Physico-chemical and Microbiological Evaluation of Surface Water in the Vaiusu Bay

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Abstract. The objective of this study was to evaluate the present levels of physico-chemical and microbiological parameters of the receiving environment at Vaiusu bay. Water samples from selected locations were collected and analyzed for total coliforms bacteria and faecal coliform bacteria, and dissolved oxygen (DO) and ammonia. Counts of total coliform and fecal coliform bacteria across all sites were higher compared to the maximum microbial contaminant level established by SPREP and WHO. There was no significant difference in the microbial counts between sites by comparison, which suggest that the level of contamination is similar across the sites. Preliminary chemical analyses show DO and Ammonia levels were within permissible maximum concentration of environment quality standard WHO.

Introduction. Samoa's coastal and natural water resources continue to face risks of pollution as a result of inadequate wastewater discharge practice. With increasing population growth and urbanization, a rise in the number of land use developments (Jones and Cocks 2003) and commercial business operations in the urban area[1] of Apia have improved the demand for production of industrial wastewater and discharge. This puts pressure on the receiving environment[2] affecting coastal water quality and consequently fisheries stock which sustains the communities (Global Environment Fund 2007). Industrial wastewaters vary in chemical and biological composition depending on the type of commercial activity and the level of treatment processes that take place. For example, brewing operations produce high levels of organic components that result in high biological oxygen demand (BOD) and chemical oxygen demand (COD) (Brito et al. 2007). Centralized wastewater treatment systems[3] and sewerage treatment plants are a major source of BOD, COD, dissolved oxygen (DO), suspended solids, total suspended solids (TDS), nitrate, nitrite and ammonia, phosphate, salinity and a range of other nutrients and trace metals (Igbinosa and Okoh 2009; SPREP 1996 and Thirupathaia et al. 2012). An excess level of these pollutants above the standards stipulated by national, regional and

[1] Urban area covers the area from Vaimauga West to Faleata East. (Samoa Bureau of Statistics 2011)
[2] Receiving environment, *biophysical or otherwise, receives waste*. (Jones and Cocks 2003:31)
[3] Centralized wastewater treatment system refers to the "*collection of wastewater from homes and commercial facilities in an urban area that consists of a sewer network (reticulation) with a centralised treatment facility".* (Samoa's National Sanitation Policy 2010:17)

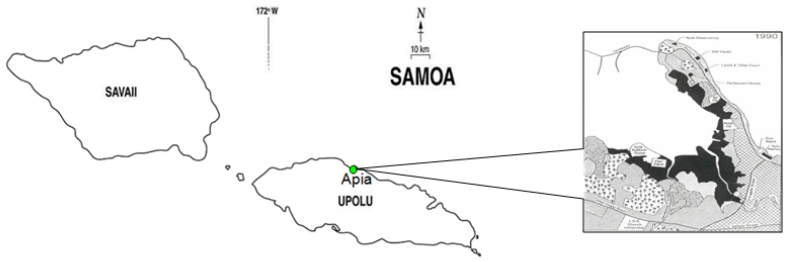
international regulatory bodies is considered unacceptable in receiving water bodies. This will lead to eutrophication and various health impacts in humans and animals (Akpor and Muchie 2011). A report on the status of coral reefs of the Pacific (Chin et al. 2011) highlighted the adverse impacts of land-use practices including wastewater pollution on the condition of Samoa's coral reefs. It further explains the need for more information to quantify the risks involved. In Samoa, previous reports (Global Environment Fund 2007; Suluvale 2002) articulated concerns over wastewater contamination of streams and selected mangrove areas based on ample (anecdotal and) visual evidence. Vaiusu Bay is an important ecosystem that is known for its extensive coverage of mangrove community (Suluvale 2002). However Vaiusu Bay is the recipient water (Global Environment Fund 2007) of waste and wastewater from land use developments and domestic activities. It is clear from previous reports (Global Environment Fund 2007; MNRE 2010; MNRE 2006) that there is a lack of documented quantitative and scientific data in terms of physico-chemical and microbiological evaluation, to verify any health and environmental implications. At present there is a lack of quantitative and scientific data for baseline information to document health and water quality problems associated with inadequate discharge processes. This type of information is imperative not only to identify degree and cause of any pollution load but for decision making and future developments. Thus, this study will provide quantitative and scientific baseline data on the present status of quality of surface water in Vaiusu bay. The key objective of this study is to evaluate the present levels of physico-chemical and microbiological parameters of the receiving environment at Vaiusu bay

Materials and Methods.

A. Site Selection.

Vaiusu Bay is selected based on its present pollution condition, which according to a definition by SPREP (1996:9) can be classified as "*receiving and assimilated areas where they are known that a level of pollution exists and recognizable degraded through nutrient input"*. A map of the

Figure 1. Map of Sampling location.



(Taise, A 2008, Map of Samoa. In Master Thesis. p.62; Suluvale 2002:17)

sampling location is provided in Figure 1. The three sites investigate are at Vaitele behind CCK building complex (13°81' S and 171°80 W and 13°81' S and 171°80'W), Vaitele right across from Vailima Breweries Ltd (13°82' S and 171°79 W and 13°82' S and 171°80 W) and Sogi (13°82' S and 171°77' W and 13°83' S and 171°77 W).

B. Sample location.

Water samples were collected from each of the three sites on the same day and was consistently performed at least once or twice a month from July to October 2015. Samples included water from near the surface. Sampling activities were carried out at low tide.

C. Microbiological Test.

Microbiological tests were performed by the widely used method described by UNEP and WHO. To test for total coliforms and faecal coliforms, the Membrane Filtration Technique was used where MEndo LES and MFC agar culture media were prepared and used according to DIFCO instructions. 500 ml raw samples were collected each time of sampling. From this, a 30 ml aliquot was added to 270 ml of sterilized water to obtain a 1/10 dilution of the sample. From this dilution, 30 ml was transferred to 270 ml of sterilized water to obtain a 1/100 dilution. This was repeated until a 10^{-4} dilution of the original sample was obtained. 100ml from the 10^{-4} and 10^{-3} dilutions were vacuum filtered through a 0.45 µm nitrocellulose millipore membrane. The membrane filtered aliquot was placed on mEndo agar and another 100ml was membrane filtered and placed on mFC agar. For detection of faecal coliforms and total coliforms, culture media plates were incubated inverted for 24 h at 44.5°C and 37°C respectively. Colonies were counted in each culture plate after 24 h.

D. Data Analysis.

Data obtained was validated by conducting comparative statistical analyses of power transformed results using the R-package statistics software.

Results.

Microbiological Evaluation for Total coliforms

Results and analyses show that Counts are high across all sites as indicated by the average means (Fig.3.). (Eventhough there are no documented national or regional standards to compare, there is an existing SPREP guidelines 1989 that lists the standard of total coliform 150/100mL and 35/100mL for pristine waters). Further, there was no significant difference between sites by comparison. As expected, there was a significant difference between dilution rates by comparison.

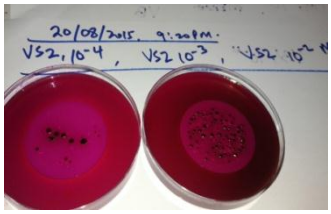


Fig. 2. Plate cultures

Sites					
CCK1	CCK2	VB1	VB2	VS1	VS2
24005	15790	17510	15050	29590	27035

Fig. 3. Table Of Means (grand mean = 21496.67)

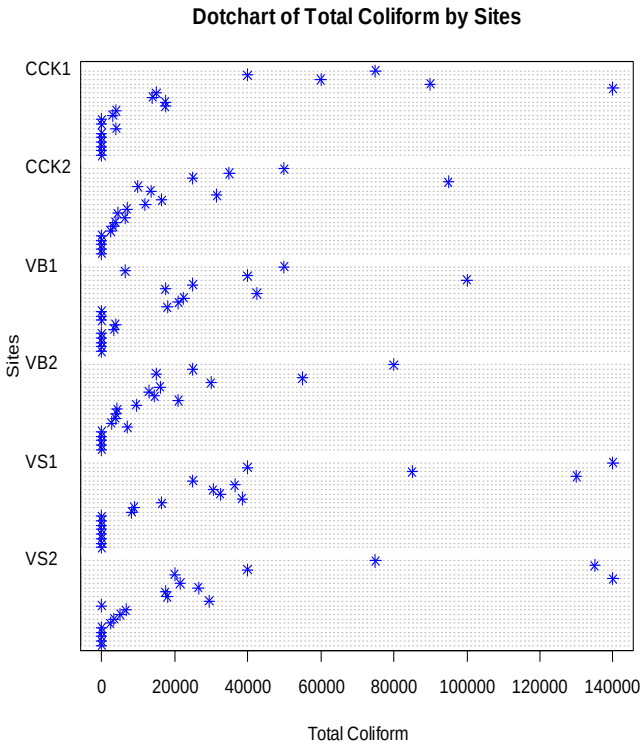


Fig. 4. Dot chart of Total Coliform by sites

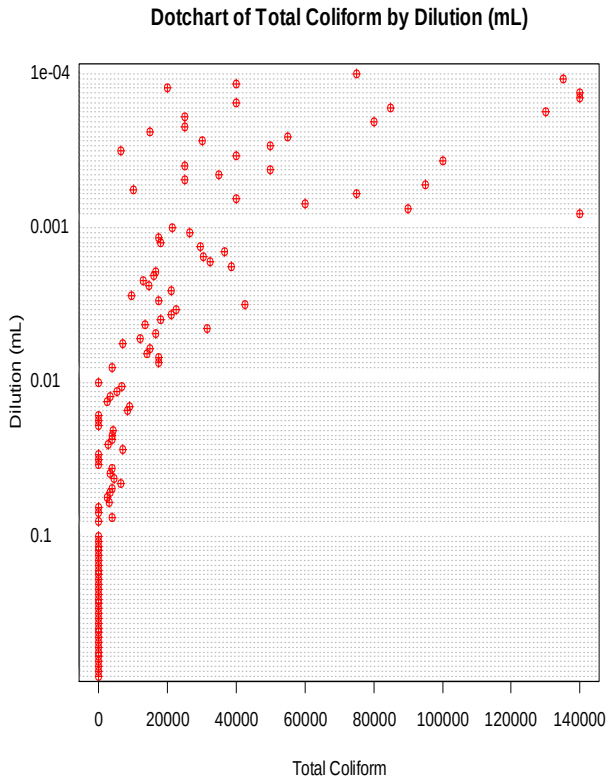


Fig. 5. Dot chart of Total Coliform by dilution

Microbiological Evaluation for Faecal coliforms

Results and analyses show that Counts are high across all sites as indicated by the average means (Fig 6) (no documented national or regional standards to compare. However SPREP guidelines 1989 lists the standard of total coliform 150/100mL and 35/100mL for pristine waters. No significant difference between sites by comparison. As expected there was a significant difference between dilution rates by comparison.

Sites					
CCK1	CCK2	VB1	VB2	VS1	VS2
14480	9805	18330	11410	12035	23240

Fig. 6. Table Of Means (grand mean = 14883.33)

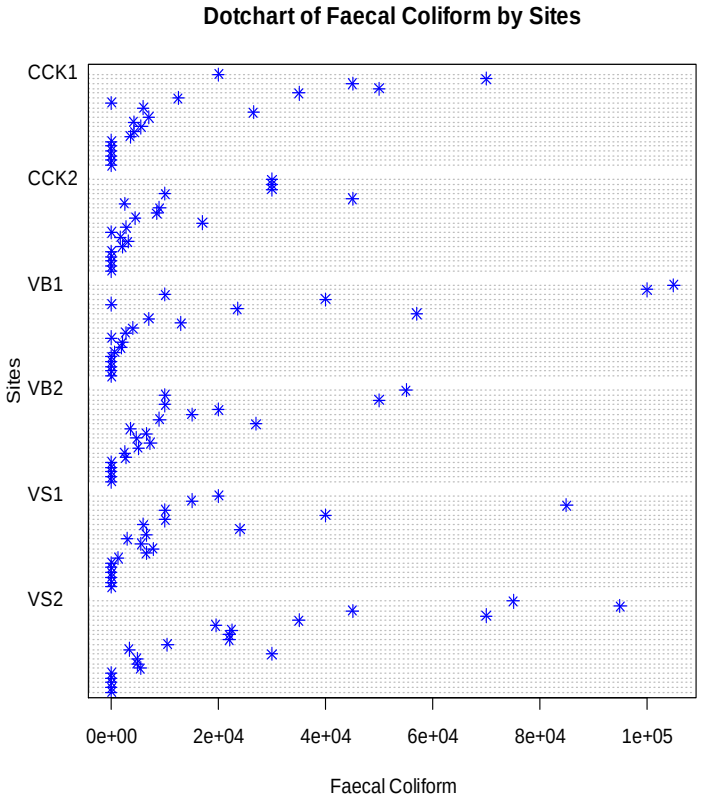


Fig. 7. Dot chart of Faecal Coliform by sites

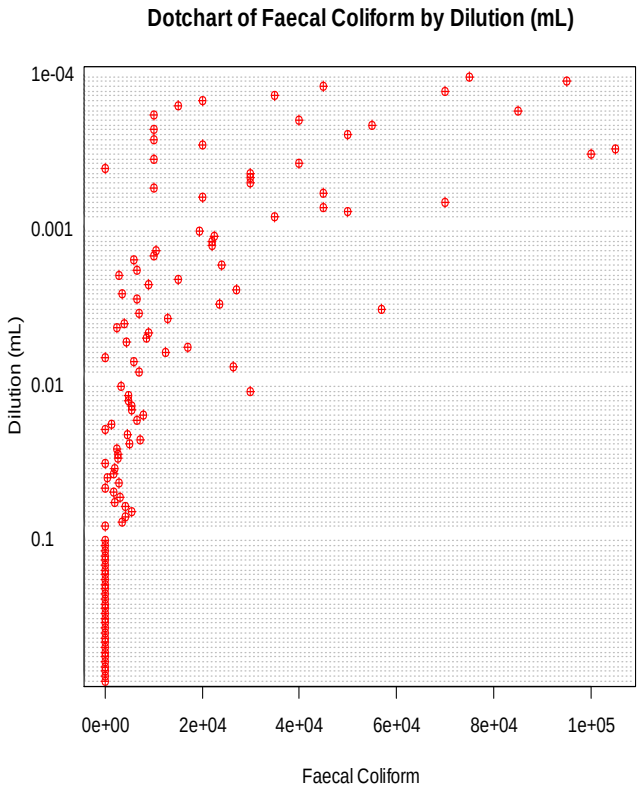


Fig. 8. Dot chart of Faecal Coliform by dilution

DO and Ammonia

Analyses of data continuing.

Discussion.

Although there was no significant difference in the counts between sites, the levels of total coliform and faecal coliforms across sites was still high, which suggest some level of contamination exist. Total coliforms are suspected to source from entry of soil or organic matter into the water while faecal coliforms derived from wastewater discharge (and sewage) from commercial and residential properties.

Conclusion.

This study discovered higher levels of contaminant bacteria in water in selected locations at Vaiusu bay. This finding is only preliminary and has provided basic baseline information for similar studies in the future. It is anticipated that an extensive study be conducted at more sites in Vaiusu bay and a more coordinated approach is needed to perform a similar study in the future.

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