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Point and nonpoint source analysis of nutrients, metals, and pathogens in the sediment and water column in Las Vegas Wash

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Formerly an ephemeral watercourse, Las Vegas Wash is now a perennial system due to urban runoff and wastewater treatment plant (WWP) effluent. Las Vegas Wash flows into Lake Mead, where the discharge point is only a few miles upstream of Las Vegas’ main water intake. This small water cycle establishes the necessity to evaluate water quality especially due to non point sources pollution, wherein my research lies. Several points along Las Vegas Wash upstream and downstream of WWP have been chosen to represent different landuse types such as commercial, residential, wastewater treatment plants, etc. At each location, parameters including arsenic, selenium, nitrogen, phosphorus, total organic carbon, bacteria, and fecal coliforms are to be analyzed and compared for the influence of landuse change on both sediments and water.
**Point and nonpoint source analysis of nutrients, metals, and pathogens in the sediment and water column in Las Vegas Wash**

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**Abstract**

Several physiochemical characteristics of the sediment and water column in Las Vegas Wash (LVW) were analyzed to study the impact of land use change and type and water reclamation activities on Lake Mead water quality. Analytes included water chemistry, i.e., phosphorus, nitrogen, total organic carbon, metals, i.e., selenium, arsenic, mercury, and lead; and pathogens, i.e., E. coli and total coliform and total E. coli counts. The results indicate that sediment and water quality depend on and are specific to land use type. The wastewater treatment plants (WWTPs) are not contributing to bacterial levels in the Wash, but their outflows contribute significant nutrient concentrations. In general, the sediment quality is worse than the water column, particularly impacted by selenium, arsenic, and lead levels. The concentrations of nutrients, metals, and pathogens directly correlate with land use type, indicating the impact of nonpoint pollution.

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**Introduction**

- LVW is a semi-arid lowland desert area in the Lake Mead area of the southern Las Vegas Valley.
- Wastewater generated from residential and commercial development is treated in two wastewater treatment plants (WWTPs) and discharged into LVW.
- The LVW wash is a regional habitat for pollutants and pathogens, as well as a water body for wildlife and recreation.
- As urbanization increases, so does the flow causing sediment and desalinization of LVW as water enters the sediment.
- Sediment and nutrient accumulation occurs in LVW and the wash, along with microbial activity, which contaminates the water column.
- Sediment quality in the Wash is not well understood.

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**Hypotheses**

- Land-use change impacts water and sediment quality, and land-use type affects nonpoint source pollution.
- The sediment will have higher concentrations of metal than water, and pathogens are congruent to the water column, and their levels will depend on land-use type and correspondingly nonpoint-source pollution.

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**Methods**

- LVW was divided into several sampling locations (Figure 1) based on representative land use: i.e., commercial, residential, WWTP, open land, and desert.
- Water samples were collected from the top of each plots of the LVW floor during dry late January to early March 2009.
- Sediment samples were collected from the top of each plots of the LVW floor, taken in June and July 2009.
- The results of analyses were conducted by the Desert Research Institute (DRI) using a laboratory analysis and methodology compliant with the Nevada Pollutant Discharge Elimination System (NPDES) Method 503.4.
- TOC was measured by thermal conversion to CO₂ as described in the EPI Method 503.4.
- Dissolved oxygen, pH, redox potentials, and salinity were measured on-site using a multi-parameter probe (YSI 6600).
- Total organic carbon (TOC) and total nitrogen were measured at Photochemicals and Environmental Analysis Laboratory at Desert Research Institute (DRI) using a total organic carbon analyzer after pre-treatment according to EPA Method 503.4.
- Total organic carbon (TOC) was measured at DRI according to APL 2005 Method 503.4.
- Total carbon and total nitrogen were measured at CSIRO Environmental Laboratory at Alfred Deakin University (ASU) using a high-temperature combustion analyser (LECO CT-220).
- Metals were degraded of E. coli according to EPA Method 160.2 and measured at the Water Environmental Laboratory at ASU based on EPA Method 200.8 (EM 3058).
- E. coli and total coliforms were analyzed at DRI using the Colilert method (Microbics, CA, USA) and the DRI Method 160.2.
- General bacterial community analysis for E. coli were analyzed in DRI with Luna-Section E. coli according to E. coli Laboratory Experiments in Microbiology, McGraw-Hill 9th Edition.

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**Results**

- Sediment was fairly constant between sites, but at site 7, conductivity was very low due to low salinity and relatively no input of fresh water.
- Temperature was lower than the other sites, with site 1 and site 3, both of which were lower than site 2, which was warmer due to lower flow.
- pH was lower at site 1, indicating a lower alkalinity and higher acidity.
- Sediment quality in the Wash is not well understood.

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**Discussion**

- Higher temperature and ORP at sites 3 and 4 are due to WWTP effluent.
- The WWTPs are contributing significant amounts of nutrients to the water column, likely due to the plants' high nutrient levels.
- All other sites have lower sediment P concentrations compared to the water column due to particle size differences.
- Site 1 has high sediment P levels that are most likely due to pollutants from urban runoff, especially fertilizers.
- TOC is higher at site 1 because of pollution from urban runoff and low flow, sites 4-8 have higher levels of organic carbon.
- NO₃ is lower at site 1 compared to other sites due to fertilizers and urban runoff.
- Sediment selenium and mercury levels at sites 5-8 are likely due to groundwater input.
- Higher sediment mercury levels may also be correlated with groundwater or TOC levels' mitigation.
- Higher sediment lead levels as due to pollution from cars, batteries, and steel mill runoff and commercial areas.
- [As] gradient is from urban runoff and correlates with suspended solids and particle settlement.
- Sediment selenium and arsenic levels range from 10-500 mg/kg at all sites.
- Sediment lead levels are higher at sites 4-8.
- Sediment selenium and arsenic concentrations were significantly higher compared to the water column from previous studies and are not removed.
- Coliform and total coliforms in the sediment and water column were much higher at site 1 compared to other sites. Total coliform concentrations at site 1-5 is likely due to pollution from the area.
- There is a slight trend between nutrient levels and coliform concentrations.

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**Conclusion**

- The quality of the sediment and water column depend on land use change and type.
- WWTPs are not contributing to bacteria levels in the Wash, but there are high nutrient levels in the water column.
- The sediment generally has high concentrations of nutrients, metals, and pathogens compared to the water column.
- The concentrations of nutrients, metals, and pathogens directly correlate with land use type, indicating areas of nonpoint-source pollution.

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**References**


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