Cloudbridge Water Monitoring Study
Nuts & Bolts

By Joanna Souers
July 2004

Objective:
Test the water in the Chirripo River for 10 indicators of water quality. The tests are conducted the tests at 9 points on the river and are repeated at different points in time. The tests employ a simple water monitoring kit available at www.earthforce.org.

Tests:
We test for temperature, pH, phosphates, nitrates, dissolved oxygen, biochemical oxygen demand, coliform bacteria and turbidity.

- Temperature affects the oxygen content of water (oxygen levels become lower as temperature increases); the rate of photosynthesis by aquatic plants; the metabolic rates of aquatic organisms; and the sensitivity of organisms to toxic wastes, parasites, and diseases.

- pH is the percentage of hydrogen ions (H+) in a solution. A solution is more acidic when it contains more hydrogen ions. Most plants and animals are adapted to living in conditions of neutral acidity. pH values between 7.0 and 8.0 are optimal for supporting a divers aquatic ecosystem.

- Phosphates are a plant nutrient that can also be a pollutant. Phosphates in water contribute to the growth of algae, similar to nitrates. Adding phosphates to a body of water can accelerate plant growth and eventually damage an ecosystem by draining the oxygen levels when the plants decompose.

- Nitrate is found in nature in very small amounts because of the ongoing growth and decay process. Pollutants such as sewage or manure however, contain much higher levels of nitrates. An excess of nitrates in the water can result in a rapid growth of algae and other plants, which deplete the water's oxygen.

- Dissolved oxygen. Aquatic life needs oxygen to live. Aquatic life uses oxygen that is dissolved in the water and is in much smaller quantities than in the air. Oxygen, in water, is measured as dissolved oxygen (DO). If more oxygen is consumed than is produced, dissolved oxygen levels decline and some sensitive animals may move away, weaken, or die.

- Biochemical oxygen demand. When organic matter decomposes, microorganisms (such as bacteria and fungi) feed upon this decaying material and eventually it becomes oxidized. Biochemical oxygen demand, or BOD, measures the amount of oxygen consumed by microorganisms in the process of decomposing organic

matter in stream water. High BOD can cause low dissolved oxygen, to the detriment of aquatic organisms.

- Fecal coliform bacteria are found in the feces of human beings and other warm-blooded animals. Fecal coliform by themselves are generally not harmful. However, when a warm-blooded animal is infected with disease, pathogenic organisms are found along with fecal coliform bacteria.

- Turbidity is a measure of the relative clarity of water: the greater the turbidity, the murkier the water. Turbidity increases as a result of suspended solids in the water that reduce the transmission of light. With higher levels of turbidity, water loses its ability to support a diversity of aquatic organisms.

Sampling Methods:
(See Lamotte "Low Cost Monitoring Kit" Booklet for specific directions on each individual test)

1) Record time, date, land use (primary forest, disturbed forest, cultivated, pasture, or developed), the downward slope of the river, and bank slope.
2) Take a GPS reading of site location, altitude and GPS accuracy in ft or meters.
3) Use a temperature gauge or thermometer to record the temperature of the stream by submerging for at least one minute.
4) Record the turbidity in JTUs using the Lamotte Secchi disk icon sticker, following the instructions in the handbook.
5) At each site collect at least 100 ml of stream water in a sterile container by submerging both container and cap fully in an area of steady flow and recap when full, ensuring no air bubbles. This sample is for the coliform bacterial test and any other further analysis.
6) For on-site testing (ie, phosphate, nitrates, pH, D.O., and B.O.D) rinse the collection containers or test tubes four times down stream of collection before sampling, and then follow the directions outlined in the handbook for each individual test.

Preliminary Study Results:

Site	Location (°N)	Location (°W)	Altitude (ft)	GPS Accuracy (ft)	Downward Slope	Bank Slope	Land Use
1	9°28.476	83°34.048	5573	35	0°	45°	Primary forest
2	9°28.526	83°34.174	5571	26	25°	35°	Disturbed forest
3	9°28.357	83°34.707	5042	31	10°	45°	Developed
4	9°28.059	83°35.495	4594	29	5°	15°	Developed
5	9°27.885	83°35.962	4372	51	5°	35°	Developed
6	9°27.587	83°36.232			0°	25°	Developed
7	9°26.769	83°36.952			10°	30°	Developed
8	9°26.851	83°36.952	3679	23	5°	5°	Developed
9	9°26.271	83°37.498	3421	29	3°	15°	Developed

Table 1.1 Site descriptions and locations (given by GPS reading), Costa Rica 2004.

Sample	Date	Time	Temper-ature (°C)	pH	Phosphates (ppm)	Nitrates (ppm)	D.O.	B.O.D.	Coli-forms	Turbidity (JTU)
1A	7/7/04	8:23 am	12	8.5	0.0	0.0	37.0	0	Positive	0
2A	7/7/04	9:55 am	12	8.0	0.5	0.0	No data	No data	No data	0
3A	7/9/04	1:33 pm	16	8.2	0.5	0.0	No data	No data	No data	0
4A	7/8/04	12:30 pm	16	8.2	1.0	0.0	No data	No data	No data	0
5A	7/8/04	10:27 am	16	9.0	1.0	0.0	No data	No data	No data	0
6A	7/8/04	8:54 am	17	9.0	1.0	0.0	41.5	0	Positive	40
7A	7/8/04	9:33 am	18	8.0	1.5	0.0	No data	No data	No data	40
8A	7/9/04	8:27 am	18	8.5	1.5	0.0	42.0	0	No data	40
9A	7/9/04	9:25 am	19	9.5	2.0	0.0	No data	No data	No data	40

Table 1.2 Trial 1 data for each site including date and time when the sample was taken. "No data" indicates that the site was not tested for this parameter at the specified time and date the sample was taken, Costa Rica, 2004.

Sample	Date	Time	Temper-ature (°C)	pH	Phosphates (ppm)	Nitrates (ppm)	D.O. (%)	B.O.D.	Coli-forms	Turbidity (JTU)
1B	7/16/04	10:42 am	12	8.5	0.0	0.0	No data	No data	Positive	0
2B	7/16/04	11:05 am	12	8.0	0.5	0.0	37.0	0	No Data	0
3B	7/16/04	7:35 am	16	8.2	0.5	0.0	41.0	0	No Data	0
4B	7/20/04	9:45 am	16	8.2	1.0	0.0	41.0	0	No Data	0
5B	7/20/04	10:50 am	16	8.5	1.0	0.0	41.0	0	No Data	0
6B	7/21/04	12:20 pm	18	8.5	1.5	0.0	42.0	0	No Data	0
7B	7/21/04	12:05 pm	18	8.2	1.5	0.0	42.0	0	No Data	0
8B	7/21/04	11:45 am	19	8.3	2.0	0.0	No Data	No Data	No Data	0
9B	7/21/04	11:26 am	20	8.5	2.5	0.0	44.0			0

Table 1.3 Trial 2 data for each site including date and time when the sample was taken. "No data" indicates that the site was not tested for this parameter at the specified time and date the sample was taken, Costa Rica, 2004.

Sample	Date	Temper-ature °C)	pH	Phosphates (ppm)	Nitrates (ppm)	D.O. (% saturation)	B.O.D.	Coliforms	Description
C1	7/16/04	21	9.0	0.0	0.0			Positive	Rainwater
C2	7/16/04	22	9.0	0.5	0.0	92.0	0	Negative	Boiled tap water

Table 1.4 Rainwater and boiled water controls for each parameter. Rainwater was collected in a sterile container from the Cloudbridge Weather Station. Boiled water was boiled for fifteen minutes and cooled in a sterile container before testing, Costa Rica 2004.

Important Definitions:
(from www.earthforce.org)

Biochemical Oxygen Demmand (BOD) – a measure of the quantity of oxygen used by microorganisms in the aerobic oxidation of organic matter.

Combined Sewer System – a sewer system that carries both sanitary wastes and storm runoff to a wastewater treatment plant to be treated and released to a body of water.

Dissolved Oxygen (D.O.) – the amount of oxygen dissolved in water.

Eutrophication – the enrichment of water with nutrients, usually phosphorous and nitrogen, which simulates growth of algae blooms and rooted aquatic vegetation.

Fecal coliform – bacteria that are found in the excrement of warm-blooded animals or birds or sewage contamination, occurring naturally in the digestive tract to aid in the digestion of food for human beings and animals.

Inorganic – being or composed of matter other than plant or animal.

Metabolic – the chemical process in living cells by which energy is provided for vital processes and activities.

Nitrates – one form of nitrogen that plants can take up through their roots and use for growth.

Non-point Source Pollution – pollution whose source cannot be traced to a single point and reach a body of water in runoff.

Organic – a living plant or animal containing carbon compounds.

pH – a measure of the acidity or alkalinity of a solution.

Pathogens – a biological agent (bacteria or virus) that can cause a disease.

Phosphates – an important nutrient for plant growth.

Turbidity – a measure of the clarity of water.

Important Links:

"Adopt-a-Stream:" Environmental Education at La Cruces
Raul E. Rojas, LCBS Resident Biologist
raulrojas@hortus.ots.ac.cr

"Control Pesticides and IPM I Developing Countries"
[http://www.pan-uk.org/internat/IPMinDC/IPMindex.html]
International Project Officer: Mark Davis
Program Director: Barbara Dinham
International Project Officer at Pan UK: Stephanie Williamson

Catchment Management and Poverty Alleviation (CAMP)
[http://www.cluwrr.ncl.ac.uk/projects/camp/index.html]
Professor Ian Calder
I.R.Calder@newcastle.ac.uk
Graham Von Maltitz
GVMalt@csir.co.za

Wilkes University Center for Environmental Quality
Geoenvironmental Sciences and Engineering Department Homeowner Outreach Program
[http://wilkes.edu/~eqc/homeowner.htm]
Attn: Brian Oram, Professional Geologist (PG), Laboratory Director
Wilkes University, Geoenvironmental Engineering Dept
P.O. Box 111
84 West South St
Wilkes-Barre, PA 18766

Healthy Water, Healthy People
[http://www.healthywater.org/testingkits.html]
healthywater@montana.edu
1-866-337-5486

Watersafe
[http://www.sciencekits.com/watersafe.html]

Chemetrics
[http://www.chemetrics.com]
1-800-356-3072

LaMotte

[http://www.lamotte.com]
1-800-344-3100

Earthforce
[http://www.earthforce.org]

Good Luck and Enjoy the River!

Appendix 2
Contact Information

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Appendix 2
Site Descriptions and Directions:

Site 1: First Falls Located above the covered bridge, this site is accessible through the cattle pasture on the left side of the river, heading up stream. It's a bit of a bushwack, so be prepared to get sloppy, but there is a bit of a beaten path along the contour, good luck finding it. Once you've reached the small tributary, follow it down to the Chirripo and cross in front of the large rock to take your samples in the flow beneath the falls.	
Site 2: Confluence of the Pacifico and the Uran Rivers Take the River Trail to the old trail that takes you out on top of Chirripo Falls, head up stream and follow the path until it takes you to where the river splits, cross through the first branch to the island, climb some rocks and you'll come out approximately 40 meters below the confluence of the Chirripo Pacifico and the Rio Uran.	

Site 3: Amanzimtoti Falls Hop the fence into the field west of Casa Amanzimtoti and follow a path down to the river. Right where the path meets the river there is a huge fallen log, approximately 50 meters downstream from Amanzimtoti Falls. At the base of this log are some good rocky spots to take your samples.	
Site 4: Jean Christo's /Vista al Cerro Between the Chispa and Chirripo Bridges on the road up to Cloudbridge there is a blue gate that leads onto private property owned by a French gentleman by the name of Jean Christo. An alternative site, to be used in the future, lies a short way down the Chirripo river, accessible through Vista al Cerro.	

Site 5: El Descanso bridge Between the Roca Dura and the Rio Blanco bridge, is a road to your left, immediately after the Hotel y Rest el Descanso. Take this road across a red suspension bridge and slip down the drainage path to the right. There is a rocky beach at the river's edge to take your sample, but make sure you take them from the current of the stream.	
Site 6: Rio Chirripo Inn Take the turn off for the Rio Chirripo Inn, below San Gerardo de Rivas, and ask politely if you can use their access to the river's edge. Follow their path down past the pool and you'll come to a rocky beach at the river, surrounded by marsh grasses.	

Site 7: Chirripo-Talari Confluence 50 meters below the Canaan pulperia, between two houses, below Mick's place, you'll find a path to the river. Best to have Eric point it out, otherwise there's little chance you'll ever find it. Once you've reached the bottom where the Talari meets the Chirripo, cross down stream from the little grassy island out in front to access the Chirripo from some large rocks you can work from.	
Site 8: Dairy Footbridge Down past Canaan, where the road bends down to the river, you can see two foot path suspension bridges from the road. Where the road widens above the first suspension bridge climb down the bank to the river and take samples from where the rocks extend as far out as you can go.	

Site 9: Chocuyo Bridge Take a left turn at a bus stop shelter about half way between anaan and Chimmerol, and follow this road to cross a large wooden (almost like railroad ties) bridge. To the right of the bridge, follow the drainage path down to the river where you'll come out to a nice flat rocky beach. Follow the edge until you come to some bigger rocks where you can access a steady stream flow for sampling.