GROUNDWATER RECHARGE

UNIVERSITY OF CALGARY

GROUNDWATER CONNECTION FACT SHEET SERIES

RECHARGE:

- **Addition of water to the water table as a result of the infiltration of rain and snowmelt.**

TOTAL PRECIPITATION

- **All water that falls from the atmosphere in either liquid (rain) or solid (snow) form.**

OVERLAND FLOW:

- **Flow of water over the soil surface.**

RUNOFF:

- **Rainfall or snowmelt not absorbed by the soil.**

Where does recharge come from?

Groundwater recharge originates as precipitation that falls in the form of rain and snow. The precipitation accumulates on the surface of the land where it, (1) evaporates back into the atmosphere, (2) is used by plants, (3) remains as a surface water body or (4) infiltrates into the soil. Of the total precipitation recorded in the southern Alberta prairies, only about 0% to 10% becomes groundwater recharge. This makes it important to understand the recharge processes to determine what is being added to the groundwater system.

Research has found that in the Canadian Prairies (Saskatchewan and southern Alberta) recharge occurs in local depressions (Figure 1). Depressions are closed bowl-shaped low points that were formed during the Pleistocene glaciation, which ended approximately 12,000 years ago (van der Kamp & Hayashi, 2009). When precipitation falls, it can be stored in these bowl-shaped depressions in one of four ways:

> The first two mechanisms of storage are a result of overland flow from the surrounding upland due to:
>
> (1) the rate of rainfall exceeding the rate of infiltration (e.g., a heavy downpour); or
> (2) snowmelt occurs, but cannot infiltrate because the ground is frozen.
>
> The other two mechanism are:
> (3) snow blown from the surrounding snowpack into the depression;
> or
> (4) direct precipitation (either snow or rain) into the depressions.

The *majority* of water entering a depression occurs as *snowmelt runoff*, which allows for rapid groundwater recharge to occur after the ground thaws.

Figure 1: Example of depressions filled with snowmelt water in West Nose Creek watershed.

How does the recharge process work?

The aerial photo in Figure 1 is an example of a section (800m by 800m) of land in the West Nose Creek watershed, which shows water as a dark colour and ice as blue. The photograph on the right was taken on the same day as the aerial photo and shows the water pooling in the low lying depressions. Numerous depressions occur in the watershed, which are interspersed between slightly higher uplands. The precipitation on the upland part of the landscape is about equal to the use of water through evaporation and transpiration by plants (Figure 2b – green box). This leads to very little, if any, groundwater recharge. However, snowfall moves from the upland into depressions during the spring melt. The accumulation of water from snowmelt and direct precipitation is greater than the evaporation for these depressions (Figure 2b – purple boxes), allowing for groundwater recharge.

Since the ground is still frozen below the depression, water accumulates until the soil thaws and some of the water in the depression infiltrates into the soil. Some of the water is used by plants along the edge of the depression and some may even flow up towards the upland and used by crops and grasses. The remaining water travels deep enough through the subsurface to reach the water table, becoming groundwater. This process of groundwater recharge occurring through depressions is called **depression-focussed recharge** (Figures 2a & 2b). However, the depressions occupy only a small portion of the landscape, and the amount of groundwater recharge rate (for example, mm/year) averaged over an area (for example, a section of land) is much smaller than the recharge rate directly under the depressions. Figure 2b provides an example of the amount of groundwater recharge for the upland, depression and landscape average.

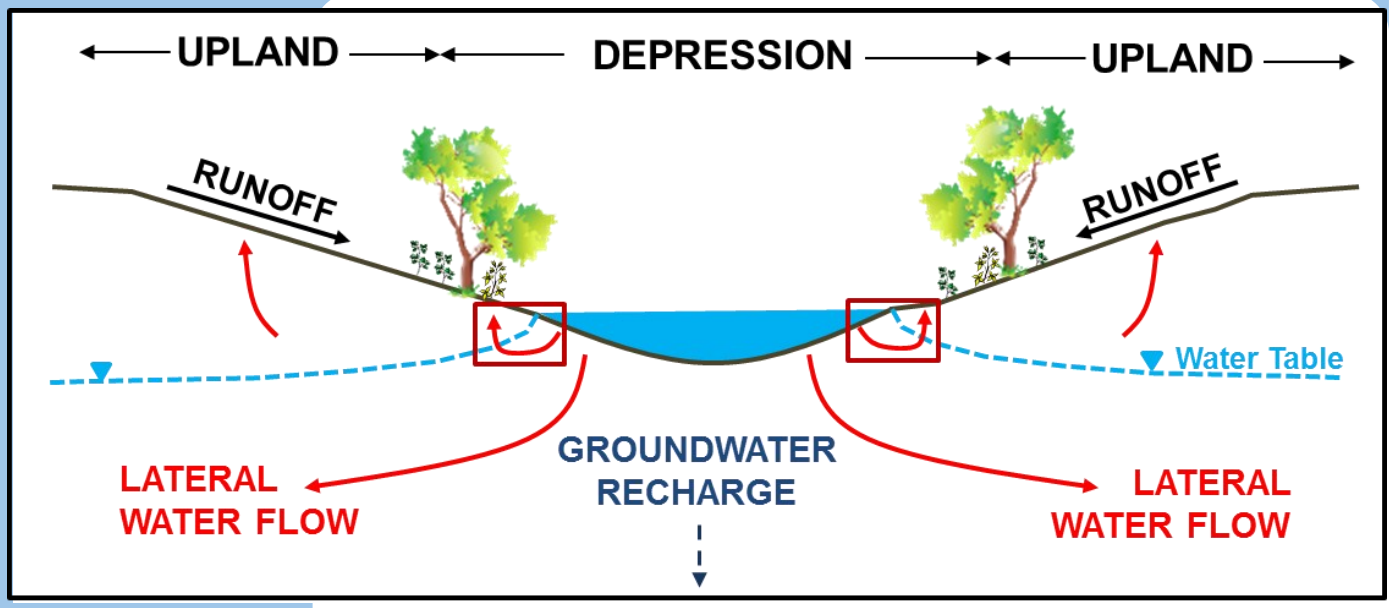

Figure 2a: Conceptual model illustrating depression-focussed groundwater recharge. The water accumulating in the depression is used by riparian plants along the peripheries of the pond (dark red boxes).

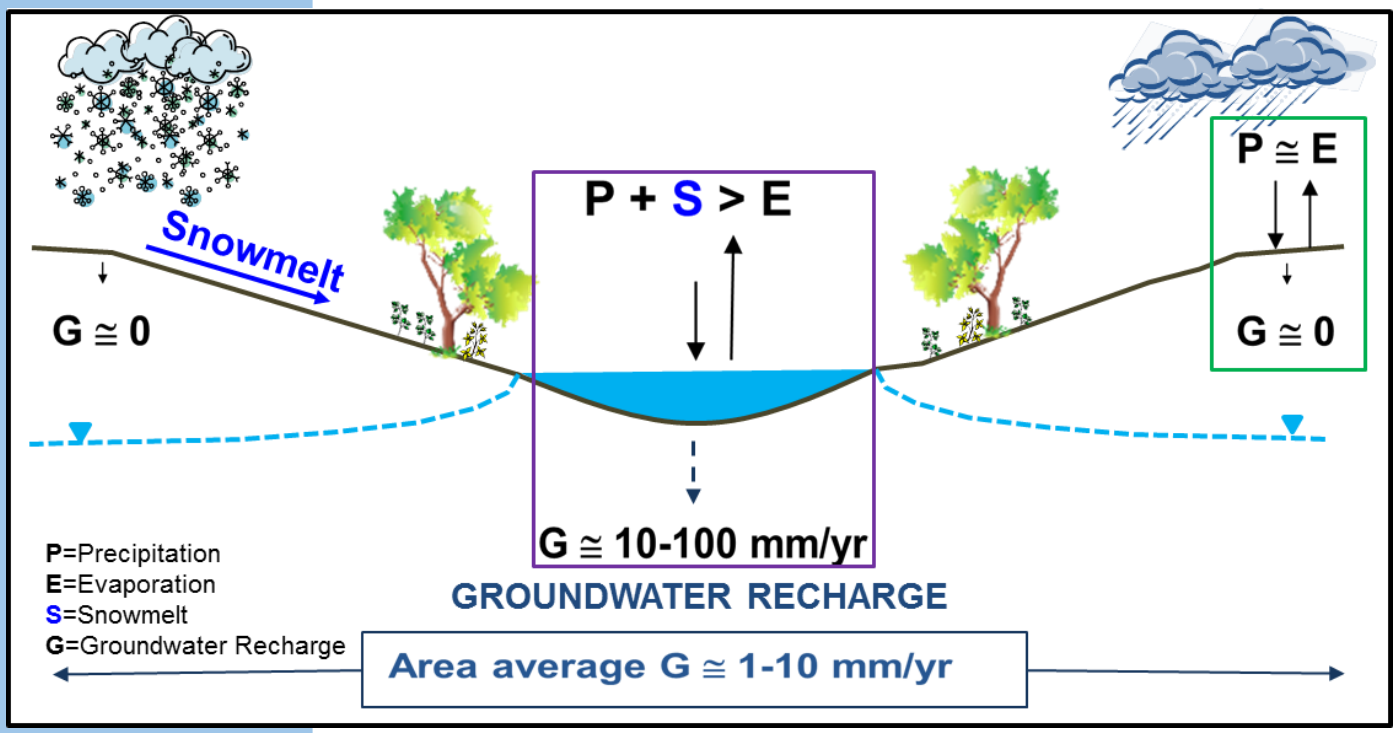

Figure 2b: Conceptual model illustrating depression-focussed recharge. In the upland area precipitation and evaporation are about equal, which results in no groundwater recharge (G=0). In the low areas, the combined precipitation and runoff input exceeds evaporation and provides a small amount of groundwater recharge, about 10-100mm/year. When the groundwater recharge is averaged over the area, there is only 1 to 10 mm of recharge per year.

Where else does the depression water go?

Water accumulates in depressions, particularly during the spring when the ground is frozen and infiltration is not possible. The water in the depression is exposed to the atmosphere and some is lost through evaporation. When the ground thaws, water will begin to infiltrate into the soil; however, this is approximately the same time as plants begin to require water in order to grow. Therefore, water is used by plants along the peripheries of the pond or is transported within the soil to the upland vegetation (Figure 2a – red boxes). This results in a small volume of water from the depression actually being available to infiltrate into the groundwater and recharge the aquifer.

Of the total precipitation recorded in the southern Alberta prairies, only about 0% to 10% becomes groundwater recharge.

Why depression-focussed recharge?

Why is the depression-focussed recharge the primary process for groundwater recharge in the Canadian Prairies? Research has found that upland groundwater recharge does not occur for two main reasons. The first reason is due to the ground freezing during winter. The ice in frozen soil blocks the pores that conduct liquid water, making the frozen soil with high ice content impermeable. This results in more overland flow into depressions and evaporation to the atmosphere. The second reason is due to Rocky View County's dry climate. During the summer period, rain infiltrates into the ground surface, but plant roots take up most of this water through a process known as transpiration. As a result, negligible amount of precipitation is able to make it to the water table (van der Kamp et al., 2003).

Why is recharge important?

Since Rocky View County relies on groundwater to supply their residents with water for both domestic and industrial purposes, the importance of understanding the process of depression-focussed recharge is critical. Based on the concept of the water balance, if a reduction in groundwater recharge occurs, there is less water available for pumping and discharge into streams. This shift in the water balance must be accommodated to ensure sustainable development of the local water resources occurs. Therefore, people need to be made aware of the possible outcomes when they drain depressions. Possible reasons for draining these depressions include; increasing the amount of arable cropland, or for domestic, commercial or industrial developments. This reduction in depressions could possibly cause a corresponding reduction in groundwater recharge.

REFERENCES

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