

# Introduction to challenges in water management in cold climates

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# What and where is Cold Climate?



Regions with annual mean temperature  $< x$  Co?



North/South of  $x$  latitude?



# Where is Cold Climate?

## AMAP

Arctic Monitoring and Assessment Programme

The **Arctic region** is the area around the North Pole, essentially an ocean surrounded by land.



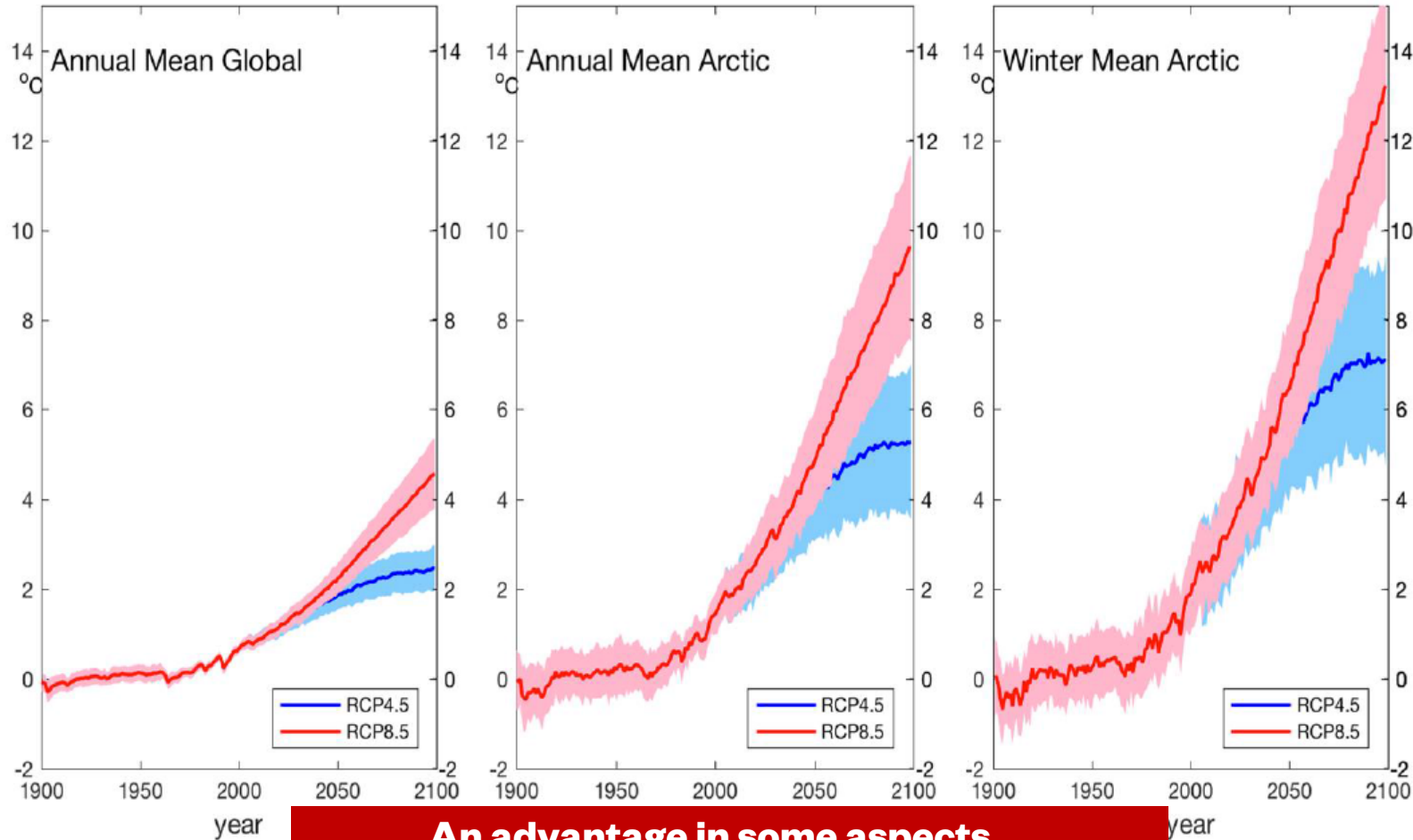
# Definition of the Arctic



--- the Arctic Circle ( 66° 33' 44" North )  
The Arctic Circle is the southernmost latitude in the Northern Hemisphere at which the sun can remain continuously above or below the horizon for 24 hours

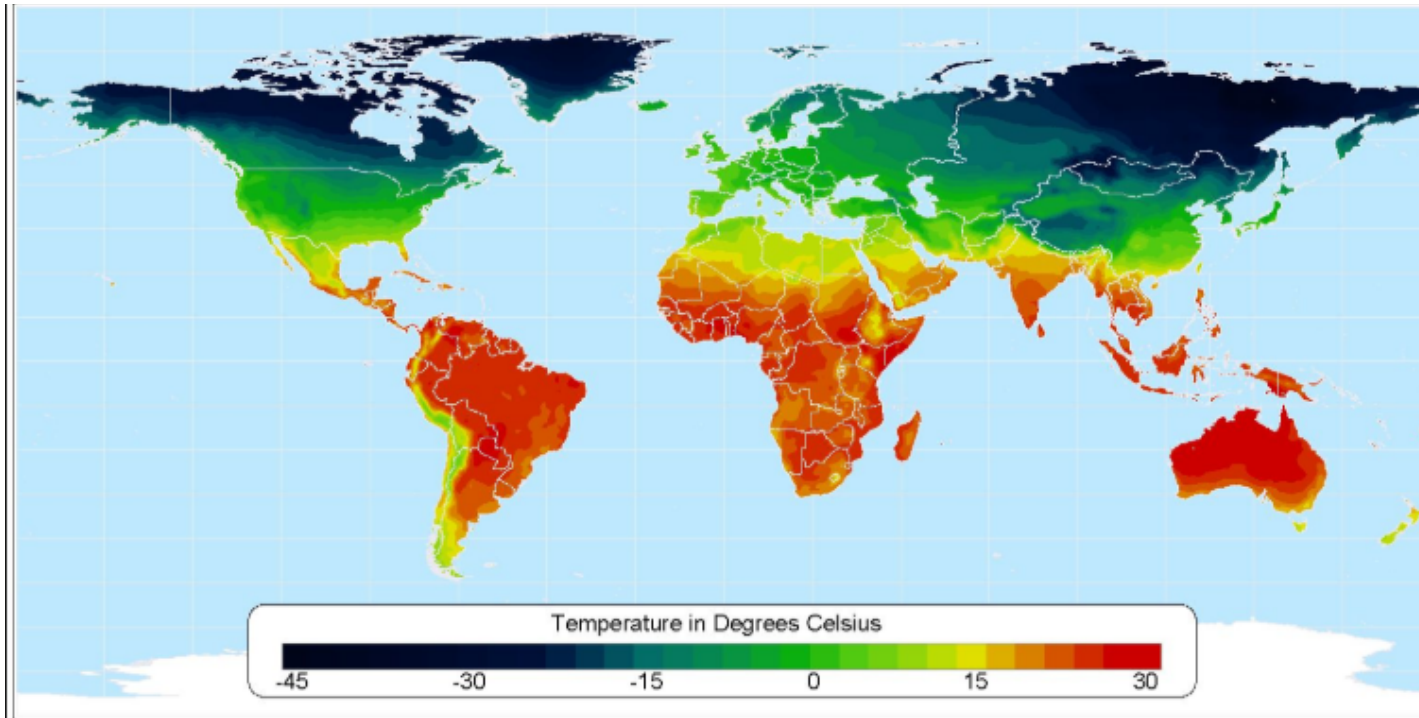
— 10°C July isotherm  
defined as being the area where the average temperature for the warmest month (July) is below 10°C / 50°F.

# Impact of Climate Change: Arctic Temperatures rise faster



**An advantage in some aspects....**

# Average Temperature Dec – Jan – Feb

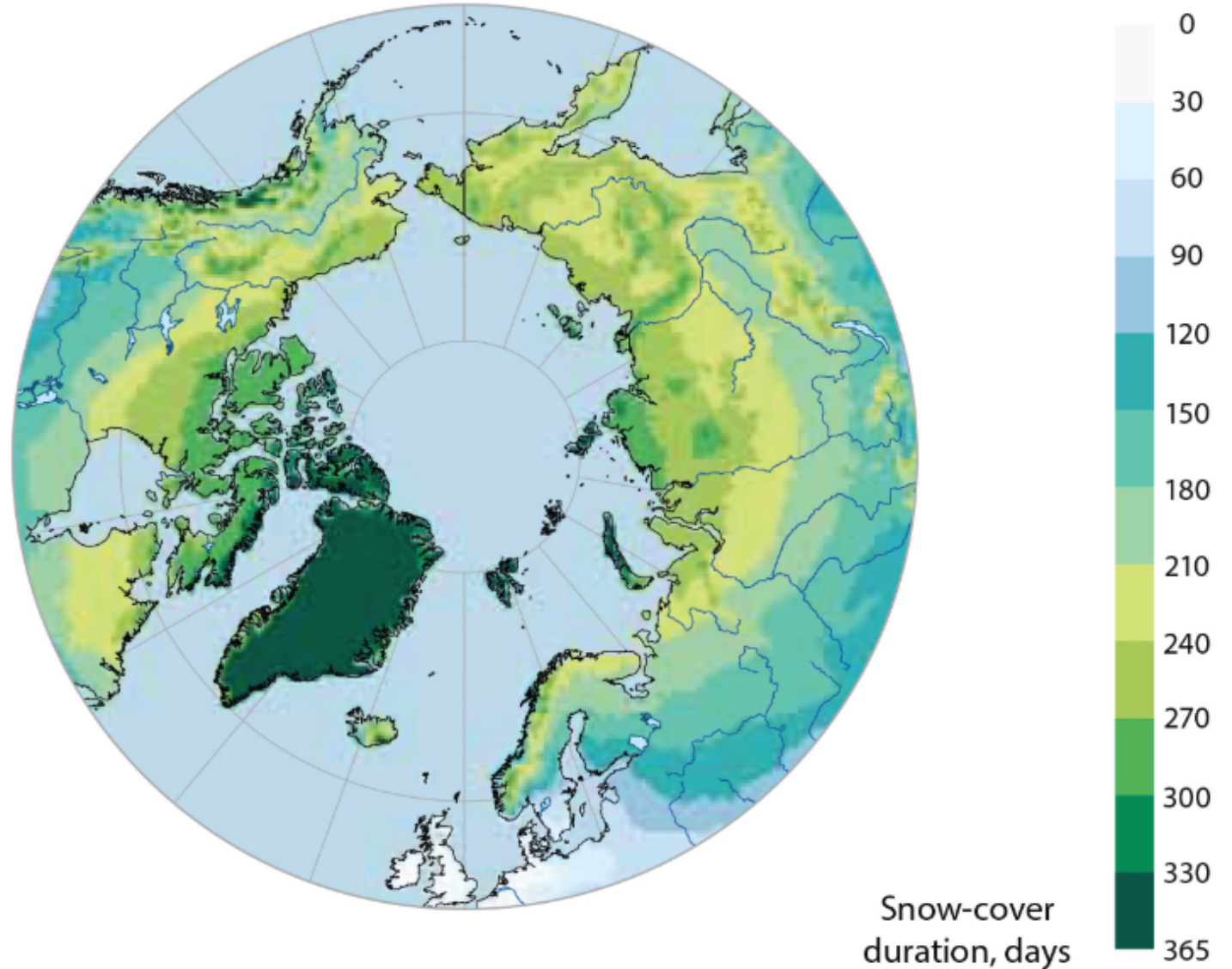


Data taken from: CRU 0.5 Degree Dataset. (New, et al.)

Atlas of the Biosphere

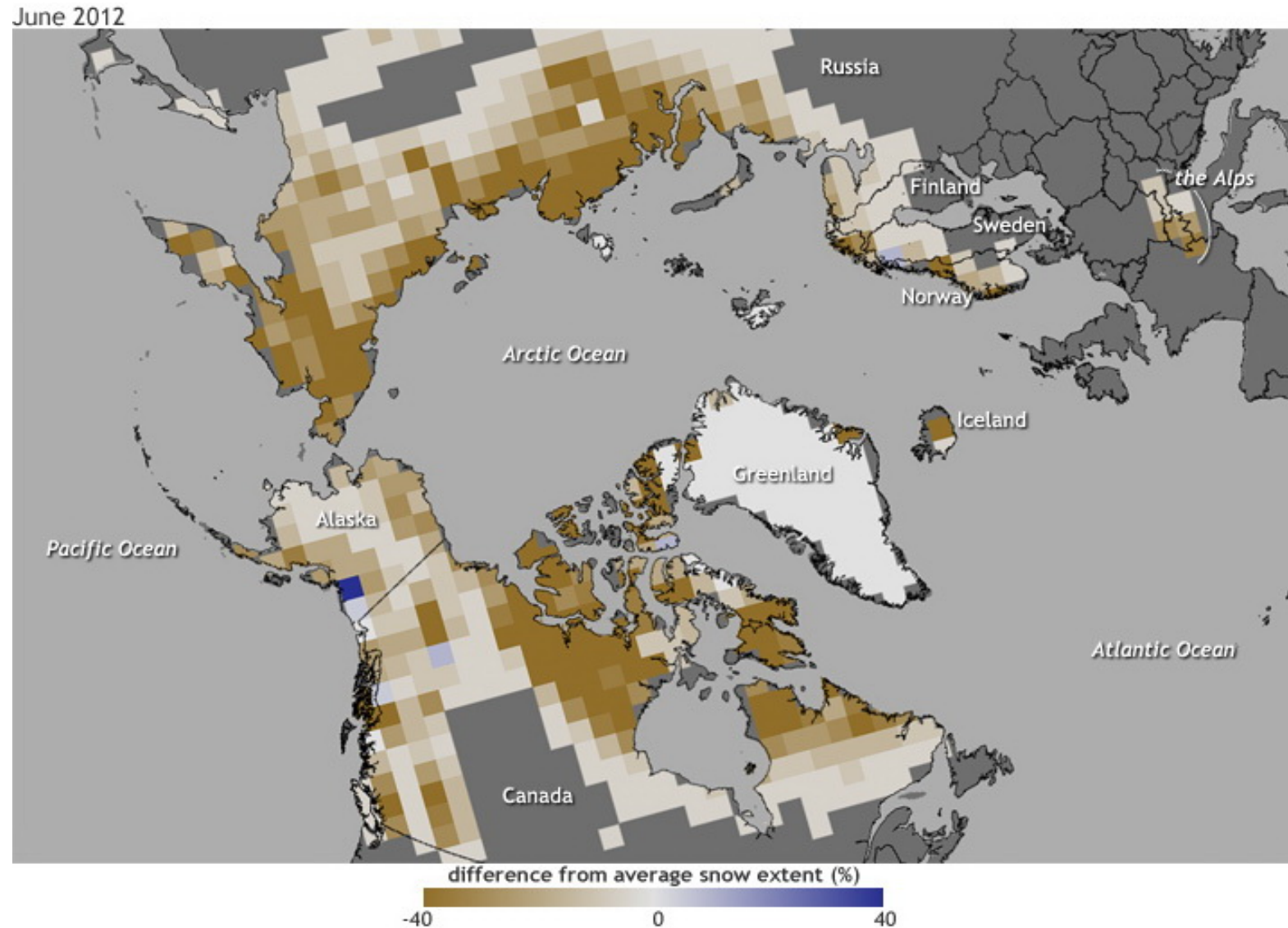
**Treatment processes slow down = larger  
facilities = higher investments**

# Average Snow-cover duration 1998 – 2007



**Open DWTPs and WWTPs are not suitable with heavy snow coverage**

# June Snow Cover 2012 relative to 1971 – 2000



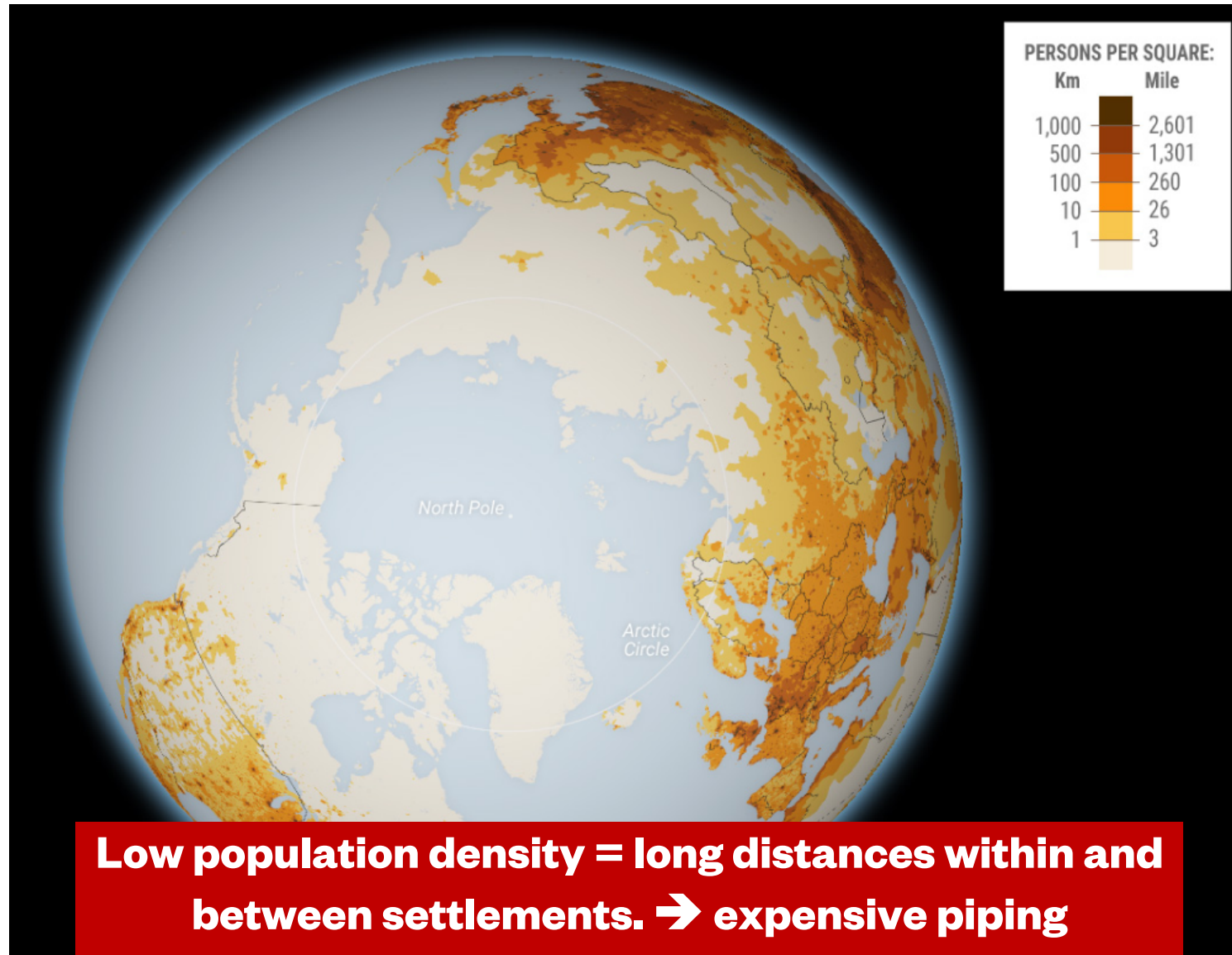


# Extent of permafrost



**Pipelines must be below the permafrost if underground: 5-10m deeper=costly**

# Low population density



# Challenges...



Freezing protection  
of water pipes



Frost heaving  
problems



Water leakage due  
to cold weather



# Water supply and wastewater management



# Water supply and wastewater management



Groundwater usually a good source – groundwater from below permafrost layer



Water from active permafrost layer or below: impurities – water treatment could be needed



Water quality in winter good – low sediment transport



Summer quality – treatment needed, freezing/thawing-processes expel impurities



Infrastructure stressed by extreme events – higher repair and maintenance costs



Treatment processes might benefit from higher temperatures

