Virgin Islands Water Resources Research Institute

Annual Technical Report

FY 1998

Introduction

Research Program

The Virgin Islands Water Resources Research Institute (WRRI) is located at the University of the Virgin Islands (UVI). UVI is a publicly funded, coeducational, liberal arts institution with an enrollment of approximately 3,000 students. The University has campuses on the islands of St. Thomas and St. Croix and has as its primary objective "the stimulation and utilization of the intellectual resources of the people of the Virgin Islands and the development of a center of higher learning whereby and wherefrom the benefits of culture and education may be extended throughout the Virgin Islands."

The WRRI serves the people of the Virgin Islands through a program that reflects current water resources issues. The tourism-based economy of the Territory requires preservation of a pristine environment. Projects conducted at the WRRI with support of the United States Geological Survey in this reporting period reflect this priority area through a comprehensive program that involved not only research but also student training, and dissemination of information to the public.

This annual report describes, in the format prescribed by USGS, the research, training and information transfer activities supported by Section 104 grants for the period March 1998 to February 1999.

Basic Project Information

Basic Project Information	
Category	**Data**
Title	Erosion and Sedimentation on St. John, U.S. Virgin Islands
Project Number	C-01 (Project in Progress)
Start Date	09/01/1997
End Date	12/31/1999
Research Category	Climate and Hydrologic Processes
Focus Category #1	Sediments
Focus Category #2	Hydrology
Focus Category #3	Models
Lead Institution	Virgin Islands Water Resources Research Institute

Principal Investigators

Principal Investigators			
Name	**Title During Project Period**	**Affiliated Organization**	**Order**
Henry H. Smith	Associate Professor	Virgin Islands Water Resources Research Institute	01
Lee MacDonald	Associate Professor	Colorado State University	02

Problem and Research Objectives

Few studies have been conducted in dry tropics where streams are ephemeral and the resultant input of sediment and other pollutants is sporadic. Similarly, not many studies have examined the links between distributed activities and nonpoint source pollution in insular environments. Islands generally have high population densities and land processes linked intimately to the ocean. Very steep slopes and complex geology in the Eastern Caribbean area combines with an exceptionally variable hydrologic regime. These unique environmental conditions mean that much of the existing data and modeling efforts from the United States mainland cannot be applied directly and a failure to consider these differences can lead to severe adverse effects on both human and natural resources. Sediments can be detrimental to coral reefs. Though several studies have examined the effects of sedimentation on coral reefs, they have not been tightly coupled to measure runoff and sediment inputs. Suggestions have been made that recent development in the Virgin Islands has been the cause of decreases in coral reef growth but there has not been an evaluation of natural or anthropogenic sediment sources over time. In the absence of studies linking terrestrial human activities to effects on the marine ecosystem, managers are unable to rigorously link land use practices to potential impacts on corals, beaches, or other marine resources. The design of the project follows the general concept of sediment budgets, as we are trying to characterize the production and delivery of sediment from the hillslope to the mouths of the ephemeral streams on St. John (known locally as "guts"). The specific objectives of the current project are to:

1. Measure runoff and sediment production from both natural hillslopes and unpaved roads at the plot and road segment scale;
2. Measure sediment delivery and, where possible, runoff in catchments ranging in size from a few hectares up to 6 square kilometers;
3. Characterize the unpaved road network on St. John;
4. Develop a set of empirical, GIS-based models to predict the changes in runoff and sediment production due to both paved and unpaved roads; and
5. Develop a set of management practices and recommendations to minimize the adverse effect of roads on stream channels and the offshore areas.

Methodology

The basic design calls for the measurement of erosion and sediment transport at a variety of scales in order to: (1) evaluate how the different processes interact at different scales of space and time to deliver sediment to the marine environment, and (2) develop specific management tools and recommendations. For example, if we understand that road cutslopes produce a certain amount of sediment, we then need to understand what size or sequence of storms moves the eroded

sediment into the channel network, pushes the sediment through the stream network, and then delivers the sediment through the mangroves and salt ponds to the reefs and beaches of primary concern. By knowing the sources and sinks of sediments and the runoff needed for sediment transport, we can develop a watershed-scale accounting system for sediment production, storage, and transport under a variety of conditions. Knowledge of what physical process dominate sediment movement at the plot, sub-catchment, and watershed scale will direct managers toward those activities that are most effective in protecting the resources of primary concern. It was planned that recording rain gages would be operated at three locations to assess rainfall intensity, total rain volume, and the spatial variablility of individual storm events. These recording gages would be complementary to existing daily precipitation gages run by the National Weather Service at East End, Cruz Bay, and Caneel Bay. Observers at Lameshur Bay and Bordeaux Mountain are also collecting daily precipitation. This network of rain gages would allow us to conduct frequency and magnitude analyses of different storms across the islands, and these data are an essential input to runoff and erosion models. In order to provide predictive capability about land use effects on erosion and sediment delivery to the bays, the data collected during the field effort would be compared to output from existing models. TR-55 and RUSLE would be examined initially because they are the simplest and most widely used. Predicted runoff, and erosion would be compared to measured values at the plot, sub-catchment, and watershed scale. These comparisons will allow us to determine what adjustments might be made to the key parameters in order to make them more applicable to the conditions on St. John and in similar environments. We expect that the more complex models, such as WEPP, CREAMS, and TR-20, would better predict the measured runoff and erosion values because they have more input variables and adjustable parameters. On the other hand, we question whether off-the-shelf models will accurately represent the actual physical process; we would easily obtain the right answers for the wrong reasons. Only by comparision to our actual runoff and sediment volumes will we know if this is the case. The primary products from the project will be a set of spatially distributed, GIS-based models, which predict runoff and sediment delivery given specific storm and watershed characteristics. A 3-5 day workshop will be conducted at the end of the project, and this will disseminate the primary results and provide training to resource management personnel and other interested parties. Users' manuals and other model documentation will be distributed in order to ensure that both model users and model consumers are aware of the key issues with regard to the assumptions, use, and limitations of the model(s). The project will also prepare a final report which specifies that data collection techniques, analyses, and reasoning followed during model development and testing. The data collected under this project will be provided to the local government and the Virgin Islands National Park in both hard copy and digital format.

Principal Findings and Significance

This project is ongoing. The following narrative describes what progress has been made from the start until the present status of the project. From March 1 to mid-June 1997, the principal graduate student involved, Mr. Ramos, was at Colorado State University, and this period was used to conduct an extensive literature review, develop the field methods, obtain necessary field supplies, and prepare for the June-December field season. The topics coverd in the literature review included road erosion, previous erosion studies in St. John, sediment budgets, and methods for measuring runoff and erosion in a tropical setting. The necessary equipment was either purchased with the grant funds from USGS or borrowed from a variety of sources, and these included the National Park Service, the Islands Resources Foundation, and Colorado State University. The Water Resources Research Institute's laboratory at UVI was identified as the site where most of the sediment and water sample analyses were to be conducted. Mr. James St.

Hillaire at UVI was identified as the field assistant. The intensive field component began in Mid-June with the arrival of Mr. Ramos on St. John. After a meeting with a variety of local officials and homeowner groups such as the Fish Bay Watershed Committee, Mr. Ramos and Mr. St. Hillaire conducted a detailed survey of the unpaved roads in several areas of St. John. The purpose of this survey was to become familiar with the range of soils and climatic conditions on St. John, obtain both qualitative and quantitative data on each road sediment with the study regins, evaluate the sites used by Mr. Sampson, a previous researcher, and identify the specific sites to be used for monitoring runoff and erosion. Early in July, a more detailed recording rain gage network was begun, refurbishing the three runoff plots installed by Mr. Sampson, and construction of new sediment traps begun. A total of five rain gages were installed in order to characterize the spatial variability in the amount and intensity of precipitation, and these were located in or near Fish Bay, Maho Bay, Lameshur Bay, Bordeaux Mountain, and the Catherineberg area. Silt fences were installed to measure sediment production from the road surface (16 sites), road cutslopes (13 sites), fillslopes (1 site), and natural hillslopes (6 sites). Complementary erosion pin networks were installed on several cutslopes and on streambanks to characterize in-channel scour. One station was established on Cocoloba Trail in the Fish Bay watershed to measure runoff with a flume and a pressure transducer, and suspended sediment using an automatic pump sampler. Similar runoff and suspended sediment sampling stations were established at the watershed-scale. These two watershed-scale sites included one watershed with few roads (Great Lameshur Bay Gut) and one watershed with more roads (main Fish Bay Gut). This is the largest catchment on St. John. During this period Dr. MacDonald, a principal investigator, also spent two weeks on St. John to help with the design of the project and installation of the field equipment. The second half of 1998 was characterized by periods of unusually high and intense precipitation. Hurricane Georges passed close to St. John and in October precipitation was substantially higher than normal. Watershed-scale sediment data collected during this period included data from two separate storm events at the Lameshur Bay Gut (a total of 46 samples), and data from nearly a dozen individual events from the main Fish Bay Gut (a total of 103 samples). A total of 40 samples from half a dozen runoff events were also collected from the station on Cocoloba Trail. Four cumulative runoff and sediment samples were collected from the erosion plots on undisturbed areas, and several water samples were collected from different bays around the island. A total of 52 measurements were obtained from the sediment traps. In late October Mr. St. Hillaire put the Water Resources Research Institute lab in order so that we could begin our analyses of the suspended sediment samples and the sediment samples obtained from the sediment traps. While Mr. St. Hillaire was trained to conduct these analyses, the unusually large number of precipitation events meant that most of Mr. St. Hillaire's time was spent collecting the field data and emptying the numerous sediments traps. Thus, Mr. St. Hillaire was only able to analyse the suspended sediment samples from Lameshur Bay Gut and a few of the sediment samples from the sediment traps. In the second half of 1998, we were also involved in increasing the awareness of the erosion issue. We concluded field trips for officials from V.I. National Park and the V.I. Government, other government personnel such as the Natural Resource Conversation Service, and the Fish Bay Homeowners Association. These field trips showed the field data collection efforts, demonstrated the magnitude of the erosion occurring from some of the road segments, and also initiated discussions regarding the diferent possibilities for reducing the current erosion rate. We were also actively involved with the Fish Bay Homeowners Association in helping them develop an environmentally-oriented road paving plan. Another important part of these efforts was the presentation of a seminar by Mr. Ramos on St. Croix, on December 11, 1998 and videoconferenced to St. Thomas. This seminar was organized by the Water Resources Research Institute. It was very well attended by government and university personnel as well as other interested parties. This seminar was an excellent opportunity to disseminate the goals of our project, our general approach, and some preliminary

findings and recommendations. During the last two months covered by this report, Mr. Ramos was back at Colorado State University to complete his source-work, finalize his research proposal and begin analysing the first year's data. Mr. St. Hillaire continued field monitoring and laboratory work, but budget limitations meant that he was able to only make weekly visits to St. John. Specific tasks accomplished during this period included emptying seven sediment traps, analysing the Lameshur Bay Gut suspended sediment samples, and determining the water content of several sediment samples. Although it is too early to provide much in the way of specific results, we can identify some general trends.

1. We can document that runoff from the road segments begins relatively rapidly after rainfall commences, while flow on the natural hillslopes only occurs during the largest storm events after the soils become saturated.
2. Road erosion rates tend to be lower at the road segment scale than at the plot scale, but the one road segment that is subjected to heavy truck traffic exhibited an extremely high rate of sediment production. These patterns of road runoff and rill erosion are very dynamic and complex, and this will complicate every effort to develop a reliable predictive model for road surface erosion.
3. Similarly, sediment production rates from cutslopes can exhibit considerable temporal variability as a result of sloughing and other relatively unpredictable processes. Nevertheless, cutslope erosion rates are generally much lower than that from road surface plots. Erosion from fillslopes is generally believed to be small unless there is rilling due to road drainage.
4. Finally, our limited preliminary work in the stream channels indicated that road-related sediment is more prevalent and travelling further than initially believed, and this suggests that the road erosion is a serious problem that will demand remedial actions and improved planning.

Descriptors

Erosion, Runoff, Sedimentation, Urbanization, Roads.

Articles in Refereed Scientific Journals

Book Chapters

Dissertations

Water Resources Research Institute Reports

Conference Proceedings

Other Publications

Basic Project Information

Basic Project Information	
Category	**Data**
Title	Applicable Indicators of Risk for Coastal Waters in Tropical Environments
Project Number	D-01 (Project in Progress)
Start Date	08/01/1998
End Date	12/31/1999
Research Category	Biological Sciences
Focus Category #1	Water Quality
Focus Category #2	Wetlands
Focus Category #3	Non Point Pollution
Lead Institution	Virgin Islands Water Resources Research Institute

Principal Investigators

Principal Investigators			
Name	**Title During Project Period**	**Affiliated Organization**	**Order**
Mayra E. Suarez-Velez	Professional Staff	Virgin Islands Water Resources Research Institute	01
Gary A. Toranzos	Associate Professor	University of Puerto Rico	02

Problem and Research Objectives

Evidence has been found against the use of fecal coliform bacteria as indicator organisms of fecal contamination in tropical waters due to the presence of these indicators as part of the resident microflora in these environments. There is a real need for the development of a rapid, easy, inexpensive and accurate method for assessing tropical water biological quality. Coliphages seem to be excellent alternate indicators of the biological quality of waters. If a correlation can be established between the presence of coliphages and the presence of fecal contamination we will have a more reliable method to determine the possible impact these waters have on public health. A great deal of effort is being placed on improving the biological quality of waters in tropical areas without taking into consideration the autochthonous nature of coliforms and fecal coliform. This project is focused toward water quality assessment on coastal environments of tropical islands for a one-year term. The objectives are to evaluate the reliability of coliphages as alternate indicators of fecal contamination and biological quality in tropical waters, to correlate the concentrations at which coliphages are present with the presence of currently used indicator organisms, and to promote the establishment of a long-term biological monitoring of coastal areas used for recreation.

Methodology

The following techniques represent the primary methods for this research:

- Bacteriological analyses - Samples will be analyzed by the membrane filtration technique with the use of m-ENDO for the detection of total coliforms, m-FC for fecal coliforms and m-Enterococcus agar for Enterorocci.
- Phage Assays - A direct, single-layer coliphage assay is being used. Briefly, a 100 to 200 ml volume of sample is mixed with liquefied (and kept at a temperature of 45 degrees Celsius)2X trypticase soy soft agar. The host (Escherichia coli C3000) is added, the mixture plated and incubated at 37 degrees Celsius. At six and twelve hours post-incubation, the plates are coated.
- Bacteriophage hosts - An E. coli C3000 (ATCC 15597) will be used as a host. We propose to test several strains of E. coli to sample waters for the presence of coliphages. This will be done in order to determine if there are any non-fecal bacterial viruses, which can also be detected in the environment.

Principal Findings and Significance

The current project has taken longer than desired as a result of logistic problems. However, the project is being carried out and samples have been obtained from Puerto Rico and analyzed for the presence of some indicators. Additionally, some students have been trained at the University of the Virgin Islands in some of the techniques to be used during this project. This training portion has been, so far, the most important part of the project, since several students have attended a short workshop conducted by Dr. Toranzos and Ms. Suarez-Velez at the University of the Virgin Islands in March 1999. At least two of these students will be invited to Puerto Rico for further training in some of the techniques to be used in the project. The purchase of some of the laboratory equipment necessary to conduct the project at UVI is also in process. At the University of Puerto Rico some E. coli strains are being tested using the polymerase chain reaction in order to construct a molecular database. So far the environment isolates have been shown to be identical to the type strains in terms of their 16S rDNA indicating that the environmental isolates are in fact E. coli. Further analyses, using restriction enzymes have indicated that the restriction patterns are also the same. It is expected that once the logistical problems have been worked out, the project will proceed as planned. Training of students and personnel at the University of the Virgin Islands will assure continuity to the project and will also allow for a continuous sampling and analyses of the waters in the Virgin Islands.

Descriptors

Water Quality, Biomonitoring, Coastal Zone, Bacteria, Viruses, Risk Analysis, and Water Quality Standards.

Articles in Refereed Scientific Journals

Project in Progress.

Book Chapters

Dissertations

Water Resources Research Institute Reports

Conference Proceedings

Other Publications

Information Transfer Program

The Virgin Islands Water Resources Research Institute is the principal provider of water resources information to the Virgin Islands public. Information dissemination is treated therefore as an integral part of all activities at the WRRI and not as a separate project. The WRRI maintains a small reference library and responds to inquiries from within the Virgin Islands as well as outside the Territory on matters pertaining particularly to water resources issues in the Territory. Full internet capability, and its linkage with other water resources research institutes, make the WRRI a much-used source of information to local clients on virtually any water resources.

Basic Project Information

Basic Project Information	
Category	**Data**
Title	Information Dissemination
Description	Information Dissemination Activities (See Methodology)
Start Date	03/01/1998
End Date	02/28/1999
Type	Conferences
Lead Institution	Virgin Islands Water Resources Research Institute

Principal Investigators

Principal Investigators			
Name	**Title During Project Period**	**Affiliated Organization**	**Order**
Henry H. Smith	Associate Professor	Virgin Islands Water Resources Research Institute	01

Problem and Research Objectives

The objective of UVI's WRRI Information Transfer Program is to make information available for wiser use of the limited water resources of the Virgin Islands.

Methodology

Both research projects detailed above involve activities to disseminate information to the public. Mr. Carlos Ramos made a presentation on his work with the St. John sedimentation project to audiences in St. Croix and St. Thomas on December 10, 1998. Dr. Gary Toranzos made a similar presentation on the applicable indicators project in March 1999. Other information activities on the sedimentation project have already been described

above. The WRRI conducts a very popular seminar series. These seminars provide a means not only of informing the public about activities of the WRRI but they also allow an opportunity for the WRRI to provide updates on water resources matters that might be applicable to the Territory and serves as a means for the public to provide input on their needs to the WRRI. In addition to Mr. Ramos' presentation other seminars held in the reporting period were as follows:

1. "Bacterial Indicator Organisms in Cistern Water in the Virgin Islands" by Dr. Robert H. Ruskin on April 16, 1998. Dr. Ruskin now resides in Arizona and his presentation was a summary of his dissertation that was based largely on work he did at the WRRI some years ago.
2. "Minimizing the Impact of El Nino Induced Drought in the Western Pacific" by Dr. Leroy Heitz on Juy 20, 1998. Dr. Heitz is of the University of Guam.
3. "Alternative Onsite Sewage Disposal Systems in the United States Virgin Islands" by Ms. J. Hodge and Mr. B. Emerich on October 6, 1998.

The WRRI maintained exhibits at the annual food and agricultural fairs on St. Thomas and St. Croix; made presentations at schools and took advantage of all opportunities to share information on its activities with the public. One method used was visits to classrooms and presentations to clubs and other groups. Another method was tours of the WRRI meteorological station. This was a well-received means of introducing young people to the importance of water resources in their lives.

Principal Findings and Significance

Not applicable.

Articles in Refereed Scientific Journals

None applicable pertaining to this section.

Book Chapters

Dissertations

Water Resources Research Institute Reports

Conference Proceedings

Other Publications

USGS Internship Program

Student Support

Student Support					
Category	**Section 104 Base Grant**	**Section 104 RCGP Award**	**NIWR-USGS Internship**	**Supplemental Awards**	**Total**
Undergraduate	1	N/A	N/A	N/A	1
Masters	N/A	N/A	N/A	N/A	N/A
Ph.D.	N/A	1	N/A	N/A	1
Post-Doc.	N/A	N/A	N/A	N/A	N/A
Total	1	1	N/A	N/A	2

Awards & Achievements

The WRRI received the University of the Virgin Islands' 1998 Research and Public Service Component Award. This award recognizes and rewards excellence in performance and achievement.

Publications from Prior Projects

Articles in Refereed Scientific Journals

Book Chapters

Dissertations

Water Resources Research Institute Reports

Conference Proceedings

Other Publications