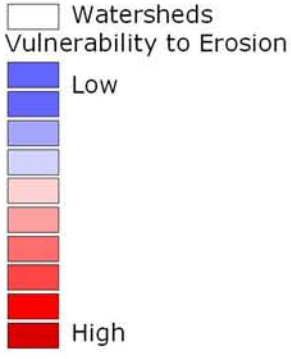


St. Thomas and St. John



St. Croix

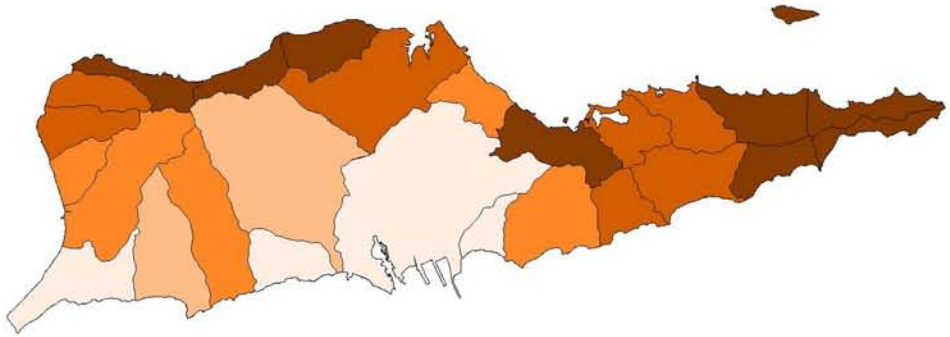
Physical factors, such as the slope of the land, the texture of the soil, and the precipitation regime influence erosion in an area. We have developed a simple indicator of the erosivity of the land based on slope, precipitation, and the K-ffactor of the soil (erodibility of the given soil type.) This indicator does not consider the current land cover or land use. Rather, it provides an overall indicator of erosion-prone areas, and hence, areas where development / land conversion / road construction should be avoided.



Source:
"Relative Vulnerability to Erosion" was developed by WRI and NOAA, 2005, under the Reefs at Risk Project. Watershed boundaries provided by the USVI Department of Planning and Natural Resources and the University of the Virgin Islands (UVI/CDC).

Mean Vulnerability of Land to Erosion (by watershed)

St. Thomas and St. John



St. Croix

Physical factors, such as the slope of the land, the texture of the soil, and the precipitation regime influence erosion in an area. We have developed a simple indicator of the erosivity of the land based on slope, precipitation, and the K-ffactor of the soil (erodibility of the given soil type.) This indicator has been summarized for major watersheds in the USVI.

Mean Vulnerability by watershed

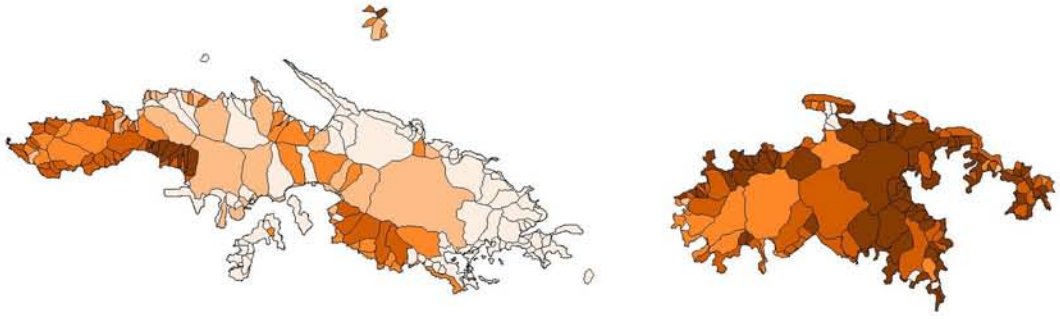
Low

High

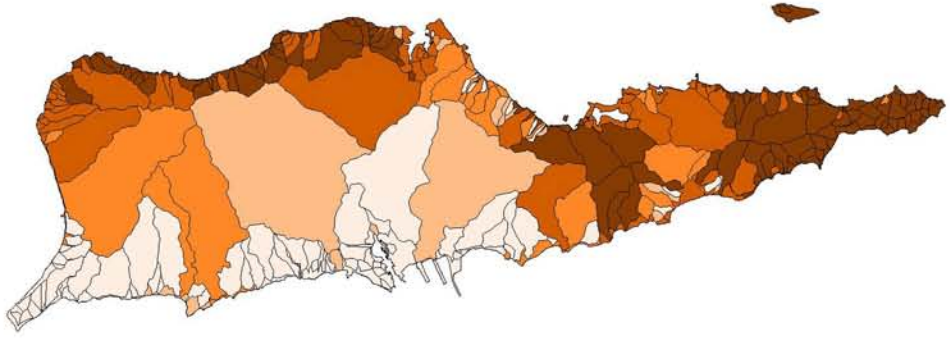
Source:
"Relative Vulnerability to Erosion" was developed by WRI and NOAA, 2005, under the Reefs at Risk Project. Watershed boundaries provided by the USVI Department of Planning and Natural Resources and the University of the Virgin Islands (UVI/CDC).

5 0 5 Kilometers

Mean Vulnerability of Land to Erosion (by basin)



St. Thomas and St. John



St. Croix

Physical factors, such as the slope of the land, the texture of the soil, and the precipitation regime influence erosion in an area. We have developed a simple indicator of the erosivity of the land based on slope, precipitation, and the K-ffactor of the soil (erodibility of the given soil type.) This indicator has been summarized for basins in the USVI.

Mean Vulnerability by basin

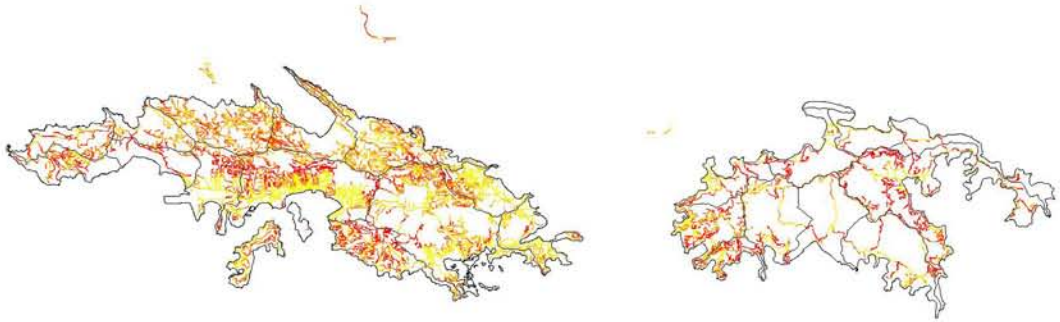
Low

High

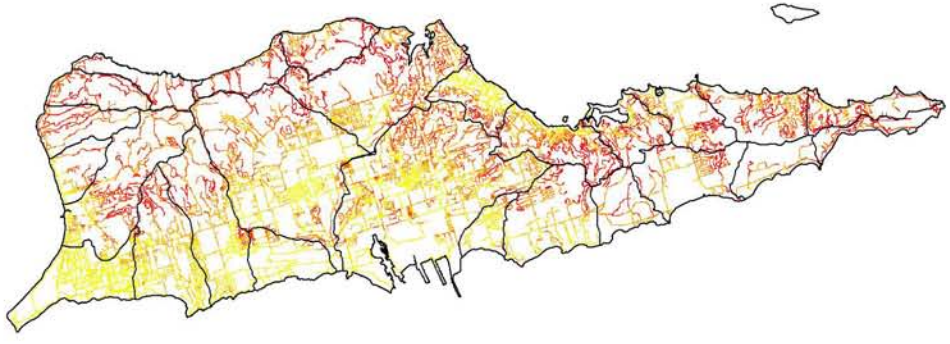
Source:
"Relative Vulnerability to Erosion" was developed by WRI and NOAA, 2005, under the Reefs at Risk Project. Basin boundaries derived from a hydrologic model by WRI and NOAA, 2005.

5 0 5 Kilometers

Vulnerability of Roads to Erosion



St. Thomas and St. John



St. Croix

Roads are a major source of erosion, particularly in steep areas on tropical islands. Roads are the largest source of erosion within the USVI. Erosion is generally most severe during road construction, but can also result in longer-term erosion due to exposed shoulders and abrupt changes in slope adjacent to the road.
We developed an indicator of the relative vulnerability of roads to erosion based upon slope, precipitation, and the K-ffactor of the soil (erodibility of the given soil type.)

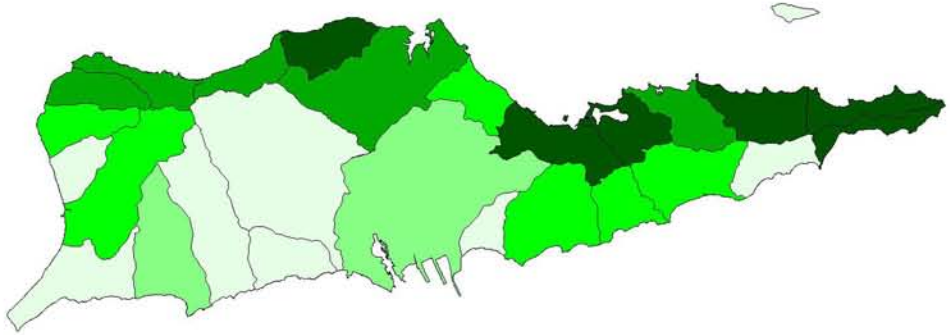
Watersheds
Roads by Vulnerability
Low
High

Source:
"Vulnerability of Roads to Erosion" was developed by WRI and NOAA, 2005, under the Reefs at Risk Project.
Watershed boundaries provided by the USVI Department of Planning and Natural Resources (DPNR) and the University of the Virgin Islands (UVI/CDC).

5 0 5 Kilometers

Estimated Erosion from Roads (mean for watershed)

St. Thomas and St. John



St. Croix

Roads are a major source of erosion, particularly in steep areas on tropical islands. We have developed an indicator of the relative vulnerability of roads to erosion based upon slope, precipitation, and the K-ffactor of the soil (erodibility of the given soil type.) This indicator has been summarized by watershed. This is an area weighted indicator, so will be high in areas of high road density and steep terrain.

Mean Road-based Vulnerability by watershed

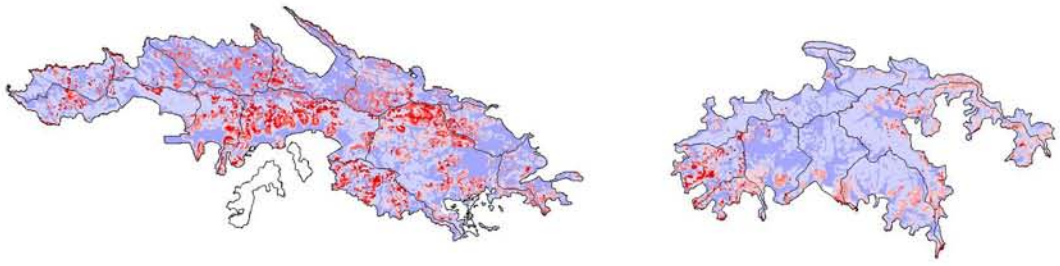
Low

High

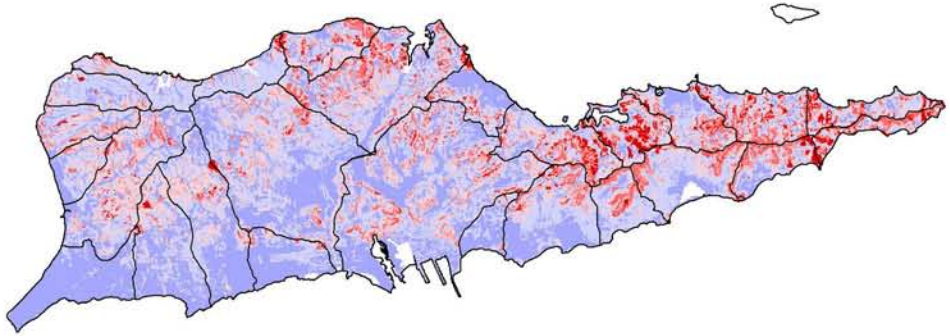
Source:
"Vulnerability of Roads to Erosion" was developed by WRI and NOAA, 2005, under the Reefs at Risk Project. Watershed boundaries provided by the USVI Department of Planning and Natural Resources (DPNR) and the University of the Virgin Islands (UVI/CDC).

5 0 5 Kilometers

Relative Erosion Potential (given current land cover)

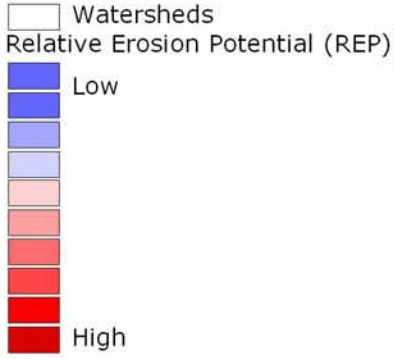


St. Thomas and St. John

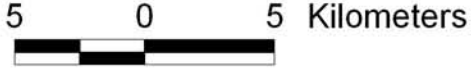


St. Croix

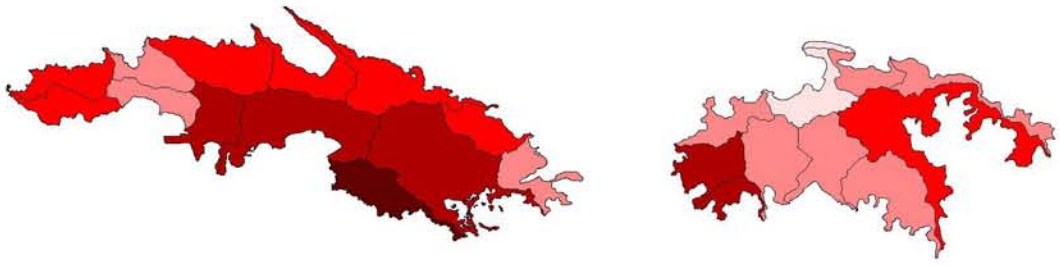
Agriculture and other land use activities far inland can have an adverse impact on coral reefs through the increased delivery of sediment and pollution to coastal waters. We have developed a simple indicator of relative erosion rates from the land, given current land cover. The analysis uses a simplified version of the Revised Universal Soil Loss Equation (RUSLE) (USDA, 1989). It incorporates land cover type, slope, the soil erodibility factor (k-factor), and precipitation for the peak rainfall month in order to estimate relative erosion rates for each 30m resolution grid cell.



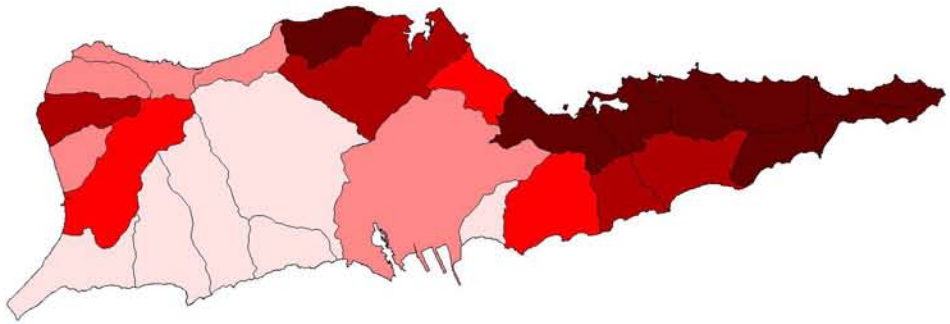
Source:
"Relative Erosion Potential" (REP) was developed by WRI and NOAA, 2005, under the Reefs at Risk Project. Watershed boundaries provided by the USVI Department of Planning and Natural Resources (DPNR) and the University of the Virgin Islands (UVI/CDC).



Relative Erosion Potential (by watershed)



St. Thomas and St. John



St. Croix

We have developed a simple indicator of relative erosion rates from the land, given current land cover. The analysis uses a simplified version of the Revised Universal Soil Loss Equation (USDA, 1989). This incorporates land cover type, slope, a soil erodibility factor (k-factor), and precipitation for the peak rainfall month in order to estimate relative erosion rates for all land areas within a watershed. The mean relative erosion potential (REP) for the watershed is presented.

Mean Relative Erosion (REP) by watershed

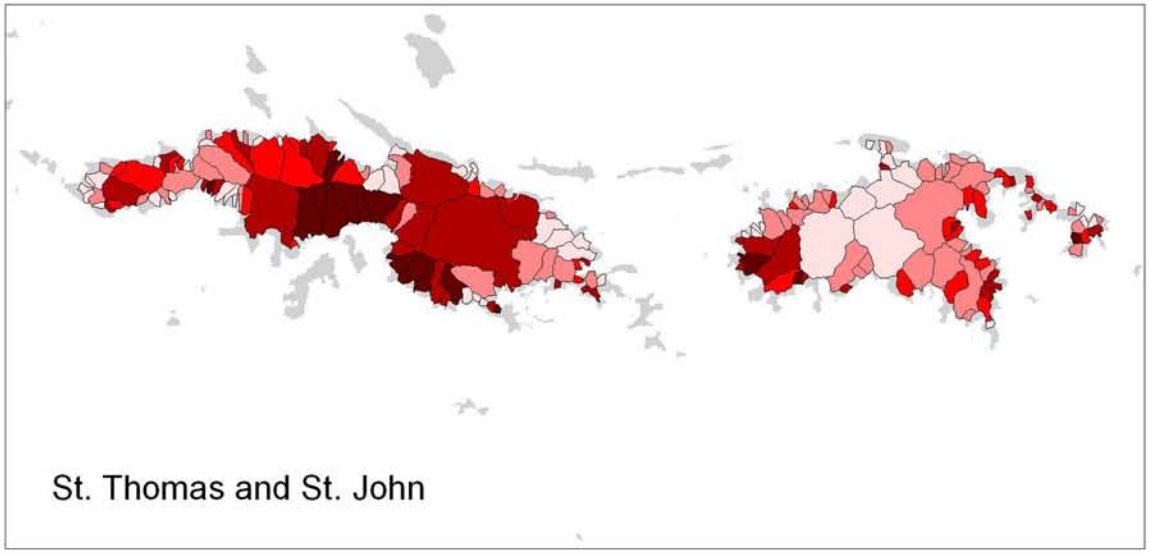
Low

High

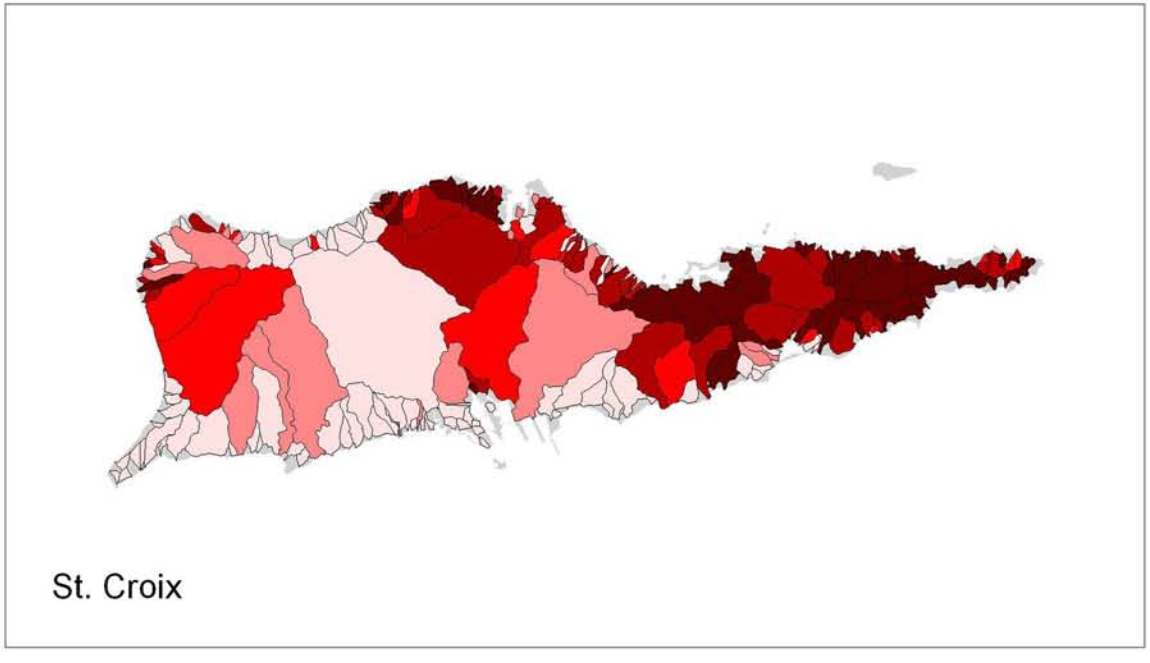
Source:
"Relative Erosion Potential" (REP) was developed by WRI and NOAA, 2005, under the Reefs at Risk Project. Watershed boundaries provided by the USVI Department of Planning and Natural Resources (DPNR) and the University of the Virgin Islands (UVI/CDC).

5 0 5 Kilometers

Relative Erosion Potential (by basin)



St. Thomas and St. John



St. Croix

We have developed a simple indicator of relative erosion rates from the land, given current land cover. The analysis uses a simplified version of the Revised Universal Soil Loss Equation (USDA, 1989). This incorporates land cover type, slope, a soil erodibility factor (k-factor), and precipitation for the peak rainfall month in order to estimate relative erosion rates for all land areas within a watershed. The mean relative erosion potential (REP) for the basin is presented.

Mean Relative Erosion (REP) by watershed

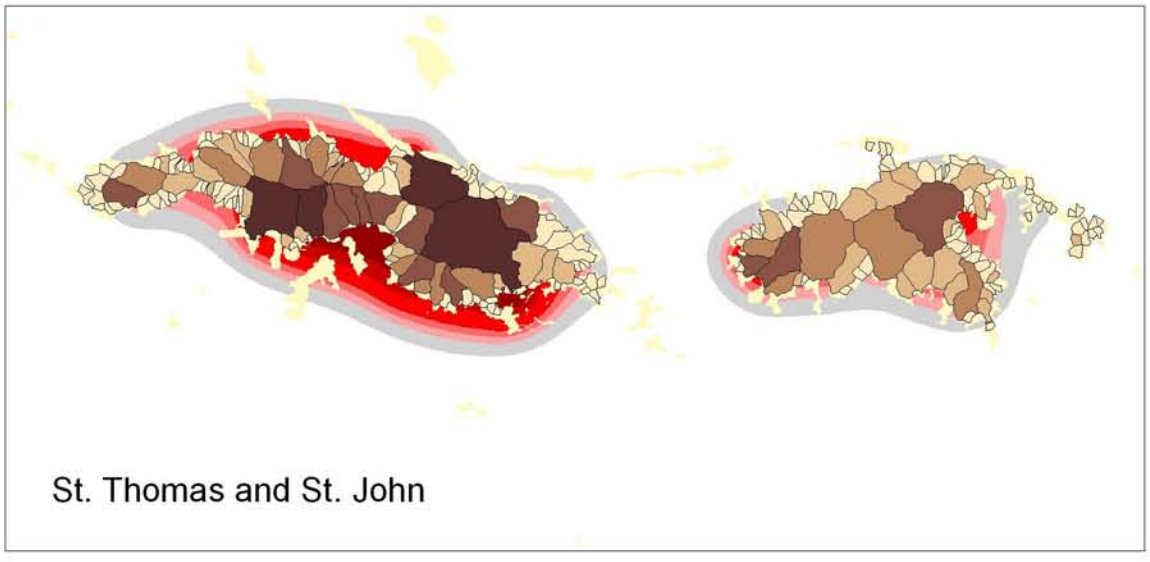
Low

High

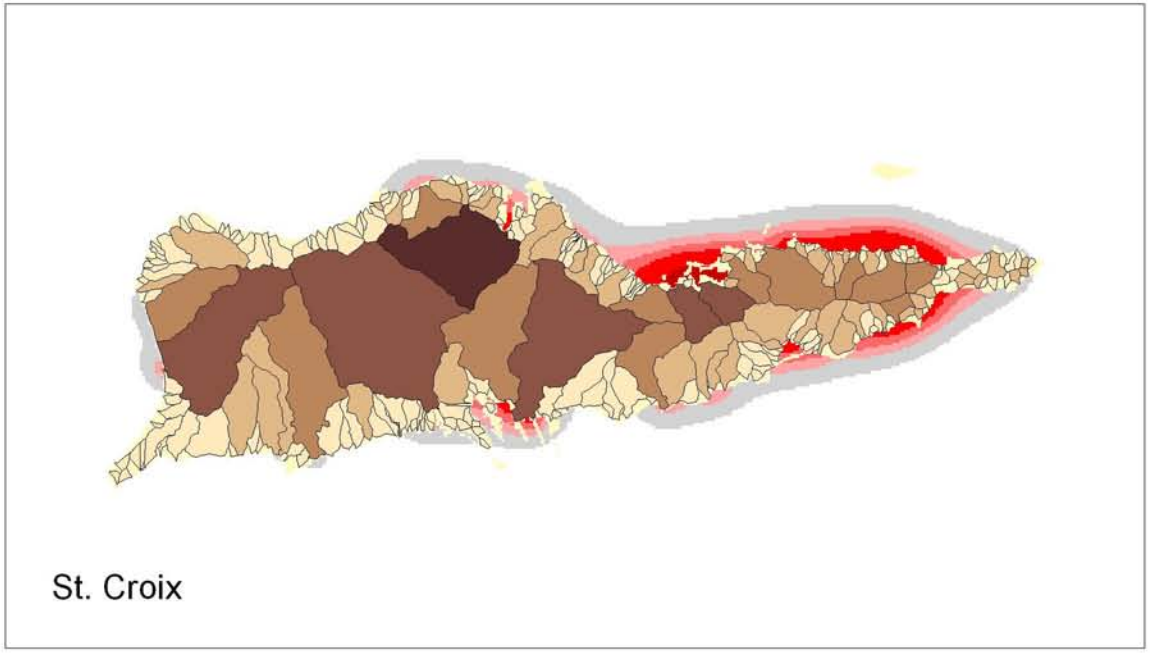
Source:
"Relative Erosion Potential" (REP) was developed by WRI and NOAA, 2005, under the Reefs at Risk Project. Basins were derived from elevation data by WRI and NOAA, 2005.

5 0 5 Kilometers

Relative Sediment Delivery (by basin) and Estimated Plume



St. Thomas and St. John



St. Croix

Relative sediment delivery by basin is estimated based on the total relative erosion potential (REP) within the basin, adjusted by watershed size. This approach uses a simplified version of the Revised Universal Soil Loss Equation (USDA, 1989). This incorporates land cover type, slope, a soil erodibility factor (k-factor), and precipitation in order to estimate relative erosion rates for all land areas within a watershed. (It does not specifically examine erosion due to roads.) Relative sediment plumes were evaluated based on relative sediment delivery at the gut outflow and distance from the outflow.

Relative Sediment Delivery by basin

Low

High

Estimated Relative Sediment Plume

Low

Medium

High

Source:
"Relative Sediment Delivery" was developed by WRI and NOAA, 2005, under the Reefs at Risk Project. Basins were derived from elevation data by WRI and NOAA, 2005.

5 0 5 Kilometers

Credits:

This analysis of land-based sources of threat to coral reefs in the U.S. Virgin Islands was funded by the U.S. National Oceanic and Atmospheric Administration, and was implemented by the World Resources Institute and NOAA, in collaboration with many partners. Project staff at WRI (Lauretta Burke, Robert Soden, Stephen Adam, and Zachary Sugg) and at NOAA (Aurelie Shapiro and Steve Rohmann) designed and implemented the analysis. The atlas was developed at WRI.

Reference: WRI and NOAA, 2005. *Land-based Sources of Threat to Coral Reefs in the U.S. Virgin Islands*. Washington, DC.

Photos: Coastal image by Aurelie Shapiro
Sedimentation in USVI by Lauretta Burke
Sponge and fish by Henry Woolcott

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