Investigating Groundwater-Surface Water Interactions in a Coastal Tidal Wetland Using Radon(^{222}Rn)

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Abstract: The determination of groundwater-surface water interactions is an important process in the hydrological cycles and the worlds water balance. Research focused on groundwater-surface water interactions can be used to characterize the evolution of the wetland's water cycle, which plays an important role in the management of water resources. In addition, groundwater plays an important role in the functioning of wetlands. For example, in dry seasons, the groundwater aquifers replenish wetlands (P.Martinez-Santos et al., 2018).This process ensures the flow in the wetland and protects the ecological environment around it. The interaction of groundwater and surface water has become a popular topic of research because of its significance in a rational management and exploitation of the water resources. The exchange of groundwater and surface water is due to the difference between groundwater table and surface water elevation (Wmiter et al.,1998; Healy, 2012). Specifically, if the groundwater elevation is higher than the wetland elevation, the groundwater can discharge into the wetland. Limited research has been done on the connectivity of groundwater and surface water in the tidal wetland of Kooragang Island, Hunter River Estuary, Newcastle, Australia. Therefore, the groundwater tracer radon (^{222}Rn) is used to assess the groundwater and surface water interactions in the tidal wetland.

Keywords: Radon (^{222}Rn); Groundwater-Surface Water

1. Radon (^{222}Rn) - a natural groundwater tracer

Radon is a good groundwater tracer because it is more concentrated in groundwater compared to surface waters. Groundwater often has higher radon (^{222}Rn) concentrations compared to surface waters, and thus radon (^{222}Rn) can be used as a proxy for identifying areas of groundwater seepages.

2. Methods

2.1 Study site

The study site for this study is a coastal tidal wetland located at Kooragang Island of Newcastle. Kooragang Island (35.4 square kilometers) is located in the Hunter region of New South Wales in eastern Australia. The Kooragang Island was formed by reclaiming the land and combining the islands of the hunter's estuary. A small 24-ha tidal wetland located on Kooragang Island was chosen as the study site.

2.2 Sampling procedures and data collection

Sampling of surface water and groundwater was done separately at the site. An automated radon Monitor (RAD7, Durridge Co) was used to measure radon in surface water. The RAD7 is placed on the bank of the entrance channel at the wetland and to

measure ^{222}Rn, a constant stream of surface water was pumped at approximately 3L/ min into a gas equilibration exchanger (Dulaiova et al., 2005).

3. Results

3.1 Surface water

The concentration of radon was plotted against time and is shown in Figure 1. Error bars show the uncertainties of radon concentration in Figure 1. Concentrations of radon had several peaks but were clearly aligned with water depth at the wetland following a negative trend with tide height. However, this phenomenon was not apparent on the first two days of measurements. The average water depth was 0.8 meters. ^{222}Rn concentrations ranged from 8 to 852 Bq/m^3 and averaged 467 ± 61Bq/m^3.

The shaded areas in Figure 2 indicates nighttime. Peaks of water depth are found during the day and night, which suggests the independence of water depth from time. Similarly, the concentration of radon is neither related to night or daytime.

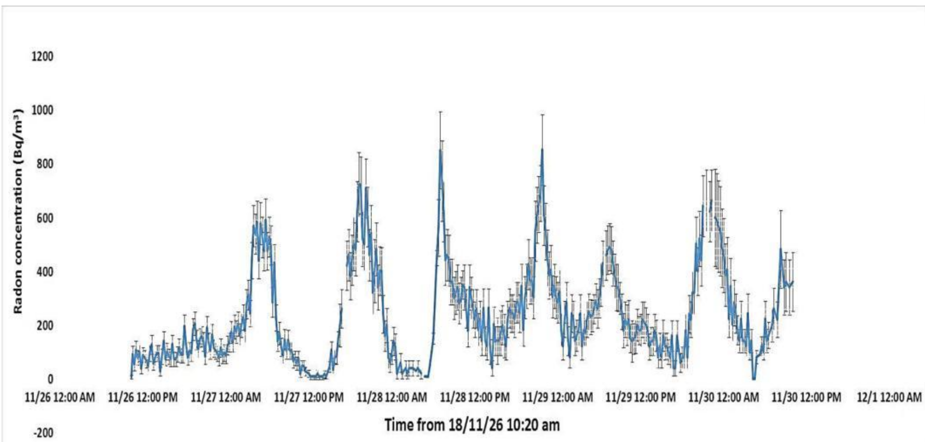

Figure 1. The radon concentration of the surface water. Error bars show uncertainties.

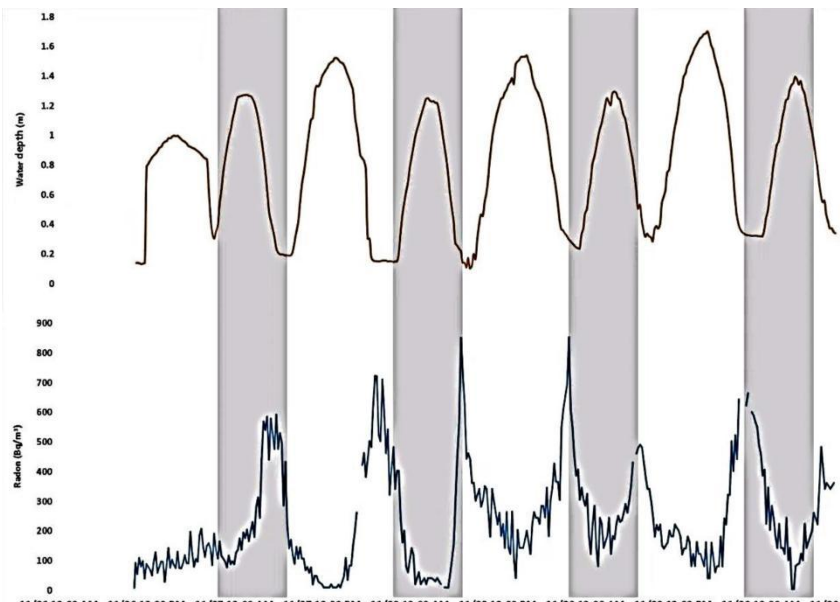

Figure 2. Time series of surface water depth, and ^{222}Rn. Shaded areas indicate nighttime.

3.2 Groundwater

For the 12 groundwater samples that were collected, the average values of salinity, temperature, pH, dissolved oxygen and radon concentration were 49, 22 C, 7, 1 mg L, 882 Bq/m^3, respectively (Table 1). The average radon concentration in groundwater was 882 which is 2-fold higher than those observed in surface water.

Table 1. Groundwater observations in Kooragang Island, Sydney, Australia.

Sample	Depth (m)	Salinity	Temp (°C)	pH	DO (mg/L)	Radon (Bq/m^3)
1	1.3	49.4	20.1	6.9	1.2	810
2	1.0	51.7	22.3	6.9	1.4	725
3	1.3	47.4	24.6	7.1	0.9	884
4	1.2	48.4	22.3	6.4	0.5	710
5	1.3	53.4	23.8	6.6	2.1	985
6	1.2	51.0	24.4	7.1	3.4	879
7	1.2	51.2	21.2	6.4	1.2	994
8	1.5	51.3	23.7	6.6	0.9	1060
9	1.2	48.3	22.6	6.4	1.1	950
10	1.2	42.1	21.8	6.9	0.8	980
11	1.1	48.2	21.2	6.8	1.3	790
12	1.3	45.9	22.7	6.6	1.7	820
	Median	49	22	7	1	882
	Std Dev	3	1	0.5	0.9	113

4. Conclusion

In conclusion, the groundwater-surface water interactions of a coastal tidal wetland on Kooragang Island was investigated by using radon as a groundwater tracer. As an effective and efficient scientific method of tracing groundwater into surface water, the radon tracing method indicated groundwater seepage into the coastal tidal wetland during low tides. The higher concentration of radon in groundwater compared to surface water supported the idea that groundwater was seeping into the wetland. Using this method, the significance of this groundwater to surface water bodies can be assessed and its contribution to the hydrological processes can be determined. By enriching our hydrological understanding of these interactions, we can better understand both qualitative and quantitative hydrological processes at tidal coastal wetlands.

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