Virgin Islands Water Resources Research Institute
Annual Technical Report
FY 2008

Introduction

The Virgin Islands Water Resources Research Institute (VI-WRRI) is located on the St. Thomas campus of the University of the Virgin Islands (UVI). The institute supports works done by investigators at UVI and other institutions that address issues in water resources. The research, training and information dissemination activities conducted with VI-WRRI support, focuses on those issues particularly relevant to small, tropical, oceanic islands.

The U. S. Virgin Islands, the USVI, consists of a grouping of many small islands and cays in the Caribbean Sea about 1,100 miles southeast of Miami, Florida and 90 miles east of Puerto Rico. They are primarily volcanic in origin. The principal islands are St. Croix, St. Thomas, St. John and Water Island which together have a land mass of less than 135 square miles. The terrain is generally hilly, soil layers are thin and surface water supplies are essentially non-existent. Sea water desalination and rain water harvesting are the principal sources of fresh water. Ground water supplies are very limited.

Water quality and quantity are both issues of concern in the USVI. This report summaries work done primarily with support from the U. S. Geological Survey to address these during the period March 1, 2008 to February 28, 2009. Some of this work is continuation of efforts begun before this period and some of the activities described will be continued beyond the period of this report. The VI-WRRI is the only entity of its kind in the USVI and continues to hold paramount, along with the entire University of the Virgin Islands, responsiveness to the needs of the community in which it is located.

Research Program Introduction

The Virgin Islands Water Resources Research Institute is the only entity of its kind in the U. S. Virgin Islands. In an area of the world where the population relies on water supplies that are generally considered unconventional, the WRRI then is faced with a very challenging and daunting responsibility. It is expected, and has an obligation to, conduct investigations that will lead to safer and more sufficient water supplies to the residents of the Virgin Islands though relatively little research has been conducted and comparatively little is known of these water sources. This is done from the University of the Virgin Islands, a primarily undergraduate teaching institution, where research is not a primary focus. As a result of this, the WRRI relies heavily on UVI researchers working through arrangements where available time, facilities and other conditions are not always optimal. To augment UVI faculty and staff participation in WRRI supported activities, faculty from other universities often work in collaboration with UVI counterparts on water resources investigations. This leads to a continual inflow of new ideas and makes available facilities and other resources not maintained at UVI.

Summaries of research conducted with support of the VI-WRRI during the reporting period follows. The range of work done is indicative of the range of critical water resources issues that must be routinely addressed by water resources professionals in the islands. In this way, the VI-WRRI is making significant contributions to improving the quality of life for persons who make the U. S. Virgin Islands their home and providing a safe and pleasant experience for those who visit the islands.

Impervious Surface Analysis of Terrestrial Watersheds of the U.S. Virgin Islands with Application to the East End Marine Park, St. Croix

Basic Information

Title:	Impervious Surface Analysis of Terrestrial Watersheds of the U.S. Virgin Islands with Application to the East End Marine Park, St. Croix
Project Number:	2006VI67B
Start Date:	3/1/2006
End Date:	2/28/2009
Funding Source:	104B
Congressional District:	Not applicable.
Research Category:	Water Quality
Focus Category:	Non Point Pollution, Water Quality, Methods
Descriptors:	
Principal Investigators:	Colin Finney, Henry H. Smith

Publication

1. Rennis, Denise, Colin Finney, Henry Smith, 2008, Impervious Surface Analysis of Terrestrial Watersheds of the U. S. Virgin Islands, Virgin Islands Water Resources Research Institute, University of the Virgin Islands, St. Thomas, U. S. Virgin Islands, 55 pages.

PROBLEM AND RESEARCH OBJECTIVES

One of the principal effects of development and urbanization is the conversion of pervious surfaces into impervious surfaces—anthropogenic surfaces that inhibit the infiltration of water into the soil. In the US Virgin Islands (USVI), housing, roads, and commercial and industrial development are increasingly replacing natural terrestrial environments, such as grasslands and forests. Research over the past two decades has indicated that increased quantities of impervious surfaces are closely associated with environmental degradation (Schueler, 1994; Arnold and Gibbons, 1996), specifically that the quantity of impervious surfaces in a watershed is inversely correlated with the health of that watershed and the health of waterbodies, such as coastal environments, that receive discharges from that watershed (Center for Watershed Protection, 2003).

Land-use regulations have placed some controls over development activities and these help to limit the impacts from impervious surfaces; however, the effectiveness of these controls can only be evaluated by long-term monitoring of the environmental impacts, both site-specific and cumulative, of land-use decisions, and this rarely occurs. Field monitoring sites are often difficult to reach, the weather may be too inclement, and field sampling is expensive both in terms of budget and staff resources. Using imperviousness as an environmental indicator for watershed health has been gaining popularity over the last decade. Imperviousness is measurable and the data can easily be presented in geographical information systems (GIS).

The goal of this study was to develop a remote sensing/geographical information system-based methodology that classifies impervious cover to a much finer level than currently exists so that impervious surfaces can be monitored as an index of watershed health. The Coral Bay watershed on St. John, USVI, where nonpoint source pollution from incompatible upland development has been identified as a major threat, was used as a case study. The major thrust of this study was focused on the GIS-based methodology for discriminating, mapping, and quantifying terrestrial impervious surfaces at a watershed and subwatershed scale, using remote sensing imagery.

METHODOLOGY

The methodology involved the following steps:

1) Selection and analysis of the remote sensing component;
2) Establishing classification categories;
3) Image analysis and processing;
4) Impervious surface class cover validation;
5) Calculation of impervious surface cover;
6) Application of infiltration coefficients and threshold values;
7) Evaluation of change over an 11-year period;

8) Assessment of the application of the methodology to other watersheds.

PRINCIPAL ACCOMPLISHMENTS AND SIGNIFICANCE

We developed a remote sensing/GIS-based methodology that enables land managers and regulators in the USVI to monitor and quantify impervious surface cover on a subwatershed, watershed, or island basis. Our use of multispectral IKONOS imagery [courtesy of the National Oceanic and Atmospheric Administration (NOAA)] allows large land areas to be covered by one or two high-resolution scenes; this is not possible with aerial photographs. Another advantage of using satellite imagery is the increased frequency that images become available and obtainable, allowing assessments over a shorter time period than the 5- or 10-year periods that have been typical for monitoring changes in vegetation cover. As growth (i.e. impervious surface cover) tends to come in spurts, the ability to monitor more frequently is a necessity.

The land-cover classes identified in this study are consistent with the land-cover classes of NOAA's Coastal Change Analysis Program (C-CAP) initiative (NOAA, 1995). Using our methodology land managers in the USVI would be able to compare changes in impervious surface cover with land-cover changes reported by NOAA for other regions over the nation where such information exists. To date, no C-CAP investigation has been undertaken for the USVI.

Our methodology was applied to the Coral Bay watershed, St. John, where we categorized impervious surfaces into five classes based on false-color processing and selected five subsets (one on the east coast, one on the south coast, one in the northern uplands, and two around the town of Coral Bay) for more detailed analysis (Fig. 1). We showed that impervious surface cover across the watershed appears to be below a threshold that warrants concern, but specific areas of the watershed, particularly around the town of Coral Bay and in at least one area of the south coast, are experiencing growth that should be more closely examined (Table 1). Early detection of environmental problems will help to limit or prevent environmental degradation and help protect biological diversity.

Figure 1. Processing of the IKONOS image resulted in five false-color classes of impervious surfaces in the Coral Bay, St. John, watershed. Also shown are enlargements of the five selected areas for detailed analysis (includes material © Space Imaging LLC, all rights reserved).
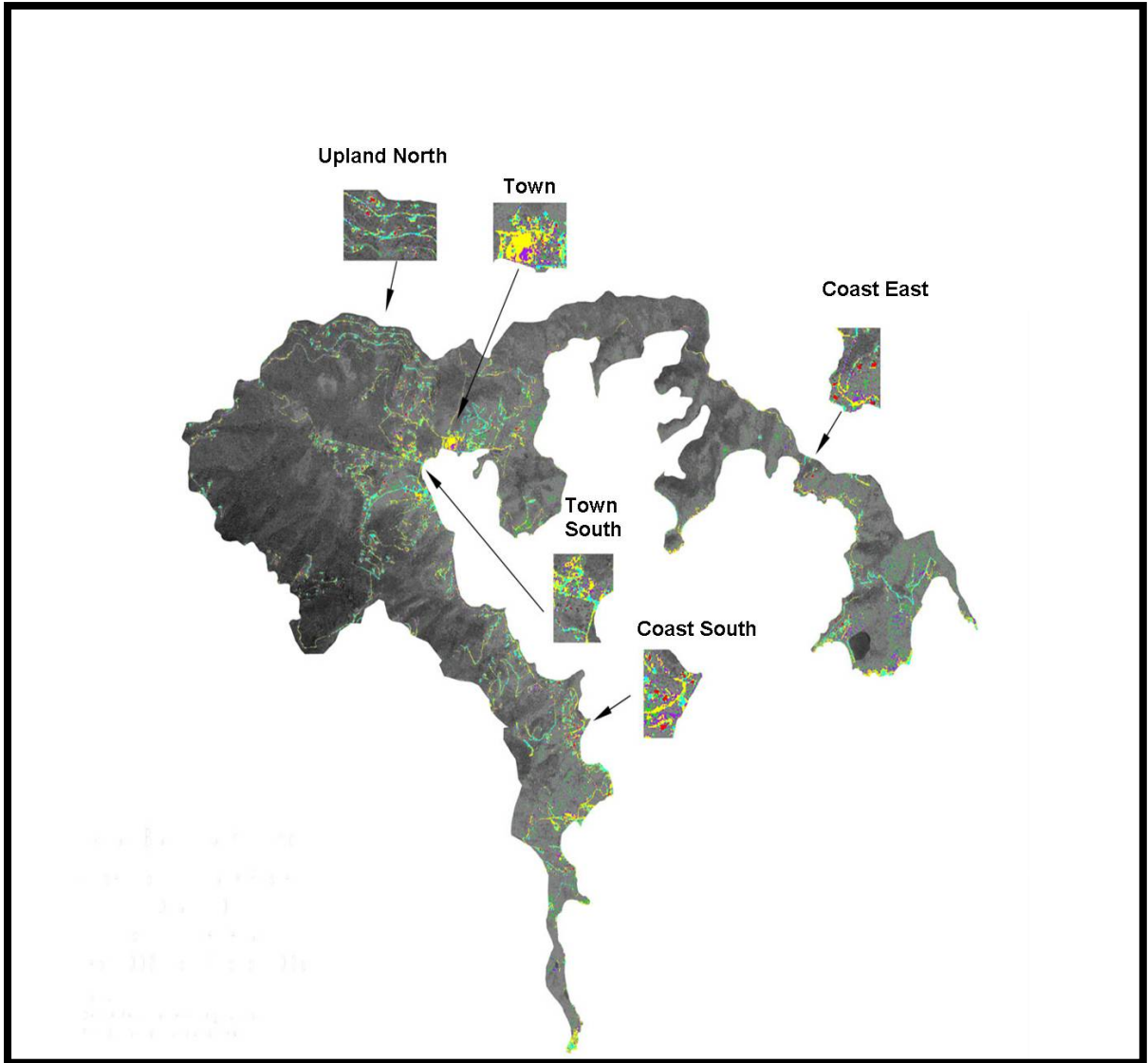
Table 1. Percentage of impervious surface cover in each of the five classes for the Coral Bay watershed and subsets, incorporating an infiltration coefficient.

Class	Watershed	Coast E	Coast S	Upland N	Town	Town S
Total Area (ha)	18,851.50	89.59	65.27	203.12	111.66	138.33
Class 1	0.21	1.29	1.68	0.69	0.67	0.29
Class 2	2.23	5.2	10.88	2.93	18.43	8.86
Class 3	1.42	2.3	4.25	3.78	5.13	4.42
Class 4	1.25	3.16	6.12	1.18	5.56	2.95
Class 5	0.5	1.06	1.66	0.41	0.98	0.87
Total (%)	5.61	13.01	24.59	8.99	30.77	17.39

Despite considerable effort, discrimination between different types of impervious surfaces (e.g., older versus newer concrete roads, concrete versus asphalt, man-made surfaces versus natural rock outcrops) based on their spectral signatures was not accomplished. To some extent this was due to topographic slope and angle of the sun during image capture, both of which affect surface reflectivity. Greater resolution should be possible with a satellite system that uses a larger number of bands than the IKONOS system (which uses five). Impervious surfaces in the Coral Bay watershed include both anthropogenic surfaces as well as natural ones, and we consider the ability to quantify the natural imperviousness of land as essential in order to better evaluate the effects of anthropogenic changes. Further work on refining the spectral signatures will be necessary to achieve this.

By performing an analysis of change in impervious surface cover over the last 11 years (Table 2), we demonstrated that at least one different technique for calculating change can be compatible with our described methodology.

Table 2. Percent change in impervious surface cover in the Coral Bay watershed over an 11-year period.

Subset	Percent Impervious Surfaces		
	1994	2005	% Change
Coast East	10.35	13.01	2.66
Coast South	7.17	24.59	17.41
Upland North	8.61	8.99	0.38
Town	15.43	30.77	15.33
Town South	4.20	17.39	13.20

Ideally similar techniques should be used in comparison studies to limit design differences that might affect results; however, until the use of spectral signatures from satellite imagery is more widely used, existing baseline data are likely to be in a form that is not satellite based.

The methodology we describe in this study can easily be applied to other watersheds and other islands. The watershed of the St. Croix East End Marine Park (SXEEMP), in particular, would benefit from extensive monitoring of impervious surfaces to ensure economic growth in the watershed does not lead to water quality degradation and loss of biodiversity in the marine park.

References Mentioned in this Summary

Arnold, Jr. C.L. and C.J. Gibbons, 1996, Impervious surface coverage. The emergence of a key environmental indicator, Journal of the American Planning Association, 62(2), 243-258.

Center for Watershed Protection, 2003, *Impacts of Impervious Cover on Aquatic Systems*, 150 pp., Ellicott City, MD.

National Oceanic and Atmospheric Administration (NOAA), 1995, NOAA Coastal Change Analysis Program (C-CAP): Guidance for Regional Implementation, NOAA Technical Report NMFS, 123, 92 pp.

Schueler, R.R., 1994, The importance of imperviousness, Watershed Protection Techniques, 1, 3, 100-111.

Response to Uncertain Irrigation Supplies Through Recovery and Application of Aquaculture Wastewater for Agronomic Crops Cultivated in the U.S. Virgin Islands

Basic Information

Title:	Response to Uncertain Irrigation Supplies Through Recovery and Application of Aquaculture Wastewater for Agronomic Crops Cultivated in the U.S. Virgin Islands
Project Number:	2007VI90B
Start Date:	3/1/2007
End Date:	2/28/2009
Funding Source:	104B
Congressional District:	Not applicable.
Research Category:	Biological Sciences
Focus Category:	Agriculture, Irrigation, Water Use
Descriptors:	
Principal Investigators:	Jason James Danaher, Kathryn M Lincoln

Publication

1. Danaher, J. 2008. Maximizing available freshwater resources through integrated farming practices in the U.S. Virgin Islands. Agrifest 2008 The business of agriculture: The way forward . 37th Annual Agriculture and Food Fair of the U.S. Virgin Islands. February 16 -18, St. Croix, U.S. Virgin Islands.
2. Danaher, J. 2008. Evaluating Geotextile Technology to Enhance Sustainability of Agricultural Systems in the US Virgin Islands. Aquaponics Journal, Issue #50 (3rd Quarter), Pages 18-20.
3. Danaher, J.J., J.E. Rakocy, D.S. Bailey, R.C. Shultz, and K. Lincoln. 2008. Use of a Geotube® for recovery of aquaculture wastewater for agronomic crops cultivated in the U.S. Virgin Islands. Aquaculture America 2008, Disney s Coronado Springs Resort, Lake Buena Vista, Florida, USA, February 9-12.
4. Danaher, J.J., J.E. Rakocy, R.C. Shultz, and D.S. Bailey. 2009. Reclaimed aquaculture effluent for use on cucumbers Cucumis sativus cv Eureka grown in the U.S. Virgin Islands. Aquaculture America 2009, Seattle, Washington, USA, February 15 -18.

PROBLEM AND RESEARCH OBJECTIVES

Improving water use efficiency is critical to most Caribbean islands where there is low per capita freshwater availability. Concerns for water conservation in the U.S. Virgin Islands have promoted the development of intensive, recirculating fish production systems. These systems treat and reuse a major portion of their production water, but rely on the removal of nutrients and organic matter through biological and mechanical processes to ensure system sustainability. Discharged aquaculture effluent is comprised of organic matter and high levels of nitrogen and phosphorus which can pose an environmental threat; thus increasing waste production through intensification will require novel methods for managing aquaculture effluent. To abate the environmental impact new management practices need to be adopted to reuse the nutrients and water. Integrating recirculating aquaculture systems with the production of other valuable agronomic crops to recycle nutrients and reuse water could provide a viable solution to sustainable food production in semi-arid regions. Experiments have demonstrated aquaculture effluent to be an excellent nutrient source for agronomic plants; thus, effluents should be treated as a resource management and not as a disposal problem. One major constraint to the integration process has been clogging of irrigation systems due to high levels of organic matter. Technology that is capable of separating the solid fraction from the liquid portion of fish effluent would give farmers increased options for integrating aquaculture and vegetable production.

Geotube technology now exists and creates a more flexible approach for the integration of aquaculture effluent with agronomic crops. A Geotube is constructed from a high strength woven geotextile fabric that can be filled repeatedly with aquaculture effluent and allowed to dewater for a period of time. This process could possibly create options and opportunity for the agricultural operator by allowing the solid fraction retained in the Geotube to be used as a fertilizer and the filtrate exiting the Geotube to be used as a water source for agronomic crops.

The objectives of the project are to:

1. Evaluate geotextile material (Geotube) for the recovery and reuse of solids, wastewater, and dissolved nutrients from aquaculture effluent for use on agronomic crops.
2. Evaluate the efficacy of drip irrigation systems delivery of Geotube filtrate.
3. Evaluate the nutrient content of Geotube retained solids, establish its quality for amending soils in agronomic crop plots, and establish if the filtrate is a nutrient source based on plant response.

METHODOLOGY

Experiment A

Objective I and objective 2 were assessed through experiment A. A 150-m3 lined, storage pond was the source of the fish effluent. A Geotube measuring 7.6m x 2.3m was installed adjacent to the storage pond. A 3/4-Hp vertical lift aerator and horizontal mixer were used to agitate the fish effluent prior to each pumping event. A 1/3-Hp pump, pumped effluent at a rate of 114 liters/minute. Prior to entering the Geotube the effluent was treated with a polymer, Hyperfloc CE 854, (Hychem, Inc., Tampa, FL) at a concentration of 14.2 mg/L and allowed to mix by passing through a series of 90-degree PVC elbows. The first two pumping events occurred on 29 November and 14 December 2007. The final occurred on 17 January 2008. On each sampling date, three pond sludge (PS) samples were collected directly adjacent to the pump at a depth of 30 cm. A 250-mL aliquot of the samples was sent for water quality analysis of PS. On each sampling date three samples of Geotube (V filtrate (GF) were also taken from different locations where filtrate was weeping from the Geotube during filling. A 250-mL aliquot of the samples was sent for analysis of GF. A sample of retained solids (RS) in the Geotube was taken on 17 January prior to the final pumping event and analyzed for pH, organic matter, moisture content and nutrient concentrations. Water samples of PS, GF, and RS were sent to Micro Macro International, Inc. (Athens, GA) for analyses of micro- and macronutrient concentrations. Over a four-week period GF was pumped through a T-tape irrigation system to determine if clogging occurred.

Experiment B

This is an on-going project evaluating objective 3. The study is evaluating RS and GF as nutrient sources compared to a commercial inorganic, slow release fertilizer (Osmocote). The experiment consists of three treatments with three replicates (28_M2) each. The control is a slow-release 12-12-12, inorganic fertilizer [Osmocote] with rainwater. Treatment two is RS with rainwater and treatment three is RS with GF. A Randomized Block Design was used for the experimental design and data will be analyzed using ANOVA

Based on an initial soil test of the growing area a recommended fertilization application was applied. Each fertilizer was applied and rototilled in on 1 April. Osmocote was applied at the equivalent of 880 kg/ha and RS (83 % moisture) was applied at the equivalent of 5 mt/ha. Cucumber (Cucumis sativus v. Eureka) were seeded in the greenhouse 8 April. On April 21s' a Geotube was filled and filtrate was collected for irrigation purposes. A sample of the filtrate and rainwater was sent for nutrient analysis. A T-tape'v irrigation system was installed to deliver water. On 21 April a soil test was performed at the beginning of the experiment and another will be performed at the end of the experiment to compare soil pH, buffer pH, N03-Nitrogen, Ca, Mg, K, P, B, Cu, Fe, Mn, Na, S, Zn, organic matter, calculated cation exchange capacity (CEC), and base

saturation %. Transplants were planted on the 22 April. Spacing between rows is 0.37 m and plant spacing within each row is 0. 1 9 in. Straw mulch was added on 25 April.

PRINCIPAL FINDINGS AND SIGNIFICANCE

Experiment A

Table 1. Averages of water quality parameters and nutrient concentrations measured during experiment for pond sludge (PS), geotube filtrate (GF), and geotube retained solids (RS)

	Pond Sludge Mean±S.D.	Geotube Filtrate Mean ± S.D.	Percent Removal	Geotube Solids
!pH	7.6 ± 0.3	7.7 ± 0.4		8.1
Temperature	24.5 ± 0.5	24.5 ± 0.5		
Alkalinity (mg/L)	860.0± 34.6	801.3 ± 90.5		
TSS (mg/L)	22,525.0 ± 3,892.2	115.0 ± 68.7	99	
Macronutrients (mg/I.)				
NPK(%)	0.09: 0.15 : 0.03	0.02 : 0.04 : 0.03		3.6 : 6.0 : 0.2
Total Nitrogen	89ft 7 ± 27.3	244.5 ± 59.7	73	36,400.0
Phosphorus	670.3 ± 550.1	155.7 ± 207.5	77	60,026.0
Potassium	248.4 ± 151.1	225.8 ± 151.3	9	1,852.0
Calcium	3,404.5 ± 2,878.4	417.3 ± 333.4	88	136,242.0
Magnesium	127.D±62.J	66.3 ± 69.4	48	2,447.0
Micronutrients (mg/L)				
Iron	33.3 ± 14.1	14.5 ± 19.9	56	2,028.0
Copper	8.0± 7.0	8.3 ± 10.5	-4	112.0
Zinc	23.8 ±22.0	22.3 ± 15.9	6	1,195.0
Boron	5.5 ± 3.7	13.5 ± 19.1	- 73	48.0
Manganese	13.0± 9.0	5.8 ± 10.8	55	773.0
Molybdenum	7.3 ± 9.0	13.3 ± 20.0	- 82	0.0

Results are presented in Table 1. The geotextile bag reduced TSS concentration 99%. The T - tape® drip irrigation system did not clog using GF. All macronutrient concentrations decreased, while micronutrient concentrations were found to either increase or decrease in GF samples. The pH of RS was higher than the average PS or GF readings. Results found RS contained substantially higher NPK levels than either the PS or GF. Comparison of PS and RS showed the *geotextile* bag concentrated rnacronutrients and micronutrients by factors ranging from 7 - 40x and 0 - 60x, respectively. Analysis of RS showed it was composed of 59.3% organic matter with 86.4% moisture content after four weeks of dewatering.

In conclusion, the geotextile bag was highly effective in reducing the concentration *of TSS* in fish effluent. The GF contained a dilute nutrient concentration and a total of 1,230 liters of GF was shown to pass through standard, commercial irrigation systems without clogging or need for further filtration. The GF and RS from the geotextile bag would allow an integrated farming system to utilize aquaculture effluent on agronomic crops during seasonal water shortages or persistent droughts; however, the nutrient quality of the filtrate may be dependent on the source of effluent. Thus, fresh effluent exiting an established tilapia production system may have higher nutrient concentrations compared to the anaerobic effluent pond used in this experiment.

Experiment B

Results found GSGF and GSRW had significantly higher (P < 0.05) total number of fruits, total yield, and marketable yield compared to the Control (Table 2). There was no significant difference (P ≥ 0.05) in the average fruit weight between treatments. There was no significant difference (P ≥ 0.05) in plant tissue analysis between treatments (Table 3); however, plant tissue nutrient levels were below recommended ranges in all treatments. In conclusion, the low nutrient level of the filtrate provided no additive effect for cucumber production. Fresh effluent exiting an established tilapia production system may have higher nutrient concentrations compared to the anaerobic effluent pond used in this experiment and thus when dewatered may provide a better source of nutrients. Nonetheless, fish solids outperformed the inorganic fertilizer in field production of cucumber. However, it is believed cucumbers were unable to extract the slow-released nutrients from either fertilizer at the applied rate. Therefore, a second trial will be conducted with increased rates of fertilizer application.

Table 2. Average total number of fruits, total yield and marketable yield for treatments

Values followed by different letters within rows are significantly different (P less than 0.05).

	Control	GSRW	GSGF
Ave. Fruit Wt. (g)	118.7 a	131.8 a	128.8 a
Total Number of Fruits (no./ha)	16,498 b	21,017 a	21,985 a
Total Yield (kg/ha)	1,976 b	2,869 a	2,927 a
Marketable Yield (kg/ha)	1,976	2,844 a	2,905 a

Table 3. Recommended nutrient levels for plant tissue.

Values followed by different letters within columns are significantly different (P less than 0.05)

	%N	%P	%K
Control	3.1 a	0.2 a	2.2 a
GSRW	3.1 a	0.2 a	2.2 a
GSGF	3.0 a	0.2 a	2.0 a
Recommended	4.5 -6.0	0.3 - 1.3	3.9-5.5

Presentation of Findings

The findings of this research have thus far been formally presented at two workshops. The first was at an aquaculture short course for members of the St. Croix farmers cooperative and other members of the St. Croix community held during the period May 6 to June 11, 2008. This was held on the St. Croix campus of the University of the Virgin

Islands and 35 persons participated. Results were also presented at the Tenth Annual Aquaponic and Tilapia Aquaculture Short Course, June 15 – 22, 2008. Participants in the course were entrepreneurs, researchers, educators and students from all over the world. This course was also held on the St. Croix campus of UVI and 73 students participated.

Water Quality in Virgin Islands Rain Water Collection Cisterns.

Basic Information

Title:	Water Quality in Virgin Islands Rain Water Collection Cisterns.
Project Number:	2008VI109B
Start Date:	3/1/2008
End Date:	12/31/2009
Funding Source:	104B
Congressional District:	Not Applicable
Research Category:	Water Quality
Focus Category:	Water Quality, Toxic Substances, Sediments
Descriptors:	
Principal Investigators:	Thomas Archibald, Stanley L. Latesky

Publication

1. None. Project is not completed.

PROBLEM AND RESEARCH OBJECTIVES

Water usage in the Virgin Islands is an interesting scientific and an important public health problem. Historically water has been available mostly from catching rainwater and storing that water. The island aquifers are small and provide a small percentage of the water needed. Rainfall averages 40 inches per year and is seasonal. Today most of the water used on the islands is supplied by desalination. Notwithstanding this the distribution system is concentrated in the cities resulting in the fact that greater than 50% of the residences found in the USVI use cisterns, required by Virgin Islands law as part of residential structures, as their only source of water.

The availability of desalinated water has taken the focus off the wide-spread use of cisterns. Many cisterns are aging and subject to contamination. Rain water collected from roofs are contaminated by urban pollution, bird and reptile waste material and particulate matter deposited from African dust clouds and volcanic activity.   Of particular interest are cisterns in the Bovoni Dump area because of the possibility of direct contamination and the dump's history of fires and other questionable use patterns. Because of the seasonal variations in rain, cisterns are often refilled by trucks filled from desalinated sources where there is a potential for contamination from pumps, pipes and the trucks themselves. Coatings use in cisterns may also lead to contamination. New coating materials are not subject to analysis of suitability. Older cisterns may have compromised coatings which can cause contamination due to leaching.

The object of this research will be to survey cisterns in the Virgin Islands and establish whether they meet legal minimum standards for heavy metals and dangerous hydrocarbons.

METHODOLOGY

During this program, workers will collect water samples from at least 40 cisterns chosen randomly from various parts of St. Thomas, St. John and Water Island. During the collection process sediments from cistern bottoms will be collected where feasible. The users of the cisterns will be asked to fill out a questionnaire which will collect data on such variables as usage, repair, chlorination, purchase of water, and other factors of interest.   This data can be used to track sources of contamination.

Each cistern will be sampled four times during the year to look for seasonal variations due to variations in rainfall. Sampling of water before and after trucked water has been added to cisterns will be investigated.

The water and sediment samples will be analyzed by state-of-the-art analytical equipment following standard Environmental Protection Agency (EPA) methods. Hydrocarbons, including PAHs, will be analyzed using a gas chromatograph equipped with a mass spectrometer detector (GC/MS). Trace heavy metals will be analyzed by Inductively Coupled Plasma Spectrometer equipped with a Mass Spectrometer Detector (ICP/MS).

Biological contamination in cistern water is also of interest. That study is not part of this proposal but may be proposed at a later time.

Data will be analyzed using conventional statistical methods and compared to recognized pollution sources such as commercial gasoline, jet fuel, pump oils and diesel exhausts. Metals detected will be compared to freshly sampled dust samples of African dust and if possible, ash from volcanic activity in the region.   Variability due to seasonal factors will be studied as well.

Collection and operation of the analytical instruments will be used as a training tool for UVI students and they are expected to do most of the hands on work. The goal will be to train operators for follow on work on other water related issues.

PRELIMINARY FINDINGS AND SIGNIFICANCE

Analyses were conducted using a Metrohm 850 Professional IC system operating at an optimum pressure of 10.8 megapascal (MPa) at a flow rate of 0.7 mL per minute at a temperature of 30 ^{o}C. The IC column used for the analyses was a Metrosep A Supp5-250 250 mm column which gave optimum separation of the typical inorganic anions found in drinking water. The instrument used a conductivity detector equipped with a cation suppressor. The eluent used in the analyses was a mixture of 1.0 millimolar (mM) sodium bicarbonate and 3.0 mM sodium carbonate. The eluent was prepared from concentrate using a Metrohm 845 eluent synthesizer. Reagent grade (18.2 M   ) was prepared using a Barnstead Diamond deionization equipped with a UV lamp to remove Total Organic Carbon from the water. Feedwater for the deionizer was supplied by a Barnstead RO water system. Data analyses were conducted using a five point calibration curve (Figure 1) based on the standards shown below (1, 5, 10, 15, and 20 ppm) for (in order of elution) fluoride, acetate, chloride, nitrite, bromide, nitrate, phosphate, and sulfate.
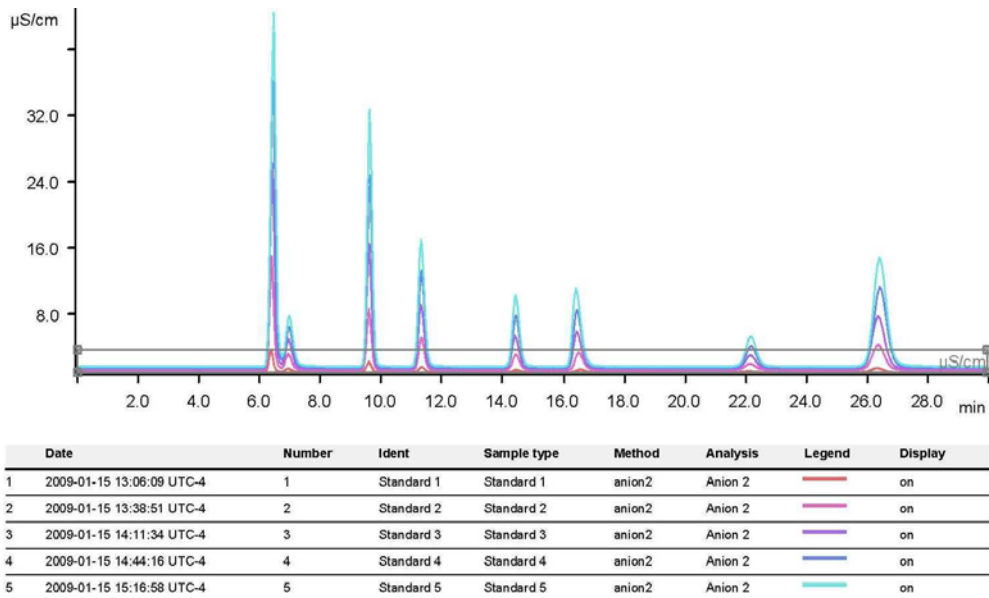
	Date	Number	Ident	Sample type	Method	Analysis	Legend	Display
1	2009-01-15 13:06:09 UTC-4	1	Standard 1	Standard 1	anion2	Anion 2	—	on
2	2009-01-15 13:38:51 UTC-4	2	Standard 2	Standard 2	anion2	Anion 2	—	on
3	2009-01-15 14:11:34 UTC-4	3	Standard 3	Standard 3	anion2	Anion 2	—	on
4	2009-01-15 14:44:16 UTC-4	4	Standard 4	Standard 4	anion2	Anion 2	—	on
5	2009-01-15 15:16:58 UTC-4	5	Standard 5	Standard 5	anion2	Anion 2	—	on

Figure 1: Standard calibration chromatograph

Results

A total of forty water samples were analyzed. The samples analyzed represented a cross-section of cisterns on St. Thomas, St. John, and Water Island. As expected, the major anion component was chloride with smaller amounts of nitrate, sulfate and acetate detected. The concentration of chloride ranged from 8 ppm to 60 ppm, depending on the island and location of the cisterns. As a comparison, tapwater (WAPA Desalinated) was also analyzed. The results are highlighted in the four figures given below. The smaller peaks are fluoride at around 7 minutes (from cisterns replenished by WAPA water) and nitrate at around 18 minutes. WAPA water showed a detectable concentration of sulfate (at around 27 minutes) because their source of water is seawater.
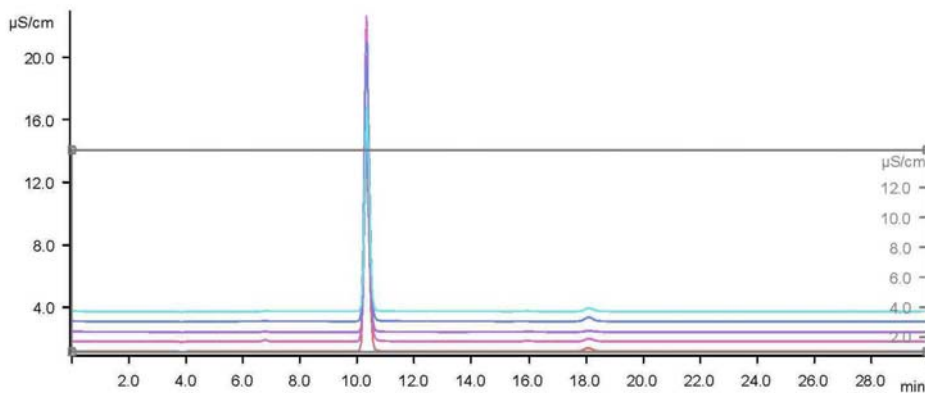

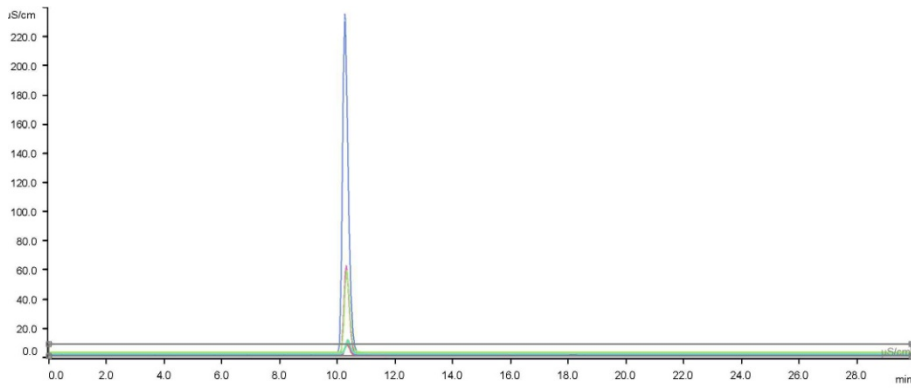Figure 2: IC for the Water Island samples
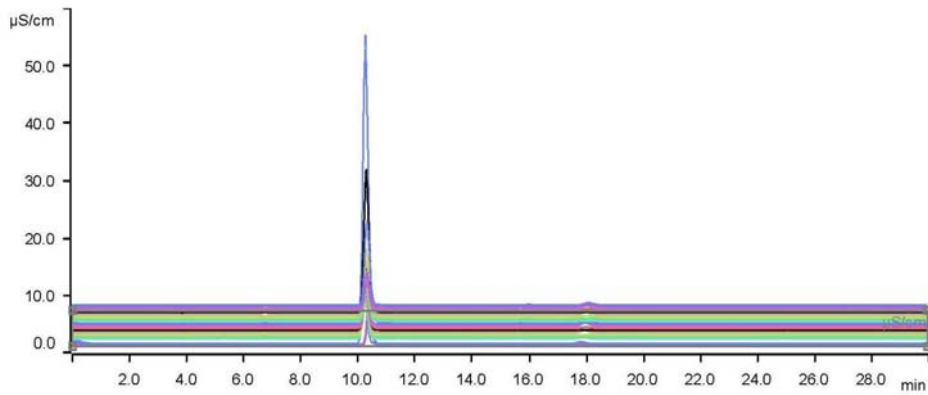
Figure 2: IC for the St. John water samples
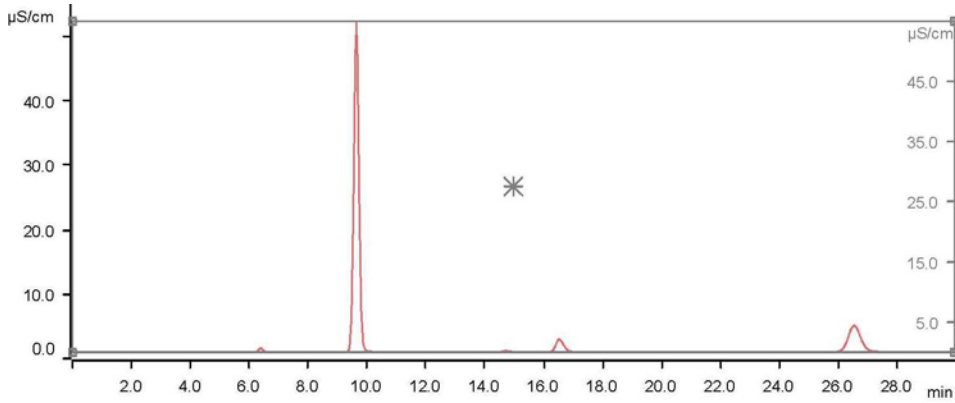

Figure 3: IC for the St. Thomas water samples

Figure 4: IC for UVI tap water

Conclusions and future work

The small data set indicates little or no unexpected concentrations of anion contaminants in any of the cistern samples analyzed. The range in chloride concentration is more than likely due to some cisterns being occasionally replenished by trucked in WAPA water. Future work will involve analysis of water for organic contaminants using solid-phase extraction to concentrate the contaminants followed by analysis using either gas-chromatography mass-spectrometry (GC-MS) or liquid-chromatography mass-spectrometry (LC-MS). Metals analysis will be accomplished using a Inductively Coupled Plasma-Mass Spectrometer. We also plan on beginning a monitoring plan to examine how African Dust and volcanic ash affect the concentration of trace-metals in cistern water quality in the Territory.

Use of Wetland Plants to Manage Nitrate Levels in a Biofloc Fish Production System

Basic Information

Title:	Use of Wetland Plants to Manage Nitrate Levels in a Biofloc Fish Production System
Project Number:	2008VI112B
Start Date:	3/1/2008
End Date:	8/31/2009
Funding Source:	104B
Congressional District:	
Research Category:	Water Quality
Focus Category:	Agriculture, Water Quality, Water Use
Descriptors:	
Principal Investigators:	Donald Bailey, Jason James Danaher

Publication

1. None. Project is continuing.

PROBLEM AND RESEARCH OBJECTIVES

Maximizing the use of freshwater resources and output from production systems is critical for the future success of agricultural enterprises in the U.S. Virgin Islands. The average rainfall in the region can vary from 400 - 1300 millimeters per year and is concentrated in the wet season (September to November). The U.S. Virgin Islands have only intermittent seasonal streams and freshwater impoundments that frequently dry through evaporation and seepage. Farmers rely on wells or haul water to their field plots for irrigation.

Dual use of the freshwater resource can be achieved by first culturing fish and then applying fish effluent to agronomic crops as irrigation water. The University of the Virgin Islands has developed a commercial biofloc system for the production of tilapia but nitrate-nitrogen accumulates in the system as part of the biological treatment processes. Reducing nitrates to a level where they do not impact fish production nor become a source of groundwater pollution (if applied extensively to agronomic crops) is a desire of farmers incorporating an aquaculture component into their farm enterprise.

The research will determine which of nine wetland plants is best suited for removing nitrate-nitrogen from aquaculture water circulated through denitrification raceways. Reducing nitrate levels to less than 100 mg/l will allow the water to be used extensively on agronomic crops. Farmers will be able to incorporate aquaculture into their farm enterprise and produce additional crops of value. These could include flowers or foliage for sale to florists or a marketable wetland plant for sale to developers mitigating land damage. The results of this study will allow producers to maximize use of their production system without the need to perform undesirable water exchanges to improve water quality

The research will evaluate nine littoral, bog or wetland plants for their growth, production and nitrate removal efficiency in the UVI Aquaculture Program biofloc system denitrifying raceways. The U.S. Virgin Islands have few native freshwater wetland plants due to previous agricultural practices, development and lack of natural freshwater resources. Three have been identified, *Sesuvium portalacastrum*, sea purslane, *Pluchea odorata*, fleabane and *Thalia geniculata,* bent alligator flag (Acevedo-Rodriguez, 2005). These will be cultivated because of their market potential to developers that are required to mitigate wetland damage caused by construction activities. Six other plants have been identified for their use by florists, either for flowers or foliage.

METHODOLOGY

Wetland plants, native and introduced species, will be planted into the denitrification raceways and allowed to establish in blocked areas. The biofloc system will be operated for a six-month period as a fish production trail with daily management including feeding, aeration, sludge removal and pH adjustment. Water quality and plant tissue will be analyzed periodically throughout the fish production trial. Data analysis will

determine the absolute decrease in nitrate-nitrogen over the length of the raceways and the rate of nitrate-nitrogen accumulation in the system over the production period.

After the production trial, the fish will be held in the rearing tank and the system managed as a pre-sale holding facility before the fish are marketed. The denitrification raceways will be planted with two species of wetland plant, one species in each raceway. Water quality data analysis will determine the rate of nitrate-nitrogen accumulation and the absolute decrease in nitrate-nitrogen over the length of the raceways. Data on the growth, production and harvest of marketable plant products will be collected and analyzed. An economic analysis of each plant species will be made to determine the best plant for inclusion in the biofloc system.

PRELIMINARY FINDINGS

The biofloc aquaculture system is being used for this research which evaluates the production potential of several wetland plants in raceways using the culture water. The 200-m^3 circular tank was stocked with 5,000 153-g tilapia fingerlings on September 3, 2008. The system also has a 2-m^3 clarifier for removal of fecal solids and other settleable solids, a base addition tank, and 2 raceways for denitrification of the water. Water is pumped through these units with a 1/20th hp circulating pump. The tank water was continuously circulated horizontally with one ¾ hp prop aerator and was aerated with up to 3 vertical aerators.

The fish were reared for 168 days (24 weeks) at which time they were harvested. Final production was 3,711 kgs or 18.55 kg/m^3. During the production period the fish were fed twice each day to apparent satiation for 30 minutes. Digestion and metabolism produce feces and ammonia, NH_3^+. The feces were removed by the clarifier and the raceways. The ammonia was removed by biological processes of nitrifying bacteria in the water column. The end product of nitrification, nitrate-nitrogen (NO_3-N) accumulated in the water. Feces and solids that accumulate in the raceways form anaerobic zones where denitrifying bacteria thrive and can convert nitrate to nitrogen gas. (Figure 1.)

Nine varieties of wetland plants were randomly planted in each raceway. Each variety was planted in a quadrent of 2-m^2 at a density of 4/m^2. These plants were allowed to grow, without tending, by their natural propagation pattern. The two cana lily varieties did not survive. Not all of the other varieties thrived. *Colocasia esculenta*, Green Taro or Dasheen, grew well and produced many plantlets. Final yield was 33.32 kg/m^2. *Cyperus papyrus*, Egyptian papyrus, was the next most productive variety but yielded only half as much plant mass, 16.02 kg/m^2. (Table 1.)

The second phase of this research is ongoing. *C. esculenta* has been planted in one raceway at a density of 4/m^2 and allowed to grow. Water quality is being monitored in this raceway with a YSI Multiparameter water quality sonde which hourly records pH, ammonium and nitrate values. A UVI student worker is assigned to the maintenance and monitoring of this equipment. Water quality is monitored by standard methods biweekly in the rearing tank and at the effluent ends of each raceway. The second raceway

maintains samples of the surviving plant varieties. None of these exhibited a clear advantage in production.

One production constraint which was not anticipated was the late season in which the wetland plants were obtained from Florida. As they were purchased in October some had entered winter dormancy and did not exhibit new growth until the early spring here in the Virgin Islands. A reexamination of these plants would validate the production values that were achieved.
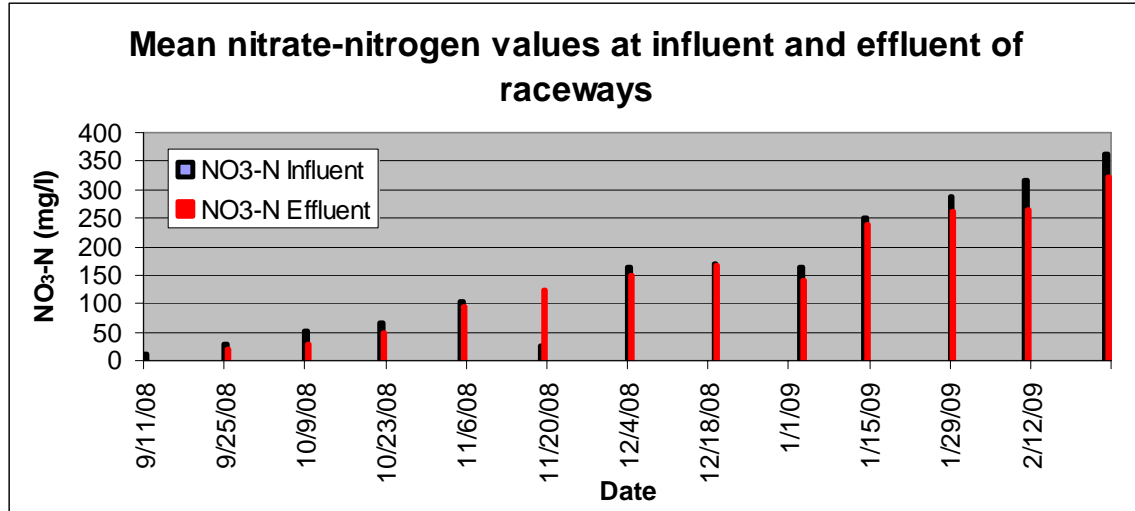

Figure 1. Mean nitrate-nitrogen values show a decline in values from the denitrification occurring in the raceways between the influent and effluent ends.

Table 1. Wetland plants grown in denitrifying raceways show a wide range of production.

Latin Name	Common Name	Raceway 1	Raceway 2	Mean kg/m^3
C. esculenta	Green Taro (dasheen)	32.86	33.66	33.26
C. papyrus	Papyrus	18.67	13.361	16.02
S. lancifolia	Giant Sagittaria	6.926	6.034	6.48
I. versicolor	Iris	0.277	0.817	0.55
H. caribaea variegata	Verigated spider lily	0.224	0.338	0.28
C. americanum	Bog lily	0.187	0.162	0.17
T. geniculata	Bent aligator flag	0	1.579	0.79

A Comparative Analysis of St. Croix's Waterways

Basic Information

Title:	A Comparative Analysis of St. Croix's Waterways
Project Number:	2008VI114B
Start Date:	3/1/2008
End Date:	5/31/2009
Funding Source:	104B
Congressional District:	N/A
Research Category:	Not Applicable
Focus Category:	Water Supply, Groundwater, Water Quality
Descriptors:	
Principal Investigators:	Brian Daley

Publication

2. Daley, Brian, (Factsheet in preparation), Forest, Agriculture and Development in a Changing Landscape: Land-cover Change Analysis of St. Croix, USVI using Landsat Satelites from 1992 to 2002.
3. Daley, Brian, (Factsheet in preparation), A Comparative Analysis of Soil Characteristics in St. Croix's Waterways: A Look at the Dirt in our Guts.

PROBLEM AND RESEARCH OBJECTIVES

The Virgin Islands territory is a dynamic ever-changing landscape. Human land uses such as agriculture and residential development are the primary activities determining land cover of the islands. Land uses that result in the loss of forest cover are frequently associated with subsequent decreases in water quality and negatively affect an aquifer's ability to naturally recharge. Unhealthy waterways exhibit increases in sedimentation, erosion, water speed, water temperature and evaporation. This can result in decreased water quality, lowering water tables and increased costs for the farms and communities that rely on these resources. Over the past two decades the water table in St. Croix has been steadily lowering

There is no known territory-wide health analysis of Virgin Islands' waterways. Within the territory, these natural waterways are referred to as guts. Guts in the Virgin Islands tend to be ephemeral, meaning they are dry for portions of the year. This project will be a preliminary study on how to efficiently accomplish a comprehensive gut health analysis using GIS (Geographic Information Systems) and GPS (Global Positioning System) technology. To this end, findings of a recent AES (Agricultural Experiment Station) land cover change analysis will be combined with field collected data on waterways. By comparing data from forested, deforested and recently reforested waterways, we will be able to describe and quantify the impact various land-uses have on our water resources.

This project will analyze the condition of waterways on St. Croix using state of art GIS and GPS technology. This research project will compare soil and water permeability characteristics from waterways in three distinct land uses. The comparative analysis will be a dynamic combination of field data with current remote sensing research on land cover change in St. Croix between 1992 and 2002. In the process, we will train UVI students to collect field data and provide them with certification in GIS software. Students will present their research in poster format and results will be made available to the community in the form of fact sheets. In keeping with UVI's mission, students will be educated and trained to use this technology during the project.

METHODOLOGY

Students will conduct the ArcGIS 9.2 certification workshop in a UVI computer lab in St. Croix. After the training, we will lead the students in creating digital map layers that delineate the primary waterway or guts in each watershed on St. Croix. The students will create buffers around the guts and then overlay it on a forest cover change layer recently created by UVI-AES. This polygon layer identifies all areas on St. Croix that were deforested or reforested during a recent 10-year period. Students will identify 30 data collection points by intersecting the two layers and choosing 10 points in each category (stable, deforested and reforested) of guts.

Using a Trimble GPS unit we will go to the ten waterways in each category and collect data on forest canopy, land use, topography, and soils characteristics from the USDA-NRCS soils tests. Soils tests will include aggregate stability, water nitrate levels, salinity tests, slake test, and bulk density test. These tests relate to water quality and water movement through the soil indicating what is happening during and after rain events. (Direct sampling of the water in guts can not be done with systematic regularity due to their ephemeral nature.) Some of the tests will be conducted at the UVI-AES lab. When field data collection is completed the students and staff will analyze the data using GIS and statistical methods. The scientific results of this study will be shared with the academic and technical community by archiving the findings with the Virgin Islands Information Council (GIC) and UVI's CDC. The results will be summarized and presented to the Virgin Islands community during a public seminar at the conclusion of the project and also distributed as a fact sheet.

PRINCIPAL ACCOMPLISHMENTS AND SIGNIFICANCE

The results support our original hypothesis that soil in forested sites would have superior characteristics to soil in change areas. Forested guts had the greatest average slope and their banks are significantly steeper than deforested sites (Table 1). Although steep slopes are more prone to erosion, we observed less erosion in the forested sites. Water infiltration rates are influenced by several factors such as soil particle size and soil organic material, but water infiltrated soil in stable forest sites significantly faster than in deforested and reforested sites. Average soil moisture did not differ between sites, with most sites registering on the lowest end of the range. We attribute this to the prolonged dry-period before our sampling and not to an accurate measure of soil organic matter.

Average pH values in deforested sites were significantly higher than in other sites. This is likely due to erosion of pH neutral top-soil leading to exposure of the alkaline sub soils. There was also a trend of soil from forested sites having lower values for, electro-conductivity, temperature, and bulk density. These results are a trend only and did not meet our criteria for statistical significance. Electro-conductivity measurements for forested and reforested fell within the healthy range while deforested sites registered levels that begin to impede plant growth. St. Croix's landscape is highly fragmented and the course of a gut passes through alternating forested and deforested sections.

The conditions at the 30 data collection sites ranged from intact, native forest with deep organic soil, to exposed, treeless sites where the gut was lined with stone (rip-rap) and no soil was present. The original classification of forested, deforested and reforested was completed in 2005. The 10 forested sites were still forested, while four of the reforested sites had recently been cleared and four sites classified as deforested had young patches of secondary forest establishing. These findings emphasize variable and dynamic nature of land-cover change sites.

We conclude that land-cover change in St. Croix is directly linked to the degradation of ephemeral waterways or guts. Degradation in the Virgin Islands can be measured by decreased water infiltration rates and increased pH, bulk density and electro-conductivity. We interpret these results to be a proximal measure of soil compaction and increased run off volume and velocity.

The results from this small-scale pilot study merit additional investigation of the watersheds of the Virgin Islands and the rates, patterns and practices of development in the territory. The first step in this process is to generate a temporal series of classified maps of the U.S Virgin Islands. This can be accomplished using traditional aerial photo interpretation methods, or with increasingly accessible satellite imagery.

Soil and water sampling on a larger scale may result in support of the prediction that forest removal also leads to increased soil temperature. To prevent damage to the island's waterways, we support the Virgin Islands law (Title 12, Chapter 3 section 123) prohibiting cutting of any trees with 25 feet of the edge of a watercourse. Enforcement of this code would simultaneously protect forests, fresh water, soil, and coastal marine systems.

Presentations arising out of this project were presented by UVI students who participated in this project. Both students were junior biology majors and they made presentations at the UVI Annual Fall Research Symposium held on the UVI St. Thomas campus on Sunday, September 21, 2009. The names of the students and the titles of their presentations were as follows:

- Balkaran, Hemma, "A Comparison of Soil Characteristics Based on Land-cover Classification in St. Croix, U. S. Virgin Islands"

- Muhammad, Tristian, "A GIS Analysis of St. Croix's Waterways"

In summary:

1. The GIS training for this project effectively prepared UVI students to execute a research project using ArcGIS 9.1 and additional tools
2. The method of using GIS technology and an existing land-cover change map for St. Croix was an effective in selecting sample sites and the USDA Soil Quality Test Kit was an effective way of collecting data from ephemeral streams during the dry season.
3. Results indicate that forested sites tend to be located on steeper slopes, yet have less erosion and significantly greater water infiltration rates than sites experiencing land-cover change.
4. Deforested sites have higher pH values due to exposure of alkaline parent material and recently reforested sites (abandoned agriculture) had potentially harmful levels of salts in the soil.

5. The other variables, while not statistically significant, also showed a trend of forested sites having relatively healthier soil characteristics, and thus supported our original predictions.
6. This method demonstrates potential for a broader application and an analysis of the territory's waterways on a watershed-by-watershed basis.

Table 1. Averages for each measurement by land-cover type.
(Statistical differences between averages are denoted by different letters.)

Measurement	Average values by Land cover change type		
	Stable Forest (FF)	Reforestation (FN)	Deforestation (NF)
Bank slope *	27.0% a	21.0% a	10.9% b
Hill slope*	4.0% a	1.0% b	2.0% ab
Infiltration rate (cm/hr)***	597.4 a	462.0 b	271.0 bc
Relative temperature (^{0}F)	-10.25	-9.36	-8.32
Soil moisture (g/g)	0.160	0.189	0.167
Bulk density (g/cm^3)	1.181	1.061	2.486
Electro-conductivity (dS m^{-1}) *	0.375 a	1.219 ab	2.486 b
pH *	7.49 a	8.21 b	7.66 a

Analysis of variance using Least Squared Means with alpha level of *0.1 or ***.001

Information Transfer Program Introduction

With a population of about 125,000 persons, the U. S. Virgin Islands might seem relatively small and it might appear that communicating with all residents might be a very simple matter. In fact, great effort is taken by the Virgin Islands Water Resources Research Institute to be sure that USVI residents are aware of not only the findings of research conducted at the VI-WRRI but that they also learn of developments elsewhere that might be of use to them in the utilization of the limited available water resources. The institute maintains a web page on the website of the University of the Virgin Islands and takes advantage of the ready access that UVI has to both the print and electronic media. Additionally, the WRRI participates actively in workshops, seminars and conferences with collaborators within the University such as the Cooperative Extension Service, the Virgin Islands Marine Advisory Service and the Virgin Islands Experimental Program to Stimulate Competitive Research. The VI-WRRI also partners in its information dissemination efforts with external agencies such as the Virgin Islands Department of Planning and Natural Resources and the V. I. Waste Management Authority.

While all projects conducted through the VI-WRRI provide for dissemination of findings, two projects were primarily intended for sharing information with the Virgin Islands community. One project provided for an open public discussion on the impact of climate change on the region as well a focused discussion on that issue with the Governor of the Virgin Islands and key members of his cabinet and other pertinent officials. The second project allows for demonstration of an application of GIS technology in addressing a water resources issue of concern in the U. S. Virgin Islands. Both of these projects are summarized in this section of the annual report.

Virgin Islands Water Resources Map Study

Basic Information

Title:	Virgin Islands Water Resources Map Study
Project Number:	2008VI118B
Start Date:	3/1/2008
End Date:	8/31/2009
Funding Source:	104B
Congressional District:	Not Applicable
Research Category:	Water Quality
Focus Category:	Management and Planning, Sediments, Surface Water
Descriptors:	
Principal Investigators:	Stevie Henry

Publication

1. None as yet. Project is continuing.

PROBLEM AND RESEARCH OBJECTIVES

A sediment reduction program was prepared for the U.S. Virgin Islands Department of Conservation and Cultural Affairs in 1979 by the firm BC&E-CH2M Hill. The stated purpose of the program was to minimize the occurrence of soil eroding and being transported into the islands' coastal waters. A sediment reduction map was produced as an output of the study used to establish the Virgin Islands Sediment Reduction Program (VISRP).

The sediment reduction maps were produced to be used for planning and enforcement within the VISRP. The sediment reduction maps were named the "Water Resources Map" and became a requirement for the acquisition of a development permit. The maps display terrestrial and marine features that are directly related to sediment reduction or biological communities sensitive to the affects of sediment discharge.

Despite changes to the landscaped and seascape of the Territory, the water resources map has not been updated and development permit applicants are still required to submit a copy of the map section with the area to be developed. There is evidence that the delivery of sediment to the coastal system has increased exponentially during the past 50-60 years. Development practices ignoring the management of soil erosion has been identified as the primary contributor to sedimentation. How reliable is the information contained in the water resources map for making land use decisions?

Impoundments are major features on the water resources map. They serve an essential role in sediment control. The overtopping protection and holding capacity are indicators of how well an impoundment is functioning.

This study will review the relevancy of how the water resources map is used currently. The existing condition of impoundments within study areas on St. Thomas and St. Croix will be surveyed and mapped. Procedures will be developed for expanding, integrating and maintaining updates of the data needed for planning and enforcing sediment controls. The goal of this project is to evaluate the reliability of the impoundment data contained in the water resources map for making land use decisions. This will be accomplished by evaluating:

- How the inventory of impoundments is maintained and used by the Department of Agriculture.

- How is the updated Department of Agriculture impoundment inventory shared with and used by other users (Department of Planning and Natural Resources and engineers, etc.)?

- Evaluate how GIS technology could be used to improve planning and enforcement of sediment reduction.

METHODOLOGY

Since the water resources map was produced 20 plus years ago there have been significant advances in desktop Geographic Information System (GIS). These advances have made the collection, update, analysis and dissemination of spatial data cheaper and more efficient.

Field surveys will be conducted in the study areas to assess the existing condition of the impoundments shown on the existing water resources map. In addition, impoundments changed or developed in the study areas after 1978 will be identified and mapped. The primary source for this information will be a review of historical aerial photos and records at the Department of Agriculture and the Department of Planning and Natural Resources.

This study will review the workflow for the portion of the permitting review process relating to sediment control. A focus group comprised of plan reviewers, natural resource managers, scientists and developers in land development related field will be utilized to develop recommendations for expanding, integrating and maintaining updates of the data collected by this study.

PRELIMINARY FINDINGS AND SIGNIFICANCE

The study area inventory of impoundments GIS layer based on an on-screen aerial photo survey was completed. The St. Thomas point layer has a total of 24 features and St. Croix 33 features. A total of 80 pictures have been catalogued: 24 for St. Thomas and 56 for St. Croix;

Students from the MESA (Math and Environmental Science Summer Academy) Non-Point Source Project which is based at the St. Croix Education Complex High School continue to show interest in studying impoundments in the study area. Some of the students are developing a project to study the impact of water hyacinths on the ponds.

UVI undergraduate Duvane Hodge, a biology major, was hired and trained to complete the GIS layer for St. Thomas. After conducting a literature review of best practices for monitoring sediment/impoundment ponds, a 10 item checklist was developed to score the condition of the impoundments during field survey. Duvane using her programming skill has developed a macro which would allow a user to enter a value for each of the 10 items on the check list then present a maintenance required score.

No maintenance needed	😁
Slight maintenance needed	🙄
Intermediate maintenance needed	😟
Major maintenance needed	🥺

Figure 1 Symbols for maintenance requirement score

A GIS project and draft maps are being prepared for a focus group presentation to resource managers and development plan reviewers to provide feedback on a proposed workflow for updating the water resources map and utilizing GIS to support the permitting review process relating to sediment control.

Figure 2 View of the St. Thomas Water Resources GIS project map view

Next Steps

June 2009

- Focus Group
- Report compilation
- Conduct final Focus Group meeting

July 2009

- Complete GIS project production, map production and report compilation

Let's Talk Water! Water Voices From Around the World

Basic Information

Title:	Let's Talk Water! Water Voices From Around the World
Project Number:	2008VI130B
Start Date:	3/1/2008
End Date:	2/28/2009
Funding Source:	104B
Congressional District:	N/A
Research Category:	Not Applicable
Focus Category:	Water Supply, Climatological Processes, Water Use
Descriptors:	
Principal Investigators:	Lydia M Harris

Publication

PROBLEM AND RESEARCH OBJECTIVES

A sediment reduction program was prepared for the U.S. Virgin Islands Department of Conservation and Cultural Affairs in 1979 by the firm BC&E-CH2M Hill. The stated purpose of the program was to minimize the occurrence of soil eroding and being transported into the islands' coastal waters. A sediment reduction map was produced as an output of the study used to establish the Virgin Islands Sediment Reduction Program (VISRP).

The sediment reduction maps were produced to be used for planning and enforcement within the VISRP. The sediment reduction maps were named the "Water Resources Map" and became a requirement for the acquisition of a development permit. The maps display terrestrial and marine features that are directly related to sediment reduction or biological communities sensitive to the affects of sediment discharge.

Despite changes to the landscaped and seascape of the Territory, the water resources map has not been updated and development permit applicants are still required to submit a copy of the map section with the area to be developed. There is evidence that the delivery of sediment to the coastal system has increased exponentially during the past 50-60 years. Development practices ignoring the management of soil erosion has been identified as the primary contributor to sedimentation. How reliable is the information contained in the water resources map for making land use decisions?

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- o How is the updated Department of Agriculture impoundment inventory shared with and used by other users (Department of Planning and Natural Resources and engineers, etc.)?

- o Evaluate how GIS technology could be used to improve planning and enforcement of sediment reduction.

METHODOLOGY

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PRELIMINARY FINDINGS AND SIGNIFICANCE

The study area inventory of impoundments GIS layer based on an on-screen aerial photo survey was completed. The St. Thomas point layer has a total of 24 features and St. Croix 33 features. A total of 80 pictures have been catalogued: 24 for St. Thomas and 56 for St. Croix;

Students from the MESA (Math and Environmental Science Summer Academy) Non-Point Source Project which is based at the St. Croix Education Complex High School continue to show interest in studying impoundments in the study area. Some of the students are developing a project to study the impact of water hyacinths on the ponds. A presentation was made by one of the students, Ms. Tabitha Cuffy, on her project at the Fourth Annual GIS Conference. This conference, titled '"Regional and Local Integration of GIS Technology through Business and Intergovernmental Collaboration", was held on St. Thomas, November 19 – 21, 2008.

UVI undergraduate Ms. Duvane Hodge, a biology major, was hired and trained to complete the GIS layer for St. Thomas. After conducting a literature review of best practices for monitoring sediment/impoundment ponds, a 10 item checklist was developed to score the condition of the impoundments during field survey. Duvane using her programming skill has developed a macro which would allow a user to enter a value for each of the 10 items on the check list then present a maintenance required score.

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Intermediate maintenance needed 😟

Major maintenance needed 😢

Figure 1 Symbols for maintenance requirement score

A GIS project and draft maps are being prepared for a focus group presentation to resource managers and development plan reviewers to provide feedback on a proposed workflow for updating the water resources map and utilizing GIS to support the permitting review process relating to sediment control.

Figure 2 View of the St. Thomas Water Resources GIS project map view

Next Steps

June 2009

- Focus Group
- Report compilation
- Conduct final Focus Group meeting

July 2009

- Complete GIS project production, map production and report compilation

USGS Summer Intern Program

None.

	Student Support				
Category	Section 104 Base Grant	Section 104 NCGP Award	NIWR-USGS Internship	Supplemental Awards	Total
Undergraduate	11	0	0	0	11
Masters	0	0	0	0	0
Ph.D.	0	0	0	0	0
Post-Doc.	0	0	0	0	0
Total	11	0	0	0	11

Notable Awards and Achievements

None.

Publications from Prior Years

1. 2004VI39B ("Production, Pricing and Distribution Policies of Public Water in St. Thomas, U. S. Virgin Islands") - Water Resources Research Institute Reports - Solomon, Hossana, 2006,Production, Pricing and Distribution Policies of Public Water in the U. S. Virgin Islands, Virgin Islands Water Resources Research Institute, University of the Virgin Islands, St. Thomas, U. S. Virgin Islands, 40 pages.

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