

Water Resources Research Institute

Annual Technical Report

FY 1998

Introduction

Research Program

The program goals of the Puerto Rico Water Resources Research Institute are three folded. First, to train student scientists and engineers through hands-on participation in research; secondly, to facilitate, through outreach and technology transfer activities, the incorporation of research results into the knowledge base of water resources professionals in Puerto Rico and the U.S.; and third, to conduct research aimed at resolving local and national water resources problems working with the complexity of geological and hydrological situation and the Puerto Rico's unique cultural, social, and political circumstances. To accomplish these objectives, the Institute used to identifies Puerto Rico's most important water resources research needs, funds the most relevant and meritorious research projects proposed by faculty from universities of the Island, encourages and supports the participation of students in funded projects, and disseminates research results to scientists, engineers, and the general public. Recent changes of language of the Water Resources Research Act and the move to the regional competition concept, have precluded the Institute to fulfill some of the program goals and priorities. The PRWRRRI selects proposals under the FY 1998 grant while under the direction of Dr. Jorge Rivera Santos, who issued the Request for Proposals and coordinated an evaluation of the proposals received by the EAC composed by water resources professionals and officials in industry and government, as described in the PRWRRRI's FY 1998 regional competition proposal. None of the proposals submitted for consideration was granted funds. The Director continued to act as liaison between the University of Puerto Rico and government agencies for all matters related to water resources problems and activities. He is also responsible for defining and overseeing cooperative activities to be undertaken with the US Environmental Protection Agency under a Memorandum of Understanding signed by the EPA and the University in 1992. This year the Director will continue to attract research funds from other sources. A new goal of the Institute is to extend its services to other areas besides research. Education including K-12 grades, public awareness, professional development and continuing education; as well as, consulting services are some of the new areas in which the Institute will be incurring. Internationalization is another goal, of which first efforts have already began with the submission of a proposal for a technology transfer project with Dominican Republic. Other similar projects are under consideration with Costa Rica and El Salvador.

Basic Project Information

Basic Project Information	
Category	Data
Title	Monitoring Land Use and Land Cover in the Jobos Bay National Estuarine Research Reserve Watershed
Project Number	S-02
Start Date	07/01/1997
End Date	08/01/1998

Research Category	Engineering
Focus Category #1	Conservation
Focus Category #2	Management and Planning
Focus Category #3	None
Lead Institution	Water Resources Research Institute

Principal Investigators

Principal Investigators			
Name	Title During Project Period	Affiliated Organization	Order
Linda L. Velez-Rodriguez	Associate Professor	University of Puerto Rico	01

Problem and Research Objectives

Jobos Bay National Estuarine Research Reserve (JBNERR) is located on the southeastern coastal plain of Puerto Rico, within the subtropical dry forest life zone of Puerto Rico's tidal and submerged wetlands. Important wildlife habitats within the reserve limits include coral reef, extensive seagrass beds, sand beaches, 15 small mangrove cays and the mangrove forest and lagoon areas of Mar Negro. Endangered species such as the West Indian Manatee, hawksbill and green sea turtles, the brown pelican and yellow shouldered blackbird live within the reserve. Jobos Bay Watershed is subjected to different land uses and land cover, which could be impacting its unique environmental characteristics. A sample of these include extensive and intensive agricultural activities, thermoelectric power generation, sanitary landfill, residential areas, golf courses, and marinas. The objective of this project was to establish a digital database of the land use and land cover for the JBNERR watershed using a Geographic Information System and remote sensing technology.

Methodology

The project was divided in two phases. Phase I consisted on identifying current land use and land cover in the vicinity of the Jobos Bay Research using photointerpretation techniques, one of the basic forms of remote sensing. To define the study area and for purposes of georeferencing it to the USGS topographic quadrangles series of 7.5 minutes of Coamo, Cayey, Patillas, Salinas, Central Aguirre and Guayama at scale 1:20,000 were used. Phase II consisted of building the Jobos Bay Reserve remote sensing database and relating it with a GIS. The conversion of the remote sensing data from the aerial photographs to digital form are the foundation of the digital database.

Principal Findings and Significance

The prevailing land use and land cover classification of the study area was agricultural land followed by forestland closed. Each land use and land cover classification was established with their total area and percentage of coverage. A color map entitled Jobos Bay Watershed 1999 was produced. The map shows the study area and the main product of this research. With the data generated by this research the

JBNERR ended with adequate information about its nearby land use and coverage. The digital data base generated in this project provides baseline information that will serve to compare land use trends through time. The information provided by this project is a valuable tool in the development of priorities for the management of the reserve resources which are under natural and man induced stress.

Descriptors

Articles in Refereed Scientific Journals

Book Chapters

Dissertations

Water Resources Research Institute Reports

Velez-Rodriguez, Linda, 1999, The Use of a Geographic Information System and Remote Sensing Technology for Monitoring Land Use and Land Cover of the Jobos Bay National Estuarine Research Reserve Watershed of Puerto Rico, Puerto Rico Water Resources Research Institute, University of Puerto Rico, Mayaguez, Puerto Rico, p. 35.

Conference Proceedings

Other Publications

Basic Project Information

Basic Project Information	
Category	Data
Title	Recirculation of Leachate within the Landfill for the Leachate Treatment
Project Number	C-01
Start Date	09/01/1997
End Date	08/01/1998
Research Category	Water Quality
Focus Category #1	Groundwater
Focus Category #2	Non Point Pollution
Focus Category #3	Water Quality
Lead Institution	Water Resources Research Institute

Principal Investigators

Principal Investigators			
Name	Title During Project Period	Affiliated Organization	Order
Ning Hsi-Tang	Professor	University of Puerto Rico	01
Arturo Massol-Deya	Assistant Professor	University of Puerto Rico	02
Elba Diaz	Research Associate	University of Puerto Rico	03

Problem and Research Objectives

Most of the treatment processes for water and wastewater treatment may be used for leachate treatment. However, the aerobic treatment for the reduction of high concentration of organics in the leachate, will be too expensive. Anaerobic treatment technology will be more suitable for leachate treatment. The other leachate treatment technology is the recirculation of leachate over the landfill. This technology is attractive because it is simple and economical. Essentially, the landfill itself is used as a giant anaerobic reactor for the treatment of the leachate. This project examined the suitability of the leachate treatment recirculation. Gas production, COD and other variables were monitored during the recirculation process in the Cabo Rojo municipal landfill in the west part of Puerto Rico. The specific objectives of the project were: 1. To characterize the organic matters (COD), the inorganic matters (heavy metals) in leachate during the recirculation. 2. To monitor the gas production rate during the recirculation.

Methodology

Cabo Rojo landfill is a relatively new facility of just three years old. This facility is divided into 20 cells. Each cell is a square entity with an area of 9,000 ft² and a depth of solid wastes of 90 ft. It is sufficient for receiving the city solid wastes for a period of two years. At present, the first cell is completed. In each cell there are two specially constructed gas vents and a manhole with a depth of 90 ft located near the center of the cell. Cabo Rojo landfill is located in a dry area of Puerto Rico. There is about 20 ft of leachate accumulated over the past two years in the bottom of the cell. The following procedures have been used for achieving the project objectives: 1. To install the recirculation facilities and the gas meter at the gas vents. 2. To analyze the leachate sample from the recirculation flow twice a week 3. To monitor the gas production rate on a daily basis.

Principal Findings and Significance

The average gas production during recirculation once a week was 53% higher than before recirculation. The increase of the gas production after the operation of leachate recirculation demonstrates that the use of the landfill as a bioreactor for leachate treatment is possible. The recirculated leachate washes down the organics within the landfill causing an increase in the COD concentration in the leachate. However, it is believed that the COD in the leachate will be reduced as the recirculation continues. This approach is promising as an effective leachate treatment, but more research is required to determine the optimal recirculation flow and the duration needed to achieve the required pollutant reduction for final disposal.

Descriptors

Waste Disposal, Water Quality Control, Wastewater Treatment

Articles in Refereed Scientific Journals

Book Chapters

Dissertations

Gómez, I., 1998. "Recirculation of Leachate Within the Landfill for the Leachate Treatment," MS thesis, Department of Civil Engineering, University of Puerto Rico, Mayagüez Campus, Mayaguez, PR.

Water Resources Research Institute Reports

Tang, Ning-Hsi, 1999, Leachate Treatment By Recirculation Within the Landfill, Puerto Rico Resources Research Institute, University of Puerto Rico, Mayaguez, Puerto Rico, 84 pp.

Conference Proceedings

Other Publications

Basic Project Information

Basic Project Information	
Category	Data
Title	Program Management
Project Number	B-01
Start Date	03/01/1998
End Date	02/28/1999
Research Category	Engineering
Focus Category #1	Management and Planning
Focus Category #2	Management and Planning
Focus Category #3	Management and Planning
Lead Institution	Water Resources Research Institute

Principal Investigators

Principal Investigators			
Name	Title During Project Period	Affiliated Organization	Order
Jorge Rivera-Santos	Associate Professor	University of Puerto Rico	01

Problem and Research Objectives

The objectives of the Puerto Rico Water Resources Research Institute (PRWRRRI) are 1. To conduct, direct and promote research activities oriented toward the solution of local and national water resources and environmental problems 2. To offer training to scientists, engineers and technical personnel, through

research and technology transfer activities. 3. To transfer research results to the water resources and environmental professionals of Puerto Rico and the United States. As part of its mission, during 1998, the Institute's research program focused on the need for good management practices for watersheds in Puerto Rico. Also, the Institute continued to promote research for a better understanding of the water demand needs in the Island and the improvement of modeling techniques in this area. A proposal related to watershed management for the Mayaguez Bay was submitted to the Environmental Protection Agency. This proposal was approved and the first phase of the project was successfully completed. A proposal titled "Technical and Academic Cooperation in Water Resources between the University of Puerto Rico and the Technologic Institute of Santo Domingo in Dominican Republic" was submitted and approved by the ATLANTEA program of the University of Puerto Rico. This proposal promoted the interrelationship between faculty members of the Technologic Institute of Santo Domingo in Dominican Republic and faculty member of the Mayaguez Campus of the University of Puerto Rico. An extended proposal to provide technology transfer and training for the development of Floodway Delineation Maps for Dominican Republic was prepared and is pending of approval. The Institute also sponsored a short course and workshop on river hydraulics offered in June and July 1998 and a seminar on the NPDES regulations. A proposal for the determination and mapping of the land use for the Jobos Bay National Estuary Reserve (JBNER) watershed was submitted to the NOAA's Coastal Zone and Estuary Program through the Department of the Environment and Natural Resources of Puerto Rico. The proposal was approved and the project is undergoing successfully. This proposal was submitted as part of a Memorandum of Understanding (MOU) already signed with JBNER. Conversations with the Executive Director of the Puerto Rico Aqueduct and Sewer Authority (PRASA) lead to the preparation of a MOU for research, consulting, and training services. Unfortunately, PRASA was privatized before the MOU was signed and negotiations had to be started again with the new administration. The Institute has continued its participation in the government's umbrella committee. This committee consists of representatives from all government agencies and offices that are related to water and environment resources in the Island. The committee meets twice, or more, a year and establishes the research and consulting needs for these agencies. Proposals are then submitted by the USGS district office (the sole participant) and evaluated by the committee. Successful proposals are funded and administered by the President of the Environmental Quality Board of Puerto Rico (the equivalent to EPA).

Methodology

To accomplish its objectives, the PRWRRI identifies the most important environmental and water resources research needs in Puerto Rico, encourages scientists and professionals from the higher education institutions of Puerto Rico to write proposals for competitive grants, promotes the participation and support of students in funded projects; and, disseminates research results to all the interested public. Problems related to watershed management, technology transfer and water distribution and demand were given priority during this year. Those research projects developed during this year are described separately in this report.

Principal Findings and Significance

The project Management Plan for the Mayaguez Bay was divided into several phases. Phase one was successfully completed. The priority issues for the watershed were selected and ranked. A literature review of hydrologic and environmental data available for this region is available as a database. Also, several maps were created by using remotely sensed data included in a Geographic Information Systems Phase II of this project is on-going at this time and the stakeholders forum from the watershed will soon be formed. The VIP methodology has proven to be very successful for use in watershed related problems. The project on technical and academic cooperation in Water Resources with the Technologic

Institute of Santo Domingo in Dominican Republic (INTEC in Spanish) brought three professors in the area of water resources from INTEC to visit the Mayaguez Campus of the University of Puerto Rico during March 1999. During their visit, these colleagues presented conferences on the effects of hurricane Georges in the Dominican Republic, which hit this Island very badly in September 1998. They also visited different research and teaching facilities at the Mayaguez Campus and met with several researchers and authorities of the University. New ideas and contacts were products of this visit.

Descriptors

Project Management Watershed Management

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	Comprehensive Integrated Management Plan for the Mayaguez Bay Watershed
Project Number	S-01
Start Date	06/01/1998
End Date	02/28/1999
Research Category	Engineering
Focus Category #1	Management and Planning
Focus Category #2	Conservation
Focus Category #3	Education
Lead Institution	Water Resources Research Institute

Principal Investigators

Principal Investigators			
Name	Title During Project Period	Affiliated Organization	Order
Jorge Rivera-Santos	Associate Professor	University of Puerto Rico	01
Jorge I Velez-Arocho	Professor	University of Puerto Rico	02
Walter F Silva-Araya	Associate Professor	University of Puerto Rico	03
Jose Norat	Professor	University of Puerto Rico	04
Felix Aponte	Professor	University of Puerto Rico	05

Problem and Research Objectives

The Río Grande de Añasco watershed, located in the western coast of Puerto Rico, represents a valuable natural resource for the region, offering a diversity of uses to the inhabitants and the surrounding areas. The River discharges into the north part of the Mayaguez Bay. The increasing urban development and poor agricultural practices are affecting the intrinsic value of the natural resources of the watershed. In addition to the urban waste products and agricultural chemical products, the basin is also vulnerable to pollution deriving from chemical industries and wastewater treatment plant discharges. Also, the dismantling of land for development and the lack of management of agricultural practices promote excessive erosion that contributes to an increase the sediment load into the rivers and the Mayaguez Bay. Being the region traditionally agricultural, recent city and community expansions and the development of infrastructure, have deteriorated the quality and quantity of natural resources in the Añasco watershed, particularly in the lower parts of the basin. These changes have a direct impact in the estuarine resources and the Bay of Mayagüez. The increasing pollution in the watershed and its effects on the Bay have been of concern for many local, state, and federal government agencies, as well as for private groups and citizens. Several efforts to research and control the pollution have been attempted by various entities; however, the effects on the solution of the problem is not significant. The lack of integration and coordination of efforts among the interested parties is a major cause of the limited impact of these initiatives. The objective of this proposal is to develop a comprehensive integrated management plan for the Mayaguez Bay watershed that permits the restoration, conservation and protection of the quantity and quality of its natural resources, and that establishes a balance within the system uses and its ecological integrity. This project will lead to improved quality of life for all the inhabitants within the Bay and the watershed, as well as, the surrounding areas. The establishment of the Management Plan will allow the best utilization of the resources, ensuring the integrity of the ecosystem. Integration and communication between the different stakeholders will be greatly promoted.

Methodology

The project was divided into several phases and funding was requested to the EPA for Phase I and Phase II as described next: Phase I. Investigation of previous works and existing information This part of the project consist of a search and evaluation of literature related to the natural resources of the Río Grande de Añasco Watershed, as well as, the acquisition and presentation of existing remotely sensed and Geographic Information Systems data. Phase II. Organization of the Stakeholder Forum The Vital Issues Process (VIP) methodology was used to organize the stakeholders of the watershed. This strategic planning tool identifies a group of programmatic activities for an organization, aimed at satisfying high-level goals and objectives. The methodology is implemented by a series of one-day long intensive workshops with active participation of the private sector, stakeholder communities, state and federal government and academy.

Principal Findings and Significance

Phase I of this project was successfully completed. The priority issues for the watershed were selected and ranked. A literature review of hydrologic and environmental data available for this region is available as a database. Also, several maps were created by using remotely sensed data included in a Geographic Information Systems Phase II of this project is on-going at this time and the stakeholders forum from the watershed will soon be formed. The VIP methodology has proven to be very successful for use in watershed related problems.

Descriptors

Watershed Management Plan for the Mayaguez Bay

Articles in Refereed Scientific Journals

Book Chapters

Dissertations

Water Resources Research Institute Reports

Rivera-Santos, Jorge, 1999 "Comprehensive Integrated Management Plan for the Mayaguez Bay Watershed", Puerto Rico Water Resources Research Institute, University of Puerto Rico, Mayaguez, Puerto Rico.

Conference Proceedings

Other Publications

Basic Project Information

Basic Project Information	
Category	Data
Title	Technical and Academic Cooperation in Water Resources between the UPR and the INTEC (Dominican Republic)
Project Number	S-02
Start Date	07/01/1998
End Date	12/01/1999
Research Category	Engineering
Focus Category #1	Education
Focus Category #2	Floods
Focus Category	

#3	Hydrology
Lead Institution	Water Resources Research Institute

Principal Investigators

Principal Investigators			
Name	Title During Project Period	Affiliated Organization	Order
Walter F Silva-Araya	Associate Professor	University of Puerto Rico	01

Problem and Research Objectives

Problems related to management and control of water resources are common to all the Caribbean Islands. Cyclonic waves are usually associated with large amounts of rainfall, producing flash floods in urban areas. These periodic events cause significant economic losses and, in many cases, the death of human lives. The objective of this project is to promote the interchange of information and technology transfer between researchers and engineers from the University of Puerto Rico and the Technologic Institute of Santo Domingo (INTEC in Spanish). This interaction started by bringing three professors in the area of water resources from INTEC to visit the Mayaguez Campus of the University of Puerto Rico during March 1999. During their visit, these colleagues presented conferences on the effects of hurricane Georges in the Dominican Republic, which hit this Island very badly in September 1998. They also visited different research and teaching facilities at the Mayaguez Campus and met with several researchers and authorities of the University. New ideas and contacts were products of this visit. Four faculty members from the University of Puerto Rico will visit the Dominican Republic in September 1999 to interact with professors, engineers and students from this Island. They also will take the opportunity to offer short courses in hydrology, hydraulics and geographic information systems supported partially by the funds of this project. This project will serve as a model to develop similar interaction with other Caribbean countries.

Methodology

This project promoted the technology transfer and interaction among faculty members of the University of Puerto Rico at Mayaguez (UPRM) and the Technologic Institute of Santo Domingo (INTEC). It also pretended to interact with professional of water related disciplines in both islands. To achieve this purposes the following activities were programmed: 1) Four faculties from the UPRM visited the Dominican Republic to get acquainted with project related to the water resources management and to offer short courses in hydrology and hydraulics related to the construction of flood prone zones maps. The courses offered were Statistical Methods in Hydrology, Hydrologic Modeling using HEC-HMS, River Hydraulics Analysis using HEC-RAS and GIS Applied to Flood Delineation Mapping. 2) Three faculty members from INTEC visited UPRM to get acquainted with the research projects, education and other related projects in Puerto Rico. They also offered several conferences in which flood related problems in the Dominican Republic were presented.

Principal Findings and Significance

This project is serving as a model to develop similar interactions with other Caribbean countries. The courses offered in Dominican Republic created new interest in flood control management; however, the attendance from the government agencies related to flood control and management problems was not

sufficient. New attempts ideas for continuation in this effort were developed during the interaction with professionals and faculty members from both countries.

Descriptors

Technology Transfer

Articles in Refereed Scientific Journals

Book Chapters

Dissertations

Water Resources Research Institute Reports

Conference Proceedings

Other Publications

Information Transfer Program

Basic Project Information

Basic Project Information	
Category	Data
Title	Third International Symposium on Tropical Hydrology and Fifth Caribbean Islands Water Resources Congress
Description	International Symposium and Conference
Start Date	07/01/1997
End Date	07/01/1998
Type	Conferences
Lead Institution	Water Resources Research Institute

Principal Investigators

Principal Investigators			
Name	Title During Project Period	Affiliated Organization	Order
Jorge Rivera-Santos	Associate Professor	University of Puerto Rico	01

Problem and Research Objectives

The tropics are the most hydrologically active regions of the world - the regions were the great

rainforests are located. The moisture and heat circulation cycles of the tropics affect weather patterns on a global scale. Research in tropical hydrology is making evident the tremendous importance of this field to understand the roll of the hydrologic cycle in weather systems, ecosystem dynamics, and ecological effects of human activity. The objective of the Conference was to bring together water related professionals to share data and research findings in areas related to tropical hydrology and water resources.

Methodology

The wide range of topics covered by the Conference are representative of the breadth of disciplines that has found application in the field of tropical hydrology. The fields of water supply and distribution, climatic changes, water resources planning, water quality, ecosystem studies, and water resources education were aptly represented by several symposium paper reflecting the diversity of current research efforts in the field of tropical hydrology. The papers were grouped into specific sessions according to the topics requested in a call for abstract. First draft of papers were peer reviewed and returned to authors for preparation of final manuscripts. These are the papers presented in the proceedings.

Principal Findings and Significance

Thirty six papers were selected for presentation during the Conference. The activity was attended by approximately 90 participants from all over the world. The proceedings are useful for students, practitioners and researchers alike due to the diverse number of contributors to the publication. Contributions from universities, research institutes, government agencies, and consulting firms are indicative of the widespread involvement of a gamut of organizations in the field of tropical hydrology.

Articles in Refereed Scientific Journals

Book Chapters

Dissertations

Water Resources Research Institute Reports

Conference Proceedings

Segarra-Garcia, Rafael I., 1998. Tropical Hydrology and Caribbean Water Resources. Proceedings of the Third International Symposium on Tropical Hydrology and Fifth Caribbean Islands Water Resources Congress, AWRA, Herndon, VA, TPS-98-2, 233 pp.

Other Publications

Basic Project Information

Basic Project Information	
Category	Data
Title	1999 Summer Professional Development Center
Description	Continuing Education Short Courses and Workshops
Start Date	06/01/1999
End Date	06/30/1999
Type	Conferences
Lead Institution	Water Resources Research Institute

Principal Investigators

Principal Investigators			
Name	Title During Project Period	Affiliated Organization	Order
Walter F Silva-Araya	Associate Professor	University of Puerto Rico	01
Jorge Rivera-Santos	Associate Professor	University of Puerto Rico	02

Problem and Research Objectives

The Puerto Rico Water Resources Research Center established the Professional Development Center with to objective of organizing and offering short courses, seminars and workshops in the water resources and environmental engineering fields.

Methodology

Two short courses and workshops were offered during summer 1999. The courses were titled Hydrologic Modeling Using HMS and River Hydraulics and Hydraulic Modeling Using HEC-RAS. Hand-on experience was given in the use of the computer programs by given a personal computer to each participant. The courses lasted three days each and 2.0 Continuing Education Units were granted to the participants. Co-sponsors of this project were the College of Engineers and Land Surveyors of Puerto Rico and the General Engineering Department of the University of Puerto Rico.

Principal Findings and Significance

The courses provided a comprehensive introduction to the theory and practice of the river hydraulics and hydrology using well-known computer models.

Articles in Refereed Scientific Journals

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	N/A	2	N/A	N/A	2
Masters	5	1	N/A	2	8
Ph.D.	N/A	N/A	N/A	N/A	N/A
Post-Doc.	N/A	N/A	N/A	N/A	N/A
Total	5	3	N/A	2	10

Awards & Achievements

Third International Symposium on Tropical Hydrology and Fifth Caribbean Islands Water Resources Congress brought together distinguished researchers water related disciplines from many countries as far as China and Guam. The participants shared ideas and results in a friendly professional environment. The web site developed for the watershed management project (<http://www.ece.edu/cohemis/vip>) has attracted international inquiries about the methodology used. Countries such as Costa Rica and El Salvador invited the PI's to offer a conference about the project and to discuss possible collaboration for similar research activities in their countries. The Institute's Director was invited to participate as a member of the Steering Committee of the United Nations project "Reducing Pesticides Discharges to the Caribbean".

Publications from Prior Projects

Articles in Refereed Scientific Journals

Book Chapters

Dissertations

Water Resources Research Institute Reports

Conference Proceedings

Other Publications

