Topic: **Wastewater Management**

Title: **Improving Wastewater Management in Ortoire, Mayaro**

Author: **Samantha G. Noel (Water Resources Agency, WASA)**

Key Words

Water Quality, Anthropogenic, Sustainability, Watershed Management

Abstract

Water is one of the world's most valuable resources, yet it is under constant threat due to wastewater pollution, threatening the health and well-being of humans, plants, and animals. Consequently, effective wastewater collection and treatment are pivotal from the perspective of both environmental and public health. The ultimate goal of wastewater management is the protection of the environment in a manner commensurate with public health and socio-economic concerns.

The major objective of this paper is to determine the need for a Wastewater Treatment System (WWTS) within the Ortoire Village as a result of the domestic waste due to land based anthropogenic activities. Accomplishing this objective entailed determining the extent of the domestic waste and its effects on the water quality of the river by conducting water quality testing of parameters including temperature, pH, dissolved oxygen (DO), total dissolved solids (TDS), conductivity, nitrate, phosphate and faecal coliform.

The Ortoire Watershed is located in the south-eastern part of Trinidad. The Ortoire River begins its course in the vicinity of New Grant and travels in an easterly direction before out falling on the south-eastern coast at the boundary between Manzanilla and Mayaro. On its route to the outfall, the Ortoire River passes through settlements such as Hindustan, Tableland, Mafeking and Ortoire and crosses the Rio Claro/Guayaguayare and Naparima/Mayaro Roads. (Water Resources Agency, WASA, 2001) Sixty percent (60%) of the Ortoire watershed is of evergreen forest while the remaining forty percent (40%) is very diverse including agricultural activities, increasing urban development, an upsurge of commercial areas and continuous development of oil and gas mining. (Noel, 2014)

The water quality results indicated that the land base activities within the Ortoire region are impacting on the water quality of the Ortoire River. If this continues at the current rate it will threaten environmental health and well-being of humans, plants, and animals. Therefore, this feasibility study concludes that there is a need for a Wastewater Treatment System within the Ortoire Village.

Introduction

The Ortoire Watershed located in the south-eastern part of Trinidad is one of the largest hydrological regions in Trinidad. The Basin has its northern boundary at the foot of the Central Range, southern boundary along the Mayaro Forest Reserve, eastern boundary roughly of Latitude 61o20' and its western boundary open to the Atlantic Ocean. Major tributaries out falling into the Ortoire River include the Poole and Balata Rivers. (Water Resources Agency, WASA, 2001). **Figure 1** below shows the Ortoire River Watershed.

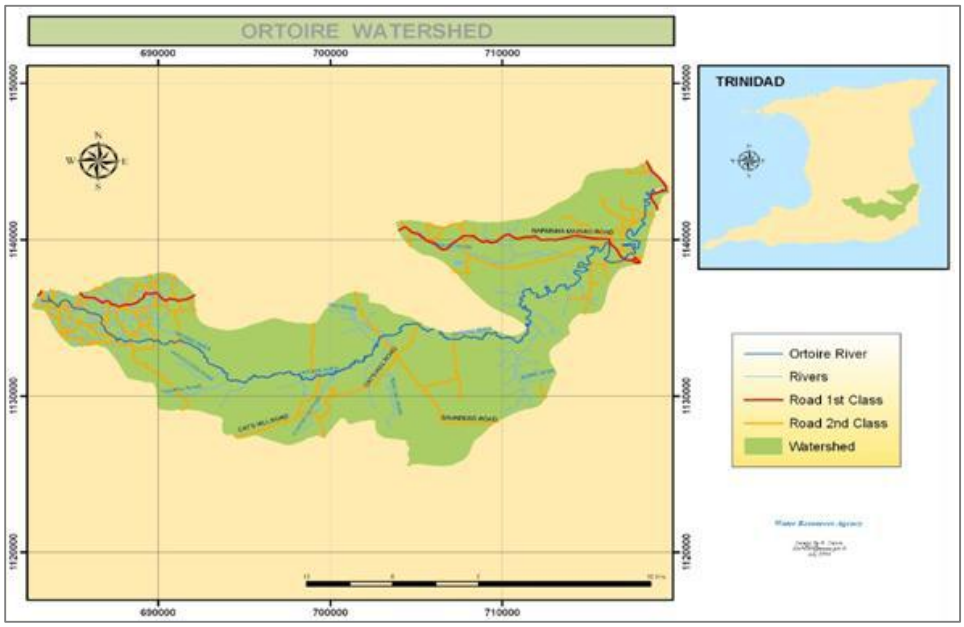


Figure 1: Map of Ortoire Watershed

Source: (WRA, 2013)

Sixty percent of the Ortoire watershed is of evergreen forest while the remaining forty percent is very diverse with agricultural activities, land leases used for oil mining and increasing urban developments. Fishing is perhaps the most important means of income for the people of the area. A Fringe and basin type mangrove exists on the river, which is the "home" of the cascadura fish and it also supplies a ready source of brackish water. Oyster fishing are prominent with conch and crabs also being main catches sold by roadside peddlers. Cash crop farming is limited to lettuce, some vegetables and watermelons in particular. Livestock rearing is another means of income for the population. Pigs, cattle and poultry are the main animals reared. (Water Resources Agency, WASA, 2001).

Background

In Trinidad, the quality of the surface water resources is in many places deteriorating, as evident by high levels of biological oxygen demand (BOD) and bacterial content, turbidity and the presence of chemical pollutants in the rivers. The main threats are uncontrolled

point waste discharges, in particular from industries and domestic sources, as well as, the high level of erosion in the upper catchment of the watercourses. Pollution of surface waters not only affects the production of potable water but also the ability of the rivers to provide productive habitats for terrestrial and aquatic species is endangered. (Water Resources Agency, WASA, 2001).

Risks to the quality of the water resources, are presented from all sectors of the society. Large amounts of untreated domestic waste, in particular sewage, enter the surface water sources. It is estimated that 30% of households in Trinidad and Tobago are at present connected to the sewerage system, and the remaining 70% of the population is serviced by septic tanks with seepage pits or pit latrines (GENIVAR, 2008). The potential agricultural and industrial threats lie in the non-point or diffuse sources from pesticides and agro-chemicals, and from oil production, refining and toxic chemicals, inclusive of heavy metals. (Water Resources Agency, WASA, 2001). **Figure 2** below shows the water quality status of watersheds throughout Trinidad and Tobago.

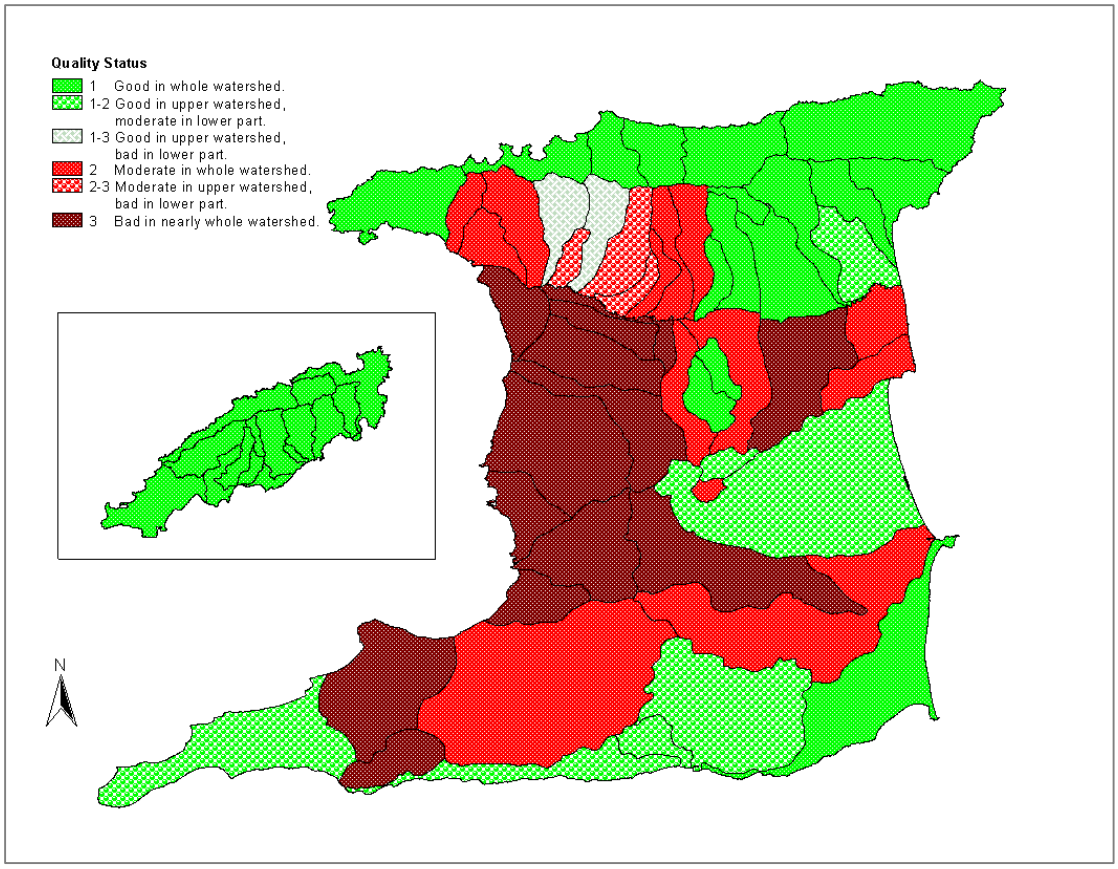


Figure 2: map showing Water Quality Status in T&T
Source: (Water Resources Agency, WASA, 2001)

Methodology

Water Quality Testing (in-situ and laboratory)

During the period June 24 to July 08, 2014, samples were taken from Monday to Thursday for ten (10) days to accommodate laboratory testing the following the day. Ten (10) sites were identified along the Ortoire River and mapped site 1 started at the mouth of the river all the way to site 10 into the watershed.

Basic physicochemistry data (Temperature, Dissolved Oxygen, pH, Total Dissolved Solids and Conductivity) was collected using the YSI 556 MPS water quality meter. One grab liquid sample was retrieved from each of the ten sampling sites. The samples were then preserved at approximately 4^{o}C in ice coolers where they were transported to the New WASA Beetham Wastewater Treatment Plant Analytical Laboratory at Beetham, Port-of-Spain and analyzed within the specific holding times for Nitrates, Phosphates and Faecal Coliform. In the lab, field blanks, field duplicates, lab replicates, calibration blanks and calibration standards were used to ensure quality control throughout the process. **Figure 3** illustrates the sample locations.

Figure 3: map illustrating sample locations
Source: (Noel, 2014)

Results

Figure 1

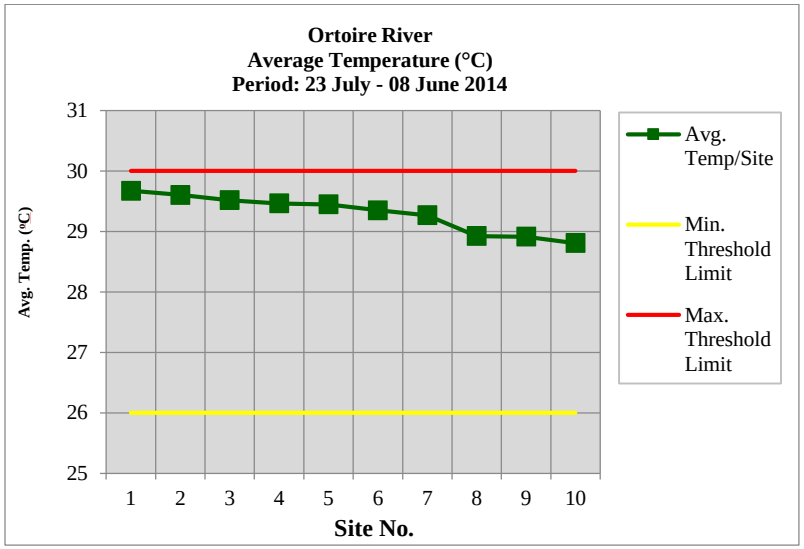
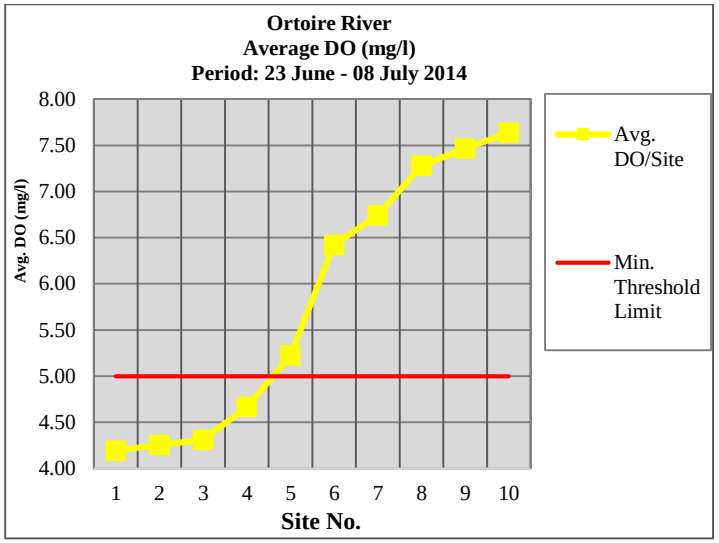


Figure 2



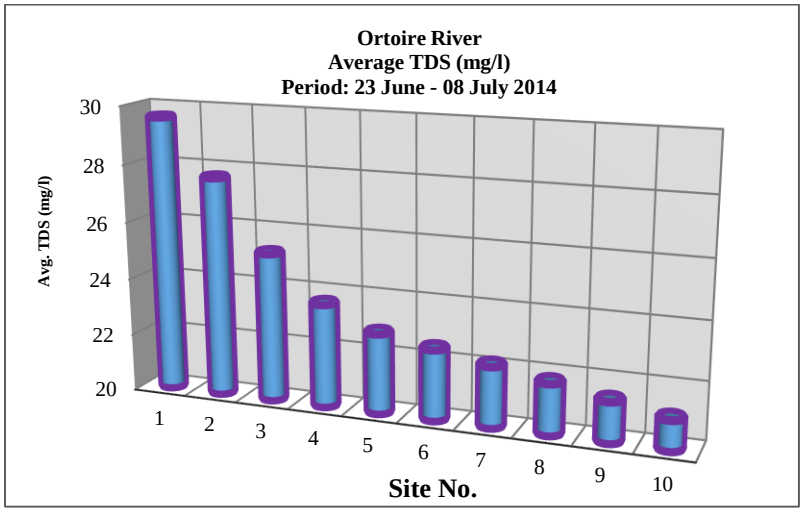


Figure 3

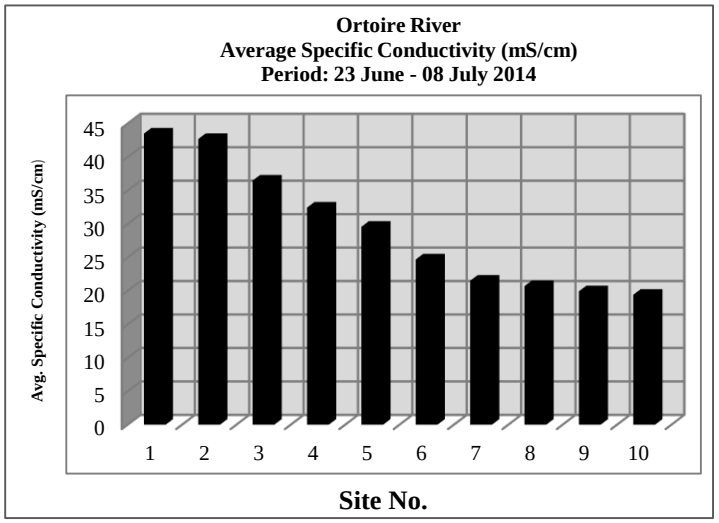


Figure 4

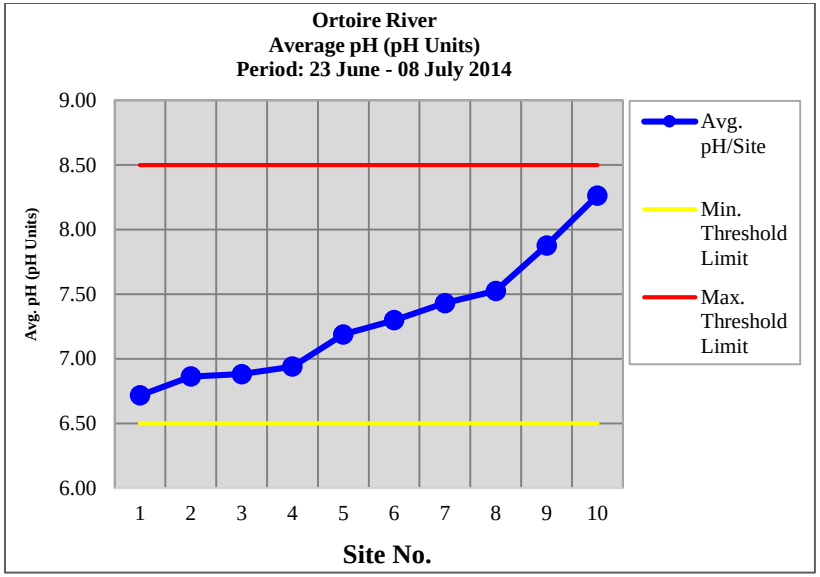


Figure 5

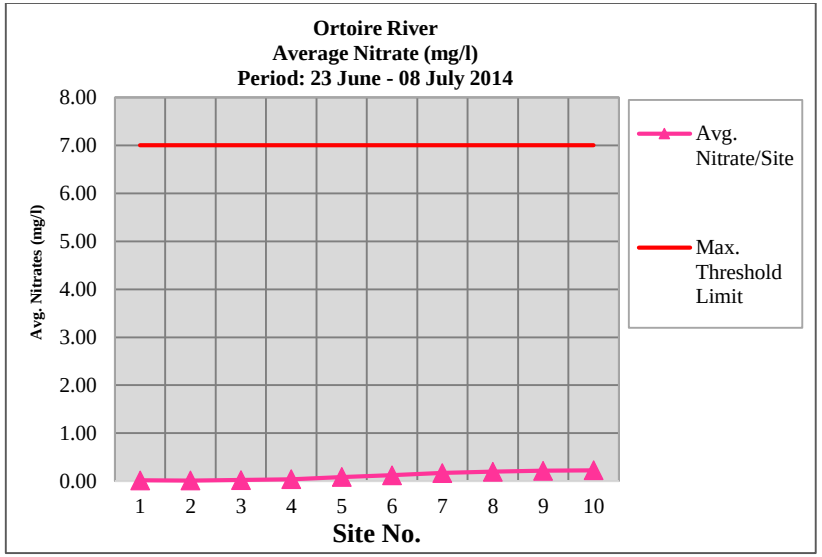


Figure 6

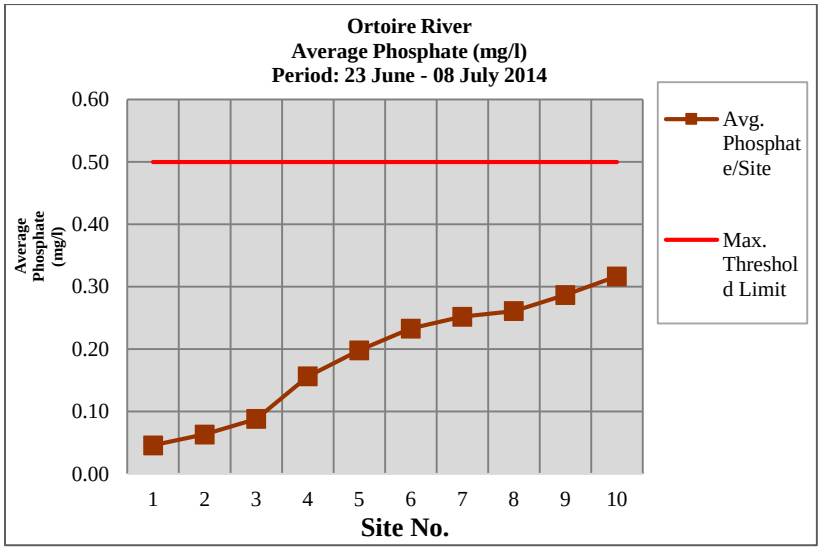


Figure 7

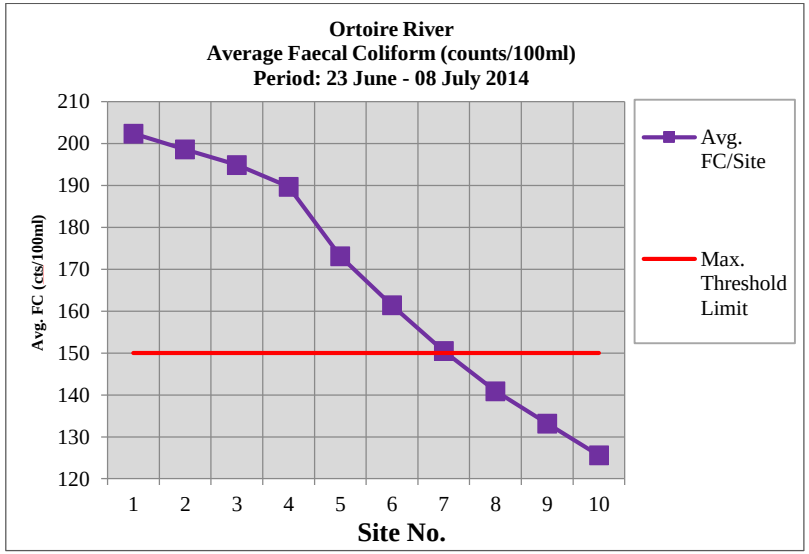


Figure 8

Discussion

Water Quality Standards

For the purpose of this study, the Philippine; Department of Environment & Natural Resources (DENR) Clean Water Act, 2004 for ambient water quality was used as guide, as the Philippines is archipelagic country and has a climate similar to Trinidad and Tobago (Vilma T. Cabading). The water classification that was used for inland surface water is Class B Recreational Water Class I. This classification is intended for primary contact recreation such as bathing, swimming, fishing etc. (DENR, 2008). **Table 1** below gives the DENR permissible limits that were used in this study as well as a comparison between the EMA and DENR water quality standards.

QUALITY PARAMETER	DENR (2008), Philippines
DO (mg/l)	min 5
pH (pH unit)	6.5 – 8.5
Nitrate (mS/cm)	max 7
Phosphate (mg/l)	max 0.5
Temperature (°C)	26°C - 30°C
Faecal Coliform (cts/100ml)	max 150
TDS (mg/l)	-
Conductivity (mS/cm)	-

Table 1: EMA and DENR water quality standards

Water Quality Analysis

All water quality results are summarized in **Figures 1-8.** The temperature, DO, pH, nitrate, phosphate and faecal Coliform recorded at sites 1 to 6 were all not within the DENR Philippines ambient water quality standards, while, sites 7 to 10 were all within compliance. The DENR Philippines have not yet established ambient water quality standards for TDS and conductivity and hence there were no values to compare. However, values for TDS and conductivity at sites 1 to 10 follow the exact trend for the aforementioned water quality parameters, where, the TDS, temperature and conductivity were all relatively high at sites 1 to 6 and lower at sites 7 to 10. This may be because of the fact that sites 1 to 6 were all immediately within the village, while sites 7 to 10 were further into the watershed. This indicates that there may be anthropogenic impacts from the village on the river.

The DO values in inland surface waters are affected by many factors such as temperature, flow, aquatic plant, dissolved or suspended solids, human activities etc. Since the village impacts stops at site 6, the DO sag curve of the Ortoire River proceeded to recover gradually from this site and can be seen to fully recover at site 10. Similarly high faecal coliform counts affects the DO and as such, it is seen to decreased at sites 1 to 6 and as the faecal coliform counts dropped the DO increased at sites 7 to 10 again this phenomena is illustrated in the DO sag curve.

Furthermore, nitrate and phosphate generally occurs in trace quantities in surface waters and are referred to as the limiting nutrient for plant growth. Nitrates and phosphates are used in fertilizers for agriculture to grow crops, and on many farms the landscape has been greatly modified in order to maximize farming output. The nitrate and phosphate values recorded at sites 1 to 10 were all within compliance with the DENR Clean Water Act, 2008. However, it should be noted that these parameter values increases gradually further into the basin, where the higher concentrations are recorded at sites 6 to 10, which can be attributed to some kind of anthropogenic activities for example, agriculture further into the basin. Additionally, given that the Ortoire River flows in the direction towards the Atlantic Ocean it can be seen that the concentrations of nitrates and phosphates considerably decreases from sites 5 to 1.

Finally, it is evident that the high temperatures, TDS, conductivities, faecal coliform counts and the low pH and DO values at sites 1 to 6 can be attributed mainly to land base activities such as surface runoff from anthropogenic activities, on-site septic systems, domestic and wild animal manure, storm runoff etc. On the other hand, the lower temperatures, TDS, conductivities, faecal coliform counts and the higher pH and DO values at sites 7 to 10 can be supported by the fact that these sites are within relatively pristine areas of the basin where influence of anthropogenic activities is minimal.

Impending Impacts on the Health of the Ortoire River

Ecological Damage

Sewage-contaminated water causes eutrophication, which is the increase in concentration of chemical elements required for life. The nitrates, phosphates, and organic matter found in human waste serves as food for algae and bacteria. (Planetary Notions, 2002) When this occurs, organisms in the river may overpopulate to the point where they use up most of the dissolved oxygen that is naturally found in the water, making it difficult for other organisms in the Ortoire River to live.

Health Risks

Bathers of the Ortoire River can be at increased risk of contracting illness due to bacteria and viruses present in sewage effluent. Gastrointestinal disorders have been linked to sewage pollution, with viruses implicated as the cause. Shellfish strain water through their gills to trap microscopic plants and animals for food. If the water is contaminated with disease-causing bacteria, these could be consumed as food by shellfish. When eaten raw or partially cooked, these shellfish can make people sick. Additionally, certain fish in such contaminated waters can accumulate high levels of toxic substances, when these foods are consumed frequently over a lifetime, they may increase the consumers' risk of adverse health effects.

Economic Loss

The economic consequences of water pollution can be rather severe due to detrimental effects on human health and on the environment. Various sectors of the economy, including agriculture, recreation, tourism, productivity of water resources (e.g. fisheries output) can be disastrous. The fishery economy is the most significant in this region and environmental degradation can reduce the productivity of the water resources used directly by the people, resulting in job loss and economic hardship. Additionally, economic losses from competitive recreational activities and tourism can also be affected, given that this region has become a destination for tourism and host yearly kayaking competition on the river.

Conclusion

The water quality data indicates that the river is contaminated with respect to faecal coliform with source being anthropogenic or more likely, from the poor wastewater treatment within the village area at sites 1-6. As a result, this type of pollution and other physicochemical parameters, such as temperature, dissolved oxygen and nitrates, did not standards. This type of pollution is of concern given that the Ortoire River is used by residents as a means of livelihood and recreation. Hence, there is the possibility of impending ecological, economic and health impacts on the river if this pollution trend continues as is.

Recommendations

In recognizing that the environmental health of the Ortoire River depends on both natural and anthropogenic activities which occur in the watershed and in order to promote watershed management and support sustainable development the following is recommended:

- Construction of a WWTS - to cater for the future development in the area due to population growth, housing development & increased pollution due to expanding fisheries and small business development.

- Establishment of a water quality programme to include pollution identification, monitoring and control.
- Development of watershed management plans, and the implementation of soil and water conservation measures and reforestation activities – Adopt A River Programme.
- Establishment of public awareness/education programme to promote shared vision, partnership and shared ownership of the resources – Adopt A River Programme.
- Proper zoning and enforcement
- Further research is needed, the multiple use of the river should be explored
- Regularize fishermen and provide adequate fishing depot facility with adequate waste disposal.

References

DENR. (2008). *Water Quality Guidelines and General Effluent Standards.* Retrieved from http://www.emb.gov.ph/wqms/Draft%20DAO%20on%20the%20Revised%20WQG%20and%20GES%20rev%20121807.pdf

Noel, S. (2014, July). Pictures of the Ortoire River.

Planetary Notions. (2002). Effects of Dumping Sewage Water Directly Into the Sea. (L. Saida, Compiler) Lebanon, Saida, Lebanon. Retrieved 07 30, 2014, from http://gobiidae.com/PN/dumpingsewage.html

Vilma T. Cabading. (n.d.). *Water Quality Management in the Philippines.* Retrieved from http://www.wepa-db.net/pdf/0712forum/paper03.pdf

Water Resources Agency, WASA. (2001). *Integrating The Management of Watersheds and Coastal Areas in Trinidad and Tobago.* Port of Spain.

WRA. (2013, August). Map of Ortoire River Basin. WRA.

Williams, W. O. (2006). *Sustainable Wasterwater Management in Trinidad and Tobago.* Water and Sewerage Authority, Wastewater Planning and Development. Port of Spain: WASA

GENIVAR. (2008). *Water and Wastewater Master Plan and Policy for T&T.*
AECOM. (2010). *Environmental Impact Assessment Establishment of a Regional Wastewater Collection System and Treatment Plant for San Fernando and Environs.* Port of Spain.