Investigating the impact of river and groundwater inputs on the water quality of Kingston Harbour, Jamaica

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Introduction

Kingston Harbour is the 7th largest natural harbour in the world. Its resources sustain the survival and economic well-being of many people, and its varied habitats is home to various marine species. It supports numerous fishing villages, air and sea transportation, research institutes and urban and industrial development. Modernisation has adversely affected the water quality of the harbour since the 1960s.[1]

A recent study in the Kingston Hydrologic Basin has indicated an increase in nitrogen pollution in the groundwater which is expected to have a significant impact on the water quality of Kingston harbour.[3] Numerous studies have demonstrated the impact of surface water pollution on this harbour with the most recent published in 2011[2]. However, little is known about the groundwater discharging into the harbour and the impact of this groundwater on Kingston harbour water quality.

This research will provide information on the current status of the water quality and assess the significance of the submarine groundwater discharge (SGD) into the harbour. The data obtained will aid in developing sustainable plans for future ecological and urban interests in the area.

Figure 1. Map of Kingston Harbour showing water sampling and CTD points (Source: Google Maps©)

Methods and Materials

Field Sampling

1. Conductivity-salinity-temperature-depth (CTD) profiles were obtained at 44 points in Kingston Harbour during May 2022 using a SonTek CastAway© probe during May 2022.
2. Water samples were collected at 15 sites using a Niskin© water sampler. The samples were transferred to acid-cleaned (1 M HCl) 1-L HDPE amber bottles.
3. Samples were transported to The UWI Mona Environmental Research Lab, filtered through 0.45 µm filters and stored at 4°C for further analysis.

Figure 2. Solid waste entering the Kingston Harbour via surface gullies

Laboratory Methods

1. Water samples collected were analysed for total oxidised nitrogen (TOxN = NO_3^- +NO_2^-), total dissolved nitrogen, soluble reactive phosphorus (SRP), and total dissolved phosphorus using the methods outlined in Parsons et al.[4]
2. Quality Control (QC) procedures included duplicate samples, spiked samples and reagent blank analyses.

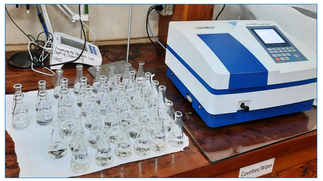
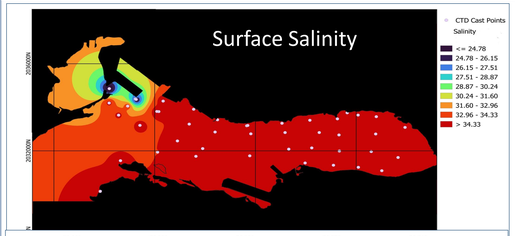
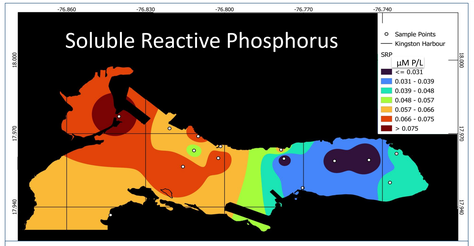


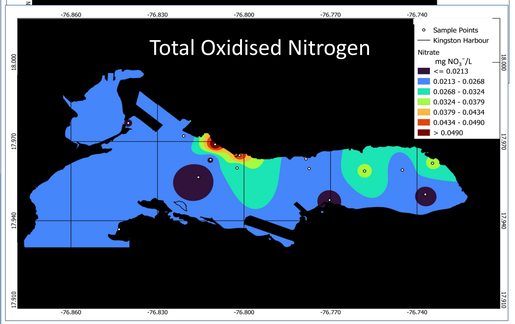
Figure 3. SRP Analysis

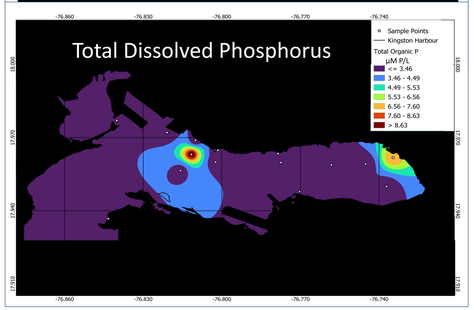
Figure 4. TOxN Analysis

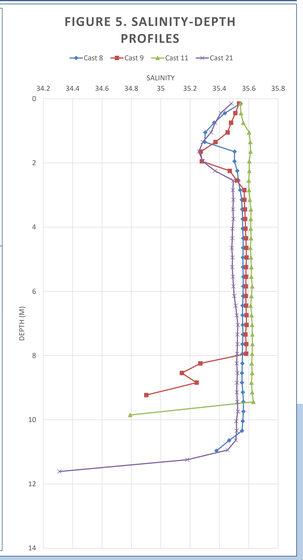
Results











Discussion

- SGD may be occurring in the eastern section of the harbour where decreases in salinity were recorded at depths **below 8 m** (see Figure 5).
- TOxN and SRP concentrations in the harbour were relatively low with maxima detected in the north-western section of the harbour.
- SRP concentrations were highest at the entrance to Hunt's Bay, the harbour's largest freshwater input source.
- Elevated concentrations of TDP were detected in samples collected offshore Tivoli Gully and Caribbean Cement Company Ltd. (7.53 µM P/L and 9.82 µM P/L, respectively) indicating possible inputs of organic phosphorus at these sites.

On-going Work

- Water sampling and CTD measurements will be continued in Kingston Harbour to obtain additional data, under varying rainfall patterns, and identify the SGD locations.
- The SGD results will be used to determine the contribution of Kingston groundwater to marine pollution from land-based activities, particularly nutrient pollution.
- The research data obtained can aid in framework and policy development towards further reduction in pollution, waste management and awareness for sustainable development and lifestyles in accord with nature.

References

(1) Webber, M.; Henry, W.; Christian, T. Clean Kingston Harbour: Pipe Dream or Pot of Gold? In *Clean Kingston Harbour: Pipe Dream or Pot of Gold?*; GraceKennedy Foundation: Kingston, 2019; pp 6–66.

(2) Francis, P. A.; Maxam, S. A.; Webber, M. K. Rapid Reassessment of the Eutrophication Status of Kingston Harbour, Jamaica Using the Zooplankton Community. *Rev. Biol. Trop.* **2014**, *62* (3), 223–239. https://doi.org/10.15517/rbt.v62i0.15918.

(3) Mandal, A.; Gordon-Smith, D.; Harris, P. Groundwater Availability and Security in the Kingston Basin, Jamaica. In *Global Groundwater: Source, Scarcity, Sustainability, Security, and Solutions*; Mukherjee, A., Scanlon, B., Aureli, A., Langan, S., Guo, H., McKenzie, A., Eds.; Elsevier Science: Cambridge, 2020; pp 97 – 112.

(4) Parsons, T. R.; Maita, Y.; Lalli, C. M. *A Manual of Chemical and Biological Methods for Seawater Analysis*; Pergamon Press, 1984.