Abstract

Water bodies in the regional parks of the East Bay provide aesthetic value and critical ecosystem services, but are often adversely affected by the activities and infrastructure of the intensely urban environment that surrounds the parks. The East Bay Regional Parks District (EBRPD) leases a golf course in one of its public parks in the Berkeley Hills, Tilden Regional Park. Application of nutrients and herbicides, essential to maintain turf systems, may be transported via surface runoff or through subsurface drainage to surface water, leading to the perception that golf courses are a major contributor to water pollution. We are studying the hydrography of the watershed and the possible contribution of nutrients (NO₃⁻N and PO₄–P) transported via storm-generated surface runoff and via pollution. We are studying the hydrography of the watershed and the possible contribution expected to be observed as changes in water quality.

Radon-222

Mixing of different water sources that may contribute variable amounts to the water budget and carry variable contaminant loads can be observed using natural chemical and isotopic tracers. To study the locations and fluxes of groundwater input, we analyzed water samples for radon-222 activity, which has a half-life=3.82 days. Radon is a product of the natural radioactive decay series of 238U and a direct product of alpha disintegration of 222Ra (Bertin and Bourg, 1994). 238U is the most abundant isotope in natural uranium and is found in most rock types (Cecil and Gesell, 1992). However, because of atmospheric evasion, radon activity is low in surface waters downstream of influx locations (Cecil and Green, 2000).

Radon-222 Methodology

Radon samples were collected along Wildcat Creek to determine locations of groundwater inflow to the stream. The samples were measured on a RAD7 Radon Detector within a day or two of being collected; the results are then corrected using the decay equation, Aₙ=A₀ exp(−λt).

Oxygen-18 in mixing model (pre-event)

End Members:
Irrigation water (Q₁), δ¹⁸O = -13.1‰.
Baseflow (upstream of golf course) (Q₂), δ¹⁸O = -6.57‰.

Mixed:
Stream Water (Q_stream)= δ¹⁸O value of -6.93‰.
Q_stream=Q₁ = f₁ (1 - f₂) + f₂ (1 - f₁)
f₁ = 0.945 = 94.5% baseflow in the mix
f₂ = 0.055 = 5.5% irrigation water

Stable Isotopes as Natural Tracers

Variations in δ¹⁸O and δ¹⁴N values in Wildcat Creek during the dry, summer months of 2017 were used to differentiate locally-derived water from irrigation water on Tilden Golf Course and calculate the effect of irrigation water on the stream.

This separation was possible due to the large and constant isotopic signature contrast between natural stream water and (imported) irrigation water.

Radon-222 Discussion

Radon-222 results are plotted on the map above.

- Wildcat Creek has several points of groundwater inflow along the creek, showing gaining, and neutral or losing reach.
- The two samples ES and GS were taken from springs and their Radon-222 activities represent the groundwater endmember that feeds the stream in the upper reach.
- Knowing the signature of the groundwater allows us to carry out hydrograph separation during the summer months, a process aided by the study of the stable isotopes of water and that will be explained in depth in the next section.

Stable Isotopes of Water and Precipitation

δ¹⁸O in precipitation is isotopically heavier than stream water during the event. The stream carries a significant component of light, pre-event water, which is likely from groundwater inflow. The isotopic signature of the pre-event water may be affected by isotopically light irrigation water.

Nitrate increases during the event, but conservative chloride decreases by dilution. Phosphate is tied to turbidity, as it sorbs to particulates.

In previous sampling campaigns, we have also observed an increase in nutrients between ‘natural’ upstream background and the golf course, making it likely that turf management results in increased nutrient loads.

Combined Radon-222, stable isotope, and nutrient concentration results indicate that groundwater, carrying nutrients, is transported to the stream during rain events.

Preliminary Results

- Rainfall hyetograph is correlated with δ¹⁸O in Wildcat Creek.
- δ¹⁸O in precipitation is isotopically heavier than stream water during the event.
- The stream carries a significant component of light, pre-event water, which is likely from groundwater inflow. The isotopic signature of the pre-event water may be affected by isotopically light irrigation water.
- Nitrate increases during the event, but conservative chloride decreases by dilution. Phosphate is tied to turbidity, as it sorbs to particulates.
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Citations
