INSTITUTO INTERAMERICANO DE COOPERACIÓN PARA LA AGRICULTURA (IICA) – ACT/ REPÚBLICA DOMINICANA
DEPARTAMENTO DE AGRICULTURA DE LOS ESTADOS UNIDOS (USDA)
SERVICIO DE CONSERVACIÓN DE RECURSOS NATURALES (NRCS)
en cooperación con
SECRETARÍA DE ESTADO DE AGRICULTURA (SEA)
INSTITUTO NACIONAL DE RECURSOS HIDRÁULICOS (INDRHI)

EVALUACIÓN DE LOS IMPACTOS DEL HURACÁN GEORGE'S SOBRE EL AGUA Y EL SUELO EN LA REPÚBLICA DOMINICANA

Informe de viaje del 2 al 10 de Diciembre de 1998

Santo Domingo, Abril de 1999

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PROLOGO

Este informe resulta de la visita de evaluación de los efectos sobre el agua y el suelo del huracán Georges que pasó por la República Dominicana en Setiembre de 1998. A pedido del Representante del IICA en la República Dominicana, Rafael J. Marte, en virtud del Convenio IICA/USDA de 1994, se conformó un equipo compuesto de dos técnicos del Servicio de Conservación de Recursos Naturales del Departamento de Agricultura de los Estados Unidos (USDA/NRCS): Gary Domian, Conservacionista Asistente del Estado de New Hampshire, y Manuel Rosales, Conservacionista del Estado de Colorado. La coordinación fue realizada por Manuel Paulet Especialista Regional del IICA en Suelo y Agua con sede en Costa Rica y Otto Gonzalez del Servicio Agrícola para el Exterior del USDA. En la República Dominicana, la coordinación la realizó Raúl Pineda, Especialista en Comunicación del IICA. Al equipo se sumaron, además de Manuel Paulet, tres técnicos de los organismos cooperantes en el país: Héctor Melo, de la División de Manejo de Cuencas del Instituto Nacional de Recursos Hidráulicos (INDRHI); Teófilo Payano y Máximo Portoreal del Departamento de Inventario de Recursos Naturales (DIRENA) de la Sub-Secretaría de Recursos Naturales de la Secretaría de Estado de Agricultura (SURENA/SEA). Se contó con la más amplia colaboración de las autoridades del INDRHI y de la SEA, así como con el apoyo e informaciones brindadas por el BID y el AID, a través de Sergio Mora y Carleen Yocum, respectivamente.

Se incluyen con este prólogo dos ilustraciones obtenidas del Departamento de Meteorología de la SEA/RD sobre la incidencia del George's y otros huracanes en el país.

Santo Domingo, Abril de 1999

Gráfico 1

TRAYECTORIA DE ALGUNOS DE LOS PRINCIPALES HURACANES QUE HAN AFECTADO A LA REPUBLICA DOMINICANA

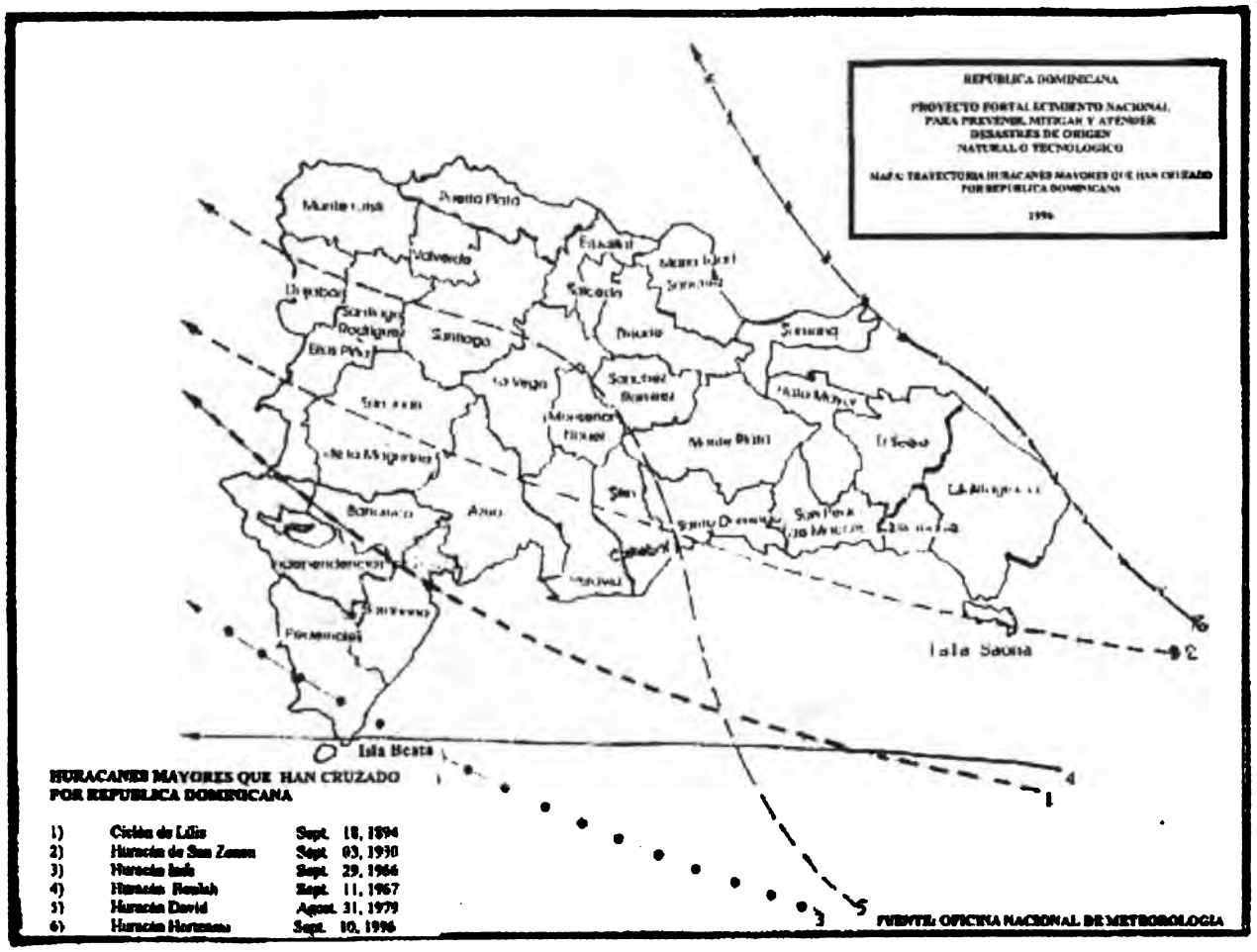
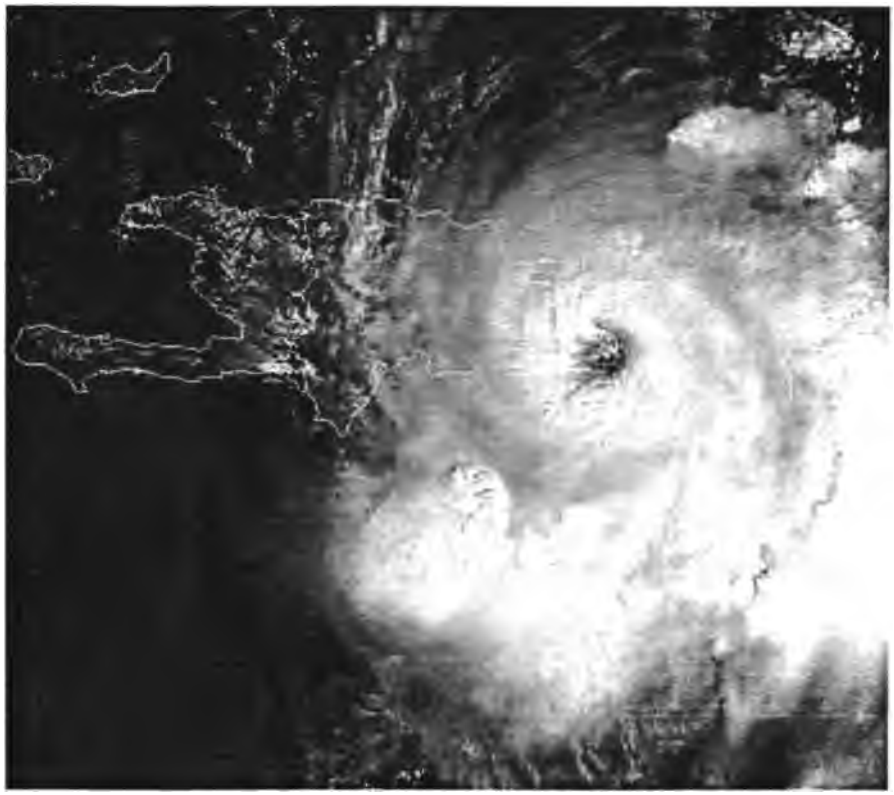


Gráfico 3
HURACÁN GEORGES AL TOCAR TERRITORIO DE LA REPÚBLICA DOMINICANA



Fuente: Imagen satelital del NWS, proporcionada por el Centro De Operaciones Conjuntas de las Fuerzas Armadas y Policía Nacional de la República Dominicana (C.O.C.)

CONTENIDO

TRIP REPORT

UNITED STATES DEPARTMENT OF AGRICULTURE (USDA)

NATURAL RESOURCES CONSERVATION SERVICE (NRCS)
(formerly the Soil Conservation Service-SCS)

SHORT TERM TECHNICAL ASSISTANCE

DECEMBER 2-10, 1998

PREPARED FOR THE

INTERAMERICAN INSTITUTE FOR COOPERATION ON AGRICULTURE (IICA)

RELATIVE TO THE ASSESSMENT OF DAMAGE CAUSED BY HURRICANE GEORGES SEPTEMBER 22-23, 1998

IN THE COUNTRY OF THE DOMINICAN REPUBLIC

Mano Matuey, a rural village in the mountainous area of San Cristobal Province, suffered major damage. There was loss of life, homes, a school and significant damage to abutments supporting an already deteriorated bridge. Bridges such as this one occupy the only route in and out of the village.

USDA United States Department of Agriculture
Natural Resources Conservation Service (NRCS)
http://www.nrcs.usda.gov

March 26, 1999

Dr. Rafael J. Marte
Inter-American Institute for Cooperation on Agriculture (IICA)
Dominican Republic Office
Apartado Postal No. 711
Santo Domingo, Dominican Republic

Dear Dr. Marte,

Please find attached to this letter a copy of the report *Technical Assistance Short Term Assignment to IICA in the Dominican Republic by the USDA Natural Resources Conservation Service (NRCS) Technical Assistance Team Relative to the Assessment of Damage Caused by Hurricane Georges on September 22-23, 1998.* Manuel Rosales, Conservation Agronomist and Gary Domian, Assistant State Conservationist represented the NRCS Technical Assistance Team, from December 2-10, 1998.

We want to thank you and Dr. Manuel Paulet Iturri, and all the members of the IICA staff in the Santo Domingo office who helped make our visit a success. The coordination with INDRHI, the Dominican Republic Department of Agriculture and the Banco Interamericano de Desarrollo was critical to being able to meet the terms of reference.

The report meets the terms of reference prepared by the IICA . The terms of reference directed the NRCS Technical Assistance Team to:

- Produce a report about the impacts of Hurricane Georges on soil erosion and sedimentation and damage to water resources in the Dominican republic
- Make reference to the major impacts on the irrigation and other infrastructure caused by flooding and excess runoff
- Make quantitative observations about the damage and explain the cause of the damage
- Use existing resource information available
- Spend 4-5 days on field reconnaissance
- Spend 3 days to write a report and present it to local authorities
- Include in the report recommendations for further analysis as more data and better tools become available.

In addition to the report, the NRCS Technical Assistance Team prepared a proposal for a project that would help to improve and advance the technology currently used in watershed management in the Dominican Republic. The *Proposal for an Integrated Approach to Natural Resources Conservation on a Watershed Basis*, has as the main goal to increase farm production and income of residents living in rural communities, while minimizing soil deterioration by erosion on agricultural land in the Dominican Republic. A number of project components are proposed and project management recommendations are also proposed.

Documentation of the field observations made by the NRCS Technical Assistance Team and closing comments made on December 9, 1998 are attached to the report.

We do apologize for any inconvenience caused to you and IICA due to the delay in getting this report to you. We would gladly respond to any concerns, questions or comments that you may have about the report. Please do not hesitate to contact either of us.

Thank you for your support and interest in conserving the natural resources of the Dominican Republic.

Sincerely,

Manuel Rosales
Conservation Agronomist
Soil Quality Team
USDA-NRCS
Central Great Plains Research Station
40335 Co. Rd. GG
Akron, CO 80720

Gary S. Domian
Assistant State Conservationist
USDA-NRCS
2 Madbury Road
Durham, NH 03824

Cc: Dr. Jerome Hammond, USDA/NRCS International Division, Washington, DC
Otto Gonzales, Program Specialist, USDA/FAS/ICD/DRD/NRE, Washington, DC
Alan Price, Acting State soil Scientist, USDA/NRCS, CO
Dawn W. Genes, State Conservationist, USDA/NRCS, NH
Dr. Manuel Paulet Iturri, IICA Sede Central/Area II, San Jose, Costa Rica
Kevin N. Smith, Agricultural Attache, USDA-FAS, Santo Domingo, DR
Sergio Mora C., Banco Interamericano de Desarrollo, Santo Domingo, DR
Hector Melo Abreu, Instituto Nacional de Recursos Hidraulicos, Santo Domingo, DR
Frank T. Rodriquez, Executive Director, INDRHI, Santo Domingo, DR
Teofilo Payano and Maximo Portorreal, DR Department of Agriculture, Santo Domingo, DR
Carleen Yokum, USFS c/o USAID, DR

CONTENTS

Appendix

EXECUTIVE SUMMARY of KEY TECHNICAL RECOMMENDATIONS THAT CAN BE ACCOMPLISHED THROUGH THE USE OF NRCS TECHNICAL ASSISTANCE

Public Works

- Remove obstructions and debris from channels immediately where the threat to loss of life and property continues.
- Remove uprooted trees and other rafted material from flood plain immediately.
- Stabilize steep slopes by using a combination of gabions, riprap and bioengineering techniques. Standards need to be developed.
- Weathered rock in road cuts tends to slide when wet. These formations need to be cut back and covered by steel nets or grouted to keep fragments off of the roadbed.
- Review bridge designs for proper footings, aprons and pylons and concrete strength
- Continue to inspect principal spillways and secondary spillways on all flood control and water supply reservoirs, especially before and after each major storm. Inspections must be documented.
- Support the recommendations of the Regional Environmental Advisor, USAID, and USFS/IITF.

Health and Safety

- Pesticide container disposal stations are recommended for disposal of containers and plastic bags.
- Pesticide mixing stations are recommended as an additional water quality measure.
- Institute a national program of bridge safety inspection.
- Conduct flood hazard analyses in the areas most prone to frequent flooding and where loss of life was heaviest during Hurricane Georges.

Technical Recommendations – Develop Standards and Specifications

- Develop standards and specifications for road drainage ditches. Include maintenance as part of those standards. Include vegetative standards that take into account agro-ecological zones.
- Develop standards and specifications in order to plan, design and install spring developments in rural areas.
- Develop standards and specifications for cut back slopes and bench terraced slopes that are used for borrow material.
- Develop standards and specifications in order to promote the use of bioengineering techniques to stabilize soil.
- Develop standards and specifications for drop structures used along roads and in agricultural areas
- Develop standards and specifications for conservation practices that add organic matter to soils and maintain soil health in order to sustain productivity.

- Support the recommendations of the Regional Environmental Advisor, USAID, USFS/IITF.
- Develop a standard or adopt a system of stream and river classification in order to better understand and predict the behavior or streams and channels during and after storm events.

Training Needs

- Provide training to road designers and road builders about the proper design, construction and inspection of roads. Special emphasis will be placed on secondary roads and rural access roads.
- Provide training in the design of drainage systems that require culverts and other structures under roads.
- Provide training and certify inspectors that inspect the installation of structures such as dikes, dams and culverts where the failure of those structures could lead to the loss of life.
- Train natural resource planners in the use of surficial geology and bedrock geology maps and information. This information can provide indicators where certain types of erosion and mass wasting may occur.
- Provide comprehensive training to soil conservationists. Rill and gully erosion on cropland indicates a need for conservation planning and application of erosion control practices.
- Training in the use of ecosystem identification and assessment needs to be considered, especially as it relates to being able to determine the impact of hurricane damage on ecosystems.

Program Recommendations

- A National Watershed Survey and Planning Program is recommended. This program would be designed to protect watersheds from damage caused by erosion, floodwater, and sediment. This program would also contribute to the conservation and development of soil, water and land resources.
- A River Basin Survey Program is recommended. This program would provide surveys and studies, flood hazard analysis, and flood plain management assistance.
- A national Irrigation and Water Conservation Planning Program needs to set standards for irrigation efficiency in the Dominican Republic.
- A National Soil Survey is recommended as a primary way of providing consistent and reliable soil resource information.
- A National Plant Materials Program and the establishment of Conservation Plant Materials Centers are recommended.
- A national initiative is recommended to set in place Soil Bioengineering as a technical discipline.
- The implementation of automated flood warning systems is recommended.
- A national program, Emergency Preparedness Education Program, is recommended.

TECHNICAL ASSISTANCE SHORT TERM ASSIGNMENT

TO

IICA IN THE DOMINICAN REPUBLIC

BY THE USDA NATURAL RESOURCES CONSERVATION SERVICE (NRCS)

TECHNICAL ASSISTANCE TEAM (TAT)

DECEMBER 2-10, 1998

This bridge in Tireo Arriba, collapsed into the river as a result of storm damage. Debris removal began ***immediately in order to prevent further obstruction and a continued threat to loss of life and property. This is considered an exigency or urgent action.***

Terms of Reference

The **Terms of Reference** prepared by IICA directed the NRCS Technical Assistance Team to:

- produce a report about the impacts of Hurricane Georges on soil erosion and sedimentation and damage to water resources in the Dominican Republic
- make reference to the major impacts on the irrigation and other infrastructure caused by flooding and excess runoff
- make quantitative observations about the damage and explain the cause of the damage

- use existing resource information made available in the Dominican Republic
- spend 4-5 days on field reconnaissance
- spend 3 days to write a report and present it to local authorities
- include in the report recommendations for further analysis as more data and better tools become available.

Hurricane Georges

Hurricane Georges made landfall on the east coast of the Dominican Republic September 22, 1998. The hurricane moved northwesterly and westerly across the Dominican Republic with intensity rated as II-III on the Saffir-Simpson scale. One estimate placed wind speeds between 180 km/h (115mph) and 200 km/h (130mph). The hurricane moved slowly and took 12 hours from where it made landfall on the east coast until it moved northwesterly out of the Dominican Republic. Approximately seventy per cent of the country was affected by the hurricane including areas along the outer edges of the hurricane. Puerto Plata, a province on the northwest coast of the Dominican Republic, suffered hurricane damage in the southwestern part of the province. Urban sectors were severely damaged and much of the country's agricultural land was damaged or destroyed by the hurricane. Extensive damage had been observed from San Pedro de Macoris to Santo Domingo.

Early assessments noted impacts on agriculture, housing and infrastructure. 54% of perennial crops were damaged or destroyed and 40% of annual crops were damaged or destroyed. It was estimated that 55% of homes, 43% of roads, 35% bridges, and 41% of the tourism infrastructure was damaged or destroyed.

About the Dominican Republic

The Dominican Republic occupies the eastern two-thirds of Hispaniola, an island in the northern Caribbean. The climate is dominantly subtropical and varies from extreme dryness in the valleys and coastal zones in the southwestern part, to the very humid slopes and lowlands in the Northeast. There are two well-defined rain seasons, the more intense one between April and June and the other, moderate, between September and November. Average annual rainfall is approximately 37.5 inches (952.5 mm).

The Dominican Republic has a total land area of 48,670 square Km (18,792 square miles), about twice as large as the state of New Hampshire, US. There are four parallel mountain ranges, which extend along the territory in a northwesterly direction, the most important of which is the Central Range. Pico Duarte at 10,417 feet above sea level, is the highest point in the Caribbean. Approximately 75% of the land is mountainous with steep to very steeply sloping landforms. 14% of that land lies at an elevation at 500 meters or more.

important and produced the basic food, although in lesser proportion than the larger farms. Crop production occupied most of the arable area, followed by livestock (non-poultry) operations especially on farms in the 50-100 hectare range.

Environmental problems in the Dominican Republic are associated with the adverse consequences of wide scale removal of topsoil, toxic by-products, and land degradation from mineral extraction activity, water pollution, land use, coastal zone management and natural hazards. Between 1990-1995, at least 5 hurricanes and severe tropical systems at an estimated recovery cost of US$16 million affected the Dominican Republic.

Field Observations

Field observations covered a wide geographic area and a complex system of hydrology and geologic landforms. For example, there are 14 major coastal watersheds and 36 sub-coastal watersheds in the Dominican Republic. These watersheds range in size from 68 square km to over 7,040 square km. Therefore, there is no simple solution or recommendation for the prevention of the type of damage caused by Hurricane Georges that will fit all watersheds. Even under the best of watershed management scenarios, the destruction caused by Hurricane Georges can happen again. From 1971 to 1998, 51 hurricanes and tropical storms caused damage to the Dominican Republic.

Field visits were conducted December 4-5 and 7-8, 1998. The team visited over 30 towns and villages in 8 provinces. Observations were made in 18 subwatersheds and 5 major watersheds. The field visits began in Santo Domingo and covered the south central portion of the country as far north as Monsenor Nouel Province and ended in the western part of the country in San Juan Province. These areas had the highest death rates due to Hurricane Georges and the highest amount of persons displaced as a result of the hurricane.

What can be influenced is the magnitude and frequency of damage, which can be decreased through watershed management techniques including soil and water conservation intervention. Certainly, government watershed management policies can be used to reduce the loss of life and property along areas that have a history of flooding. Automated flood warning systems and local emergency response groups are one example where government intervention can provide a benefit over a relatively short time at a low cost.

The field observations are recorded in a table titled *Recorded Field Observations by the Hurricane Georges IICA/NRCS/DR Technical Assistance Team.* The NRCS field team followed basic criterion for determining the extent of watershed impairment. The criterion follows.

Criterion for Determining Extent of Watershed Impairment

Objective

To provide technical assistance in order to relieve imminent hazards to life and property from floods and the products of erosion created by natural disasters. The hazards are caused by a sudden impairment to the watershed. The imminent threat to loss of life or property must significantly exceed that which existed before the impairment.

Manuel Rosales, NRCS Agronomist (l) and a villager document the height of floodwaters. ***This village, Tamayo, is in Baoruco Province. Tamayo suffered considerable flood damage with the height of floodwaters reaching 2 meters or more. Sediment accumulations of nearly 1 meter were recorded. Businesses lost inventory and buildings collapsed as a result of flooding. Loss of life was light compared to other areas of the country.***

Scope

Emergency watershed protection consists of emergency measures to reduce hazards to life and property from floods, drought, and the products of excessive erosion.

Exigency Situations (Urgent)

An exigency exists when there is an immediate threat of damage to life or property. An exigency exists as long as the probability of damage continues at such a high level.

Non-exigency Situations (Not urgent but must be addressed)

A non-exigency situation occurs when the near-term probability of damage to life or property is high enough to constitute a continued hazard, but not an immediate threat to

life or property. A non-exigency exists as long as the probability of damage remains high enough to be considered an emergency.

Eligibility for Technical Assistance and Emergency Funding

The Government of the Dominican Republic will set eligibility criteria. International donors or sponsors may also have eligibility criteria for use of funds. In general, assistance could be made available to the private and public sector and to others who have a legal interest in or a responsibility for the values threatened by a watershed emergency. A sponsor should have the legal authority to obtain real property rights, water rights, and permits, if needed.

A sponsor will also have to provide for the operation and maintenance of completed measures.

Eligible Measures for Emergency Conservation Assistance

A measure or practice must retard runoff to prevent flooding or prevent erosion, reduce threats to life or property (permanent improvements) resulting from a watershed emergency. More than one individual should benefit from the emergency work unless an exigency situation exists where only one person benefits. These situations need to be reviewed and approved in advance.

All measures must be economically and environmentally defensible and technically sound. Measures used must be cost effective and provide immediate, adequate, and safe relief from the hazard causing the emergency.

The Need for Developing Conservation Practice Standards and Specifications

The eligible measures mentioned above are also referred to as conservation practices. These conservation practices can be structural measures, vegetative measures, or a management activity used to protect, enhance, or manage soil, water, air, plant, animal and human resources.

A *Conservation Practice Standard* is a set of statements that defines the practice or measure. It also identifies the purposes and applicability of the practice; established criteria to support each purpose; lists special considerations useful in planning, designing, and constructing the practice; and establishes installation and operation and maintenance requirements.

A *Conservation Practice Specification* contains site-specific documents that establish the technical details and workmanship required installing the practice in accordance with the requirements of the practice standard.

Channel Morphology and Assessing the Damage Along Rivers and Floodplains

Field observations were made quickly without the benefit of in-country technical information and surveys. Conclusions were based on what a technician or specialist saw in the field and evaluated on experience and discussion with others on the team. Regardless, there are points that need to be considered in future reviews and assessments of rivers, floodplains and watersheds.

The following questions need to be asked and answered when assessing damage reaches along a river:

- What caused the problem?
- How did the river respond?
- What were the consequences of the river's response?
- What is the remedy to the problem?
- How can the problem be prevented from recurring?
- How can mitigation be applied?

Obviously, a multidisciplinary approach to solving watershed problems is a necessary part of deriving suitable answers to these questions.

In order to begin a dialogue about the questions above, a more thorough knowledge of river morphology, as well as design and engineering principles, is recommended. Changes in a watershed can significantly alter stream flow magnitude and timing and therefore lead to the change in channel characteristics and stability indices. Various models have been developed that emphasize the importance of recognizing inherent differences between river types and the diversity of river response to a variety of land use activities.

Many of the measurements, such as stream dimensions, patterns, and bed features associated with the longitudinal river profile are generally described as a function of channel width measured at the *bankfull stage*. Determining bankfull stage requires field training and experience but it is still important to introduce this concept in order to understand river morphology. The bankfull stage corresponds to the discharge at which channel maintenance is the most effective. In other words, at this stage or elevation of river bank, the discharge in the channel is moving sediment, forming or removing sediment bars, forming or changing bends and meanders, and generally doing the work that results in the development of the average morphological characteristics of the channel. River channels, like other natural systems, have a balance and when certain elements go out of balance, the river responds accordingly. For example, Lane (1955) showed a proportional relationship between sediment discharge, stream discharge, particle size and slope to a stable channel balance.

Catastrophic flooding as caused by Hurricane Georges makes it difficult to estimate where the active floodplain is. After storm events such as Hurricane Georges, flooding is often seen on abandoned flood plains or low terrace features. Knowing where the active flood plains are is important to developing watershed-planning strategies. This is not to

say that low terrace or abandoned floodplains do not need to be addressed, rather it points out a need to plan these areas for floods of larger magnitude. Flooding at bankfull stage happens at a greater frequency and on floodplains lower in elevation than abandoned floodplains or low terrace features.

Many of the river channels and tributaries were altered as a result of the hurricane. The width and depth of the channels were affected. Stream width is a function of:

- stream flow occurrence and magnitude
- size and type of transported sediment; and
- the bed and bank materials of the channel.

In the case with Hurricane Georges, changes in channel width were influenced by previous channel disturbances, such as channeling and changes in the riparian vegetation that may have altered the boundary resistance and susceptibility of erosion. Other changes in stream flow regimes due to changes in the watershed; and finally changes in the sediment budget are also important.

Channel depth is more difficult to predict and understand because there are variables in each stretch of the river. Channel depth varies greatly by reaches due to the sequence of riffle and pool bed features. The present flow and sediment regime as well as morphology, basin relief, and nature of the bed and bank material influence river morphology. These variables account for why the intensity of flood damage varied with different geologic, soil, topographic and land-use patterns.

Hurricane damage also changed the pattern or shape of some rivers. This is important especially if rivers have been classified in qualitative terms such as straight, meandering

or braided. It wasn't determined if the Dominican Republic classified rivers qualitatively. The objective of a stream classification system is to:

- Predict a rivers behavior from its appearance
- Develop specific hydraulic and sediment relations for a given stream type and it's condition
- Provide a mechanism to extrapolate site specific data to stream reaches having similar characteristics, and
- Provide a consistent frame of reference for communicating stream morphology and condition among a variety of disciplines and interested parties.

Straightening river channels is not always the solution. Ultimately, straightening leads to a state of instability. Straightening river channels often causes river entrenchment and corresponding changes in morphology and stability. Channel alteration will be required in many of the major tributaries observed in the field. Channel alterations can increase channel capacity, increase sediment transport capacity, prevent floodwater encroachment on flood plains, and increase flow depths. Regardless, proper engineering and studying the hydrology of the watershed and hydraulics of the river is necessary.

Stream bank erosion was serious on nearly all rivers and tributaries observed. Understanding basic concepts of planning can lead to the application of measures that lead to the ability of a stream bank to resist erosion. Planning has to consider and examine

- the ratio of stream bank height to bank full stage
- the ratio between the riparian vegetation rooting depth to stream bank height
- degree of rooting density
- composition of stream bank material
- stream bank angle
- stream bank material stratigraphy and presence of soil lenses; and
- stream bank surface protection afforded by debris and vegetation.

The slope of the river channel, width, volume of water and the nature of the bed and bank material differed ***at each location.. Common to nearly all sites was the large volume of material deposited in the channel. In addition, large volumes of floating debris rafted during high flow and became lodged against bridge abutments and pylons. This created additional force against abutments and pylons. In some cases the rafted material completely blocked flow under bridges and culverts and caused failure of these structures.***

Applying Soil Bioengineering Techniques

The USDA-NRCS technical assistance team observed numerous instances in which soil bioengineering techniques can be used for restoration and protection of roadside banks and stream banks. See recorded field observations in the appendix for examples of damage.

Soil Bioengineering is an approach, which uses living plants, often combined with structural materials, by embedding live, dormant, and/or dead plant materials into soil. Combined with engineering design and geomorphic principles, soil bioengineering can serve as a valuable tool in natural resource conservation. A few examples of soil bioengineering techniques are: Vegetated rock gabions, live cribwalls, vegetated rock walls, live staking, live fascines, brush layers, branchpacking and live gully repair.

Soil bioengineering techniques are appropriate for immediate protection of slopes against surface erosion, shallow mass flow wasting, cut and fill slope stabilization, earth embankment protection, and gully repair treatment. Other areas where soil bioengineering has been effectively applied include: reservoir draw down areas where plants can be submerged for extended periods; areas with highly toxic soils; dune stabilization; wetland buffers; and stabilizing shorelines and streambanks.

Availability of Plant Materials and Conservation Plant Materials Centers

Field observations indicated that conservation plant materials are used in certain locations but not in all locations where plant materials would be helpful. A national program of plant materials would help the Government of the Dominican Republic to provide native plants that can help solve natural resource problems. Plant materials have a soil conservation use as well as a use for biomass production, carbon sequestration, erosion reduction, wetland restoration, water quality improvement, streambank and riparian area protection and other special conservation treatment needs.

A national Plant Materials program would have several Plant Materials Centers in strategic locations in the Dominican Republic. The centers would seek out plants and test their performance. If the plant is proven, it is released nationally for conservation use.

Estimating Runoff

An estimate of runoff from each location was not made. The Dominican Republic uses certain parameters for estimating runoff and has a series of weather stations around the country to collect data. Some of the automatic weather stations were damaged by the hurricane and therefore some rainfall and runoff rates were not conclusive.
NRCS utilizes an equation for estimating runoff using a Runoff Curve Number (CN) method. This discussion will not compare the NRCS method to other methods, it will only discuss some of the factors considered in determining "Q" or runoff. The CN is critical to calculating the NRCS runoff equation. The major factors that determine CN are the hydrologic soil group, cover type, treatment, hydrologic condition, and antecedent runoff condition. Another factor considered is whether impervious areas outlet directly to the drainage system (connected) or whether the flow spreads over pervious areas before entering the drainage system (unconnected).

Field observations showed that surficial geology and soils varied widely throughout the daily transect. Infiltration rates of soils vary widely and are affected by subsurface permeability as well as surface intake rates. In the NRCS system, soils are classified into four groups, A,B,C,and D according to their minimum infiltration rate, which is obtained for bare soil after prolonged wetting.

Urban areas were damaged as a result of Hurricane Georges. Most urban areas are only partially covered by impervious surfaces: the soil remains an important factor in runoff estimates. Urbanization has a greater effect on runoff in watersheds with soils having high infiltration rates than in watersheds, which generally have low infiltration rates.

There was much discussion about the hydrologic condition of the watersheds where most of the damage and sedimentation occurred. In order to get at a reasonable estimate, several factors need to be considered. Some of these factors require ground truthing. In order to estimate the effect of cover on infiltration and runoff, the following factors need to be considered:
(a) canopy or density of crops or other vegetative areas;
(b) amount of year-round cover;
(c) amount of grass or close seeded legumes in rotation;
(d) percent of residue cover; and
(e) degree of surface roughness.

Time of Concentration

Time of concentration is an important concept to employ especially when working in complex watersheds such as those in the Dominican Republic. Travel time (Tt) is the time it takes for water to travel from one location to another in a watershed. Travel time is a component of time of concentration (Tc) which is the time for runoff to travel from the hydraulically most distant point of the watershed to a point of interest within the watershed. (Tc) is computed by summing all the travel times for consecutive components of the drainage conveyance system. (Tc) influences the shape and peak of the runoff hydrograph.

Factors affecting time of concentration and travel time are surface roughness, channel shape and flow patters, and slope.

The Need for a National Watershed Surveys and Planning Program

A national program, similar to the Watershed Surveys and Planning program administered by the Natural Resources Conservation Service (NRCS) in the US, provides an opportunity for the Government of the Dominican Republic to work with Provincial and local government and NGOs in promoting effective watershed management.

The purpose of such a program in the Dominican Republic would be to protect watersheds from damage caused by erosion, floodwater, and sediment and to conserve and develop water and land resources. This program could address the following resource concerns:

- water quality
- opportunities for water conservation
- wetland and water storage capacity
- agricultural drought problems
- rural development
- municipal and industrial water needs
- upstream flood damages, and
- water needs for fish, wildlife, and forest-based industries.

An effective national program could conduct surveys and plans, which include watershed plans, river basin surveys and studies, flood hazard analyses, and flood plain management assistance. These plans would be used to identify solutions that use land treatment and non-structural measures to solve resource problems.

The Need to Review Irrigation and Water Conservation Planning

During the field review of damage caused by Hurricane Georges, irrigation systems received a lower priority than sites that had the potential to cause the loss of life or continued damage to property and infrastructure. The irrigation systems observed were basic to modern and utilized water conveyance structures, pipes, pumps and sprinklers to irrigate cropland. Most of the irrigated land appeared to be used for plantain and vegetable crops.

Damage was most extensive to those areas where the land was inundated and large deposits of sediment covered irrigated fields and irrigation systems. In those cases, crop loss as well as loss of the systems was high.

Planning irrigation systems as part of a watershed system is important. A national program of developing irrigation plans as part of an overall conservation plan is recommended. Irrigation systems planning includes:

- Sustaining or improving soil condition, including productivity
- Maintaining or improving surface and ground water quality and quantity
- Making the most efficient uses of limited water supplies
- Providing an environment for maximum production while not degrading other resources
- Considering water use for domestic animals and wildlife
- Reducing impacts caused by soil erosion and deposition, and
- Considering the need for water for human consumption.

The recommended planning process involves nine basic steps in the development of a total conservation management system. This nine step process can also be used to assess whether or not planning or the lack of planning lead to the damages sustained by Hurricane Georges in all cases.

Step 1 Identify the problem including resources of concern – Water source, quality, and quantity; soil erosion; labor and energy.

Step 2 Determine objectives – User needs and other watershed and community concerns are included.

Step 3 Inventory the resources – Soils, water, air, plant, and animal resources, including drainage, salinity, existing irrigation systems, and labor available.

Step 4 Analyze resource data – Consider the effect each resource has on the other

Step 5 Formulate alternatives – Select alternatives for the irrigation method, system, and components. Include irrigation scheduling methods appropriate for the irrigator.

Step 6 Evaluate the alternatives – Consider potential environmental impacts, costs, and on-farm labor and skill availability.

Step 7 Water user decision – The user decides which irrigation method, system, and components to use; and, overall water management desires.

Step 8 Water user implements the plan.

Step 9 Follow-up – Evaluating the results of the plan implementation, onsite, and offsite. Revise the plan as needed.

Some soils are more susceptible to rill and gully erosion than others. The absence of a soil survey makes it difficult to predict how soils will respond to certain treatments. A national soil survey program will provide land users and those who make land use decisions with soil survey information necessary for understanding, managing, conserving, and sustaining the limited soil resources of the Dominican republic. Soil surveys provide an orderly, on the ground, scientific inventory of soil resources that includes maps showing the extent of soils, and data about the physical and chemical properties of those soils.

The Need for a National Soil Survey

It is recommended that efforts to continue with developing a national soil survey be continued. Basically, a national soil survey program would provide consistent reliable

soil resource information. The agency or ministry charged with the national soil survey program would have national responsibility for:

- making of studies and reports necessary for the classification and interpretation of soils
- an intensification of the use and benefits of a National Cooperative Soil Survey
- furnishing of technical and other assistance needed for use of soil survey
- consultation with other national ministries and departments necessary to carry out the soil survey mandated in legislation

The availability of soil survey information should be considered a prerequisite for land use and watershed planning.

A Need for Emergency Preparedness Education Program

The Dominican Republic has a history of experiencing a high frequency of hurricanes and severe tropical systems. An emergency preparedness education program is highly recommended. Such a program should address the following:

- Schedule conferences to discuss emergency procedures and hold practice drills as an example of an emergency procedure
- Establish shelter locations for emergency situations
- Establish emergency plans for families, schools, and workplaces
- Determine evacuation routes and alternates
- Post emergency telephone numbers, including poison control
- Establish emergency broadcast systems on radio and television stations
- Establish emergency guidelines and educate people on emergency food and water procedures
- Set up a locally led network of trained people, to watch over critical issues such as maintenance of roads, bridges, flood control measures, etc. These people will network with government authorities to do necessary actions to be prepared or correct any malfunction that might pose a threat to life and property.

APPENDIX

Itinerary and Discussion Notes

December 2, 1998 – Travel to the Dominican Republic by NRCS TAT.

December 3, 1998 – Contacts throughout the day:

- Manuel Paulet, Soil and Water Conservation Specialist, Inter-American Institute for Cooperation on Agriculture (IICA)
- Rafael Marte, Director, IICA
- Frank Rodriquez, Director of the Instituto Nacional de Recursos Hidraulicos (INDRHI)
- (INDRHI)
- Teofilo Payono and Maximo Portorreal, Secretaria De Estado De Agricultura (Secretariate of the State of Agriculture
- Ing. Hector Malo, INDRHI
- Sergio Mora C., Banco Interamericano de Desarrollo
- Kevin Smith, USDA-FAS Agricultural Attaché, Dominican Republic
- Luis C. Gonzales B., MA, Economic Policy Coordinator, United States Agency for International Development (USAID), Dominican Republic
- Carleen Yokum, Regional Environmental Advisor for the Caribbean, USAID, Dominican Republic

Discussion

A team was established to prioritize the watersheds damaged by Hurricane Georges September 21-23, 1998. The team members represented IICA, USDA-NRCS, SEA, and INDRHI. Members from INDRHI and SEA gave the NRCS a briefing about the hurricane and the nature of the watersheds.

Prior to planning the field review on December 4, 1998, the team reviewed each watershed and assigned a priority to those needing review. The review was be conducted to determine the extent of damage to soil and water resources, including irrigated areas, erosion, and sedimentation. Consensus was reached that Cuenca (Watershed) Rio Yaque Del Sur is the first priority. Cuenca Rio Yaque Del Sur Norte, and Cuenca Azua, Bany y San Cristobal, and Cuenca Rio Yuna followed this.

Manuel Paulet, IICA explained the terms of reference to Frank Rodriquez, Director, INDRHI. INDRHI is a lead partner in developing a strategy to implement Locally Led

Watershed Management in the Dominican Republic. INDRHI provided staff support and transportation for the field visits.

Sergio Mora, Banco Interamericano de Desarrollo (BID) met with IICA, NRCS, and INDRHI. Mr. Mora explained that the storm damaged most of the automatic pluviometric monitoring devices, therefore rainfall intensity and runoff data is not consistently available. The duration of the intense rainfall lasted 14 to 26 hours in a single location. Approximately 650 mm of rain fell during this period.

BID conducted an overflight of the damaged area and produced maps at a scale of 1:500,000. The BID prepared several reports about Hurricane Georges and found out that other reports prepared by the Government of Dominican Republic and international donors contained different data and that each report provided what appeared to be good rationale for the data. Their report reviewed the intensity of landslides, flooding and damage to forests.

Mr. Mora said that due to the damage by Hurricane Georges, it would be difficult to quantify pluviometric data. There is also a lack of consistent base data throughout the country. Regardless, BID is looking to the future for watershed management in the Dominican Republic. BID wants to establish a common front for landuse planning, policy as a strategy for the state, and sustainability of natural resources in the Dominican Republic. The BID strategy will answer the questions about who is responsible; the measurement of progress; which terms will be set by the bank; and what is needed to address the issues of watershed management.

BID made reference material available to the NRCS technical assistance team.

Kevin N. Smith, USDA-FAS Agricultural Attaché, met with IICA, INDRHI and the NRCS Technical Assistance Team. The NRCS Terms of Reference were explained to the attaché. Kevin then briefed the team about the Dominican Republic and shared some observations with them about a meeting he recently attended. He explained how USDA was using the Title 416 program to assist the Dominican Republic in recovering from Hurricane Georges. He recommended that the team meet with Luis C. Gonzales B. about the political and economic aspects of the DR.

The team met with Luis C. Gonzales B., USAID Economic Policy Coordinator. Luis discussed the concept of the Technical Secretariat in administering the Title 416 program in the DR. The Secretariate essentially is paid by generating it's own resources. The Government of the Dominican Republic (GODR) has a very centralized form of government, which creates challenges to locally led and run projects. The Secretariat is composed of several GODR offices, which include the National Budget Office, National Planning Office and others.

The team met with Carleen Yocum, Regional Environmental Advisor, USAID, USFS/IITF. Carleen discussed observations made during her field visit of October 19-23 and 29-31, 1998. She shared photo documentation and the team discussion observations

from her trip report about the damage to the forest resource. Carleen visited public lands managed by the Direccion General Forestal (Foresta or DGF); private operations and NGO managed sites. The recommendation for soil conservation called for increased support to already existing activities in soil conservation practices. Live vegetated barriers, agro-forestry, seeding of road banks, etc. was recommended. In addition, there was a recommendation that long-term programming consider assistance with water diversion and/or storage regulation measures.

Field Visits

December 4-5, 1998 –The technical assistance team made 17 stops in four provinces, Monsignor Nouel, La Vega, San Cristobal, and Peravia. The stops allowed the technical assistance team to identify damages and to classify them as *Exigency* or *Non-Exigency*.

Many other field observations were made in order to determine the scope of damage in quantitative and qualitative terms. This was one of the most difficult parts of the assignment due to a lack of base data and time to make field measurements. The members of IICA and the agency staff from the Government of the Dominican Republic helped the NRCS staff tremendously by providing information at their disposal.

Over 60 such observations are found on the table Recorded Field Observations by the Hurricane Georges IICA/NRCS/DR Technical Assistance Team. This table shows the location, observation notes and Cause/Effect and Conclusions based on the field observations.

December 7-8, 1998 – The technical assistance team continued field assessments of damage caused by Hurricane Georges. The team proceeded further west and northerly to San Juan. Observations were made in or near 9 towns or villages in four provinces, Azua, Baoruco, Barahona, and San Juan.

Natural resource disasters that cause earth movements frequently cut off or destroy shallow sources of water used by villagers for household use, livestock watering, and small scale, home garden irrigation. The threat of pollution to these water sources greatly increases, as does the chance of illness caused by water borne disease. Inexpensive water holding facilities and water distribution systems can reduce the occurrence of illness caused by polluted water after storm events.

December 9, 1998 – The NRCS Technical Assistance Team delivered their close-out presentation to the Government of the Dominican Republic, IICA, USAID and NGOs from the Dominican Republic. The presentation was bi-lingual and focused in the following areas:

- Review of the Terms of Reference
- Location of Observations
- Major Watersheds Visited
- Criteria for *Exigency* and *Non-Exigency* Situations
- Technical Assistance Necessary During an Emergency Situation
- Criteria for Eligible Measures or Treatments
- Natural Resource Considerations
- Watershed Impairments Caused by Hurricane Georges
- Land Uses Impacted
- Important Links to the Damage Caused by Hurricane Georges
- Soil Conservation as Part of the Solution
- Resource Planning Steps
- Recommendation: Locally Led Watershed Management
- Recommendation: National Leadership in the Watersheds of the Dominican Republic
- Recommendation: Watershed Surveys and Planning
- Recommended Components for Conservation Projects

❑ Acknowledgements

December 10, 1998 – The NRCS Technical Assistance Team departed the Dominican Republic and returned to their duty stations in the United States.

Roads in the rural and mountainous areas were especially hard hit during Hurricane Georges. Many factors contributed to the failure of roadbeds and road drainage systems. Several factors include poor road fill; poorly maintained road drainage ditches, undersized culverts, and blocked culverts. Maintenance and stabilizing road cuts with vegetative and structural methods can reduce the failure of roadbeds and road drainage systems.

SAMPLE ASSESSMENT TOOLS

DAMAGE ASSESSMENT FIELD REPORT

REVIEW DATE: _____ *NUMBER OF SITE VISIT:* _____

LOCATION (Province, village, river, route, etc.):_____

_____

Type of Impairment: Please check the type of impairment or write in a description of the impairment.

Landslide	Gully erosion (cropland)	Gully erosion (other)
River bank erosion	Sediment moving from site	Flood plain filled in
River flowing out of natural channel		Wetlands filled in

_____ _____ _____

Hydraulics of channel or other flowage impaired by the following debris:

Fallen trees	Soil material	Rock and soil	Trees/soil/rock
Home debris	Road debris	Steel bridges	Wood bridges

_____ _____ _____

Please enter volume estimates and a sketch of the area including recommendations

SKETCH

VOLUME ESTIMATES

DISPOSAL SITES

Narrative and Recommendations

Health and Safety Risks

The following materials should be noted because they could pose a risk to safety and health whether they are buried or exposed:

Toxic or volatile chemicals	Fuel drums or fuel lines	Natural gas lines
Electric lines or cable	Dead farm animals	Bodies of victims
Mass movement still active	Vehicles	Water impounded by debris
Water contaminated	_____	_____

Agricultural land damage

Topsoil washed away	Severe gully erosion	No grass/leg. cover
No tree canopy	No annual crop production	No perennial crops
No access to cropland	No organic matter supplements	Subsoil exposed
Bedrock exposed	Exposed dense soil	Slope > 25%
Exposed soil loose sand & gravel	Exposed soil silt & clay	_____
Terrace systems destroyed	Waterways gullied	Access road gullied
Productive capacity decreased	_____	_____

Please provide a sketch of the area along with recommendations

SKETCH
Conservation Recommendations
Debris disposal sites

Narrative and recommendations

Cultural, Archeological and Historic Sites

Has watershed impairment put in danger cultural, archeological and historic sites?

If so, please list:

Other Environmental Issues

Has watershed impairment destroyed or damaged fish and wildlife habitat? Have threatened or endangered plants and / or animals been destroyed or their environment destroyed?

Upland habitat	Lowland habitat	Coastal habitat	Birds
Mammals	Fish	Plants	Flowers
Change in vegetation	_____	_____	
_____	_____		

Please provide a sketch of the area along with recommendations

SKETCH
Restoration Recommendations
Species impacted by this disaster

Narrative and recommendations (continue on back of page)

Impoundments

Dams are considered dangerous if the following apply:

Principal spillways are washed out or are filled with debris
Emergency spillways are gullied and unprotected
Dam or dike has been breached but not totally destroyed
Failure of the dam would result in the immediate loss of life and property
Pool elevation remains at flood stage leaving little or no storage
No vegetative cover or rock cover on critical slopes
Sediment in pool exceeds the design life of the dam
Seepage at the toe of the dam or dike is permanent and flowing
No breach analysis has been conducted thereby endangering those below

Irrigation Systems need emergency repairs if:

Irrigation channels are filled with sediment or destroyed
Field surreys are needed to re-construct irrigation water conveyance structures
Portable main lines and laterals have been washed away, or are buried or collapsed
Irrigated fields need to be re-leveled
Fixed pumps, wells, valves, and pipelines have been destroyed
Sprinkler or spray nozzles and heads, and micro emitter devices are damaged or washed away
Irrigation water impoundments have been destroyed or the capacity diminished making the source of water inadequate.

Field Sketch and Notes

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Equipo de Asistencia Técnica IICA/NRCS – INDRHI/SEA – Diciembre 4 a 8, 1998

Fecha	Kilometraje	Lugar	Observación	Causa – Efecto - Conclusión
4 Dec. 1998	NR(not recorded)	Tireo Arriba	Bridge and road out; 40 homes gone; no lives lost; large machinery on site; area heavily used for vegetables; sprinkler irrigation is used.	Obstructions and debris (i.e. bridge) must be removed immediately; safe disposal area needed; wide floodplain with undulations is hydraulics issue; exigency issue is debris removal; hydrology issue is time of concentration and peak flow discharge.
		Constanza	Hillslope agriculture; horticultural crops; labor intensive; grazing; terracing used for erosion control; heavy use of chemicals. Sugar cane depletes soil resources and increases cost for production.	Hillslopes above flood plain seem in good shape; irrigation ditches have been cleaned and sprinkler irrigation is operable; concern about use of pesticide and effect on food, water, air people; potential area for locally led conservation and watershed management project. Rill erosion was observed indicating a need for soil conservation practices.
		Constanza	Water pipes exposed; hydro-rams are used	Shallow water supply lines need to be reinforced to prevent breakage and contamination of water; spring development for the more efficient use of water can be explored; check for irrigation efficiency
		Heading out of Constanza toward El Rio	High cut slopes used for borrow material in road building	Borrow areas become occupied with people after construction. These people are at risk due to the potential of land slumping and land slides of cut slopes. Cut back and bench the cut slopes that are nearly vertical so that runoff water is diverted off of the slope. Relocate people out of these areas.
		La Cotorra	Road ditches were filled with sediment. Pine trees were downed by high winds on both sides of road. Farmers were removing trees by oxen.	Road ditches need maintenance. This would be a good community project. Sediment needs to be placed where it will not wash in again. Downed trees must be removed, they create a fire and disease threat as well as a safety threat for those who work in the forests. Consider portable mills and large chippers to create mulch from the woody debris.
		El Rio area along the Rio Jimenoa	Buoyant debris in the flood plain and channel will raft then lodge and cause intermittent dams during flood events.	Large uprooted trees, broken limbs, brush and other organic debris needs to be cleaned from the flood plain and river channel. Other items, such as agricultural pesticide containers and bags, home debris, wire fencing and other obstructions must be removed. The most critical sites are those where debris has collected on bends and curves in the river, especially those areas where the river bend flows along a road bank.
		El Rio	Road ditches filled with sediment; frequent	Remove sediment before rain season. Install catch basins and

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Fecha	Kilometraje	Lugar	Observación	Causa – Efecto - Conclusión
			landslides and slumps occurring; steep, narrow valleys discharge directly to road culverts. Roads are being undercut by high velocity flows of rivers and tributaries.	culverts in areas less likely to be filled in by unstable soils. Stabilize slopes above structures such as catch basins and culverts. Armor steep slopes between road edge and river up to an elevation equivalent to bank full stage. Use rip-rap. Bio-Engineering has application along road bank cuts and in certain areas along the river. Riparian vegetation can be established above the levels protected by rip-rap and on river banks.
4 Dec. 1998	515.3	Arroyo Rio	Observations were made along a 13 mile segment heading northeasterly to Jima and Pringamosa.	Observations indicate that soil loss is considerable even during the normal rain season. Without laboratory data or a published soil survey, a volumetric soil measurement of 92lbs/cu.ft.for a loamy soil will be used to calculate the volume of soil eroded. Estimates are all based on visual observation only. Ideally, field measurements would include profiles and cross sections. It is noted that compact subsoil can have a density of 125-pounds/cubic foot. Road ditches in this area had a cross section of 3 to 4 square feet. EXAMPLE: 100 feet of road ditch with a 4 square foot cross section is 400 cubic feet (14.8 cubic yards). 400 cubic feet X 92 lbs./cubic foot =36,800 pounds (18.4 tons of soil material in that section if ditch.
	516.0		Road drainage impaired.	Maintenance is needed to remove sediment.
	517.25		Large earth movement	Approximately 10,000 cubic feet/370 cu.yds. of material
	517.8		Small earth movement	Approximately 4,000 cubic feet/148 cu.yds. of material
	517.82		Large earth movement	Approximately 8,000 cubic feet/296 cu.yds of material
	517.83		Small earth movement	Approximately 2,000 cubic feet/ 74 cu.yds. of material
	518.0		Small earth movement	Approximately 1,500 cubic feet/ 56 cu.yds. of material
	518.8		Gabion baskets being under cut	-
4 Dec. 1998	519.3-4		Very large earth movement	Approximately 50,000 cubic feet/ 1850 cu.yds. of material
	519.9		Large earth movement	Approximately 10,000 cubic feet/ 370 cu.yds. of material
	520.4		Large earth movement	Approximately 7000 cubic feet/ 259 cu.yds. of material
	521.2		Large earth movement	Approximately 8000 cubic feet / 296 cu.yds. of material
	522.8		Large earth movement	Crossed road
	523.8-9		Very Large earth movement	Filled in road ditch. Geologic formation contributing factor.

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Fecha	Kilometraje	Lugar	Observación	Causa – Efecto - Conclusión
				Formation deteriorates when exposed to rain and landslides
4 Dec. 1998			Outside of rural communities, there may not be road ditches	
	524.9		Near top of watershed break	Road cuts show no sign of having been planted. Soil is bare. Sediment is migrating off site and will eventually enter a major water course or tributary.
4 Dec. 1998	526.4		Gabions in use	
	528.4		Exposed bedrock	Geology needs to be reviewed in all damage sections to determine if damage is predictable and preventable. Aspect will be important to any predictive model.
5 Dec. 1998	-	South of Cambita Garabito	Landslides and roads washed out. Large mineral sediment deposits across roads and along side roads.	
	708.8		Vertical rock slope; rock is well weathered and fractured	Rock-slides filled in road ditches and made the road nearly impassable. Small rockslides are frequent in this formation and deposit about 150-200 cubic yards each.
	709.3		Land slumps with trees block road ditches and impede traffic.	Land slumps are usually smaller and deposit up to 100-200 cubic yards
	709.8		40-80 foot nearly vertical rock slopes. Soil material has slid down the slope.	Weathered rock formation susceptible to rock slides need to be benched at the time of construction or covered with an impervious material and steel netting if rock slides continue.
	710.2		Rock and soil material filled the road ditch. Rock bedding is near vertical with low pockets filled with soil material	Approximately 10-50 cubic yards of material
	711.7		Near vertical slopes with beds in a vertical position. Rock is soft	Variable size material
	712.8		Mixed gardens were noted around village homes.	Also noted conservation plant materials that could be used in Bio-Engineering application. The plant materials were Gliricidia (sepium), Leucaena (glauca), and Elephant Grass. A closer examination will reveal other plants that have multiple uses.
	713		Geology is bedded horizontally	
	713.4		Mature trees were topped, there was greater than 60% of the crowns were destroyed.	There is a fire and disease potential. Also, hanging limbs and tree stems present a dangerous situation for persons clearing debris. Training in safe techniques for clearing this type of

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Fecha	Kilometraje	Lugar	Observación	Causa – Efecto - Conclusión
				debris is necessary. Portable mills and commercial chipping machines will aid in the clean up. Firewood for villagers should be placed in a safe location.
5 Dec. 1998	714.2		Trees 20-30 meters high had 60-90% of crowns damaged or topped. Some of the main stems were broken.	The damage requires clean up but another important issue needs to be addressed. How will the biological and agro-ecological conditions of this forests change? Will farmers move in and open this land to the cultivation of annual crops?
	715.4	South of La Colonia		
5 Dec, 1998	716.6		70-80% of road ditches are filled with sediment	A microwave/communications/relay station is located near here
	717.9		Spring water seeping through pavement	Proper roadbed preparation cannot be emphasized enough. Sources of water should be eliminated from the roadbed. Seepage will lead to the eventual deterioration of the road surface and possible road slide.
	718.3		Spring water being used for drinking purposes	Spring water source development is a low cost technology that isolates and protects shallow subsurface water sources from pollution. Systems usually require concrete cisterns and main and lateral lines to point of use. Cost is $600-$1,500 each
	720-720.5	Mano Matuey	Mountain terrain, steep narrow valleys with narrow flood plains. Road drainage system impaired by large deposits of gravel, cobbles, stones, and boulders.	One school, a shop or store, an access road, multi-culvert drainage system and single culverts washed out. There were reports of 27 persons killed by the sudden landslide and rising floodwaters. 8 children and a family of 13 Haitians were in those killed.
			4 culvert drainage system under road is destroyed. The structural integrity will need to be examined if the structure is to be used again.	One road drainage system consisted of 4 culverts each about 2.5 feet in diameter. The structure was well built but the design may have caused early failure. One or two large box culverts or a bridge may have been more adequate. The apron and wing walls of this structure are undermined on the outlet end. The inlet is completely buried with sediment. The outlet is relatively stable but is eroding. It should be armored with large rip rap.
			Bridge abutments seriously undermined and bridge decking should be inspected to determine proper weight limits for vehicles.	The bridge was in a weakened state prior to this hurricane. A bypass road that was constructed immediately upstream from the bridge to carry heavy vehicles evidenced this. It is

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Fecha	Kilometraje	Lugar	Observación	Causa – Efecto - Conclusión
			Weight limits may need to be decreased due to damage.	surmised that this by-pass road constricted flow under the bridge and may have contributed to the type damage seen. The narrow valley was also filled in and a school and playground and parking lot was built. Local reports say that a store was also built in this area. These are additional mitigating factors that possibly led to the loss of life and severe damage to property. Bridge safety, local construction across major drainage courses, unchecked development in flood plains areas, and no warning or preparation led to this disaster. Land use practices in the uplands was also suspect but not evaluated in the field.. Because of the steep slopes, there is little land to build on, therefore people will migrate to the lower, flatter areas.
5 Dec, 1998	722.2		Geology note	Frequent landslides seen in the vista to the east. Small slumps occur frequently along the road. The substratum appears to be rotted rock from which the soil is formed. The interface between the unconsolidated soil and the firm substratum creates a slide plane.
			Slide Planes	Road cuts serve to weaken a natural soil and geologic structure. The slide plane is the surface contact between the overburden and a usually dense consolidated soil or rock material. Water runs along the slide plane when the overburden becomes saturated or pulls away and forms an opening for water to enter and then flow along the surface plane. Once the plane is lubricated by water, gravity takes over and slumping occurs, usually from the bottom out. Trees and grass appear intact on top of a slump because the action started beneath, not on top. Essentially, the soil "rides" down slope.
	723.1		Landslide scars are seen in the vista to the east	
	727.1		Weak point in rural roads in steeply sloping areas	A series of observations indicated that a common weak spot in a road is at the curve in a road where the curve is built on fill and drainage culverts installed in the fill area. There also seems to be higher failure when the outside of the curve is on the inlet or upstream end of the drainage system. It is

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				presumed from field observation that damming occurs before filling and water flows over the road and begins to erode the down stream face of the road first. Piping may also occur along the culvert if headwalls, aprons and anti-seep collars are not properly installed. Filling then occurs causing sheet flow over the road, eventually eroding the road surface until it collapses.
5 Dec. 1998	727.8		A headwall that held	A 4 m deep X 40 m wide X 60m long cement and rock headwall withstood the runoff. The headwall was upstream from the road. The down stream side of the road was armored with a rock and cement headwall.
	729.2	Los Cacaos		
	732.1-732.8		Frequent slumps and landslides in these sections.	Slumps and rock-slides most often occur on unconsolidated, severely weathered material. Rock fragments are found in road. Rock landslides appear to start at the top of the slope and end up in a fan shaped pattern at the bottom of the slope. The larger rock size occurs at the front of the movement and the finer rock fragments are found up slope at the tail of the fan.
5 Dec, 1998	737.3	Los Mineros	Vertical rock slopes are benched in order to reduce rock slides	Benching or terracing is costly but effective.
	738.5		Gully plugs and drop structures	Gully plugs and drop structures are used effectively in this area to control normal runoff.
	739		A series of large landslides caused considerable damage to road drainage systems	
	740.5		A good example of a properly constructed culvert, headwall and apron drainage system.	
	743		Culvert and apron washed out on the curve of the road. Inlet is facing up stream.	
	746.2		Vista of dam (Presa Jiguey) in Los Naranjos	
	747-753		Road was in poor condition and had many curves. King Grass, Gliricidia, and Flemingia were observed along the road and near village homes.	

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5 Dec. 1998	755		Change in Geology	The geology changed in this area, the soils were red in color and very slippery when wet. The roads were not paved. They were very wet making them nearly impassable. This was due more to design and construction than to hurricane rains. All roads need a proper road base and drainage. The road bed should be crowned and runoff from the road should enter road ditches. Road ditches need to be diverted to safe outlets and should have drop structures installed on sloping ditches. Cut banks must be stabilized by cutting the slope back and by the use of vegetative controls. The road bed should be paved with gravel and stone and rolled by machinery
	760		Met with NGO group conducting a conservation exercise with farmers. Met Father **Luis Quinn** and **Carlos Bonilla**, members of ADESJO's Directorate	A group of farmers belonging to ADESJO (Asociación para el Desarrollo de Ocoa) planting Macadamia in the top hill. Oberved secenery of very hilly terrain with terracing and countour planting. Looks OK.
	763		Road is paved with asphalt	
	774.2		San Jose de Ocoa, Rio Ocoa	This bridge is showing signs of serious erosion around the bridge abutments. Bridge abutments are a problem area with older bridges where abutment footings are not deep enough or set on piles. In these cases, abutments are undermined and slip out causing the bridge to collapse nearest the road.
5 Dec. 1998	784-789		Slumps and slides were observed	In this 5 mile section, there were 17 slumps or slides observed. The amount of cubic yards to be removed conservatively estimated at 3,000 cu. yd.
7 Dec. 1998	043	Rio Bani	Flood plain has dikes built along river. Flood plain is being filled in with garbage and debris from the hurricane	People are living between the dike and what appears to be a high terrace. This situation could be contributing to making a bad situation worse. There are social and economic factors to consider in this area. There is the potential of flooding behind the dikes. Building dikes independently of a flood analysis is dangerous and not considered good engineering.
	071.8	West of Galeón	Before reaching the Rio Ocoa, farmers were observed reclaiming agricultural lands	Flooding deposited large amounts of sediment on agricultural lands and in open irrigation channels. Farmers were clearing the land and cleaning out irrigation canals. The soils deposited on agricultural land may need organic matter supplements in order to be productive

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7 Dec. 1998	076.1		A change in the geology was observed.	
	088	West of Hatillo	This is an area of high technology agriculture, including drip irrigation.	
	094	Estebania	Another area of hi-tech agriculture with irrigated lands.	
	107	Azua to Peralta	4 bridges were dropped in this area	
	140-145.8	Rio Yaque del Sur	Wide flood plains. Banana and coconut plantations were damaged. Irrigation channels were filled with sediment. Debris and downed trees are present on flood plain.	Debris should be removed from the flood plain.
	164	Rio Yaque del Sur	Bridge withstood flood waters and large amounts of debris rafted against abutments and support piers.	Bridge abutment footings were set on driven piers. Rafted debris will need to be removed and the channel under the bridge cleared of debris. Guard- rails received damage and should be repaired. A flood hazard analysis should be conducted in reaches of the river where there are strategically important bridges and potential impacts to urban infrastructure and dwellers along the river.
	166	Tamayo	This area was subject to inundation and deposition of flood debris. High water marks were observed at 6.5 feet on buildings and sediment level marks were recorded at 2 feet. Two persons were recorded dead as a result of the flooding. Structures collapsed as a result of the height of water and weight of the sediment.	The hurricane triggered this disaster, but the root of the effect goes beyond the hurricane itself. Inundation was reported from the coast (Bahia de Neiba) west to Batey and northeast to Quita Coraza. Certainly, runoff and sediment from the upper reaches of the watershed was one factor. A definitive answer on this issue can be determined by conducting a river basin study of the Rio Yaque del Sur. Of immediate concern is the removal of debris from river channels so that floodwaters from the rain season can be circumvented around Tamayo. This is an exigency issue. Debris and sediment need to be removed as they can also create a health threat and may require vector control. Air quality is also an issue, airborne mineral and organic matter from flood sediment decrease the quality of air in the town. This area presents an opportunity for towns like Tamayo to partner with groups upstream to develop a locally led conservation process that can lead to reducing flood damage

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				through cooperative efforts.
7 Dec. 1998	182	Jaquimeyes	Rio Yaque del Sur flood plain and road crossing. The road crossing was washed out and irrigation canals were slightly damaged.	It was observed that several road crossings were washed out because of improper design and installation of culverts. Damage indicated that water was diverted around the crossing causing failure at both ends of the crossing. Consideration needs to be given to the review of existing standards and specifications and developing new standards and specifications for culvert design and installation in rural communities. Again, weak points were abutments. Where possible install crossings at elevations so that flood waters will flow over the crossing instead of around the crossing. The use of box culverts and installing footings for abutments at proper grades is critical. Install energy at the outlet end of culverts.
	183	Village (Mayagual)	Road construction created a dam behind which flood waters rose. Homes were located in the flood plain behind the road and therefore were inundated by flood water.	There is a socio-economic issue as well as a natural resource issue at this location. Sediment left behind by receding floodwaters has elevated the ground level by 2-4 feet. This means that the level of the homes is below ground level. There already exists a soil drainage problem because of the lack of outlets. This area is going to be susceptible to ponding during normal rain events and flooding if the road continues to act as a dam. Relief can be provided at low spots along the road. A flood plain study and a hazard analysis can lead to effective solutions.
8 Dec. 1998	NR	San Juan	Met with **Dr. Cesar V. Paniagua and Leonel Duarte**, CE of the Program DeSarrollo Agricola en San Juan de la Manguana (PRODAS)	The San Juan watershed is a major tributary of the Rio Yaque del Sur. Agriculture is found in the southern part of the watershed, the southeast and central part of the watershed is irrigated. The central part of the watershed is known for intensive agriculture. A hydro-power dam is located in the northwest part of the watershed, the watershed is dominantly forested. The northeast part of the watershed is occupied by National Forests. Telemetric stations are being installed in the watershed and will be hurricane proofed.
	301.3	San Juan	The community suffered substantial flood damage and loss of life and property. An entire village upstream from the main	Factors that influenced this disaster: • Amount of rainfall and subsequent runoff • Bridge down stream was overtopped due to the volume of

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Fecha	Kilometraje	Lugar	Observación	Causa – Efecto - Conclusión
			bridge was destroyed. The village appears to have been built on a flood plain. Property damage was severe and homes are not habitable. Water and sanitary systems were not available. Water levels rose to over 8 feet. The level of organic debris rafted in and lodged against buildings was noticeably higher than at other locations.	water and amount and size of rafted material lodged against it • The bridge then acted as a dam and impounded water • The main road to the bridge on the west side of the river is elevated thereby increasing the impoundment area of floodwaters. • Damage to the village downstream and below the road was minimal. • People in the upstream village were unprepared and some stayed behind to protect their property • Village may be built on a flood plain and encroachment into the flood plain may have taken place over the past 20 years • Flood waters rose quickly and caused panic when people believed the dam upstream had been breached In response to the flood, the San Juan Ministry of Public Works is considering merging two main roads onto a six-lane bridge. The purpose of this proposal is to provide two routes in and out of San Juan. Currently, only one exists.
8 Dec. 1998				An exigency situation exists as long as rafted material remains lodged against the bridge and lying in the flood plain. Rafted material should be removed from at least the bank full stage elevation. Debris must be removed from the flood plain. San Juan creates another opportunity for communities in the lower reaches of the watershed to partner with communities, agencies and groups in the watershed in order to plan effective and efficient means to reduce flood damages. River Basin studies and flood analysis should be part of the Governments assessment on how to reduce flood damages. For example, flood elevations for certain storm frequencies can be calculated and set in the community. This is a good first step for helping a community plan for future flood events.
	NR	Juan de Herrera	Grazing land and other agricultural crops	

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			such as vegetables and rice are grown here. Irrigation is used. Rainfall is 600-800 mm/year.	
8 Dec. 1998	NR	Guazumal	Brige abutment was undermined and moved out of place. This caused the bridge deck to drop. Limited traffic use is permitted but safety is questionable. A detour has been made downstream from the bridge in a narrow stream.	The abutment and bridge deck should be replaced.
	NR		A temporary crossing was made using cement bags and rock below the damaged bridge	Remove the damaged bridge. This type of temporary structure is recommended but only as a temporary measure.
	NR	Hato Nuevo	Village homes have well maintained home gardens	
	327	Sabaneta-Presa Sabaneta	Made observations at the base of the dam. Dam is being maintained and retaining walls downstream were constructed to prevent erosion. According to personnel who operate the dam, irrigation sluice gates were not opened during the hurricane.	Sediment and debris was already removed from below the dam.
			The principal spillway is called a Morning Glory due to it's design shape and fluted entry. The principal spillway operated as designed during the storm and did not become obstructed with debris according to dam personnel. Staff was able to remove debris during most of the storm.	There were no trash racks visible on this structure. Perhaps the design and size of the fluted entry of the Morning Glory does not call for trash racks. These racks would prevent the entry of floating debris into the spillway. *This design should be checked to determine if trash racks were required.*
			Emergency spillway suffered damage on the outlet end due to the high flows. The channel immediately below the emergency spillway suffered severe erosion and has a very deep and wide gully nearly to the edge of the road beneath the spillway. The road served as a type of level-lip spreader to allow for laminar flow. This part of the	Several observations were made about the emergency spillway. First, the damage immediately below the spillway was extensive and the subject of concern. *If the geology of the spillway is not suitable to carry emergency flows, then the spillway outlet must be reinforced,* The road that parallels the spillway lip was used or acted as a level lip to create laminar flow across a wide area. However, the down stream slope of the roadway was eroded probably

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			structure was threatened by this hurricane. Erosion of the emergency spillway channel was nearly complete at the outlet end where it joined the river. A valley was incised into the soil and rock formation at the outlet end of the spillway	due to the hydraulic condition caused by the large volume flow. Cement and rip-rap against the slope was probably plucked away hydraulically as water flowed over the road. *While there was no conclusive evidence of why culverts failed, it is recommended that engineers assess the potential of piping soil material along culverts during these types of events. For example, would anti-seep collars have delayed or prevented damage to culverts. Compaction around culverts appeared to be good but needs to be inspected during construction. Neoprene seals between culverts need to be of high quality and should also be inspected.*
8 Dec. 1998			Observation about the emergency spillway and flooding in San Juan	The dam was finished in 1979, the same year that hurricane David hit the Dominican Republic. The dam was dedicated in 1980. Reportedly, the emergency spillway ran for the first time during Hurricane Georges and did not run during Hurricane David. According to local personnel, when Hurricane David arrived, the pool behind the dam was not full. The runoff from hurricane David filled the pool level only to the elevation of the principal spillway. Therefore, people living below the dam never saw flows greater than those permitted through the principal spillway, the Morning Glory. During Hurricane Georges, people below the dam in San Juan reported a sudden rise in water. This is attributed to many factors, however the flow of the principal spillway, together with the emergency spillway may have been enough to send a volume of water downstream not seen since 1979. In addition, encroachment on the flood plain between 1979 and 1998 may have been a factor. The use of aerial photos can determine if *encroachment* was a factor. *Regardless, flood-warning systems were inadequate and resulted in the loss of life and property. It is recommended that a Breach Analysis and Flood Plain Study be conducted in order to determine flood elevations and to develop flood*

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				evacuation plans. Automated flood warning systems are relatively inexpensive to install but require personnel, maintenance and cooperation of all communities on the system.
8 Dec. 1998	400	Yayas de Viajama	Two bridges were buried in sediment. There is a wide flood plain and a series of new channels have developed.	
	411		Irrigation channel being constructed	
	413	Amiama Gomez	A bridge abutment is damaged; the area is being protected by the installation of gabions	
	418	Las Guanábanas	Large accumulations of sediment and bridges damaged	
			Fin de las observaciones registradas en el campo	

PROPOSAL FOR AN INTEGRATED APPROACH TO NATURAL RESOURCES CONSERVATION ON A WATERSHED BASIS

Proposed Title of Project: Conservation of Natural Resources of the Dominican Republic (CNRDR) Through Locally Led Conservation Initiatives

Goal of the Project: The goal of the Conservation of Natural Resources of the Dominican Republic (CNRDR) project is to increase farm production and income of residents living in rural communities, while minimizing soil deterioration by erosion on agricultural land in the Dominican Republic (DR). This will also include soil and water management on irrigated areas. This will be accomplished by improving farming systems and developing new technologies and management suitable for upland and lowland agricultural land uses.

Purpose of the Project: The purpose of the project is to expand and improve the institutional capacities, primarily at the provincial, local and farm level, to experiment with and apply alternative approaches.

Project Evaluation: A set of objectives and criteria and targets will be established and evaluated through out the life of the project.

Expected Outcomes: Experience and lessons learned from the project will be internalized into the organizational and institutional body best suited by legislation and policy. The following can be expected to occur:

- A permanent National Soil and Water Conservation Program is established conformed by key government organizations and representatives of private interests;
- Watershed management will be delegated to local levels with a support link to provincial and national government
- National soil conservation programs will offer technical assistance through provincial and local level offices
- One Watershed Management institution is recognized for issues regarding land treatment in watersheds
- Existing institutions would adopt the Management Information System (MIS) developed by the project.
- Provincial level government has the ability to process locally generated MIS information
- Extension is supported and directed to serve the need in the hillslope areas and irrigated land areas
- Role of agencies is defines relative to their responsibilities in conservation and watershed management
- Agricultural research is redefined so that it supports conservation and watershed management.

Project Organization: The project is overseen at the national level by the Program Steering Committee comprised of senior officials from the ministries or agencies involved in the project including an equal number of representatives of private interests. An *Executive Secretariat (ES) may* be created to serve as staff for the Project Steering Committee. The Executive Secretariat has two basic functions, national accountability for the project and keeping institutions and policy makers informed about the progress of the project and lessons learned. The ES is made up of officials from agencies involved in the project. The ES will only function if it is staffed with people committed to the functions of the ES.

The provincial level will have a *Project Coordinating Office (PCO).* The PCO has several important functions. The PCO will review and compile budget and reimbursement requests for transmission to the Executive Secretariat. They will also manage their portion of the provincial training budget; prepare annual or multi-year budgets; and compile and disseminate project management information.

The local level will have a *Project Management Unit (PMU).* The PMU is primarily concerned with the local coordination of inputs from other agencies and groups for services. They are responsible for getting the work done at the local level.

Project Components: Project components need to strengthen the institutional capacity of government at all levels to carry out an integrated program. The principal benefactors are local government and local farm groups who practice profitable and effective conservation in the upper reaches (hillslopes) of watersheds. Secondary benefactors are citizens in the lower reaches of the watershed that benefit from conservation applied in the watershed.

- **Sustainable Farming System (SFS)** – The purpose of the SFS component is to demonstrate and extend to farmers land on hillslopes, replicable, cost effective combinations of conservation farming and forestry practices. These practices need to be economically justifiable and reduce erosion rates to within acceptable limits. These locations are selected by the PMU. Farmers and local leaders select demonstration plots. A program of subsidy is implemented in order to encourage adoption of certain conservation measures. The selected areas will be allowed to expand to other areas away from the demonstration plots.
- **Promoting Irrigation Efficiency (PIE)** - The objective of the PIE component is to improve the capability of the DR to provide sound technical assistance for the maintenance of soil productivity, conservation of water and energy, and maintenance or improvement of the standard of living and the environment. Irrigation systems should apply the amount of water needed by the crop in a timely manner without waste or causing erosion, reducing water or air quality, and maintaining a quality environment for plants and animals. Efficient irrigation promotes beneficial uses such as improving crop quality,

crop cooling if necessary, allowing for chemigation, leaching undesirable soil chemicals and achieving a desirable saline and sodic balance.

- **Farming System Research (FSR)** – The FSR component needs to work within selected micro-catchments which are representative of dominant agro-ecological zones in the project area. Research must be sensitive to the unique physical, biological, and socioeconomic characteristics of each site. Researchers need to draw upon the experience of farmers, extension workers, local government leaders, and other researchers who manage fragile lands. Field laboratories are important to carrying out long term technical research under controlled conditions. The research component will also need a strategy by which to communicate the results and findings of research.
- **Human Resources Development (HRD)** – The overall goal of the HRD component is to strengthen the capacity of project personnel at all levels, to deal with the ecological, social and economic complexities of planning, implementing and maintaining sustainable conservation and production systems in the hillslope areas. The HRD component provides long-term overseas and in country training, and short term in country training. Short-term training includes workshops, intensive technical courses, study tours and demonstration visits. Information activities such as brochures for farmers, community leaders, extension workers, technical staff and managerial staff also are related to this component.
- **Conservation Access Roads (CAR)** – The purpose of the CAR component is to develop or improve:
    - Access to remote villages
    - Make available the timely delivery of production inputs, such as seed and fertilizer)
    - Capacity to move local products to market
    - Allow for extension workers to get to villages in order to provide valuable extension assistance, and
    - Roads are better built, drained and maintained locally. Road banks are stabilized.
- **Project Innovation Fund (PIF)** - The PIF component will be used to encourage proposals from villages and local groups that accelerate soil and water conservation and sustain natural resources in the project areas. Innovation needs to be defined and parameters need to be set. Innovation should equate with locally driven and cost effective initiatives such as small pilot projects. Proposals should be completed in one to two years and a paper written about the success of the initiative.
- **Develop Pilot Small Watersheds and Flood Prevention Program** – This component will provide the opportunity for local government and watershed groups to help the people who live in certain watersheds where there is frequent flooding from tropical storms and hurricanes. Local watershed workgroups will propose recommendations and solutions to solving natural resource and related economic problems on a watershed basis. Local projects are encouraged as part of this component and can include watershed protection, flood prevention, erosion and sediment control, wetland creation

and restoration, and public recreation. A guideline would be established as to the maximum size of a watershed that would be defined as a "small" watershed. For example, a 100,000-hectare size might be proposed.

Supporting Components: *Soil Survey* will be carried out in the project area ahead of the implementation of conservation planning and application in the project area. *Policy studies* will be carried out mid-way through the project and again one-year prior to the end of the project. A *regional (Caribbean) workshop* will be hosted in the Dominican Republic in order to demonstrate the project to others in the area. Based upon donor support, local *Extension Centers* will be built and staffed. The *development of local water sources* for conservation irrigation and drinking water will be financed through the project.

Project Management: Management of the project has to be decentralized in order to be successful and achieve the goals and purpose of the project. Management of the project on a national level has to be unified and the budget system is a unified budget system. Success of the project is dependent on community participation and management. This proposal should not be undertaken as a project proposal that can be implemented and carried out solely at the national level.

Management Information System: Monitoring the output of the project is necessary. A Management Information System (MIS) needs to have the capability of routinely generating data on input and output performance and providing information to project authorities at the provincial and national level.

Reports: A series of reports will be scheduled through out the project. Baseline data for villages within the selected watershed project areas will be necessary in order to evaluate the project. Baseline data will include social, economic and cultural data gathering that will be used to produce information about the report. Case studies and time series data about selected villages in certain sub-watersheds will be done later in the project. Evaluation reports on the use of technology and training will be important to evaluating the success of the project. Natural resource assessment and planning tools will be developed during the project and their use documented.

Staffing Needs: The best approach will be to have a multi-disciplinary team in country. The team would not necessarily have to be in country all at the same time. The team would consist of (1-2) Conservation Agronomists; (1) Civil Engineer with experience in the design and construction of roads and conservation structures; (1) Watershed Planner; (1-2) Soil Conservationists; (1) Management Information Specialist; (1) Soil Scientist; and (1) Team Leader who will be a liaison with the Executive Secretariat and the sponsoring agency or organization in the Dominican Republic.

Short Term Assistance: Short-term assistance will be used to bring specialized assistance to the project area to fulfill training, evaluation, assessment and reporting needs. Rural Sociologists, Economists, Engineers and Cultural Anthropologists are examples of short-term assistance required.

Term of the Project: The term of the project will be a minimum of 5 years. Year one will be spent in start-up and getting technical assistance teams in the field. Years 2, 3 and 4 will be for implementation, with a midterm evaluation taking place in year 3. Assessment of the project begins in year 4 with policy recommendations being drafted. A regional workshop should be held in year 4 or 5. Year 5 is used for closing out the project and preparing final assessments and policy recommendation. There will be a national workshop in year 5.

Presentación - Asistencia Técnica del USDA/NRCS
en Cooperación con IICA/INDRHI/SEA
Diciembre 2 a 10, 1998

EVALUACIÓN DE LOS IMPACTOS DEL HURACÁN GEORGES EN EL AGUA Y EL SUELO DE LA REPÚBLICA DOMINICANA

Equipo del USDA/NRCS

- **Manuel Rosales**, Agrónomo Conservacionista. Manuel es Agrónomo Conservacionista de Akron, Colorado.
- **Gary S. Domian**, Conservacionista de Suelos. Gary is Asistente Conservacionista del Estado en Durham, New Hampshire

Términos de Referencia

- Producir un informe sobre los impactos del Huracán Georges
- Comentar sobre los daños del agua, la erosión y la sedimentación
- Hacer referencia a los principales impactos en la infraestructura de riego y otras
- Explicar las causas y hacer recomendaciones

Se hicieron visitas de campo a estas Provincias:

- **San Juan**
- **Baoruco**
- **Barahona**
- **Azua**
- **Monseñor Nouel**
- **San Cristóbal**
- **Peravia**
- **La Vega**

Paradas en pueblos y comunidades:

- **1. Juma**
- **2. Bonao**
- **3. Piedra Blanca**
- **4. Arroyo Frío**
- **5. El Río**
- **6. Tireo Abajo**
- **7. Constanza**
- **8. Cambita**
- **9. La Colonia**
- **10. Mano Matuey**
- **11. Los Cacaos**
- **13. Los Mineros**
- **14. S. Jose de Ocoa**
- **15. Galeon-Bani**
- **16. Azua-Peralta**
- **17. Tamayo**
- **18. Jaquimeyes**
- **19. San Juan**
- **20. Guazumal**
- **21. La Pina**
- **22. Rio Arriba Norte**
- **23. Cortés**
- **24. Amiama Gomez**

Cuencas de las visitas de campo:

- **Río Yuna**
- **Río Jimenoa**
- **Río Tireo**
- **Río Yaque del Norte**
- **Río Haina**
- **Río Nizao**
- **Río Ocoa**
- **Río Yaque del Sur**
- **Río San Juan**
- **Río Maguana**

Criterios utilizados:

- **Exigencia** existe cuando hay una amenaza *inminente* de pérdida de vidas y daños a propiedades. La "**exigencia**" permanece mientras hay probabilidad de estos daños a nivel de emergencia.

Criterios (continuación)

- **La no-exigencia** ocurre cuando permanece la probabilidad de pérdida de vidas o daños a propiedades, pero ésto **no** es una amenaza inminente. La no-exigencia existe mientras la probabilidad de estos daños permanece lo suficientemente alta para llegar al nivel de emergencia.

Qué debe esperarse de la Asistencia Técnica?

- **Aliviar los riesgos inminentes de pérdida de vidas y propiedades causadas por las inundaciones y productos de la erosión.**
- **Nota: los riesgos son causados por alteraciones repentinas en las cuencas**

Las Medidas Elegibles Deben:

- **Retardar la escorrentía** para evitar las inundaciones y/o la erosión
- **reducir riesgos** a la vida y a la propiedad
- ser **económica y ambientalmente** aceptables
- ser **técnicamente** correctas
- su **costo** debe ser **compatible con el beneficio** que ofrece y debe aliviar del peligro

Consideraciones sobre los Recursos Naturales

- Erosión del **suelo,** su condición y deposición
- Cantidad y calidad del **agua**
- Calidad y condición del **aire**
- Condición, manejo y tipo de la **vegetación** relativo al medio
- Habitat y manejo de los **animales**
- Condiciones **económicas**, tierra, capital, trabajo, riesgo, ...
- Recursos **sociales** y culturales, características de los individuos y de la comunidad

Alteraciones en las Cuencas Causadas por el Huracán Georges

- **Deslizamientos de rocas y tierra**
- **Cauces de ríos llenos de sedimento**
- **Erosión por cárcavas**
- **Erosión de bancos**
- **Movimiento de sedimentos**
- **Escombros en los cauces**
- **Disminución de la capacidad productiva de las tierras**
- **Sistemas de riego llenos de sedimento**
- **Erosión en los bancos de los caminos**
- **Daños en la foresta**
- **Estructuras removidas**

Alteraciones en las Cuencas (continuación)

- **Impactos en los recursos costeros**
- **Impactos en los recursos urbanos**
- **Estructuras de control de aguas removidas frecuentemente**

Usos de la Tierra Afectados

- **Foresta**
- **Agro-foresta**
- **Cultivos anuales**
- **Cultivos permanentes**
- **Pastos**
- **Plantaciones**
- **Tierras irrigadas**
- **Casas**
- **Edificios comerciales**
- **Alojamientos para huéspedes turistas**
- **Hospitales**
- **Iglesias**
- **Bancos**
- **Servicios de gobierno**
- **Abastecimiento de agua público**

Usos de la tierra (cont.....)

- **Reservorios**
- **Presas y aliviaderos**
- **Sistemas sanitarios privados**
- **Caminos, mejorados y no mejorados**
- **Servicios de luz, teléfono...**
- **Puentes y alcantarillas**
- **Abastecimiento de agua rural**

Conecciones importantes con los resultados del Huracán Georges

- Geología superficial y del substrato
- Los bancos de caminos contribuyen con sedimento durante eventos menores de lluvia
- Cunetas de caminos requieren mantenimiento
- Debe considerarse la selección de especies de plantas con raices apropiadas a los suelos
- Desarrollar y proteger las fuentes de agua locales

Conecciones importantes (cont...)

- Alcantarillas, estribos, mandiles de caminos removidos con frecuencia
- Los deslizamientos y avalanchas de tierras y rocas son frecuentes y predecibles en muchos casos
- Los puntos débiles en los caminos rurales están en las curvas cerradas o pronunciadas
- Los puentes dañados deben ser removidos inmediatamente

Conecciones importantes (cont...)

- Los aliviaderos de emergencia deben ser armados en ambos lados, entrada y salida
- Se deben colocar collares anti-filtraciones en las alcantarillas debajo de presas y caminos
- Los gabiones pueden ser efectivos
- Considerar sistemas de aviso de inundaciones
- Árboles sueltos pueden significar problemas críticos

La Conservación de Suelos es fundamental...

- ...pero, la conservación de suelos solamente no es suficiente.

- El éxito de la conservación depende de un enfoque integrado de manejo del suelo natural, el agua, el aire, las plantas y animales y sus interacciones entre si y con la sociedad y su economía.

Pasos para el planeamiento de recursos:

Fase I. Colección y Análisis

1.Identificar problemas y oportunidades

2. Determinar objetivos

3. Inventariar recursos

4. Analizar datos de recursos

Fase II. Sistema de Apoyo a la Toma de Decisiones

5. Formular alternativas

6. Evaluar Alternativas

7. Tomar decisiones

Planeamiento de Recursos (cont...)

III. Aplicación y Evaluación

8. Implementación del plan

9. Evaluación del plan.

Se Recomienda el Manejo de Cuencas con Liderazgo Local

- El manejo de los recursos de agua se construye sobre la base de la conservación y manejo efectivos de los recursos naturales

Cuencas con liderazgo local (cont...)

- Un grupo o una asociación de una cuenca con liderazgo local trabaja por consenso a través del uso correcto de la ciencia, economía, la última tecnología, y la información actualizada

Cuencas localmente lideradas (cont...)

- Los grupos con liderazgo local tienen una *visión compartida* de su tierra y su comunidad. Las personas en las cuencas trabajan juntas para apalancar el interés y los recursos para el trabajo de conservación

Liderazgo nacional en las cuencas

- Un programa nacional proveerá liderazgo nacional para la conservación del suelo y del agua, y recursos naturales relacionados
- El programa debe proveer asistencia técnica *equilibrada* y programas cooperativos de conservación para los usuarios de tierras

Estudios de cuencas y planeamiento

- Un programa nacional ayudará a grupos nacionales, grupos provinciales y grupos locales
- protegerá a la tierra de la erosión, las inundaciones, y la sedimentación
- mejorará la cantidad y calidad del agua en las cuencas

Estutios de cuencas (cont...)

- Un programa nacional desarrollará planes, conducirá levantamientos y estudios de los recursos de las cuencas, realizará análisis de riesgos de inundaciones, y proveerá recomendaciones sobre el manejo de las planicies de inundación.

Componentes recomendados de Programas de Conservación

- Caminos de Acceso de Conservación
- Sistemas Sostenibles de Agricultura de Montaña
- Investigaciones sobre sistemas de manejo de la agricultura
- Desarrollo de Recursos Humanos
- Fondos de Innovación para Conservación con Liderazgo Local
- Tecnología Aplicada para el Manejo de Cuencas en Tierras de Ladera

Programas Recomendados (cont...)

- Establecer un Secretariado Ejecutivo Nacional
- Manejar Programas Localmente a través de unidades de Manejo de Programas
- Monitorear los Programas regularmente

Gracias!

- **Manuel Paulet**, Especialista de Agua y Suelo, (IICA)
- **Rafael J. Marte**, Representante, IICA
- **Frank T. Rodriquez**, Director Ejecutivo, (INDRHI)
- **Teofilo Payano** and **Maximo Portorreal**, Secretaria De Estado De Agricultura
- **Ing. Hector Melo**, INDRHI
- **Sergio Mora C.**, Banco Interamericano de Desarrollo

MANEJO DEL AGUA Y DEL SUELO EN LA REPÚBLICA DOMINICANA

Análisis de Necesidades depués de los Impactos del Huracán Georges[1]

Informe del viaje de reconocimiento del 2 al 10 de Diciembre de 1998

Introducción

> *La República Dominicana de 48,000 Km² de superficie tiene 60 por ciento de su territorio con tierras de topografía accidentada donde se da simultáneamente una creciente disminución del área con vegetación permanente en favor de usos intensivos, asociada a condiciones de lluvia de alta agresividad. Estas condiciones originan el deterioro por erosión acelerada de los recursos de tierras y aguas, la pérdida de capacidad de los embalses –de uso para irrigación y generación de energía eléctrica, y la disminución del flujo base de los ríos en favor del incremento de picos o avenidas que ocasionan inundaciones.*

Este párrafo aparece en la introducción del informe de término de servicios del autor en 1984[2]. Han pasado quince años y desde ese entonces se observa que no ha mejorado sensiblemente las condiciones del país para resistir eventos de la naturaleza que, como el huracán Georges, aunque esporádicamente, hay certeza se presentarán nuevamente en alguna oportunidad futura. Esta oportunidad puede ser el próximo año, o cualquier año. En algunos años los Huracanes se ven pasar sin tocar el país, con alguna regularidad continuarán las lluvias intensas responsables de la abundancia de agua en este país pero también de impactos dañinos inevitables en algunos casos pero tal vez evitables, en otros, cuando el agua resultante y los suelos por los que escurre se manejan bien.

El propósito de este informe es analizar algunos de los impactos del huracán como evidencia de la necesidad de formular e implementar sostenidamente políticas relativas a la conservación de los recursos naturales, en especial, el agua y el suelo.

Este informe preliminar incluye las observaciones del autor enriquecidas con las discusiones de grupo del equipo, y dos Anexos. El **AnexoI**, incluye una descripción resumida de las actividades realizadas en el período.

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[1] Por Manuel Paulet Iturri, Especialista Regional del IICA. Recursos de Agua y Suelo; Gary Domian, Assistant State Conservacionist, New Hamshire, USDA/NRCS; Manuel Rosales, Conservacionista Especialista en Calidad de Suelos y Aguas, Colorado-USDA/NRCS;

[2] Paulet, M. 1984. FORTALECIMIENTO DEL SISTEMA DE RECURSOS. NATURALES EN EL SECTOR AGRICOLA. Informe Final de Cooperación Técnica. IICA/RD. Período 1976-84. 32p

Antecedentes

Este informe resulta de la visita de evaluación de los efectos sobre el agua y el suelo del huracán Georges. A pedido del Representante del IICA en la República Dominicana, Rafael J. Marte, en virtud del Convenio IICA/USDA de 1994, se conformó un equipo compuesto de dos técnicos del Servicio de Conservación de Recursos Naturales del Departamento de Agricultura de los Estados Unidos (USDA/NRCS): Gary Domian, Conservacionista Asistente del Estado de New Hampshire, y Manuel Rosales, Conservacionista del Estado de Colorado. La coordinación fue realizada por Manuel Paulet Especialista Regional del IICA en Suelo y Agua con sede en Costa Rica y Otto Gonzalez del Servicio Agrícola para el Exterior del USDA. Al equipo se sumaron tres técnicos de los organismos cooperantes en el país: Héctor Melo, de la División de Manejo de Cuencas del Instituto Nacional de Recursos Hidráulicos (INDRHI); Teófilo Payano y Máximo Portoreal del Departamento de Inventario de Recursos Naturales (DIRENA) de la Sub-Secretaría de Recursos Naturales de la Secretaría de Estado de Agricultura (SURENA/SEA).

Observaciones y Discusión

Los estragos del huracán, los suelos y el agua.

Árboles: En las laderas de partes altas de las cuencas, se observaron gran cantidad de árboles cortados, con las ramas rotas o sin ramas, pero también muchos árboles caídos y muchos árboles con sus raíces depositados en los cauces de los ríos, aguas abajo, en muchos casos detenidos por estructuras de cruce como puentes y caminos. Se podría concluir que el viento huracanado "raleó" la foresta en extensiones considerables (caso notable el de las lomas de Villa Alta Gracia). Los árboles así caídos han constituido un peligro adicional –durante el huracán, durante las lluvias posteriores, y en el futuro si no son removidos- originando obstrucciones al paso del agua, conformando embalses temporales, desviando el agua y originando o contribuyendo a las inundaciones en la vera del río, precipitando la falla de estructuras y descargas o desembalses rápidos, en momentos en que el peso del agua es mayor que la resistencia de la presa temporal.

Suelos. En las laderas de las partes altas de las cuencas, se observaron numerosos deslizamientos, -notables por las manchas de color de tierra colorada sobre el color verde de la foresta o vegetación natural de tipo arbustivo; en algunos lugares se observó erosión severa sobre terrenos de cultivo -notable por la gran cantidad de surcos de recorrido sinuoso en el sentido de la pendiente de los terrenos. En algunos lugares se observa roca al descubierto, o manchas blanquecinas que se confunden con el color de la tierra en las laderas (indicando la presencia del substrato de material calcáreo). Éstas no necesariamente vinculadas con los efectos del huracán sino manifestando el efecto de la erosión cotidiana resultante del uso inapropiado de estas tierras. Estos suelos y otros donde se observa afloramiento de rocas, ya están "listos"[3]. Ya no hay capacidad de

[3] Aunque el recorrido no lo incluye, el paso del avión en el camino hacia EU el día 10 de diciembre temprano, permitió observar el uso intensivo de las tierras en las laderas de la sierra central que contribuyen al río Yaque del Norte (la Línea Noroeste). Habría que evaluarlo, mas da la impresión de un paisaje desvastado donde la erosión ya hizo efectos irreversibles en grandes extensiones.

almacenamiento de agua por infiltración y por tanto, son superficies casi impermeables donde el coeficiente de escurrimiento es casi la unidad (la lluvia que cae escurre casi inmediatamente). Tampoco parecen ser soporte adecuado para el crecimiento de árboles de crecimiento vertical y raíces profundas.

Avenidas e Inundaciones.

Indudablemente, los estragos mayores no son solamente aquellos del viento huracanado sino de las lluvias que se presentaron con suficiente duración para humedecer en toda su profundidad el poco suelo que queda en algunas áreas dejando la superficie expedita para la acción destructiva de lluvias subsecuentes de alta intensidad[4]. En estas condiciones, el empuje del viento durante el huracán explica la caída y el "raleo" de los árboles. Los deslizamientos son la caída de porciones de tierra en las pendientes cuando su propio peso vence la resistencia de substratos inferiores. La baja capacidad de almacenamiento de agua de la superficie en las cuencas altas debido al pequeño espesor del suelo, a veces con roca o arcilla de substrato, y la baja densidad de la vegetación determinan un alto coeficiente de escurrimiento, de manera que la ocurrencia de altas intensidades de lluvia en momentos determinados tuvo como respuesta la presencia de flujos "pico" o extremos en muchas cuencas. La ocurrencia simultánea de estos "picos" en cuencas tributarias del mismo río explican las grandes avenidas que se dieron –ayudadas por las obstrucciones en el paso del río, afectando poblaciones, estructuras y campos de cultivo. Estos efectos naturalmente son graves donde por falta de previsión estuvieron ubicadas poblaciones y campos de cultivo en el cauce "seco" del río. Esto es evidente en Montes de Oca, Mesopotamia, y Tamayo entre otras poblaciones afectadas. No es menos evidente en los daños sobre campos de cultivo localizados en los cauces secos de muchos torrentes que ahora se ampliaron por acción de las avenidas, y naturalmente en los cauces de los ríos observados en el viaje como Jimenoa, Tireo, Baní, Ocoa, Tábara, y el Yaque del Sur y sus afluentes, el San Juan y el Maguana.

Conclusiones y Recomendaciones

La relación entre las observaciones sobre los árboles con aquellas sobre los suelos y los efectos de las avenidas o "picos" de los ríos dio lugar a discusiones entre los miembros del grupo. Por lo menos estuvimos de acuerdo en las siguientes conclusiones y recomendaciones generales:

(1) Los programas de "forestación" debe tener en cuenta las características de los suelos. No necesariamente todos los suelos son apropiados para la siembra de especies forestales; por lo menos, algunas especies son mas apropiadas que otras teniendo en cuenta las características y el espesor del suelo. Es muy probable que la erosión que se ha producido en el país en extensiones considerables, no necesariamente con este huracán, ya ha tomado cuenta del espesor del suelo dejando muy poco para el establecimiento de plantas que, cuando alcanzan una determinada altura se vuelven

[4] Aunque de vientos (nada despreciables) de menor velocidad que el Huracán David (el mas grande del siglo) que azotó el país en 1979, el Georges se caracterizó por haber cubierto el país de cabo a rabo y por su lentitud de desplazamiento por lo que las lluvias intensas fueron de mucho mayor duración.

muy susceptibles de ser tumbadas por el viento por falta de sustentación –las raíces no pudieron extenderse.

Lo anterior sugiere las dos siguientes recomendaciones,

(2) Es necesario la constitución o fortalecimiento de un equipo –que puede ser de cooperación con Universidades y otras organizaciones, que se dedique a estudiar, experimentar y recomendar con base en la preservación de los eco-sistemas nativos, las especies de vegetación apropiadas para las condiciones de los suelos y micro-climas existentes en las cuencas.

(3) Se recomienda la constitución de un equipo –que debería ser cooperativo con otras organizaciones de investigación y los propios destinatarios, que se dedique de manera sistemática a estudiar, producir, recolectar y difundir informaciones detalladas de los suelos y su comportamiento para los distintos usos en todo el territorio del país.

(4) Dadas las condiciones de bajo almacenamiento superficial de las cuencas, la presencia de "picos" o avenidas rápidas será cada vez mayor en las cuencas de la República Dominicana. Por tanto, es probable que los sistemas de predicción en tiempo real con estaciones telemétricas hacia centros de control sean de efectividad limitada y, sin excluir éstas como apoyo, sea necesario recurrir a otras metodologías de prevención de daños que contemplen el incremento de la capacidad de almacenamiento en pequeños tributarios (mediante estructuras donde sea posible y seguro) para retardar el escurrimiento y los tiempos de concentración de áreas grandes, y la adopción de medidas económicas y de política que desmotiven el uso intensivo de tierras en las cuencas altas. Por ejemplo, el uso de prácticas de control de la erosión de tipo vegetativo y aun las prácticas mecánicas son convenientes, pero son prácticas que pueden motivar el uso intensivo para cultivos anuales. En San José de Ocoa se trabaja de esta manera desde hace 30 años. Ahora se pueden observar resultados satisfactorios y hay una gran tendencia aceptada por la comunidad hacia los usos de tipo permanente. Pero, tal vez es demasiado tarde para otras zonas donde no hay las condiciones de liderazgo por tanto tiempo que ha tenido dicho municipio. Por otro lado, y simultáneamente, es necesario el establecimiento y actualización de zonas con probabilidades de riesgos de inundación en todas las cuencas, especialmente en las planicies de inundación. Entre otras cosas, ésta sería la base para el establecimiento de seguros contra daños pero también, la adopción de procedimientos para el tratamiento de emergencias. Los residentes sabrían a que atenerse según el riesgo de la zona en que se encuentran.

(5) Todo esto, sin decir nada de los caminos y estructuras, incluyendo presas, cuyo diseño, construcción y mantenimiento debe corresponder a las características de la hidrología de la zona en que se encuentren. En este tema el trabajo a realizar es muy grande y seguramente está contemplado. Pero, es necesario que exista alguna forma de la comunidad verificar y entender lo que se hace al respecto. Naturalmente, siempre habrán daños que lamentar pero, es posible atenuarlos y estar preparados para resolver los problemas cuando se presentan.

Programa Nacional de Conservación y Manejo de Recursos Naturales

La naturaleza de los daños, su asociación con la forma histórica como se han conducido los usos de los recursos naturales en el país induce hacia la necesidad de realizar cambios importantes en el manejo de los recursos naturales. Recomendaciones de tipo técnico son bienvenidas, como lo han sido en anteriores oportunidades, pero la historia demuestra que éstas no se hacen efectivas de manera permanente. En la República Dominicana aunque la intervención de los organismos en el tema de la conservación de los recursos naturales ha dado muestras del mayor interés y profesionalismo, en muchos casos no se ha garantizado que las medidas técnicas y aun aquellas de orden legal se cumplan de manera sostenible.

Por esta razón, hay poco que asegure que las recomendaciones anteriores se lleven a efecto. Es más, no sería extraño que éstas ya hayan existido, se hayan presentado y discutido. Una de las estrategias que actualmente se utiliza cada vez con mayor éxito es hacer a la población sentirse parte y responsable de las actividades, en este caso de la conservación y manejo de los recursos naturales. Es la estrategia de San José de Ocoa. Es la estrategia actual de transferir, ya con algún grado de éxito, la responsabilidad por el manejo de los sistemas de irrigación a los usuarios en el Yaque del Norte, en San Juan de la Maguana y en otros distritos. Son las recomendaciones que coinciden con los Programas de la reunión de Río Eco-92 sobre el ambiente. Esa filosofía debe extenderse donde necesario a nivel nacional con la idea de conseguir un mayor interés de los ciudadanos incluyendo su participación administrativa y financiera, manteniendo el gobierno el papel regulador, promotor de las políticas, de apoyo técnico y financiero, y también de tutelaje irrenunciable del patrimonio de la nación.

Dentro de esta filosofía las recomendaciones anteriores caben junto con los demás aspectos técnicos, sociales, económicos y ecológicos que hacen al *manejo integrado de las cuencas hidrográficas*. Pueden distinguirse dos Programas, o pueden formar parte del mismo: (1) el Programa Nacional de Conservación de Recursos Naturales, y (2) Programa Nacional de Recursos Hídricos. En ambos casos éstos y sus componentes incluyen:

a. Las políticas, la legislación de tipo estructural y de regulación, para proteger los derechos de los ciudadanos y asegurar el cumplimiento de normas; se incluye las políticas y los mecanismos para conseguir el financiamiento sostenible –de la sociedad que se beneficia, por ejemplo, de las medidas de protección de cauces, o de aquellas para proteger las cuencas altas de la erosión proveniente de los beneficios de la generación hidroeléctrica, o los estudios para la delimitación de áreas de riesgo en las zonas inundables, y otras como la administración de los derechos de agua de los usuarios y el control de su calidad.

b. La organización a nivel de los usuarios, a nivel de las cuencas o subdivisiones políticas, a nivel de las regiones y a nivel nacional. En todos los casos de tipo participativo. La organización incluye la conformación de organismos locales para el propósito específico de conservar los recursos, proteger, desarrollar y manejar los recursos naturales de las cuencas, y también, el papel de los distintos tipos de organismos públicos y privados de los sectores vinculados, tanto de tipo administrativo,

empresarial, de servicios, de investigación y asistencia técnica, relacionados con la ejecución de las políticas indicadas. Todos en un mismo programa de acción continua y sostenible;

c. Los programas financieros de apoyo a la motivación del cumplimiento de la legislación.

El IICA en asociación con otras organizaciones internacionales y nacionales, podría apoyar en la formulación de propuestas de un Programas Nacional de Conservación de Recursos Naturales.

Anexo I

Actividades Realizadas

Miércoles 2 de Diciembre. (Manuel Paulet, del IICA llegó de Costa Rica el día anterior en la noche)

En el IICA:

(1) Reunión con Raúl Pineda del IICA quien estuvo a cargo de las coordinaciones preliminares en el país. Entregó documentación sobre informes realizados por otras organizaciones e informó sobre algunas reuniones para el Jueves 3;
(2) Reunión con Teófilo Payano y Máximo Portoreal del DIRENA/SEA sobre informaciones existentes;
(3) Reunión con José Francisco Febrillet, Eliseo Gonzalez y Gilberto Reynoso, Comité Ejecutivo de **Cultura del Agua** del INDRHI, asuntos a informar y asuntos pendientes: el INDRHI no firmó todavía el documento de constitución del comité de San Juan de la Maguana; curso sobre cultura del agua en Santa Ana; Curso de capacitación de voluntarios para Quisqueya Alerta en San Pedro fue pospuesto debido al huracán –en stand-by; la Organización Nacional de Profesores ha solicitado asociarse al Programa de Cultura del Agua y están dispuestos a colaborar con sus propios recursos; se promoverán reuniones con el BID para examinar posibilidades de financiamiento en apoyo del Programa;

Jueves 3 de Diciembre. (Los técnicos Gary Domian y Manuel Rosales, del USDA/NRCS llegaron de USA a Santo Domingo el día anterior en la noche)

(4) **En el IICA.** Reunión con Máximo Portoreal, Teófilo Payano de la DIRENA/SEA y con Orlando Añil del INDRHI, exposición de los nombrados sobre el tema del huracán frente al mapa de la República Dominicana; Añil presentó un documento sobre la hidrología durante el período crítico en la zona de San Juan;
(5) **En el INDRHI**. Reunión con el Director Ejecutivo del INDRHI, Frank Rodríguez para presentar al equipo que fue integrado desde ese momento también con Héctor Melo, de la División de Manejo de Cuencas, en representación del INDRHI. Esta reunión fue conducida por Rafael Marte, Representante del IICA en RD.
(6) **En el BID**. A las dos de la tarde el equipo se reunió con Sergio Mora, Geólogo, en la Oficina del BID quien explicó los trabajos realizados y entregó la documentación elaborada por este organismo. Puso a disposición del equipo todos los archivos, incluyendo la posibilidad de usar las facilidades físicas dsiponibles. La reunión con Sergio Mora permitió definir mejor el itinerario de visitas de campo, debido a los reconocimientos ya realizados por ellos previamente tanto por via aérea como por tierra. El banco está preparando un préstamo de mas de US$200 millones para la reconstrucción, incluyendo algunos componentes para restituir la capacidad operativa de los organismos de servicio, entre ellos, la red de estaciones meteorológicas e

hidrométricas del INDRHI. El BID está interesado[5] en apoyar las acciones de planeamiento del uso de la tierra, en las acciones que conduzcan a la concientización de la comunidad sobre la importancia de proteger los recursos naturales y, hacia la promoción de políticas y su implementación hacia el enpoderamiento local de la comunidad para el desarrollo del territorio de su ámbito con apoyo del Estado. Les gustaría que las acciones que se programen indiquen: quiénes están involucrados, en qué términos, cómo medir el progreso alcanzado, quiénes son responsables.

(7) **En la Embajada de USA**. A las 4:30pm. Reunión con Kevin Smith (688 8090), Agregado Agrícola del USDA, reunión de intercambio de información.

(8) **En la AID**. A las 5:30 pm con Luis Gonzales, sobre políticas en general, y con Carleen Yocum, Especialista Forestal del Servicio Forestal de los EU con sede en Puerto Rico. Carleen está destacada por un tiempo en la RD para hacer una evaluación de los impactos del huracán en los recursos forestales. Nos entregó copia del informe preliminar y nos hizo algunas explicaciones de sus experiencias. Estuvo de acuerdo con las áreas a visitar por el equipo.

Viernes 4 de Diciembre (equipo constituido por Héctor Melo del INDRHI; Teófilo Payano de SEA/DIRENA, M Paulet, IICA; Gary Domian y Manuel Rosales del USDA/NRCS; vehículo Mitsubishi de doble cabina aportado por el INDRHI)

(9) **Viaje a Constanza**. Por la carretera central hacia Constanza, pasando por Villa Alta Gracia, Bonao, y Tireo. Observaciones de foresta destruida, deslizamientos de diversas magnitudes, inundaciones en la Ciénaga de Río Frío y en Tireo, propiedades cortadas por el río, bancos de caminos en peligro, depósitos de sedimentos.

Sábado 5 de Diciembre (mismo equipo)

(10) **Viaje a San José de Ocoa**. Por la carretera hacia el Sur, entrando por Cambita hacia los Cacaos, pasando por la Presa de Aguacate hasta Ocoa y de regreso a Santo Domingo. Observaciones de tipo similar al viaje anterior. En una de las comunidades se observó la destrucción de algunas viviendas y una escuela (27 fallecidos) construidos en el cauce del río a unos 30m aguas arriba del puente. Entre el puente y las viviendas, paralelo a él, había un tramo de carretera para vehículos pesados con alcantarillas debajo de ella. Dicho tramo produjo un embalse de la avenida de agua que sedimentó y enterró las viviendas. Casi llegando a San José de Ocoa, en la montaña, nos encontramos con personal de la Asociación para el Desarrollo de San José Ocoa (ADESJO), entre ellos su fundador, el Padre Luis Quinn y el Ingeniero Bonilla (inseparables, ambos artífices del proyecto permanente "Ocoa"). Estaban en una ceremonia de inauguración de un asentamiento de productores conservacionistas a quienes se les habían otorgado lotes de terreno para el cultivo de especies forestales y frutales valiosos. En contraste con las cuencas anteriores, el paisaje en la cuenca del río Ocoa ya denota el cuidado conservacionista de sus pobladores. Un resultado que parece tendrá éxito en términos de su sostenibilidad.

[5] Interpretación de las notas del autor de este informe, basado en la reunión realizada, sin comprometer al BID por estas afirmaciones.

Lunes 7 de Diciembre. (se adiciona al equipo Máximo Portoreal de DIRENA/SEA, que viajan con Jeep de la SEA)

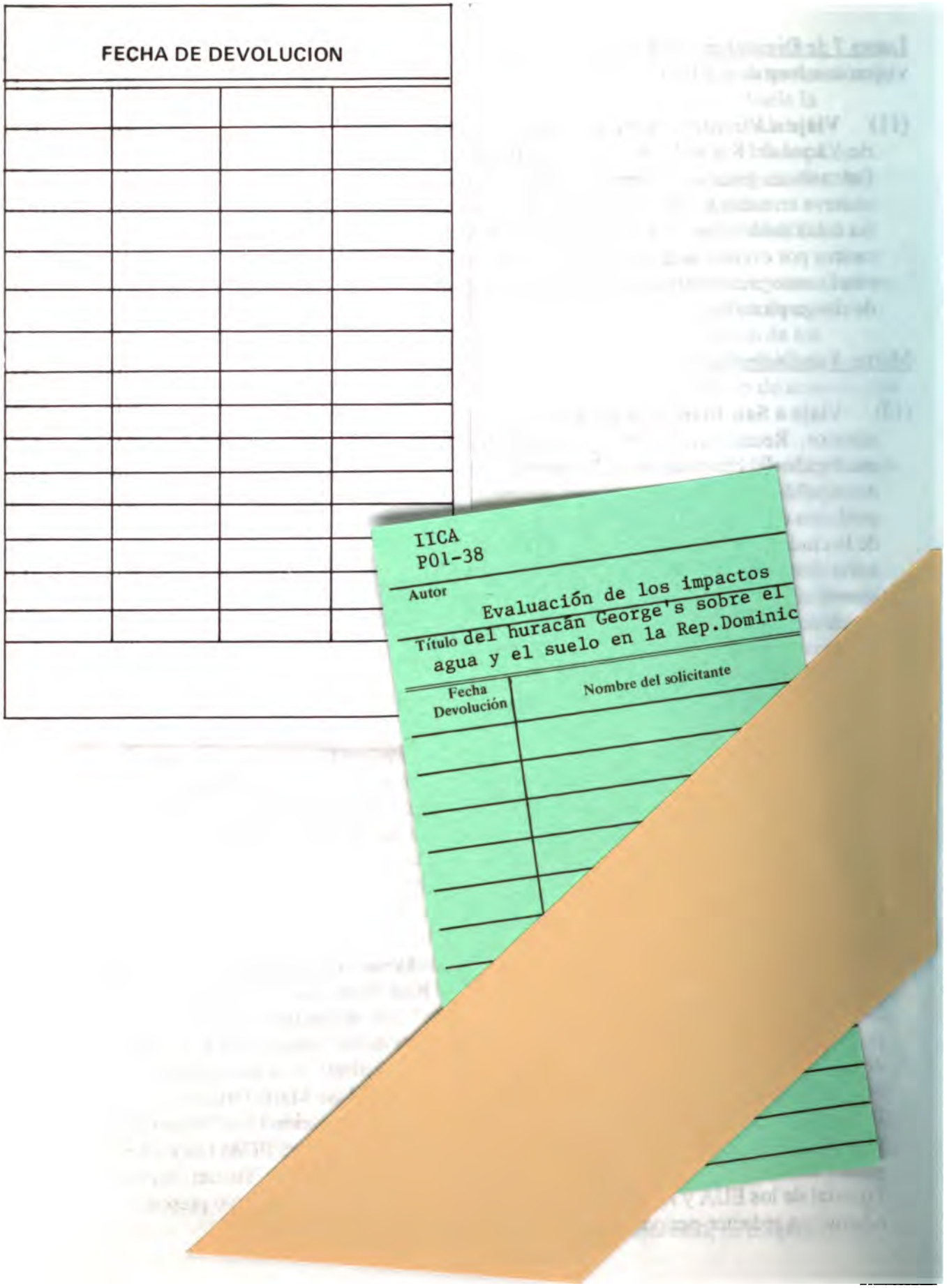
(11) **Viaje a Vicente Noble y Tamayo.** Observación de los efectos de las avenidas del río Yaque del Sur en las poblaciones aledañas al río en su parte baja, cerca de Barahona. Extensiones grandes de tierras y poblaciones afectadas por las inundaciones. Se observa en todos los casos que se trata del paso del río con caudales extraordinarios por las áreas inundables. En muchos casos las barras de sedimentos depositados en los cauces por eventos anteriores han actuado de barreras de desviación de las aguas y en otros como presas para elevar el nivel del río que invadió áreas nuevas, aunque siempre de riesgo probable.

Martes 8 de Diciembre.

(12) **Viaje a San Juan de la Maguana.** El equipo fue a dormir a San Juan la noche anterior. Reunión en las Oficinas del PRODAS con su Director, Leonel Duarte y el encargado del componente de Desarrollo Agropecuario, César Paniagua. Leonel Duarte acompañó al equipo al campo para observar los impactos de las avenidas en los poblados de Montes de Oca y Mesopotamia (entre dos brazos del río San Juan, cerca de la ciudad). También se trata de poblaciones localizadas en el camino del río. Ambas están destruidas. Los daños que se observan a simple vista aparecen mayores que lo observado en Tamayo. Luego fuimos a la unión del río Maguana con el río San Juan donde hay un puente destruido y luego a la presa de Sabaneta donde se observa los estragos de la crecida que pasó por encima del aliviadero de emergencia. Aunque las estructuras de concreto se observan en buen estado, aparentemente no hubo previsión sobre los efectos de una crecida sobre el conducto de tierra de salida del aliviadero el que fue erosionado de manera impresionante. Se observa que fueron desprendidas las alcantarillas que pasan por debajo del camino que atraviesa la salida del aliviadero. Podría asumirse que esta rotura fue explosiva cuando el nivel del agua rebasó por encima de dicho camino, descargando una mayor cantidad de agua en un momento dado que el calculado para el canal de salida. No se observaron daños en las estructuras de riego ni en los campos de cultivo.

Miércoles 9 de Diciembre.

(13) **Presentación sobre observaciones y recomendaciones preliminares.** En el IICA de las 9:00am a 12m. En reunión coordinada por Raúl Pineda del IICA, los señores Domian y Rosales hicieron una presentación sobre las observaciones del viaje y sus primeras recomendaciones. El material utilizado para dicha presentación es el Anexo II de este documento (traducido al castellano por quien escribe). Los asistentes fueron: Máximo Portorreal, y Teófilo A. Payano, DIRENA/SEA; Juan María Grullón, Departamento de Tierras y Agua, SEA; Yrene López, Planificación IAD; Héctor Melo, ONAMAC/INDRHI; Manuel Paulet; Raúl Pineda y Rubén Núñez, IICA; Gary Domian y Manuel Rosales, USDA/NRCS; Esther Soriano, INDRHI; Carleen Yocum, Servicio Forestal de los EUA y AID; Teófilo Suriel, CEDAF (antes FDA). Estuvo presente además un redactor-periodista del diario El Caribe.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Fecha Devolución
Nombre del solicitante