# UNIVERSIDAD TECNOLÓGICA DE PANAMÁ

## INFORME DE VIAJE

El presente formato tiene el objetivo de consolidar toda la información obtenida por los colaboradores, que de una u otra forma se hayan beneficiado para realizar viaje al exterior, el cual, a la vez será reportado al Ministerio de la Presidencia para justificar la gestión realizada, en correlación con el presupuesto ejecutado.

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| TIPO Y NOMBRE DE LA ACTIVIDAD | **Viaje a la Universidad de Virginia por el Dr. José Fábrega** |
| LUGAR Y FECHA (Duración) | **Charlottesville, Virginia** **Fecha**: 16 al 20 de abril de 2013. |
| OBJETIVOS | a. Reforzar la relación ya existente entre el CIHH y la Universidad de Virginia, a través del profesor Edward Berger.<br><br>b. Mostrar las diferentes áreas de investigación y competencia que tiene el CIHH a los profesores y estudiantes de la escuela de Ingeniería Civil y/o Ciencias Ambientales de esta universidad.<br><br>c. Explorar diferentes formas de colaboración entre ambas universidades (UTP/Uva). Por ejemplo:<br><br>c.1.) Evaluar las fortalezas que tiene la Uva en Ingeniería Civil y ambiental para que nuestros profesores y/o investigadores en el área puedan aprovechen éstas a través de pasantías.<br><br>c.2.) Evaluar la posibilidad que la Uva/UTP trabajen conjuntamente en cursos que actualmente dicta la Uva para sus estudiantes (Curso del Canal de Panamá por ejemplo). La idea sería plantear que a cambio de la ayuda logística que se les pueda ofrecer, se nos den oportunidades de pasantías y estudios para nuestros estudiantes.<br><br>c.3.) Plantear la posibilidad de desarrollar seminarios conjuntos para profesores, investigadores y estudiantes de la UTP en áreas en donde el CIHH tenga fortalezas (Ej. Hidrología Tropical y educación de las ciencias). |
| PARTICIPANTE (S) | **Dr. José Fábrega** |

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| ASPECTOS RELEVANTES EN EL DESARROLLO DE LA ACTIVIDAD | Aspectos relevantes en el desarrollo de la actividad<br>La visita a la Universidad de Virginia (UV) inició con la invitación por parte del Dr. Edward Berger a mi persona (ver Anexo A)<br>A. Reuniones con los siguientes profesores y autoridades<br>**Martes 16.** Llegada a Charlottesville. Fui recibido por el Dr. Edward Berger (Vice Decano para programas de pregrado). Más tarde, se sostuvo una reunión de coordinación con el profesor Edward Berger. Se habló sobre las diferentes actividades a realizar durante la visita y futuras colaboraciones en general. Se le informó, la necesidad de tener reuniones con la persona encargada de intercambios dentro de la facultad de ingeniería.<br>**Miércoles 17**. Recorrido por la universidad de Virginia dado por el profesor Berger, en donde uno de los puntos principales fue la visita al laboratorio de mecatrónica y para la creación rápida de prototipos; así como los indicadores inteligentes del edificio principal de la Escuela de Ingeniería y Ciencias Aplicadas de UV (Anexo B). Posteriormente, reunión con los profesores Andres Clarens y Wu-Seng Lung del departamento de Ingeniería Civil y Ambiental. El Dr. Clarens es especialista en métodos de captura de carbono, y el Dr. Lung trabaja principalmente en calidad de agua de ríos. Igualmente, al final del día se sostuvo una cena de trabajo con Joanna Curran y Teresa Culvert. Con ambas profesoras, se conversó sobre sus intereses en investigación y aspectos de género en la escuela de Civil y Ambiental en la Universidad de Virginia. La Dra. Curran es especialista en procesos de sedimentos en ríos y la Dra. Culver en modelación de agua subterránea. Ambos son temas con los que se pudieran realizar colaboraciones en un futuro.<br>**Jueves 18**. En la mañana, se sostuvieron reuniones con profesores del departamento de ciencias ambientales. Primeramente, me reuní con Janet Herman, quien es la directora del departamento de Ciencias Ambientales, quien hizó un recorrido por diferentes sitios en los que la Universidad de Virginia lleva a cabo proyectos de remediación. La especialidad de la Dra. Herman es hidrología urbana.<br>Luego, me reuní con Vivian Thomson, quien al igual que el Dr. Berger (Clase sobre el Canal de Panamá en Panamá) y el Dr. D´Odorico (ver párrafo siguiente) participan del "Panama Initiave", que es un programa que fomenta trabajos de investigación y docencia en Panamá, y el cual está apoyado por la Universidad de Virginia y algunas instituciones en Panamá como la Ciudad del Saber y el STRI. La profesora Thomson (proyectos de manejo ambiental, como por ejemplo el relleno sanitario de Mount Hope en Colón).<br>Con el profesor Paolo D´Odorico conversamos sobre la posibilidad que la UTP a través del CIHH participe en un proyecto de monitoreo del flujo de carbono en manglares. La idea que tiene el profesor D´Odorico, es establecer una estación para medir flujo de CO2. Estos resultados pueden complementarse con los resultados que arroje una estación similar que tiene el CIHH en Tocumen. Se habló también de la posibilidad de que el proyecto del profesor D´Odorico pudiera patrocinar a un estudiante de tesis en Panamá.<br>En la tarde, me reuní con el profesor Todd Scanlon quien tiene algunos proyectos en Africa y que trabaja en el tema de captación de cuencas.<br>Finalmente, se dio un seminario a estudiantes y profesores de los departamentos de Ingeniería Civil y Ambiental y de Ciencias Ambientales. (Ver anexo C)<br>**Viernes 19**. El día viernes me reuní con la Dra. Pam Norris, quien es la coordinadora de los programas de Investigación y Postgrado de la Facultad de Ingeniería de esta universidad. Básicamente, con ella se conversó sobre los costos de la UV para estudiantes que deseen llevar a cabo carreras de postgrado, la posibilidad de UV de apoyar contactando profesores en el área de ingeniería que estén dispuesto a recibir estudiantes panameños ya sea para estudios formales o bien para la realización de pasantías de investigación. Para los programas de intercambio (especialmente académicos), es necesario que la UTP se incluya dentro de la lista de universidades que participa en intercambios con UV. Igualmente, se me confirmó que aún cuando no se reciba un título formal (en caso de pasantías cortas), es posible que se nos expida una certificación de participación y trabajo del estudiante.<br>También el viernes se sostuvo una reunión con el Dr. Dana M. Elzey, quien es el Director de Programas Internacionales del Departamento de Ingeniería y Sociedad de la Escuela de Ingeniería y Ciencias Aplicadas de UV. Esta reunión fue complementaria a la llevada a cabo con Pam Norris y principalmente se nos comentó que lo importante con los intercambios es la reciprocidad de los mismos, es decir, por cada estudiante de la UTP que vaya a UV idealmente, debe haber un estudiante de UV que quiera venir a la UTP. En el caso de los estudiantes graduados, los intercambios dependen mucho de los profesores. La UTP no tiene que estar acreditada con ABET para que el intercambio exista y se pueden hacer arreglos particulares. Por ejemplo, hay una universidad francesa en la cual UV se comprometió a recibir dos estudiantes para investigación a cambio que Francia recibiera uno para dar clases.<br>Finalmente, me reuní con el profesor Berger en donde conversamos sobre los resultados de la visita y de algunas de las conclusiones que se había obtenido y oportunidades de colaboración existentes.<br>**Sábado 20**. Salida de Charlottesville y regreso a Panamá. |

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| RESULTADOS OBTENIDOS<br>(Contacto con futuros expositores, becas, firma de convenio, etc.) | a. Dictar un seminario en la Escuela de Ingeniería civil y/o Ciencias Ambientales de la Uva sobre la UTP en general y el CIHH en particular<br><br>b. Sostener reuniones tanto con el profesor Edward Berger, (Associate Dean for Undergraduate Programs, School of Engineering and Applied Science, UVa), como con profesores de las Escuelas de Ing. Civil y/o Ciencias ambientales de la Uva.<br><br>c. Explorar diferentes formas de colaboración entre ambas universidades (UTP/Uva). Por ejemplo:<br>c.1.) Evaluar las fortalezas que tiene la Uva en Ingeniería Civil y ambiental para que nuestros profesores y/o investigadores en el área puedan aprovechen éstas a través de pasantías.<br><br>c.2.) Evaluar la posibilidad que la Uva/UTP trabajen conjuntamente en cursos que actualmente dicta la Uva para sus estudiantes (Curso del Canal de Panamá por ejemplo). La idea sería plantear que a cambio de la ayuda logística que se les pueda ofrecer, se nos den oportunidades de pasantías y estudios para nuestros estudiantes.<br><br>c.3.) Plantear la posibilidad de desarrollar seminarios conjuntos para profesores, investigadores y estudiantes de la UTP en áreas en donde el CIHH tenga fortalezas (Ej. Hidrología Tropical y educación de las ciencias). |
| CONCLUSIONES | Conclusiones<br>1. La visita fue provechosa en la medida en que se dieron a conocer los diferentes proyectos y sitios de investigación que maneja el CIHH.<br>2. Se sostuvieron reuniones con diferentes profesores tanto del Departamento de Ciencias Ambientales como el Departamento de Ingeniería civil y ambiental. Esto permitió conocer los trabajos que llevan a cabo estos profesores.<br>3. Dado el interés mutuo de exploraron diferentes vías de futura cooperación, las cuales se presentan en la sección de recomendaciones. |

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| RECOMENDACIONES | Recomendaciones. Las principales recomendaciones que pueden hacerse a partir de esta visita son:<br>A. Explorar la posibilidad de realizar pasantías de investigación tanto de estudiantes como de profesores de la UTP a UV. Lo más factible es que las mismas sean cortas (4 a 6 semanas) por razones de costo. La ventaja de las pasantías de investigación es que al no ser actividades tendientes a la consecución de un título, no requieren el pago de matrícula. Los contactos ya establecidos con UV en posiciones de coordinación, pueden facilitar la búsqueda de los profesores y laboratorios más indicados para atender a nuestros estudiantes y profesores. Por ejemplo, Ed Berger como "assistant Dean for Undergraduate Programs" tiene contactos con todos los departamentos de ingeniería de UV, y al ser un participante de la "Panamá Initiative" tiene un gran interés por continuar colaborando con nosotros. Igualmente, Pam Norris en su posición de coordinadora de los programas de investigación y postgrado nos pudiera ayudar. Para incentivar la participación de la UTP en este programa se puede hacer que el mismo valga por un curso para los estudiantes (lo cual requeriría una contraparte UTP) y en caso de los profesores que valga por los seminarios de capacitación que estos toman en verano.<br><br>B. Igualmente, explorar la posibilidad de que este programa se aplique en reversa (Estudiantes y profesores de UV vengan a la UTP). Esta opción es buena por varias razones. Primero, permite ir estableciendo reciprocidad con UV, así si la UTP está en algún momento en capacidad de proveer hospedaje, UV debería hacer lo mismo con nuestros estudiantes o profesores. Igualmente, estas pasantías ayudan a promover nuestros proyectos en el exterior. Nuestra fortaleza pudieran investigaciones y/o proyectos en áreas únicas en nuestro país (hidrología tropical por ejemplo).<br><br>C. Los puntos A y B pueden ser aplicados en otras universidades, y me parece que tienen la ventaja, que permite a estudiantes y profesores tener una mejor idea del tipo de investigaciones que se hacen en UV , antes de decidirse antes de iniciar un programa de postgrado de dos años (maestría) o cuatro año (doctorado) |
| ANEXOS | ver documentos adjuntos |

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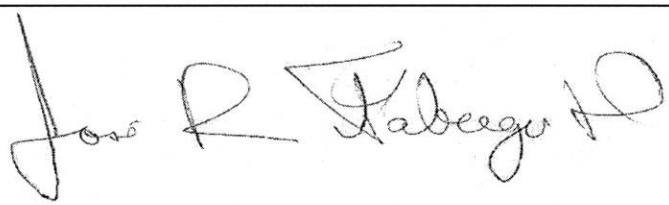
| Firma y cédula del participante: |  <br>8-252-878 |
| Fecha de entrega del informe: | 23/05/2013 |

# ANEXO A

# INVITACIÓN PARA VISITAR LA UNIVERSIDAD DE VIRGINIA

UNIVERSITY of VIRGINIA
ENGINEERING
UNDERGRADUATE PROGRAMS

March 4, 2013

Dr. José Fábrega, PhD
Director Encargado
Centro de Invest. Hidráulicas e Hidrotécnicas (CIHH)
Universidad de Tecnológica de Panamá

Dear José:

Thank you for your collaboration with me and my students during our visit to Panama in January 2013. Your presentation to the class about your research work was wonderful, and the informal discussions we had with you and your students on our final in Panama were special indeed. I appreciate all your help and your willingness to work with us on the January term class.

I would be delighted to host you at the University of Virginia from 16-20 April, 2013, so that you can deliver one or more seminars to our Civil Engineering group and/or the Environmental Sciences group. In addition, I hope we can continue to talk about collaborative work, the potential for Panamanian students to apply to Virginia for graduate study, and many other issues of mutual interest. For your trip, I will be happy to fund your airfare and accommodations while here. Please let me know at your earliest convenience if you can travel to Virginia, and we will begin to make the arrangement.

I look forward to your visit in April, and please let me know when we can begin to plan, and to advertise your seminar(s).

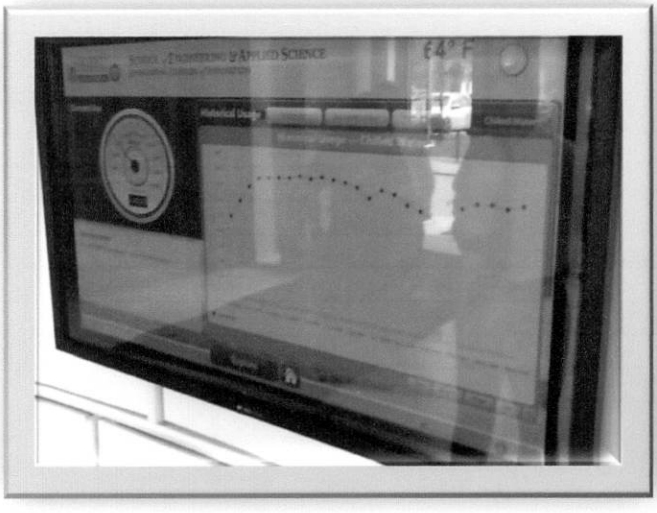
Sincerely,

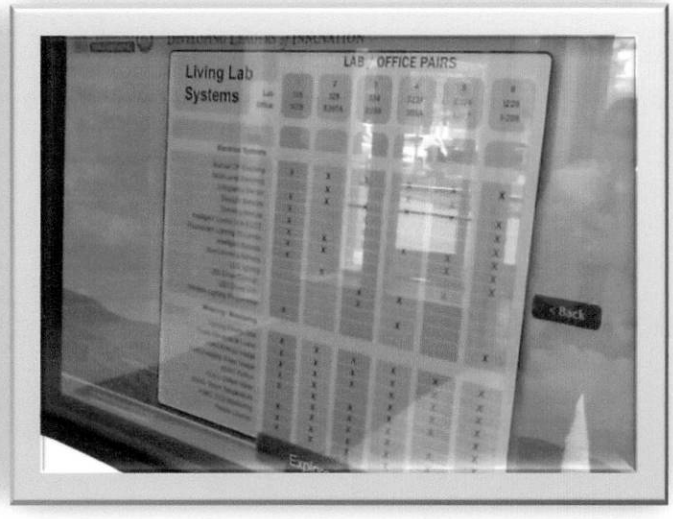
Edward J. Berger
Associate Dean for Undergraduate Programs
School of Engineering and Applied Science
berger@virginia.edu +1 434-924-6326

# ANEXO B

VISITA AL LABORATORIO DE MECATRÓNICA PARA LA CREACIÓN RÁPIDA DE PROTOTIPOS Y A LOS INDICADORES DEL "LIVING LAB SYSTEM" DEL EDIFICIO DE LA ESCUELA DE INGENIERÍA Y CIENCIAS APLICADAS DE UV

Prototipo de figuras de plástico hechas con fotocopiadoras de tres dimensiones
Vista parcialmente al fondo de la foto






PANTALLAS QUE INDICAN LA EFICIENCIA Y EL USO DE ENERGÍA EN EL EDIFICIO DE LA ESCUELA DE INGENIERÍA Y CIENCIA APLICADA DE UV . ESTA INFORMACIÓN ES LUEGO UTILIZADA PARA REALIZAR INVESTIGACIONES Y MEDIR EL AHORRO ENERGÉTICO DE ESTE EDIFICIO VERDE EN COMPRACIÓN A OTROS EDIFICIOS CONSTRUIDOS DE FORMA TRADICIONAL EN EL CAMPUS DE LA UV.

# ANEXO C

SEMINARIO A ESTUDIANTES Y PROFESORES DE LOS DEPARTAMENTOS DE INGENIERÍA CIVIL Y AMBIENTAL Y DE CIENCIAS AMBIENTAL DE LA UNIVERSIDAD DE VIRGINIA

"Research Projects of the Hydraulics and Hydrotechnical Research Center (CIHH) of the Technological University of Panama (UTP)"

CHARLOTTESVILLE, VIRGINIA,
APRIL 18, 2013

PRESENTED BY:
JOSÉ R. FÁBREGA D., Ph.D.

# Presentation Outline

*General facts – Panamá and UTP*

*Panama and water*

*Hydraulics and Hydrotechnical Research Center*

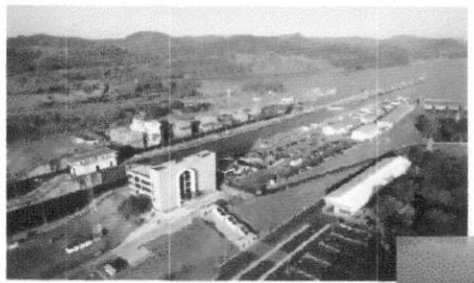
*Local funded project (SENACYT)*
- *International Collaboration Research Projects*
  - *Gamboa Site*
  - *Pacora Site*
- *Science Education Projects*

*External funded projects*

*Some challenges in Tropical Hydrology*

*Funding Opportunities in Panama*

# General facts Panama



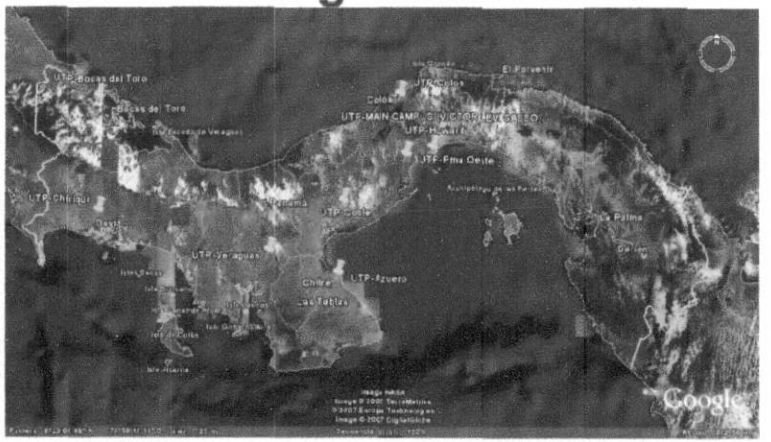
Population: 3.56 million[1]
GDP/capita: 15,300 (est. 2012)[1]
Panama city pop: 1.35 million[1]
Income distribution[1]:
lowest 10% ==) 1.1%
highest 10%==) 40.1%
Services ==) 80%

[1] CIA World Factbook

# General facts - UTP

**Largest technological university in Panamá. In 1981, it was established as an independent university**

# Universidad Tecnológica de Panamá – Regional Centers




- **Enrollment 2012: 16,105 (15536 US/ 569 GS) and 5904 in RC**
- **Faculty: 1575 (474 FT/1101 PT)**

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## Panamá and water

Panama is a country with extensive water resources that determine a great deal of its economic activity.

It has the second largest water offer in Central America with a volume of 52.437 $m^3$ per capita. (CCAD, 2005)

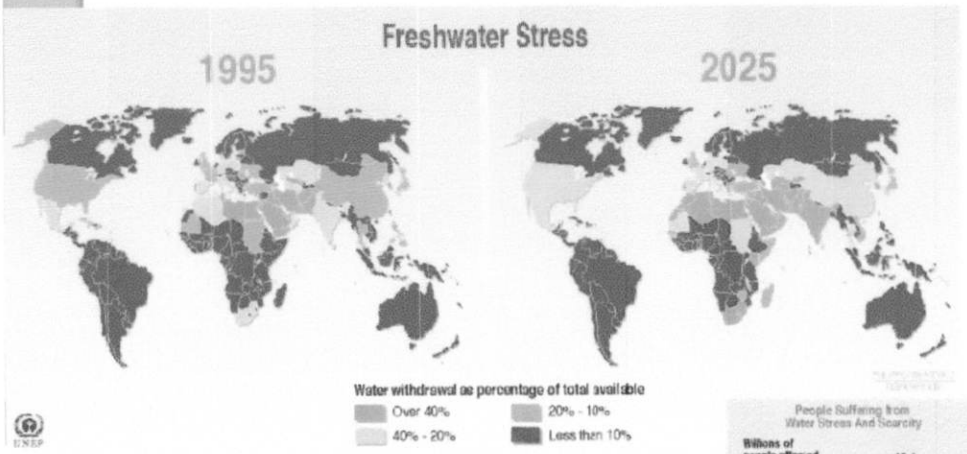
For the 1971-2002 period, Panama had a yearly average rainfall of 2924 mm (220.8 $Km^3$) and a Yearly average runoff of 1764 mm (4222 $m^3$/133.2 $Km^3$), translating in a runoff coefficient of 60.3 %. (PHI, 2008).

## Panamá and water-cont.

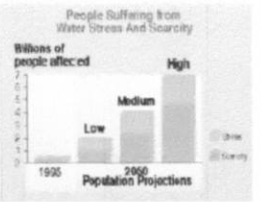
Besides agriculture and drinking water uses, water resources are considered an important economic asset in Panama.

For example, the Panama Canal Watershed composed mainly by the Chagres River provides the necessary water for the transit of vessels to the Panama Canal, which represents about 8% of Panama GDP. Also, in terms of energy production, Hydropower accounts for 50% of the electrical installed capacity in the country (Secretaria de Energía, 2012)

## N PERSPECTIVE




Source: World Meteorological Organisation (WMO) Geneva, 1996; Global Environment Outlook 2000 (GEO), UNEP, Earthscan, London, 1999.




Nakayama et al. (2012) employing long-term data from six meteorological stations around the Panama Canal, found an increment in simple precipitation intensity index in Panama, suggesting also an increment in the frequency of stronger precipitation in Panama.

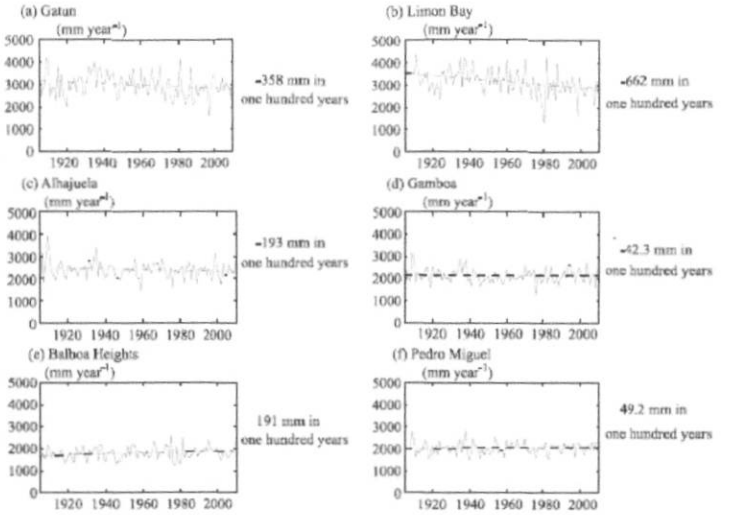



Fig. 2 Annual total precipitation at six meteorological stations. Broken lines indicate linear approximation by using least-squares method. (a) Gatun. (b) Limon Bay. (c) Alhajuela. (d) Gamboa. (e) Balboa Heights. (f) Pedro Miguel.

# Presentation Outline

*General facts – Panamá and UTP*

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# Hydraulics and Hydrotechnical Research Institute (CIHH)

## CIHH – GENERAL ASPECTS

The CIHH was created on October 21 1980 as a research center for the study of topics related to the environment and water resources in Panama. Besides research, it also participates in outreach programs and consulting mainly to the public sector in Panamá.

It has a work team of 28 people including 3 PhD, 9 Masters, 8 Bachelors, 5 technicians and 3 students.

## CIHH Labs

**Environmental Systems**

**Hydraulic modeling**

## Weather station network

Since 1988 the CIHH is managing weather stations, starting with a manual weather station located on Victor Levi Sasso Campus. Today, the CIHH manage a network of 12 weather stations (including 1 manual station). Among the meteorogical parameters being measured are: Barometric pressure, relative humidity, rainfall, temperarture, wind speed/direction and solar radiation.

**Objectives:**

- Develop and academic database of meteorological data to service students, faculty and scientists in general.
- Expand, improve, and strengthen the institutional and technical capacity of the UTP in the management and analysis of a meteorological data.

## Weather Stations Network

Davis weather station

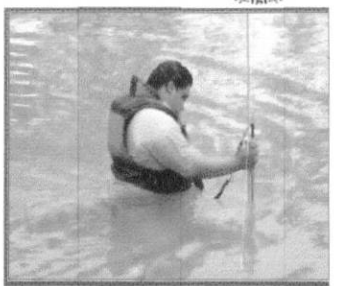
Campbell Sci. weather station


Fuente: Google Maps

# Services

CIHH provides a variety services to private institutions, government agencies and NGOs through programs funded by local and foreign agencies in the areas of:

- environmental management
- design and inspection of hydraulic and water treatment systems
- hydraulic and hydrological simulations
- Training and seminars in areas of expertise



www.cihh.utp.ac.pa

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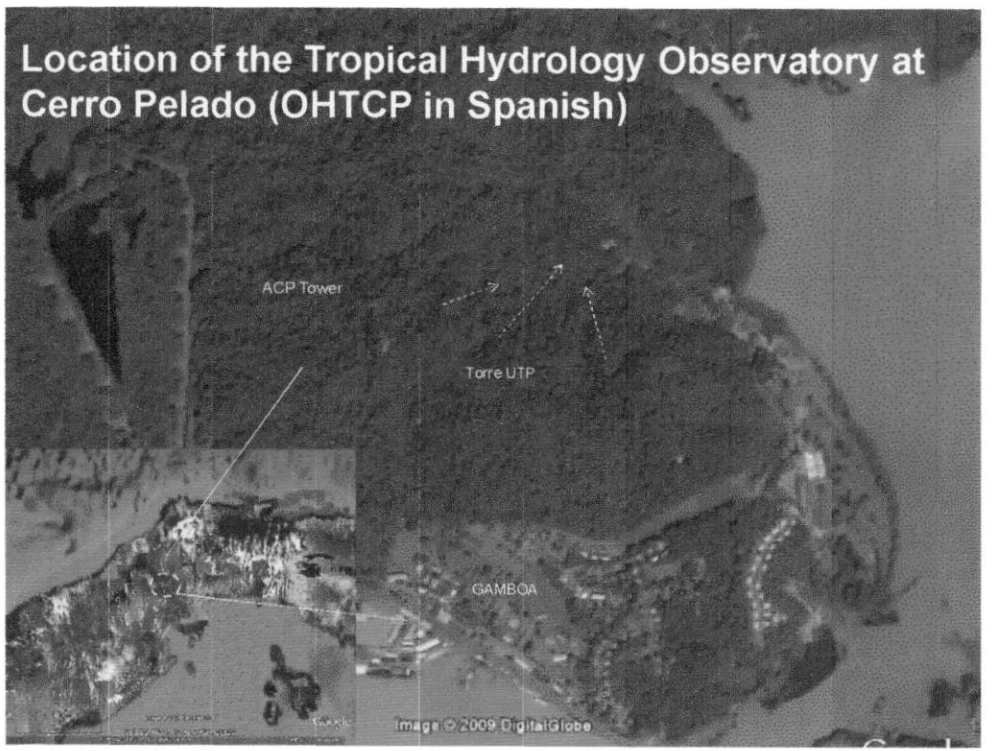
# Location of the Tropical Hydrology Observatory at Cerro Pelado (OHTCP in Spanish)




**Cerro Pelado, Gamboa**

» A microbasin (aprox. 15 Ha) located inside an area of 751.45 Ha (aprox. 2000 acres) in Cerro Pelado, Gamboa within the Panama-Canal Watershed. This 751.45 Ha site was assigned by the Panamanian Government in 2002 to the UP and UTP, to develop scientific research in tropical environments.

» **Objectives:**

Obtain a better understanding of the water and carbon cycle in tropical watersheds and its applications to the Panama Canal basin

Develop national technical capacities in these areas.

you tube video: "+ Agua + Carbono Una mirada a través del CIHH "

# Estimates of Biomass and Fixed Carbon at a Rainforest in Panama

Reinhardt Pinzón[1], José Fábrega[1], David Vega[1], Erick N. Vallester[1], Rafael Aizprúa[2], Francisco R. López-Serrano[3] Fred L. Ogden[4] and Kleveer Espino[1]

[1]Centro de Investigaciones Hidráulicas e Hidrotecnicas (CIHH) de la Universidad Tecnológica de Panamá (UTP), Panama City, Panama.
[2]Flora Tropical, Villa Zaita, Las Cumbres, Calle Circunvalación, Panama City, Panama.
[3]Universidad de Castilla La Mancha, Campus Universitario, Albacete, Spain.
[4]University of Wyoming, Laramie, WY USA.



**Objective.** Estimate the quantity of carbon fixed in trees in a one hectare (ha) plot at the OHTCP

**Importance**. The estimation of carbon fixed in trees may provide significant information on carbon flux due to water circulation, which may ultimately enable evaluation of the carbon cycle.

**Methodology.** All trees larger than 10 cm diameter at breast height (DBH) in the plot were investigated. Estimations of above-ground dry biomass (AGB) followed the methodology proposed by Brown and Lugo (1984 ) based on allometric regression equations that were fitted for tropical ecosystems by Chave et al. ( 2005)

## Method

$$(AGB)\text{est} = exp\,(-2.977 + ln\,(\rho D2H)) \equiv 0.0509 \times \rho D^2H$$

where *AGB* is above-ground dry biomass (given Mg ha−1), *D* is the stem diameter, $\rho$ is the specific density of the wood, and *H* is the total height of the individual tree. Values for each specie's wood specific gravity (density) were obtained from Chave et al. (2003) and FAO (2000)

A value of 0.24 AGB was employed to estimate BGB (Caims, et al., 1997)

**Method evaluation.** The method was evaluated by comparing the results with a second study performed in 2011, which resulted in an estimate of net new carbon (biomass) increment (NNCI), which gives 3.88 Mg ha$^{-1}$ year$^{-1}$.

**Table 1.** Above-ground biomass (AGB), below-ground biomass (BGB), total biomass and total carbon in the 1 ha plot, 2008.

| Site | AGB (Mg ha$^{-1}$) | BGB (Mg ha$^{-1}$) | Total biomass (Mg ha$^{-1}$) | Carbon total (Mg ha$^{-1}$) |
|---|---|---|---|---|
| Cerro Pelado Panama | 156.80 | 37.63 | 194.43 | 97.21 |

**Results.** Tree biomass estimations for the plot were 97.21 Mg ha−1.We identified a rare arboreal pear species (*Euphorbiaceous*) with higher carbon density than other trees in the plot. The presence of this apparently unique species may be due to specific soil characteristics.

Table 2. NNCI in different localities.

| Site of study | NNCI (Mg C $ha^{-1}$ $y^{-1}$) | Type of forest | Life zone |
|---|---|---|---|
| Cerro pelado[a] | 3.88 | Secondary | Tropical rainforest |
| Magdalena terrace and slope, Colombia[b] | 2.6–2.2 | Secondary | Tropical evergreen |
| Limon, Costa Rica[c] | 3.1 | Secondary | Tropical rainforest |

[a]NNCI present study; [b]Folster et al.[27] [c]Chacon et al.[24]

**Conclusion.** In general, the estimation of the biomass and associated carbon content found in this investigation are useful comparative data for economic evaluation of tropical forests in terms of capacity to capture carbon.

# "THE EFFECT THAT THE RAINY SEASON HAS ON THE VOLUME OF GROUNDWATER IN THE PANAMA CANAL BASIN"

José Fábrega[1], Edwin Martinez[1], Nathalia Tejedor[1], Fred L. Ogden[2]

[1]Centro de Investigaciones Hidráulicas e Hidrotecnicas (CIHH) de la Universidad Tecnológica de Panamá (UTP), Panama City, Panama.

[2]University of Wyoming, Laramie, WY USA

**Problem:** Lack of detailed studies in subsurface hydrology process in the tropics, due to lack of interest or particular difficulties of these areas. (tough landscape, dense vegetation and hard working conditions)

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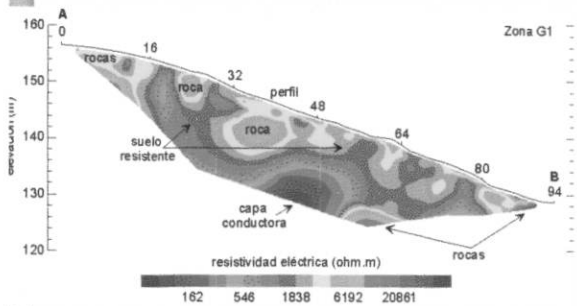
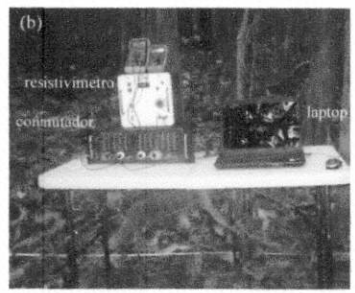
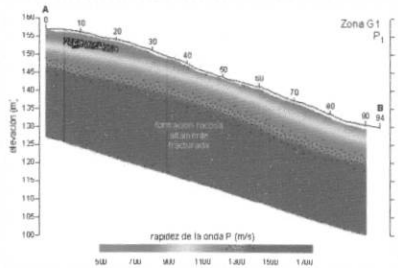
## PRELIMINARY STUDIES TO DETERMINE POSSIBLE LOCATION OF WELLS.



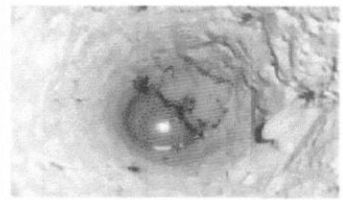



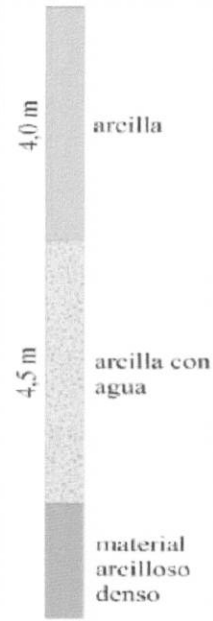

## ELECTRICAL PROSPECTION

## SEISMIC PROSPECTION




Monitoring well being constructed

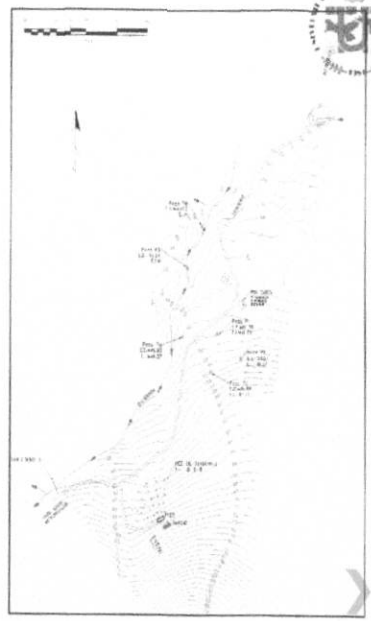





10,5 m
(fin de la perforación)

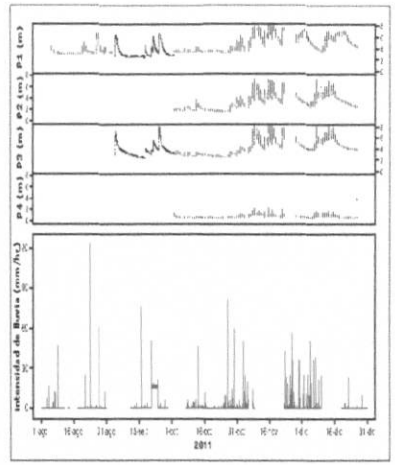
## Monitoring wells network

A network of six monitoring wells equipped with level sensors measuring water level (m), electrical conductivity (EC, µ / s) and temperature (T, ° C) in 10 minutes intervals. Also, a weather station installed in the area record rainfall data at 10 minute intervals also.

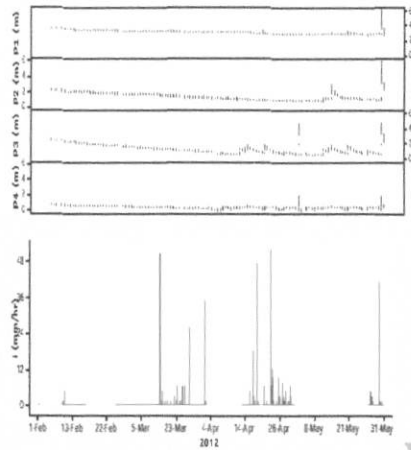




## Water level changes with precipitation



Rainy Season



Dry Season



## Water Quality

| | Flow | T (°C) | | Ph | | TDS (mg/l) | | CE (µs/cm) | | Total Solids (mg/l) | | Sediment load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2012 | Q (l/s) | Well | Weir | Well | Weir | Well | Weir | Well | Weir | Well | Weir | (mg/s) |
| Jul. 24 | | - | - | - | - | - | - | - | - | 175 | 75 | - |
| Aug. 02 | | 26 | 26 | 6.4 | 6.2 | - | - | - | - | - | - | - |
| Sep. 28 | 1.52 | 26.2 | 26.4 | 6.41 | 6.87 | - | - | 280 | 120 | 290 | 110 | 167.20 |
| Oct. 08 | 2.95 | - | 25.7 | - | 6.76 | - | 24 | - | 109.8 | 368 | 90 | 265.05 |
| Nov. 08 | | 25.7 | 25.7 | 6.01 | 6.55 | 165 | 128 | 166.5 | - | - | - | |
| Nov. 29 | | 25.7 | 26 | 5.83 | 6.55 | 101 | 23 | 101 | 23 | 314 | 120 | |



# Presentation Outline

*General facts – Panamá and UTP*

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***Local funded project (SENACYT)***

***International Collaboration Research Projects***

***Gamboa Site***

***Pacora Site***

***Science Education Projects***

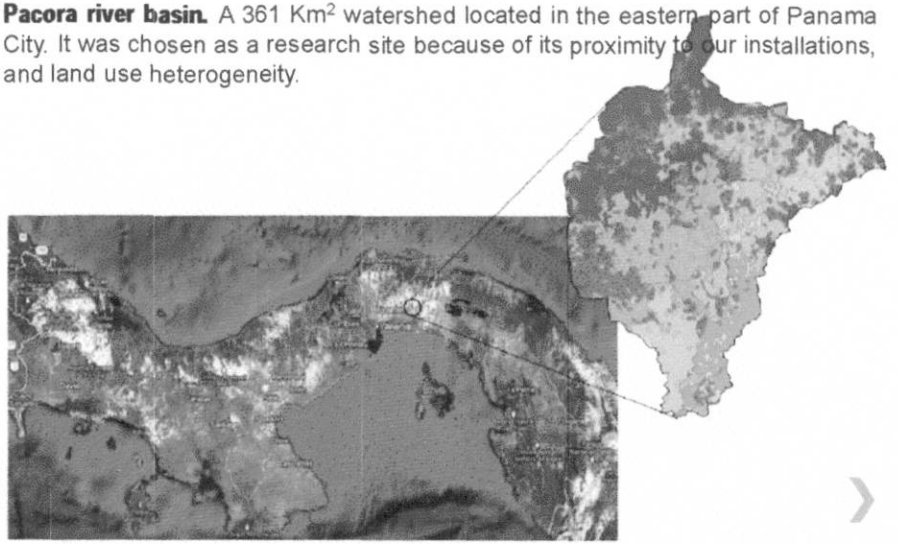
***External funded projects***

***Some challenges in Tropical Hydrology***

***Funding Opportunities in Panama***

# Pacora research site

**Pacora river basin.** A 361 Km$^2$ watershed located in the eastern part of Panama City. It was chosen as a research site because of its proximity to our installations, and land use heterogeneity.



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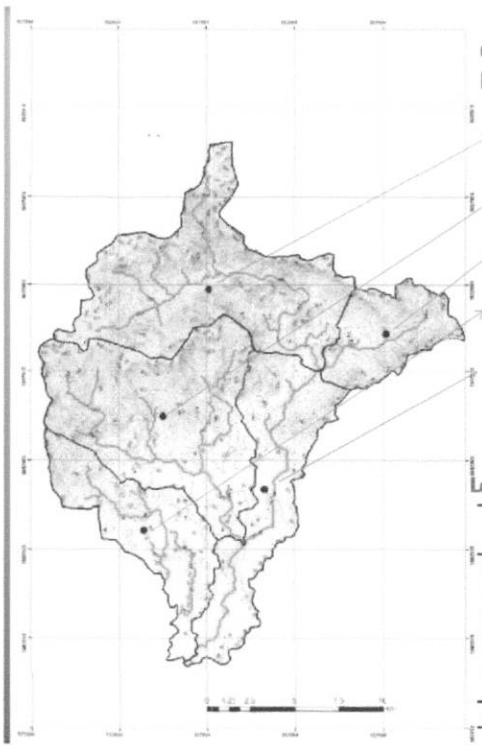
**Rainfall events and water quality in rivers employed as drinking wat sources: Pacora and Cabra Rivers.**

José Fábrega, Alexander Esquivel, Gloria Garcia, Johanna Valdes

## Problem background

In Panamá, there are 52 superficial water intakes for drinking water treatment systems. The water quality of these systems is affected by major rainfall events. Therefore, it is imperative to establish relationships among basic water quality parameters.

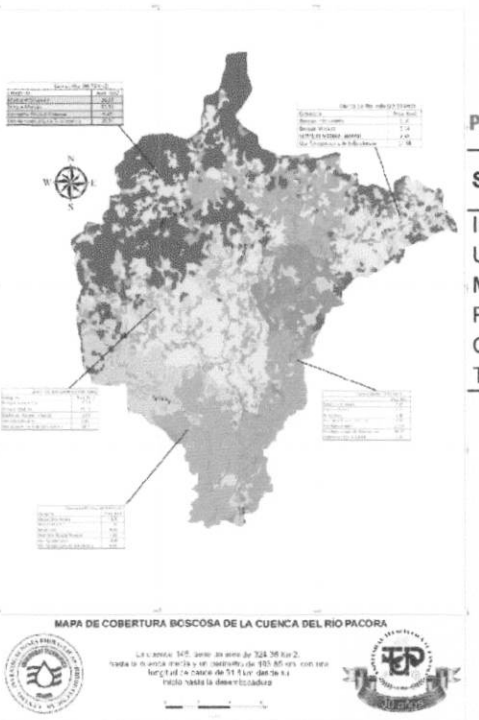


Characteristics of Pacora river sub-basins.

- Upper Pacora river sub-basin
- Cabobré river sub-basin
- Indio river sub-basin
- Tataré river Sub-basin
- Middle and lower Pacora river sub-basin.

**Length and area of the Pacora river sub-basins.**

| Name | Length (Km) | Area (Km$^2$) |
|---|---|---|
| Upper Pacora river sub-basin | 23.00 | 96.76 |
| Indio river sub-basin | 8.54 | 29.99 |
| Middle and lower Pacora river sub-basin | 24.00 | 57.13 |
| Cabobre river sub-basin | 17.40 | 94.85 |
| Tatare river sub-basin | 15.00 | 45.90 |
| **Pacora river basin[a]** | **47.00** | **324.63** |




**Pacora basin and sub-basins land use in % area.**

| Sub basin | BI | BM | OU | Ra | Ag | Ag Su | VI | Total |
|---|---|---|---|---|---|---|---|---|
| Indio | 18 | 22 | 0 | 14 | 0 | 46 | 0 | 100 |
| Up .Pacora | 19 | 53 | 0 | 9 | 0 | 19 | 0 | 100 |
| Mid/ow Pacora | 13 | 3 | 0 | 17 | 44 | 23 | 1 | 100 |
| Cabobre | 16 | 26 | 0 | 13 | 6 | 38 | 0 | 100 |
| Tatare | 29 | 5 | 0 | 10 | 42 | 14 | 0 | 100 |

BI: Intervened forest,
BM: Mature forest,
OU: Other uses,
Ra: Pioneer forest,
Ag: Agriculture and livestock,
AgSu: Subsistance Agriculture and livestock,
VI: flooding area vegetation.

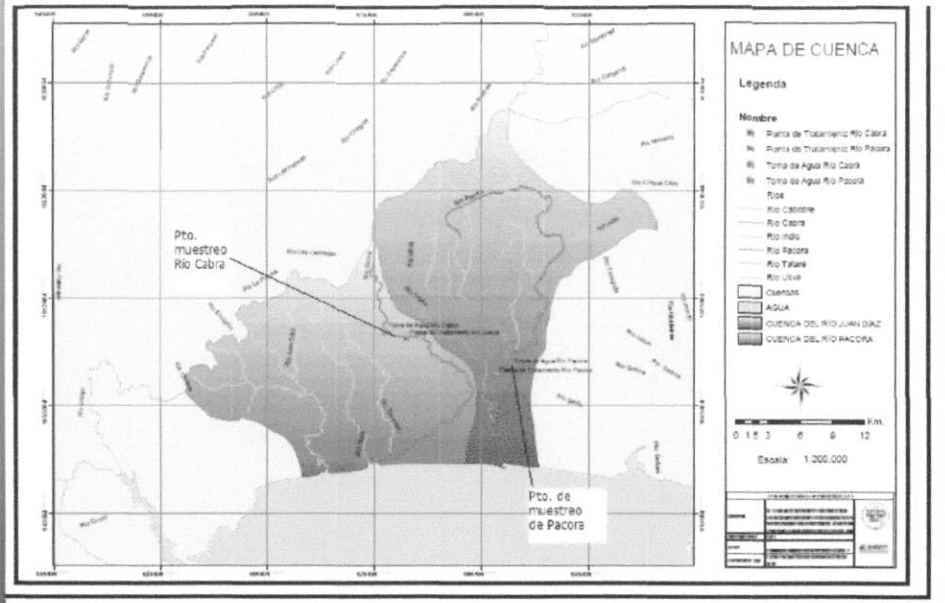
## SHORT TERM EFFECTS – RAINFALL/TOTAL SOLIDS

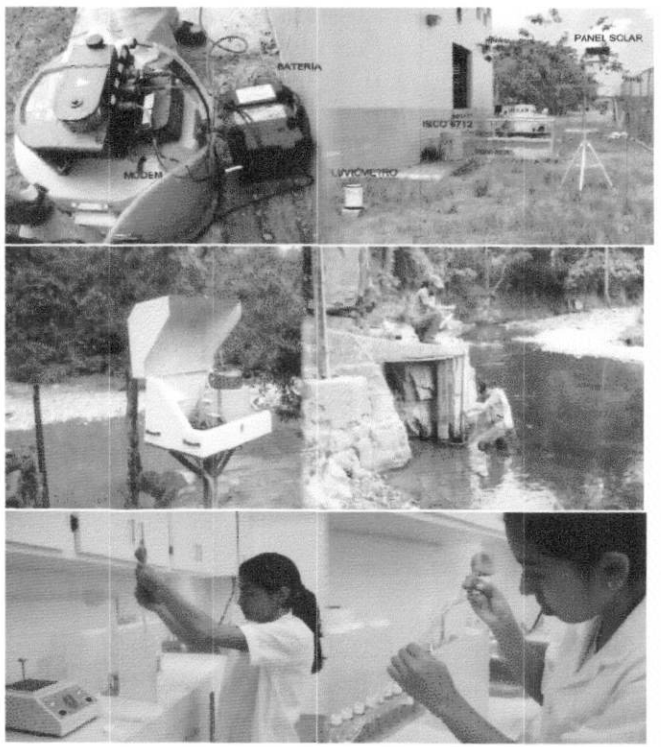
### METHODS

» **Sampling site determination.** Among the main considerations for determining the sampling site were: i) Safety of the sampler (ISCO 6712) and its accesories, ii) How easy was to access the sites and iii) proximity to the river, but out of flooding areas.

» **Water sampling and analysis.** Automatic water samplers ISCO 6712 were programed to collect samples as a function of pre-established precipitation conditions (rainfall intensity above certain value) . These values were registered with a pluviometer connected to the sampler.

• **Data collection and analysis.** A remote sensing system allowed the communication with the automatic sampler. Therefore, a text message indicating the beginning or finish of the sampling was sent . The water collected was tested for various physical-chemical parameters at our environmental systems lab-

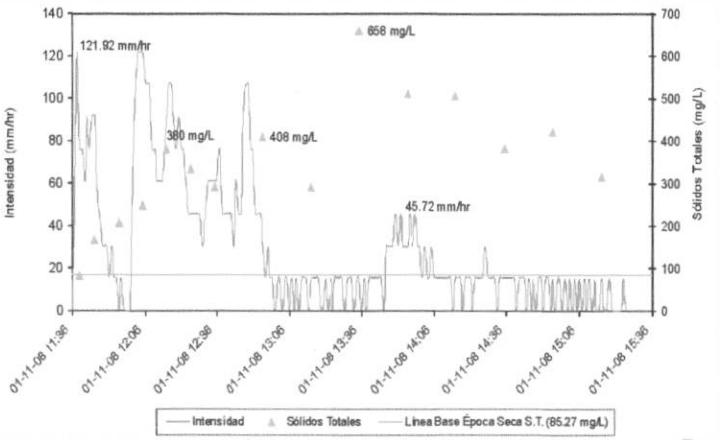



**Installation, sampling and analysis**

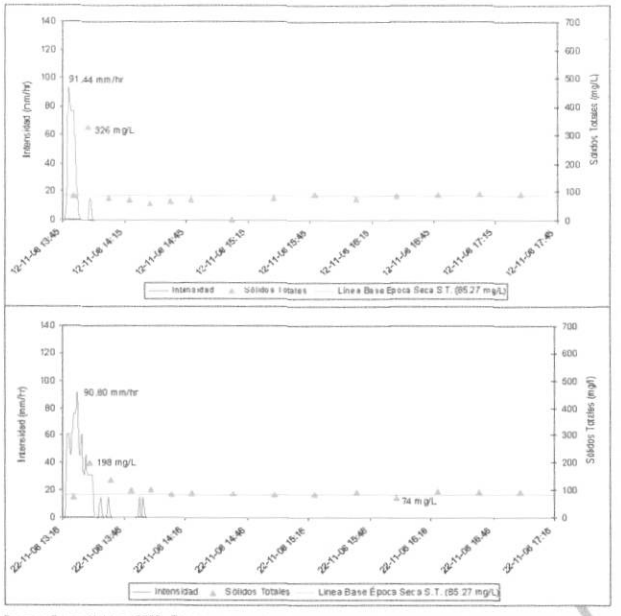
## RESULTS

» In a continuous sampling of a rainfall event with a maximum intensity of 121.92 mm/hr, a total solids variation from 85.27 mg/L to 658 mg/L. The horizontal line represent the total solid average base value for the dry season (85.27 mg/L).




Total solids variation with a rainfall event on november 1, 2008 at the Pacora river.

**Cabra river**
**Some typical results obtained for the Cabra river. The blue line represents the total solids baseline for the dry season**




Fuente: García-Valdés , 2009 , Tesis -

**Rainfall and total solids data obtained during the November 12 and November 22, 2008 sampling at the Cabra river.**

## Total solids and rainfall results

**Total solids variation with rainfall intensity in the Río Cabra sampling site.**

| Intensity (mm/hr) | Total Solids (mg/L) |
|---|---|
| Intensity>50 | Total Solids > 160 |
| 15<Intensity<50 | 70<Total Sólids <160 |
| 15>Intensity | 70>Total Solids |

This table was obtained from results similar to the ones showed in the preceeding slide, for a set of 5 coordinated sampling (sampler activated by the rainfall event) during the 2008 at the Cabra river for short term events (4 to 12 minutes). It is interesting to observe that even very short term events seems to have an effect on total solids for the water body under study.

## LONG TERM MONITORING /PACORA BASIN

Establish a monitoring network of weather station, water quality sites

First attempts were made in 2009 at Rio Cabra

At this time, we have 5 Davis Stations (One Campbell station as reference) at different sites

An ISCO sampler is located at the Upper Pacora river

**Samplers and weather station network**

EM 4

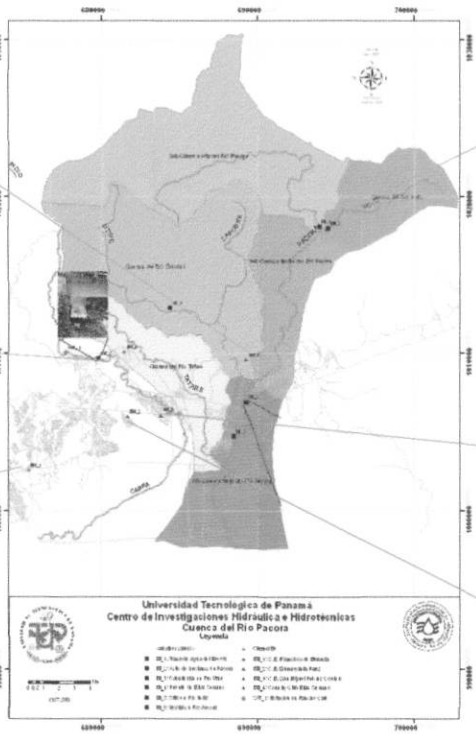
EM 5

EM 1

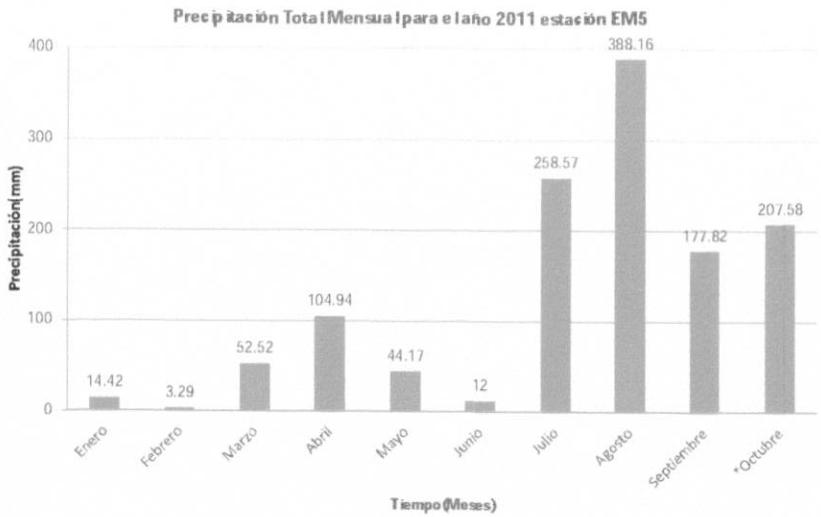
M 4

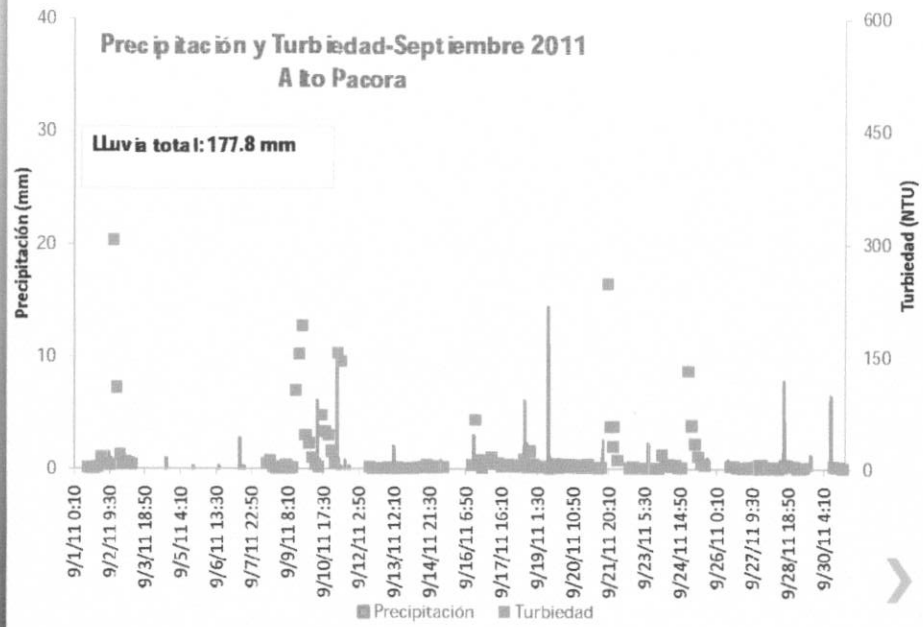
EM 3

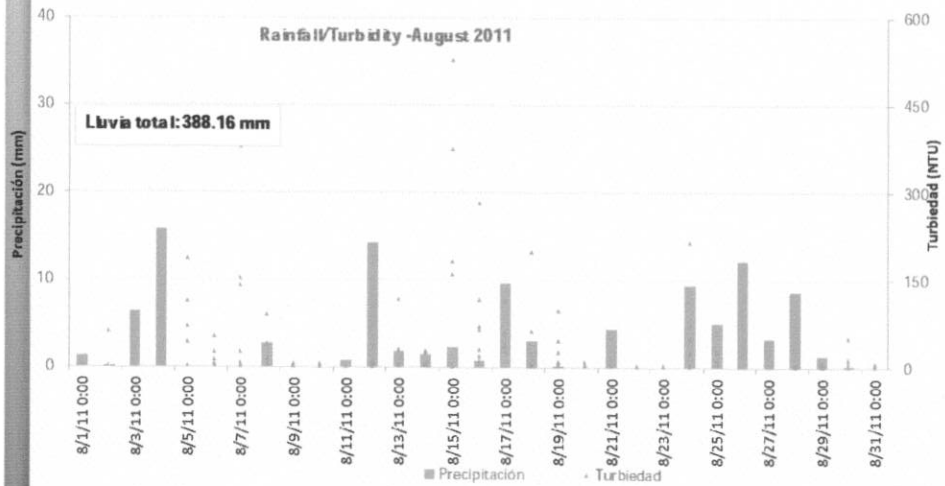
EM 2



Sample of Precipitation results - 2011




## Final considerations

» There is a trend for water quality to diminish during rainfall events at the Pacora and Cabra rivers, even for short term events

» More research is needed in these areas and we are in the process of integrating the data collected.

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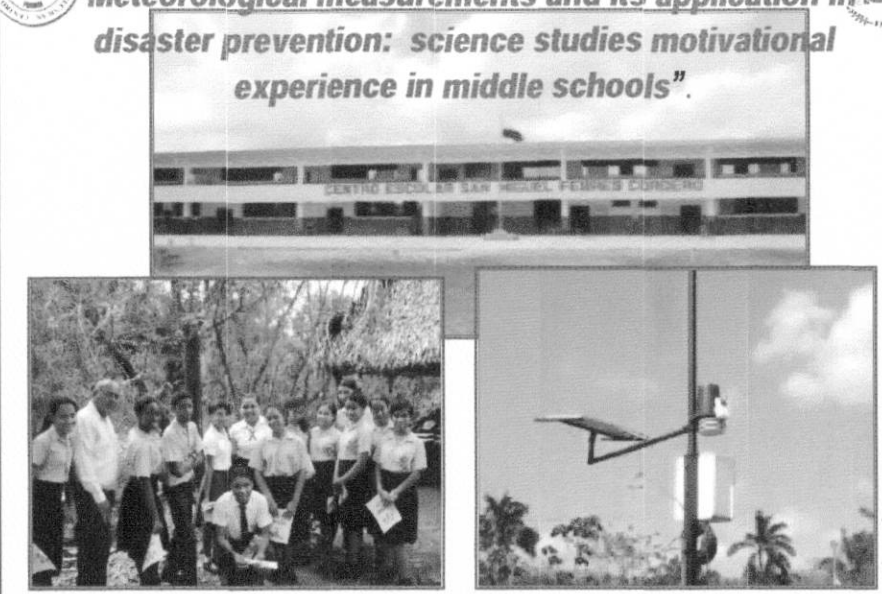
***"Meteorological measurements and its application in disaster prevention: science studies motivational experience in middle schools".***



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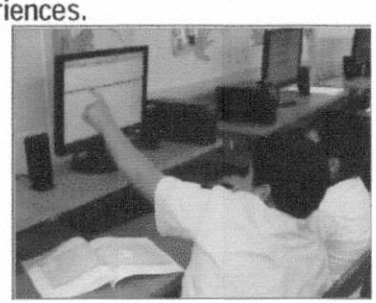
## Objective

Increase students interest for science, using basic meteorology and disaster prevention concepts as tools.

## Methodology

1. School choosing criteria (security, location, interest by school authorities and teachers)
2. Develop emergency plans with complementary field trips.
3. Development of small research experiences.
4. Forum for discussion of results.
5. Aplication of surveys
6. Disclosure of experience.



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## Results

1. The CIHH records variables, measured by weather stations installed at schools.
2. Students have generated drawings of Thiessen polygons from precipitation data.
3. Students are trained in the areas of early warning system and meteorological data downloading.

## Projections

Implementation with the Panama Canal Authority of a similar project in schools within the Panama Canal watershed.

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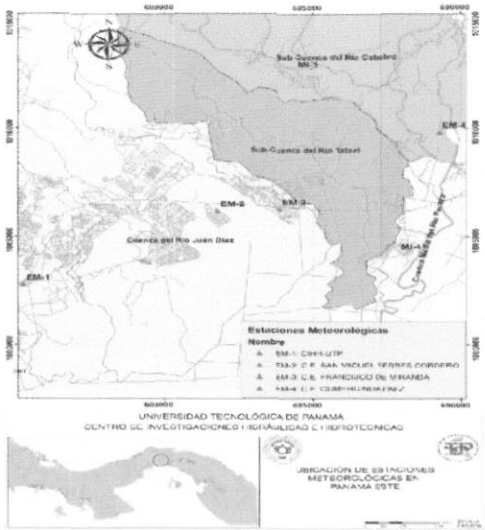
# Geographical Localitation

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***Some challenges in Tropical Hydrology***

***Funding Opportunities in Panama***

## Hydroclimate future projections in Panama in the 21st Century

**José Fábrega[1], Tosiyuki Nakaegawa[2], Reinhardt Pinzón[1], Keisuke Nakayama[3]**

[1]*Centro de Investigaciones Hidráulicas e Hidrotécnicas, Universidad Tecnológica de Panamá, Panamá, Republic of Panamá*

[2]*Climate Research Department, Meteorological Research Institute, 1-1 Nagamine, Ibaraki, Japan*

[3]*Dept. of Civil and Environmental Engineering, Kitami Institute of Technology (Koencho 165, Kitami city, Japan*

## Objective and importance

The present work objective is to analyze hydroclimate projections in Panama toward the end of the 21st century by employing the MRI-AGCM3.1 model (An AGCM model)

The results are important not only for Panamanian policy makers, but also for international trade. For example during 2011, the Panama Canal has a total of 12914 transits of large vessels with a total Gross tonnage of 369,845,400, being the (Panama Canal Statistics, http://www.pancanal.com/eng/op/transit-stats/index.html, accessed 2012)

## Study regions

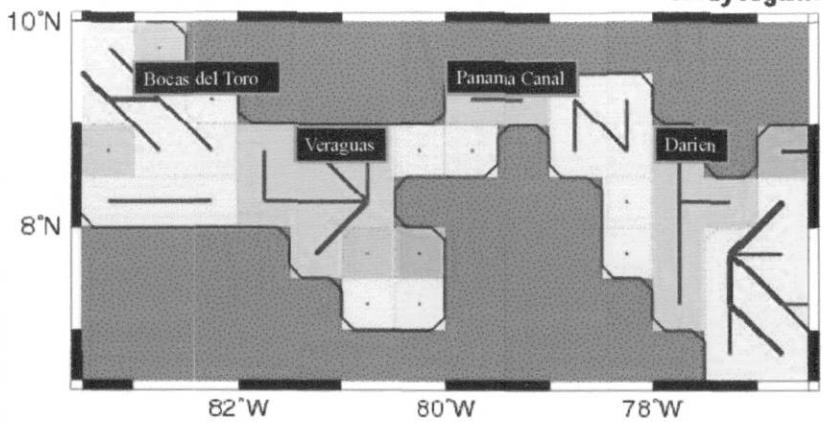


**Figure 1.** Four regions in Panama targeted in this study based on TRIP (Oki and Sud 1998): Bocas del Toro, Veraguas, Chagres, and Darien.

Note: TRIP is Total Runoff Integrating Pathways with a horizontal resolution of 0.5°

## Data

Observed precipitation data were obtained from the Tropical Rainfall Measuring Mission (TRMM) Product 3B42(Adler et al. 2000) .The horizontal and temporal resolutions of these data are 0.25° and 3 hourly respectively.

We used CMIP3 MME to quantify the uncertainties in hydroclimate projections

Then, annual mean hydroclimatological values for 2075-2099 from SRES A1B in CMIP3 MME are used for the future climate; those for 1975-1999 from the 20th Century Climate in Coupled Models experiment as a part of CMIP3 (Meehl et al. 2007) are used as the present-day climate.

## Model

The model employed is an Atmospheric GCM (AGCM) of the Meteorological Research Institute (MRI) and named MRI-AGCM3.1

The Japan Meteorological Agency (JMA) first developed an original version for operational short-term numerical weather prediction model with 60-km mesh

MRI improved it for the long-term climate simulations by implementing a 20 Km horizontal resolution. The vertical resolution is given by 50 layers up to 0.1 hPa

RESULTS

### *Climatological annual mean projection*

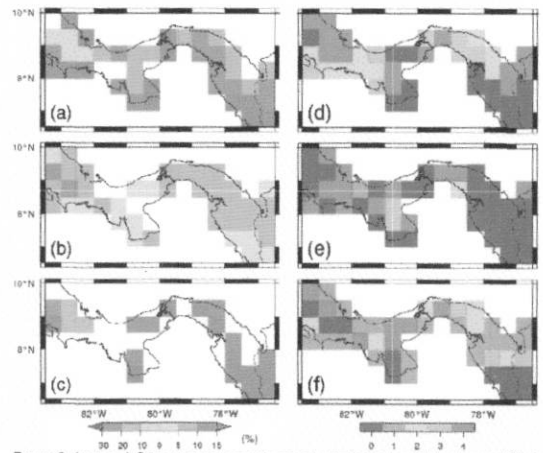


**Figure 2.** (left; a-c) Climatological annual mean hydrological variable changes (%) in the future climate relative to the present. Areas statistically significant at 95% level are colored. (right d-f) Number of the consistent change in sign in the 4 multi-SST 60-km mesh AGCM ensemble simulations with the 20-km mesh AGCM. Four represent the consistent changes in the 20-km mesh model and the 4 multi-SST 60-km mesh AGCM, while unity represent the inconsistent change between the 20-km and the 4 multi-SST 60-km mesh AGCM simulations. (a) and (d) : precipitation; (b) and (e) : evaporation; (c) and (f) runoff.

## Future change in precipitation, evaporation, and total runoff

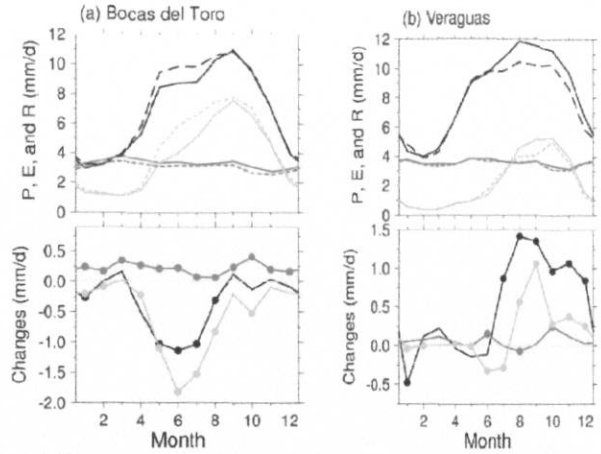


**Figure 3**. (top) Climatological regional mean seasonal variation of precipitation, evaporation, and total runoff in the present-day (dashed) and future (solid) climates and (bottom) their changes between the present-day and future climates. Black, red, and green lines denote precipitation, evaporation, and total runoff (mm/d). Circles represent statistically significant changes at 95% level.

## Future change in precipitation, evaporation, and total runoff

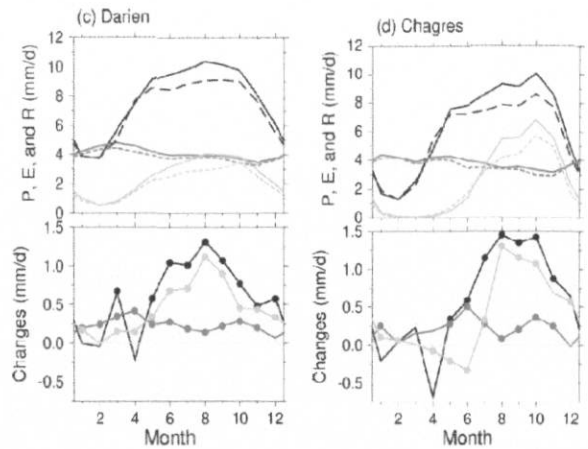


**Figure 3**. (top) Climatological regional mean seasonal variation of precipitation, evaporation, and total runoff in the present-day (dashed) and future (solid) climates and (bottom) their changes between the present-day and future climates. Black, red, and green lines denote precipitation, evaporation, and total runoff (mm/d). Circles represent statistically significant changes at 95% level.

### Future change in precipitation, evaporation, and total runoff-Comments

Future predictions presented in Figure 3 show a rainfall increment starting between May and July to the end of the year for all regions, with the exception of Bocas del Toro. In this region, a decrease in precipitation is expected for the future between the months of April to August. These results translate in greater total yearly precipitation for all regions but Bocas del Toro also increase.

Total runoff for all cases follow the trends seen in precipitation as expected.

Evaporation does not appear to be affected in the future by precipitation changes, since greater longwave radiation due to greenhouse gases supplies energy for evaporation.

Figure 3 also shows that projected changes during the rainy season were statistically significant at 95% level for all the variables. Insignificant changes were observed, during the dry season.

### You are right, one model does not fit all, but w hat if!!!!!!!!

Transportation and logistics is best represented by the Panama Canal. In this study, precipitation for the Panama Canal region showed a statistically significant increment in precipitation and total runoff (up to 1.5 mm/day for precipitation and slightly less for total runoff) for the months of May to December. These results trend to indicate more water availability for the Panama Canal in the future.

In terms of energy, Panama has an estimated total hydropower potential of 2383 MW of which 1826 MW are within the Bocas del Toro region (provinces of Chiriquí and Bocas del Toro) (http://www.energia.gob.pa/pdf_doc/potencial.pdf; accessed 2012). In this region, precipitation is expected to decrease from April to August up to 1 mm/day in June (Fig. 3). This situation might reduce the hydropower potential already mentioned and it should be evaluated in more detail.

Agriculture and biodiversity conservation are important in all regions in Panama. The increase in precipitation and total runoff observed in all regions but Bocas del Toro should be considered in order to evaluate soil erosion, possible flooded areas, changes in harvest time for crops and adaptation capacity of some species.

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## TROPICAL HYDROLOGY CHALLENGES!!

nature climate change

REVIEW ARTICLE

PUBLISHED ONLINE: 15 JULY 2012 | DOI: 10.1038/NCLIMATE1555

# The hydrology of the humid tropics

Ellen Wohl[1]*, Ana Barros[2], Nathaniel Brunsell[3], Nick A. Chappell[4], Michael Coe[5], Thomas Giambelluca[6], Steven Goldsmith[7], Russell Harmon[8], Jan M. H. Hendrickx[9], James Juvik[10], Jeffrey McDonnell[11] and Fred Ogden[12]

## GROUNDWATER EFFECTS ON SUPERFICIAL FLOW

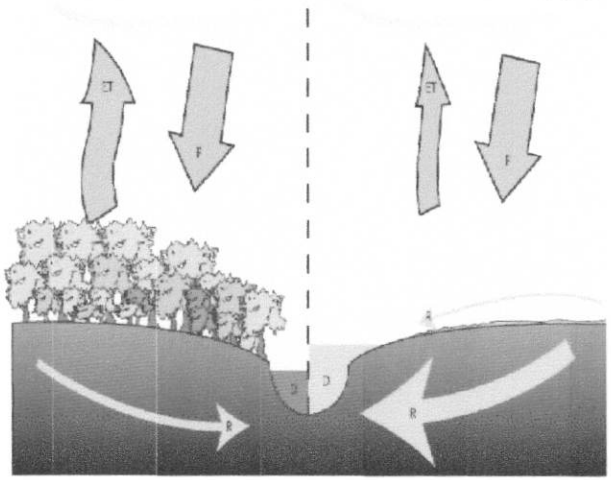
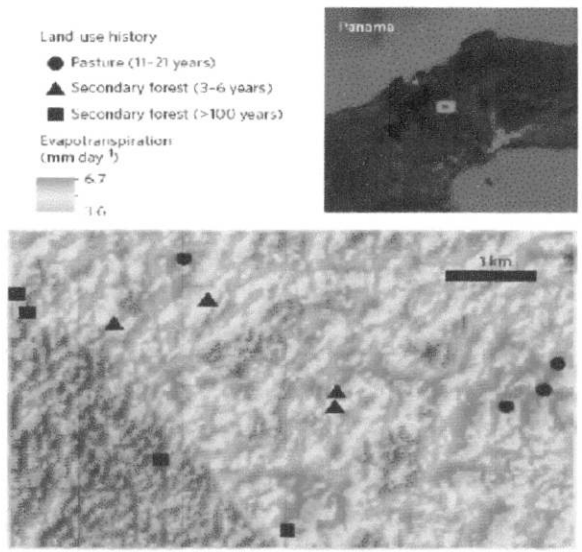



**Figure 4 | Schematic of local and regional hydrological response to deforestation.** Deforestation reduces total evapotranspiration (ET) through decreased plant water demand from vegetation or fallow fields compared with native vegetation. Even though precipitation (P) patterns may be affected at regional scales, at relatively small scales they are unlikely to be proportional to the local decrease in evapotranspiration. As a result, total water yield (R) and river discharge (D) are increased. The water yield increases with increasing area of a watershed deforested and tends to be concentrated as a baseflow increase, unless subsequent land uses substantially decrease the rate of rainfall infiltration. The size of the effect depends on the precipitation rate and land-cover changes that occur, but observations from small watersheds show a 10–25% increase for water yield[42] and a threefold increase in discharge[43].

## LAND USE CHANGE AND DEFORESTATION EFFECTS




Stallard et al., 2010

**Figure 3 | Example of how evapotranspiration rates in disturbed rainforests in the dry season are related to land-use history.** This example

**MORE DATA NEEDED**

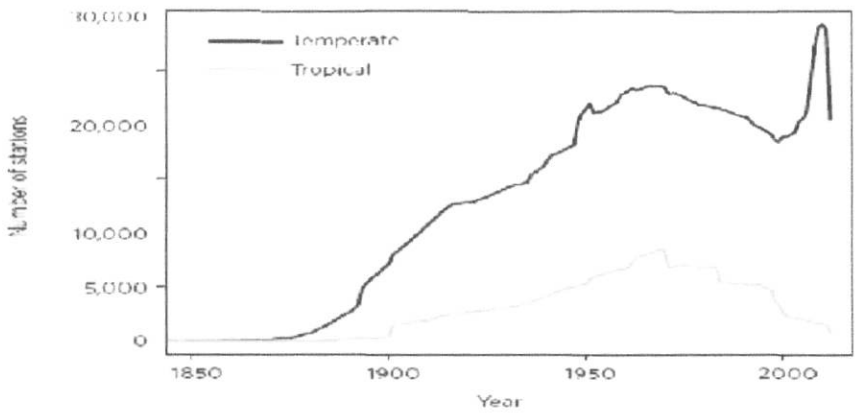



**Figure 5 | Number of precipitation stations in the Global Historical Climatology Network data set for each year.** The plot shows the much smaller and decreasing number of stations in tropical latitudes relative to those in temperate latitudes. Tropical stations are between the Equator and 25° latitude, and temperate stations are between 25° and 60° latitude in both the Northern and the Southern Hemispheres. The two lines in the plot are separate data sets, rather than cumulative numbers (that is, there are now more than 25,000 precipitation stations in the temperate zones alone).

# Presentation Outline

*General facts – Panamá and UTP*

*Panama and water*

*Hydraulics and Hydrotechnical Research Center*

*Local funded project (SENACYT)*
- *International Collaboration Research Projects*
  - *Gamboa Site*
  - *Pacora Site*
- *Science Education Projects*

*External funded projects*

*Some challenges in Tropical Hydrology*

***Funding Opportunities in Panama***

## FUNDING OPPORTUNITIES IN PANAMA

**SENACYT**
**I+D International Collaboration: 120 K**
**Support to research activities: 15 K**
**Sabbaticals: 100 K**

**UTP Grants**
**Up to 20K for research projects and up to 10K for conferences/seminar or scientific visits**

**For more information**

**www.cihh.utp.ac.pa**


## Questions

## Mesoamerican Network of Water Quality. REMECA – Panamá

- **Objective:** Develop a database of water quality variables to evaluate the effect of climate change (baseline)
- **Scope and duration:** Select four sites in Panamá to measure for three years, twice a year (dry and wet seasons different water quality parameters
- **Duration:** Three (3) years w/two sets of measurements dry and wet seasons.
- **Participating countries:** Honduras, El Salvador, Panamá, Mexico, Colombia, Panamá and Japan

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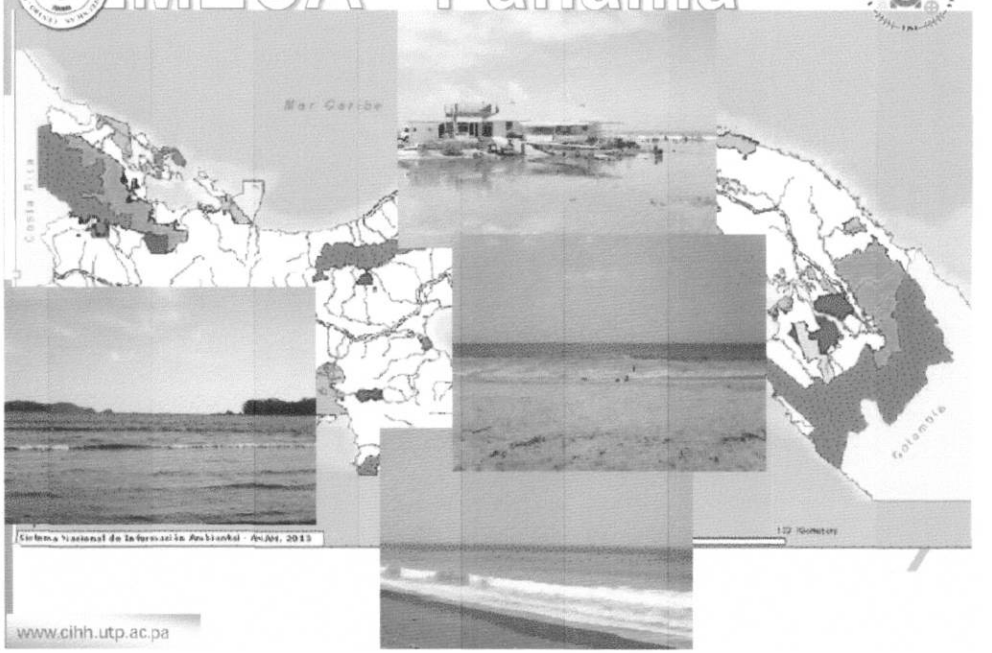
## REMECA - Panamá

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# First set of Results
# Dry season / March 11-15

| ID (Sites) | pH | Conductivity (µS/cm) | DO (mg/L) | Temp. (°C) | Salinity | Turbidity (NTU) | Chlorophylla (µg/L) (Field) | *Enterococcus* (NMP/100mL) | Nitrite (mg/L) | Nitrate (mg/L) | Phosphorus (mg/L) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Punta Barco** | | | | | | | | | | | |
| 001 | 6.63 | 48.20 | 9.57 | 24.40 | | 6.6 | 50.0 | 1 | 0.002 | 0.7 | 0.12 |
| 002 (BC) | | | | | | | | <1 | 0.002 | 0.3 | 0.03 |
| **La Marinera** | | | | | | | | | | | |
| PM-01 | 7.13 | 49.56 | 8.20 | 26.09 | | 2.0 | 8.5 | 1 | 0.004 | 0.4 | 0.60 |
| LM-004 (BC) | | | | | | | | <1 | 0.001 | 0.7 | 0.01 |
| **Playa Hermosa** | | | | | | | | | | | |
| PH-01 | 7.24 | 52.70 | 7.56 | 28.84 | | 7.9 | 9.2 | <1 | 0.002 | 1.6 | 0.33 |
| PH-02 (BC) | | | | | | | | <1 | 0.002 | 0.3 | 0.14 |
| **Punta Galeta** | | | | | | | | | | | |
| PG-01 | 8.50 | 50.10 | | 28.2 | 32.9 | | | 1 | 0.004 | 0.7 | 0.33 |
| PG-02 (BC) | | | | | | | | <1 | 0.003 | 0.3 | 0.06 |

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**round:** The Sanitation of Panama Bay at a cost of about $
of the largest infrastructure projects currently under way
ega project is designed to be completed around the firs
. Through the sanitation project, two WWTP will be
a for the purpose of improving the quality of water that ult
Bay of Panama.

**ive:** Develop the capacity for monitoring process efficien
ing radiotracers in WWTP.

**g agency:** AEIA (International Atomic Energy Agency)

# Denitrification using Natural Organic Solid Substrate as Carbon Source

## General Objective

To quantify the properties of Natural Organic Solid Substrates (NOSS) as an electron donor and organic carbon source for denitrification under different operating conditions.

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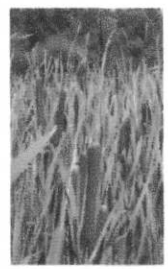
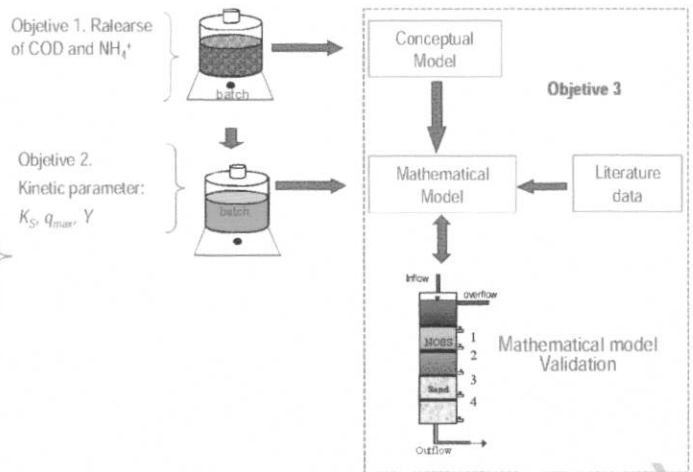
# Research Scheme



*Typha angustifolia*

*Saccharum spontaneum*



## Comparison of kinetic parameters obtained in this study with those reported in the literature

| Carbon source | Y (mg COD/mg COD) | qmax (mg N-$NO_3^-$/mg VSS·d) | Ks (mg N-$NO_3^-$/L) | Referencia |
|---|---|---|---|---|
| *Typha angustifolia L.* | 0.78 | 1.84 | 13.45 | This study |
| *Sascharum spontanium L.* | 0.55 | 5.61 | 20.15 | This study |
| Glucouse | 0.34 | 3.65 | 0.71 | Lin 2008 |
| Methanol | 0.41 | 0.65 | 24.15 | Cherchi et al. 2009 |
| Methanol | 0.50 | 1.45 | 58.97 | Cherchi et al. 2009 |
| Methanol | 0.21 | 3.14 | 18.20 | Rabah et al 2007 |



## Conclusions

The organic carbon released from SSON allowed a complete denitrification.

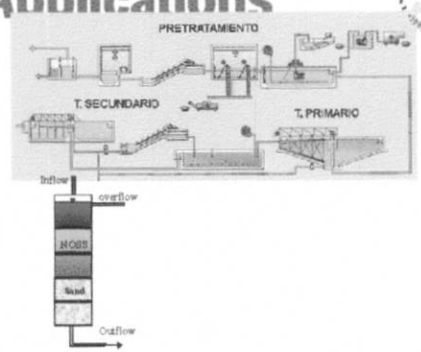
to enhance SSON using these characteristics need to be considered as nitrogen, C/N ratio and lignin content, because these variables control the release of organic carbon required for denitrification.

This study demonstrated the potential of the *Typha angustifolia L.* and *Saccharum spontanuem L.* as carbon source for denitrification



## Possible Applications

Tertiary wastewater treatment




Permeable Reactive Barriers (*in situ traetment*)