

Effect of Non-Point Source Runoff and Urban Sewage on the Yaque del Norte River, Dominican Republic



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Background Information:

- A Yaque del Norte watershed survey monitored:
  - Dissolved oxygen.
  - Likelihood of eutrophication due to nitrogen and phosphorus from point and non-point sources.
  - High conductivity likely resulting from agricultural runoff.
- Dominican Republic per capita water availability is approximately 1,500 m<sup>3</sup> per capita/year.
  - Regional water scarcity due to irrigation and urban consumption.
- Sedimentation from erosion is evident throughout the watershed.

Background Information:

- Upper mainly forested watershed has good water quality except:
  - Untreated sewage contributed by the city of Jarabacoa.



Jarabacoa



Potable water truck filling downstream from Jarabacoa sewage canal

Background Information: Sedimentation from erosion is evident.

- Mid-watershed has:
  - Deforested landscape.
  - Mixed agriculture.
  - City of Santiago contributing large amounts of nitrogen and phosphorus.



Santiago



Background Information: Sedimentation from erosion is evident.

- Lower watershed has:
  - Extensively-irrigated agriculture.
  - Runoff contributes to:
    - High nitrogen.
    - High phosphorus.
    - High conductivity.



Land use in the Yaque del Norte watershed, NW Dominican Republic



- Watershed contains 7,000 km<sup>2</sup>, or 14% of Dominican territory.
- Originates in the Central Cordillera.
- Discharging into the Atlantic Ocean near Haiti.
- Northern boundary enclosed by the Northern Cordillera.
- Watershed elevations range from 3,000 m to sea level.
- Watershed population is 1.3 million.

### Sampling sites along 200 km of the Yaque del Norte River



- 14 sites sampled up to 5 times from June to August 2004.
- 9 sites established along 200 km of the 308-km river mainstem with elevations ranging from 900 m to near sea level.
- Additional site Arroyo Hierba Buena canal, carrying raw wastewater from the mountain city of Jarabacoa, important montane tourist centre, to the river.
- Similar site, Arroyo Nibaje, established within the city of Santiago.
- In the lower watershed, sites established where 3 significant tributaries, Amina, Mao and Guayubin Rivers, discharge in the river mainstem.

### Sampling Procedure

Horiba U-10 Water Quality Checker to measure *in situ*:

- Temperature.
- Dissolved oxygen.
- pH.
- Conductivity.
- Turbidity.



Hach Surface Water Kit to measure:

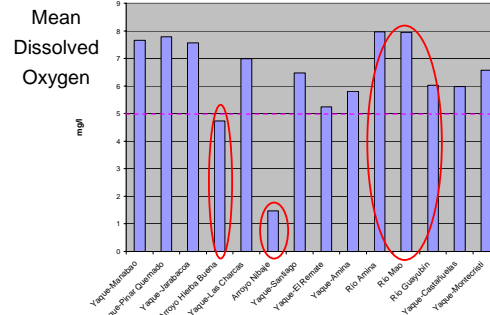
- Ammonia.



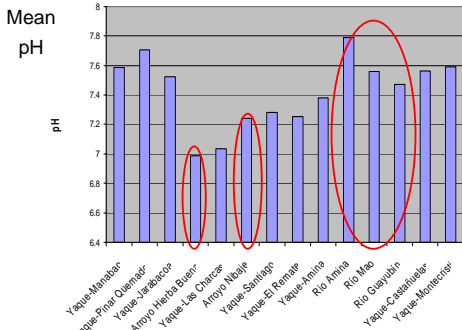
### Sampling Procedure

Additional water samples were collected, frozen and transported to Winthrop University for analysis by a Hach DR/4000 spectrophotometer:

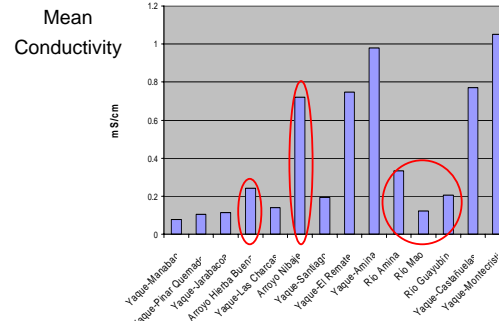
- Total phosphorus – acid persulfate digestion method 8190.
- Phosphate – molybdovanadate method 8114.
- Total nitrogen – persulfate digestion method 10071.
- Nitrate – UV direct reading method 10049.



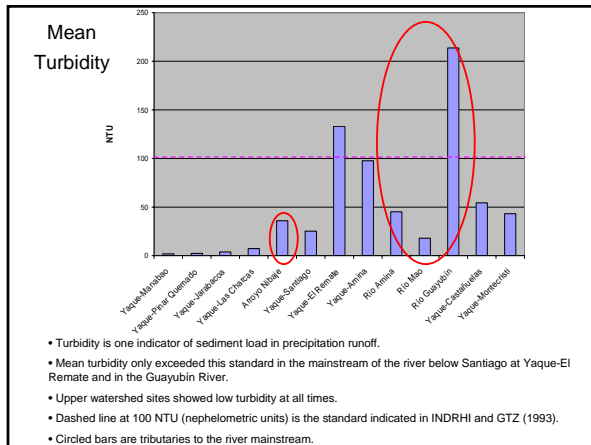
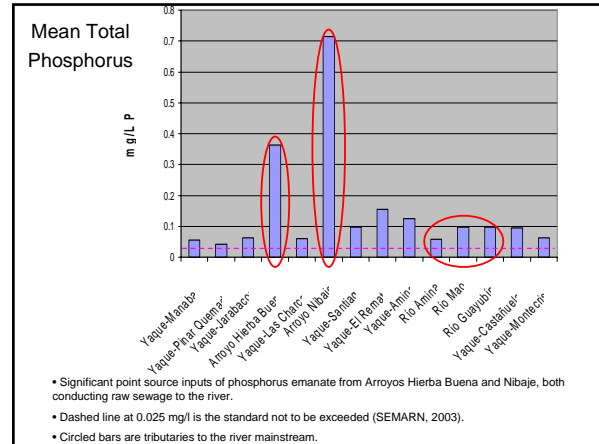
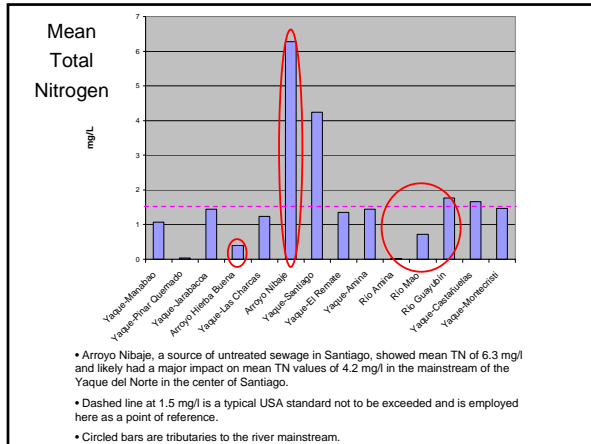
- Water quality upstream from Santiago is significantly superior to that in downstream areas.
- Dashed line at 5 mg/l indicates DO levels needed to sustain aquatic life.
- Circled bars are tributaries to the river mainstem.



- pH was consistently near 7 throughout the watershed, including the two tributaries conducting raw sewage into the Yaque del Norte River.
- These values fall within the water quality regulations set by SEMARN (2003).
- Circled bars are tributaries to the river mainstem.



- Electrical conductivity was lowest in the high watershed and upper reaches of the mid-watershed, ranging from 0.08 to 0.19 mS/cm.
- Mean conductivity in Arroyos Hierba Buena and Nibaje was significantly higher (0.24 and 0.72 mS/cm, respectively) than mainstream river waters.
- Downstream of Santiago, conductivity increased substantially to a high mean of 1.05 mS/cm.
- Circled bars are tributaries to the river mainstem.



**Conclusion**

This research represents an effort to contribute to the assessment of water quality of the Yaque del Norte River watershed for managers and regulators of this resource:

- Origin in pristine high-mountain national park.
- Drinking water source.
- Irrigation water.
- Point source pollution - treated and untreated wastewater:
  - Santiago
  - Jarabacoa
- Non-point source pollution.
- Decreased river volume due to deforestation.

**Conclusion**

This research represents an effort to contribute to the assessment of water quality of the Yaque del Norte River watershed for managers and regulators of this resource:

- Sedimentation from soil erosion:
  - Loss of reservoir capacity.
  - Smothering of aquatic fauna and habitat:
    - Soldner *et al.* (2004) determined the impact of poor water quality on macroinvertebrate fauna throughout the Yaque del Norte watershed.
  - Impact on coastal zone resources:
    - Coral reefs.
- Eutrophication:
  - Overfertilization by nitrogen and phosphorus.
  - Eutrophied waters commonly contain large blooms of algae.

**Conclusion**

With an expanding human population, intensive agriculture employing synthetic fertilizers, pesticides and extensive irrigation against the backdrop of generally mountainous terrain, the challenge of satisfactorily managing the Yaque del Norte River land and water resources for all stakeholders is critical and urgently needs to be addressed.



### Recreational Importance of Rivers

Mao River, generally good water quality



Yaque del Norte River, lower watershed near Atlantic Ocean, poor water quality



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