University of Puerto Rico – Mayagüez Campus

College of Agricultural Sciences

Department of Crops and Agro-environmental Sciences

Summary report for project:

Citizen Monitoring of Water Sanitation in a Rural Puerto Rico Watershed

QAPP title: Assessment of Water Quality and Efficacy of Water Treatment Infrastructure in Southwestern Puerto Rico

Cooperative Agreement no. 83553801 between US Environmental Protection Agency and the University of Puerto Rico Mayagüez Campus

Reporting period of: 1 Jan 2014 to 30 Dec 2014

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Topics covered in this report

1. Training of professionals and citizen volunteers
2. Outreach
3. Selection of sampling sites and land-use analysis
4. Number of samplings completed and sites sampled
5. Analysis completed
6. Major highlights of the results

This report summarizes the activities carried out under the Project Agreement for the specified dates. It is not intended to provide comprehensive details of all activities but rather to provide a general overview of what has been completed and potential implications of the results obtained. The overall objective of the project is to "Increase public awareness of sanitation issues in the Lajas Valley and Guánica/Río Loco watersheds by initiating assessments of water quality and sewage infrastructure by professionals and citizen volunteers". Specific objectives are:

1. Carry out water quality sampling for indicators of unsanitary conditions in selected watersheds
2. Use GIS tools to identify point and non-point sources of contaminants
3. Use monitoring results in combination with GIS to link contaminants to specific sources
4. Improve public awareness of the threats of contamination and provide potential solutions to public health and environmental problems.

1. Training of professionals and citizen volunteers

All of the professional project participants have been trained in field and laboratory procedures, equipment maintenance and laboratory analysis. Training was done by reading the project QAPP, trainings (two-day workshop on June 19 and 20, an afternoon workshop on November 21), formal and informal meetings and interactions. Citizen volunteers have been trained in field sampling procedures and have received a certificate as evidence (Figure 1). The project QAPP, including SOPs are available to all participants at http://www.waterqualitypr.com/.

All of the graduate students that are participating are also developing their MSc thesis within the overall project scope. The following persons are active participants in the project:

Person	Position	Role
David Sotomayor-Ramírez	Professor UPRM / Project Manager and PI	Direct and coordinate project activities: field sampling, scheduling, laboratory analysis, data management, statistical analysis, report/ publication preparation, administrative management.
Gustavo Martínez	Research-Professor, UPRM / QA Officer	Lead the laboratory analysis for nutrients, study design, training of volunteers and mentors, report/ publication preparation.
Luis Pérez Alegría	Professor, UPRM / QA Coordinator	Lead in selection of sampling sites, spatial analysis and GIS, process spatial data, study design, training of volunteers and mentors, report/ publication preparation.
Hector Torres	UPRM-AES Research Technician	Provide support in field sampling, field data gathering, equipment maintenance, laboratory support for microbial sample preparation, data entry.
Paloma Rodriguez	UPRM Graduate Student	Lead all field sampling, field data gathering, equipment maintenance, laboratory analysis of selected constituents
Cristina López	UPRM Graduate Student	Provide support in field sampling, field data gathering, equipment maintenance, co-lead all outreach activities
Armando Román	UPRM Graduate Student	Lead microbial analysis of water samples, data entry.

Person	Position	Role
Anibal Ruiz	UPRM-Agricultural Extension Service, Lajas Area Agent	Coordinate sampling excursions with citizen volunteers (Group #4)
Isbeth Irizarry	UPRM-Agricultural Extension Service, Guánica Area Agent	Coordinate sampling excursions with citizen volunteers (Groups #1, 2, 3)

2. Outreach

- **Meetings with citizen volunteers.**
    - A workshop was held at the Lajas Agricultural Experiment Station on June 19 & 20, 2014, where a two-day training was conducted for citizen volunteers and extension agents. Presentations were given by project personnel and supporters on the following topics:
        - Watershed management
        - Water quality and its implications on health
        - Sources of water contamination
        - Lajas Valley and Rio Loco watersheds
        - Sampling techniques and monitoring stations
    - Diagnostic tests were given prior to workshop commencement and at the end to evaluate volunteer learning and training efficacy. Each volunteer was certified with a diploma.
- **Presentations**
    - A poster was presented at the EPA conference on September 12, 2014
    - A poster was presented at the annual SOPCA meeting on November 7, 2014,
    - A presentation was given at Isla Magueyes Field Station on November 21, 2014, where summarized results of the first two sampling rounds were presented to students and extension agents as powerpoint and a scientific poster. A discussion was carried out regarding the results obtained and significance.
- **Sampling dates, number of participants**. Three sampling rounds have been completed with citizen volunteers and 4H students.
    - The first round was carried out the 5th and 6th of august, 2014 - 12 students and three extension agents assisted
    - The second round was accomplished September 29 and October 1st, 2014 - 8 students and two extension agents assisted
    - The third round was executed on January 12th and 19th, 2015 - 11 students assisted and 3 extension agents
- **Web page, twitter account, blog**
    - A web page was constructed for the project to provide educational material, project results and other information to citizens.
    - A blog was created on this web page to stimulate interaction and communication. Project collaborators are to make entries in this blog after

sampling. A twitter account was also created to further involve citizen volunteers in project dynamics.

- **How can we get them to be more involved in linking their results to land-use.?**
    - Ask students, or their extension agents, to do some kind of mapping exercise; maybe give them a printed map so they can paint around their stations like what we did for groundtruthing?

3. Selection of sampling sites and land-use analysis

Selection of sampling sites. Twenty-six sampling stations were selected from throughout the Lajas Valley, lower portion of Río Loco watersheds, and Guánica Bay (Figure 2). The stations were selected based on criteria described in QAPP. The original goal was to have 22 stations that would be sampled during low-flow events. We added one more station for a total of 23 (Table 1). Also, we identified some geographic points that think may be interesting based on occasional visits and these will be visited and sampled if there is suspicion of contamination.

Land-use analysis. Georeferenced land use data from the Puerto Rico Governmental Portal for Geographic data (gis.pr.gov) was obtained and clipped in ArcGIS to the Lajas Valley and Rio Loco watersheds. Six trips were made to validate this land use from the field using a blank map and coloring observed land use categories. Land use corresponded to one of the ten categories: Artificial barren, Forest, Grasslands and pastures, Grazed pastures, Hay, High-density urban development, Low-density urban development, Pond, Row crops, Woods and shrubs. Land use classification of validated areas were edited or confirmed in the attribute table of the shapefile. Table 2. The land-use maps represents the most recent and detailed landuse description to date (Figure 3 and Figure 4).

4. Number of samplings completed and sites sampled

Samplings. Three sampling incursions have been completed. The first incursion (I) was a 45-day period from 5 August to 3 September 2014, the second incursion (II) was a 33-day period from 22 September to 22 October 2014; the third incursion (III) was a 15-day period from 9 January to 26 January 2015 (Table 3). In some instances, there was a large time span during the sampling incursion. Some sites had to be re-visited more than once because the sampling criteria to have flowing water was not met.

The goal was to have 69 sampling points (23 stations x 3 incursions). We have managed to complete 59 out of 69 (or 86%) of the sampling events.

5. Analysis completed

A description of the number of samples analyzed, in progress to be analyzed, or not sampled for each parameter during each incursion is summarized in Table 3.

Daily precipitation data at Lajas UPR-Agricultural Experiment Station has been gathered from: http://www.nws.noaa.gov/climate/xmacis.php?wfo=sju.

6. Major highlights of the results

Land use. All of the stations are liked to a defined sub-basin. Land use analysis is still in progress so that linkage among nutrients, fecal contamination and land-use cannot be done, yet certain generalizations can be made (Please refer to Table 2 and Figure 4):

- 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.
- Station #6 is upstream and #7 is downstream a dairy production facility, but will be sampled primarily during storm events

Nutrients. In contrast to what has been observed in the continental USA (USEPA, 2006), nutrients have yet to be identified as a major cause of surface water impairment in Puerto Rico (PREQB, 2003, PREQB, 2008). This most probably due to the lack of adequate standards which has prevented the identification of nutrient impaired waters. For example, current nutrient water-quality standards in Puerto Rico are 1,000 µg total P/L and 10 mg NO_3-N/L (for nitrogen) for class SD waters, which includes rivers, lakes, and estuaries (PREQB, 2010). We have opted to interpret our nutrient concentration data in the context of suggested numeric nutrient criteria in rivers of Puerto Rico (Sotomayor-Ramirez et al. 2014) as:

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

- 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.

- Station #1 did not have the expected "high" Enterococcus concentrations, possibly due to chlorination; the OB signal was not 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
- Many stations draining mixed-use rural watersheds had a positive OB signal (Stations #10, #14, #15, #16 and #23) combined with high Enterococci concentrations.
- 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. These two stations are located within or at the border of Lajas municipality.
- Cattle markers where found in stations #3, #4, #5, #8, #9, #11, #15, #16, #18, #23. Presence at #5 was expected, due to its location downstream a dairy production facility.

References

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