

Climate Drivers

Permafrost system changes

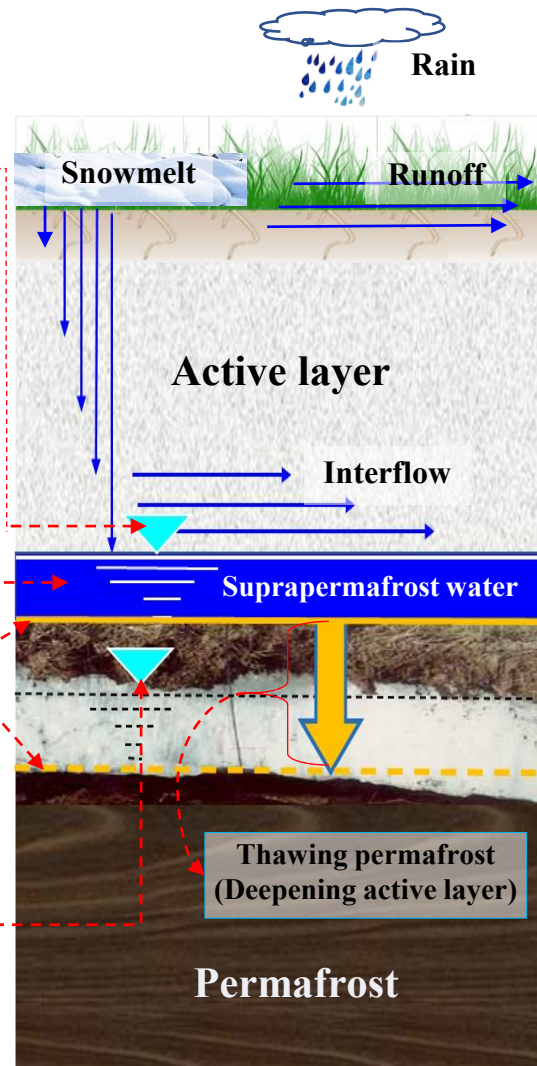
Altered hydraulic properties

Hydrological responses

Climate warming

Precipitation change

Subsurface water level
Suprapermfrost underground water
Permafrost table
Deepened subsurface water level



Surface

Active layer

Permafrost layer

Spring: snow cover present, ground partially thawed

Limited infiltration; snowmelt exceeds storage

Saturation-excess overland flow dominates; rapid snowmelt-driven peak flows

Autumn: surface freezing

Infiltration restricted

Runoff coefficients ↑; baseflow contribution declines

Spring: partial thaw, frozen layer present

Very low infiltration; shallow lateral flow only

High runoff coefficients; interflow contributes spring runoff

Summer: complete thaw, permafrost table deepens

Increased infiltration; expanded storage

Commonly observed: Surface runoff ↓; * subsurface runoff ↑; baseflow recharge ↑

Autumn: freezes from surface downward

Reduced infiltration; flow paths restricted

Commonly observed: Runoff * coefficients ↑; subsurface flow ↓

Long-term active layer thickening

Increased storage; enhanced vertical/lateral connectivity

Commonly observed: Baseflow ↑; * winter runoff ↑; reduced seasonality

Talik formation

Vertical connectivity between supra- and subpermafrost aquifers

Enhanced groundwater circulation; altered baseflow timing

Permafrost warming and thinning

Increased permeability; expanded thawed zones

Commonly observed: Increased * baseflow and winter runoff; reduced seasonality

Ground ice melting

Release of stored water; additional pore space

Direct streamflow contribution < 10 % (up to 20 % locally)

Thermokarst development

Increased surface water storage; enhanced landscape connectivity

Lake formation/drainage; wetland expansion; runoff alter

Permafrost loss (areal reduction)

Shift from hydrological to ecological dominance

Shift to groundwater-dominated systems

Groundwater flow activation

Heat to permafrost; positive thermal feedback

Accelerated permafrost thaw; further hydrological changes