Citizen-volunteer and professional monitoring to identify fecal sources of contamination in southwestern Puerto Rico

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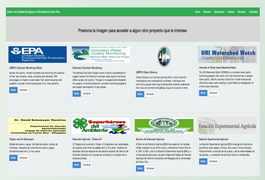


Links to other sites

Interactive calendar

Project summary

Fecal contamination from urban, suburban and agricultural activities should be minimized due to its impact on water quality and human health. In this USEPA sponsored project, we are characterizing the sources of contamination in the Lajas Valley and the lowlands of the Rio Loco in the southwestern part of Puerto Rico. Working with us are citizen volunteers that are high school students and part of the 4-H program of the Agricultural Extension Service of the University of Puerto Rico. The volunteers were trained in sampling techniques, sample management and are expected to collaborate actively in the identification of contamination sources in the assigned sub-watersheds. Some stations are sampled by the volunteers and others are sampled by professionals (students, technicians and investigators) of the College of Agricultural Sciences of the University of Puerto Rico in Mayagüez. 24 monitoring stations have been identified, each with a defined basin delineation, different covers, land use and managements. The samples are been analyzed for nutrients (nitrogen and total phosphorus), heavy metals, suspended sediments, optical brighteners (OBs), and Enterococci (as fecal contamination indicators). In the highlands of the basin there is a greater area in suburban and urban use and in the lowlands there is a larger area in agricultural use. Higher levels of Enterococci were detected in the urban areas than in agricultural, but higher concentration of nutrients have been measured in the agricultural areas than in the urban zones. We expect to identify the contamination sources in this area and provide knowledge and tools to the community so they can better manage their resources.

Project objectives

- Carry out contaminant (nutrient, metals and fecal indicators of contamination) monitoring
- Use GIS tools to identify point and non-point sources of contaminants
- Use monitoring results in combination with GIS to link contaminants to specific sources
- Educate citizen-volunteer groups in order to improve public awareness and provide potential solutions

Project workshop and volunteer training

(19 and 20 July 2014, AES Lajas)

- Five hours of theory and three hours of supervised practice
- 13 students plus their mentors completed the training
- UPRM support staff participated in the training
- All participants were given a Certificate of Acomplishment
- Topics covered
  1. Basic concepts on watershed management
  2. Description of the project; overview of Valle de Lajas and Guánica watersheds
  3. Water quality status of rivers, streams and lakes in Puerto Rico Monitoring
  4. Identification of sources of contamination, watershed deliniation
  5. Detailed explanation and description of sampling protocols, instrumentation and documentation
- Pre- and post-workshop assessment showed a 71% improvement (36 to 72%) in knowledge and skills related to learning objectives
- See presentations online at: http:// www.waterqualitypr.com/documentos.html

Volunteers during training and sampling

Sampling stations and organization

- Each volunteer group is assigned two stations
- There are a total of 24 stations
- Volunteers only sample during low-flow events
- All stations will be sampled five-times during the project
- Some stations will be sampled during storm-events by the professional group

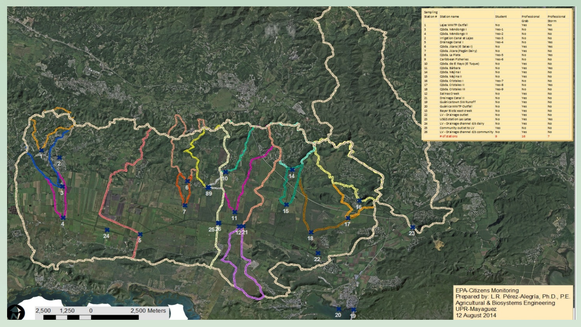
Water quality parameters being measured

- pH, specific conductance, temperature, dissolved oxygen (YSI Professional Plus Multi-probe®), streamflow
- Enterococcus (IDEXX Enterolert®), bacteroides human specific marker HF183, bacteroides cattle specific markers
- Total nitrogen (TKN + dissolved nitrate), dissolved nitrate, total phosphorus, metals (Ca, Mg, K, Na, Fe, Mn, Zn, Cu, Al, Cd, Cr, As), chloride, optical brighteners

All sampling stations have a defined watershed deliniation with land-use description

Landuse	Area	Sources	
		Human	Animal
Urban and suburban	Sewage	WWTP, sewage transfer and pumping stations, WW sewage delivery infrastructure to WWTP, upstream from WWTP discharge points, downstream from WWTP discharge points	Urban animals (poultry, wildlife, dogs, cats)
			Suburban animals (poultry, wildlife, dogs, cats), small animal (hog, goat, and poultry) production facilities
Suburban and rural	Non-sewage	Homes/buildings with septic tanks, illegal direct discharges to drainageways, sewage delivery infrastructure to WWTP	Rural animals (poultry, wildlife, dogs, cats), dairy production facilities, small animal (hog, goat, and poultry) production facilities, large animal (horse) production facilities

Land use (Gould et al. 2012)
- Urban - Area is not developed by at least 20% (< 80% in vegetative land-cover) or > 500 persons/km^2
- Sub-urban - Area has more than 80% of vegetative land-cover with > 500 persons/km^2
- Rural - Area has more than 80% of vegetative land-cover with < 500 persons/km^2



Nutrient concentrations are being interpreted in the context of suggested numeric nutrient criteria in rivers of Puerto Rico (Sotomayor-Ramirez et al. 2014)

Threshold	Total N	NO_3-N	Total P
	----------mg/L----------		
Non-enriched	<0.35	<0.25	<0.030
Enriched	>0.35-1.70	>0.25-0.97	>0.030-0.160
Impaired	>1.70	>0.97	>0.160

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- We recognize the work of G. Martínez support staff (J.L. Guzman and O. Santana) in Agric. Exp. Sta. Rio Piedras in the nutrient analysis
- We appreciate the collaboration of USEPA Program Manager Dr. W. Fisher

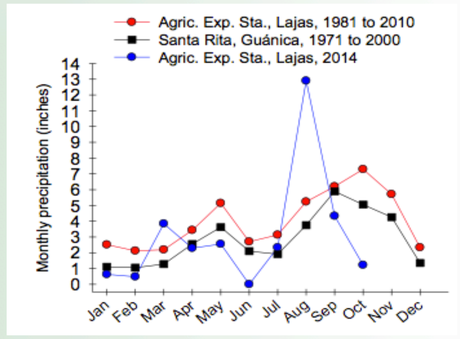
----------Results----------

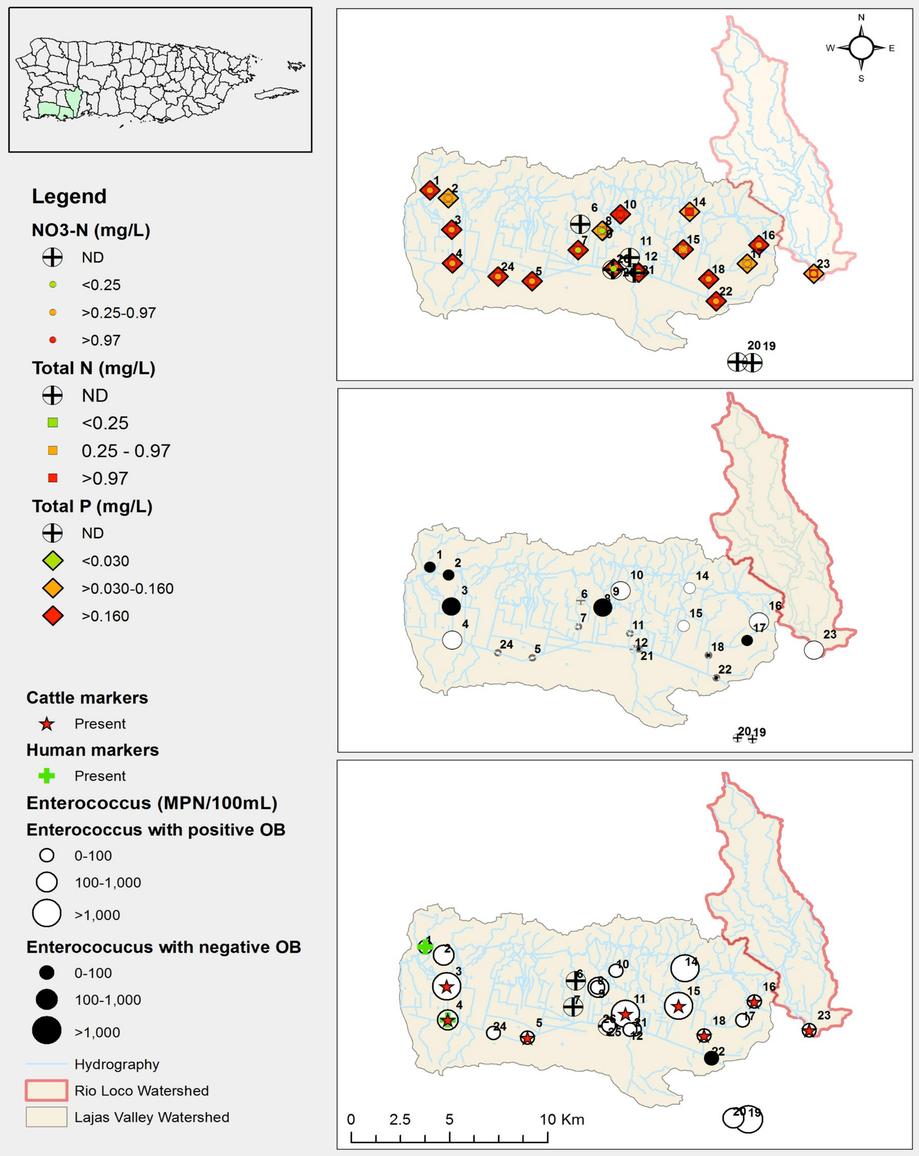
Sampling

- First round of sampling from 5 Aug to 26 Aug (21 d period), one station was sampled on 3 Sep 2014.
- Second round of sampling from Sept 22 to 22 Oct (31 d period)
- Stations were sampled during low-flows

Climatic conditions

- Precipitation from Jan to Jul was 12.1 in and the 30 yr normal is 21.2 in.
- Precipitation in Aug was 12.9 in and the 30 yr normal is 5.2 in; There was a 2-day 8.1 in event on 23 and 24 Aug
- Many of the stations had a very low hydrologic flows
- Precipitation in Oct was 1.22 in and in the 30yr normal is 7.29 in.





Land use

- All of the stations are liked to a defined sub-basin. Land use analysis is still in process, yet certain generalizations can be made:
- Station #1 is downstream the Lajas WWTP outfall, so that we expect high nutrients and fecal contaminations
- Stations #3 and #4 are within the same waterway that drains Station #1, but are downstream Lajas City. Thus we should see a strong nutrient and fecal contamination signal due to urban influence
- Station #2, located within Lajas Valley Irrigation Channel near Lajas, is considered a reference station in the sense that the channel transports water from Lago Loco and the channel should receive minimal runoff influence. Lago Loco is in the mesotrophic trophic state Index with historical total P concentration of 36 µg/L (Martínez et al. 2005).
- Stations #24, #5, #6 and #7 are downstream dairy production facilities.
- Station #23 drains the upper Río Loco watershed, which has relatively limited agricultural production area, yet has a mix of urban, suburban and rural land-uses.
- Stations #16, #17, and #18 are in tandem (within the same drainage channel); Station #18 includes waters from #16 and #17 but drains a 600 acre rice-production farm.

Nutrients

- Some of the nutrient analysis have not been completed (ND in the legend)
- Reference Station #2 (Lajas Valley Irrigation Channel near Lajas) was "nutrient enriched"
- Station #1 (Lajas WWTP outfall) was "enriched" in NO_3-N, "nutrient impaired" in total P and in total N
- Stations #3 and #4 (downstream Lajas City) were "nutrient impaired" for NO_3-N; #3 was "impaired" and #4 was "enriched" for total N
- For Stations #5, #24, and #21 (drainage channel, downstream dairy farms) were impared in terms of total P and enriched with NO_3-N and total N

Enterococci and optical brighteners (OB)

- Station #1 did not have the expected "high" Enterococcus concentrations, possibly due to chlorination; the OB signal was detected.
- Stations #1 and #2 (Lajas WWTP outfall and Lajas Valley Irrigation Channel near Lajas) had similar Enterococci concentrations. The second sampling round, station #2 had higher Enterococci than #1.
- Stations #3 and #4 (downstream Lajas City) had very high Enterococci concentrations, and both reported positive for OB in the second sampling round.
- Enterococci concentrations at the Lajas Valley drainage outlet was <100 MPN/100 mL
- On the second sampling round even more station reported positive for OB and had higher Enterococci concentrations

Human and cattle markers

- Human markers were found in station #1 and #4. This two stations are located in the Lajas town.
- Cattle markers where found in stations #3, #4, #5, #8, #9, #11, #15, #16, #18, #23. #5 was expected, due to its location downstream a dairy production facility