Wetland Mapping and Monitoring in the Regional District of Nanaimo

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ABSTRACT: Wetlands play a pivotal role within the Regional District of Nanaimo (RDN), including the Mount Arrowsmith Biosphere Region (MABR), providing ecosystem services and significant value to the region. Wetlands in this region face threats including climate change, hydrological changes, urban development, and resource extraction; therefore, it is important that we have a more in-depth understanding of their local roles. This study looks at what part wetlands play in groundwater recharge or discharge. Instrumentation was installed at three sites within the MABR, collecting water levels in three piezometers installed at different depths, precipitation, and daily site photos, with data downloaded every three months and compared to data from the nearest climate, hydrometric, and observation well stations. Data interpretation is still in the initial stages and more data is required in order to confidently conclude the role these selected wetlands have with regards to their connection to the underlying aquifers of the region.

Keywords: wetlands; groundwater; aquifer recharge

Introduction

Within the Mount Arrowsmith Biosphere Region (MABR), the Regional District of Nanaimo (RDN) exhibits diverse climatic conditions, plant communities, and ecosystems, including a variety of wetland types (MacKenzie & Moran, 2004). It has been recognized that there are significant data gaps regarding where wetlands in the RDN are located, how they are classified, and what role they play in groundwater recharge. All types of wetlands provide ecosystem services, including both physical goods and services, as well as critical regulating services like flood mitigation and

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carbon sequestration (International Union for Conservation of Nature, 2020; Were et al., 2019). Additionally, wetlands are a vital habitat for numerous species and hold important regional cultural, spiritual, educational, scientific, and recreational values (Olewiler, 2004).

Wetlands in the RDN face a variety of threats, including impacts from climate change, hydrological changes, urban development, and resource extraction. Thus, it is important to gain a better understanding of the local wetlands in order to prioritize wetlands for future monitoring, enhancement, and restoration activities. The Wetland Mapping in the RDN project was brought to fruition in response to the need to fill these data gaps. The project was facilitated by the Mount Arrowsmith Biosphere Region Research Institute (MABRRI), in partnership with the RDN's Drinking Water and Watershed Protection Program. Initially, the project focused on where wetlands were located and their classification. Now, the project and this study is focused on the role wetlands play in groundwater recharge.

Methods

In order to identify priority sites for the pilot project, which would work to evaluate what role wetlands play in groundwater recharge, an analysis was run using Esri's ArcMap 10.5.1 Modelbuilder tool. This analysis identified wetlands that were previously mapped in the initial stages of this project that were in close proximity to: observation wells monitoring surficial aquifers; existing climate and hydrometric stations; and fish-bearing streams. The concentration of groundwater wells and concentration of water rights licenses were incorporated in the analysis, as well. To begin the pilot project, one priority site was selected to install instrumentation and assess the proposed methods. The research team installed three piezometers, a rain gauge, and three trail cameras. The piezometers measure subsurface water level fluctuations, recording every hour. Each piezometer was installed at different depths to help indicate if water is moving vertically, either recharging or discharging the aquifer system. To correct for topographic variation, the absolute heights of the piezometers relative to one another was measured using a handheld laser range finder and the horizontal distance between each piezometer. From these measurements, a corrected value was applied to each piezometer's collected data. The rain gauge collects on-site precipitation values. HOBOware software and data loggers were used in the piezometers and rain gauges. The trail cameras provide visuals for the data collected, with photos taken 4 times a day at 11:00, 12:00, 13:00, and 14:00.

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Figure 1. The three types of instrumentation installed: (a) piezometer, (b) rain gauge, and (c) trail camera.

All data from each piezometer and the rain gauge were downloaded during periodic field visits, in addition to data from the nearest climate station, hydrometric station, and observation well. Based on the initial analysis of this data, it was decided that the instrumentation set-up would not change. However, there were minor modifications to the piezometer installation methods used and which wetlands were selected for instrumentation. Instrumentation was installed in two more priority sites. All priority sites fall within two of the MABR's five watersheds. Every three months, data is downloaded from the instrumentation at all three sites, corrected for errors, graphically represented, and analyzed in comparison to nearby climate station, hydrometric station, and observation well data to determine if there is a correlation between what is occurring in the wetland and what is being observed in these other data sets.

Preliminary Interpretations

To account for sources of error introduced by variation in the vertical and horizontal distances between each piezometer, the data analysis method was adjusted. After initial review, data analysis focused on how water levels respond to rainfall events in combination with patterns and trends seen between piezometers rather than looking

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explicitly at the water level values within each piezometer. Based on initial interpretations, it is likely that two of the sites have minimal to no connection to groundwater, while the other site may be connected, with variation across the wetland. However, further data collection and interpretation is required in order to make conclusive interpretations.

Next Steps

There are three main next steps that will be undertaken over the next two years, including data collection, trialing a new method to determine the absolute height difference between piezometers, and refining the data interpretation process. Data collection will continue to occur every three months at each of the sites, ensuring that the equipment is maintained and working appropriately. This portion of the project will now be conducted with the help of local volunteers, accompanying the MABRRI team to download data and record site characteristics. Instrumentation data collection will continue until at least two years of data has been collected and analyzed, as current data trends should be compared to another seasonal cycle. Additionally, the research team will be trialing a new method of measuring the absolute height difference of piezometers relative to one another to provide more accurate values to correct water levels in the piezometers to the same datum. By establishing more accurate correction values, the interpretation process will become refined, making it possible for the team to more precisely say if water is moving vertically in the system, either recharging or discharging the underlying aquifer.

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