Humans and Hydrology at High Latitudes (H^3L)

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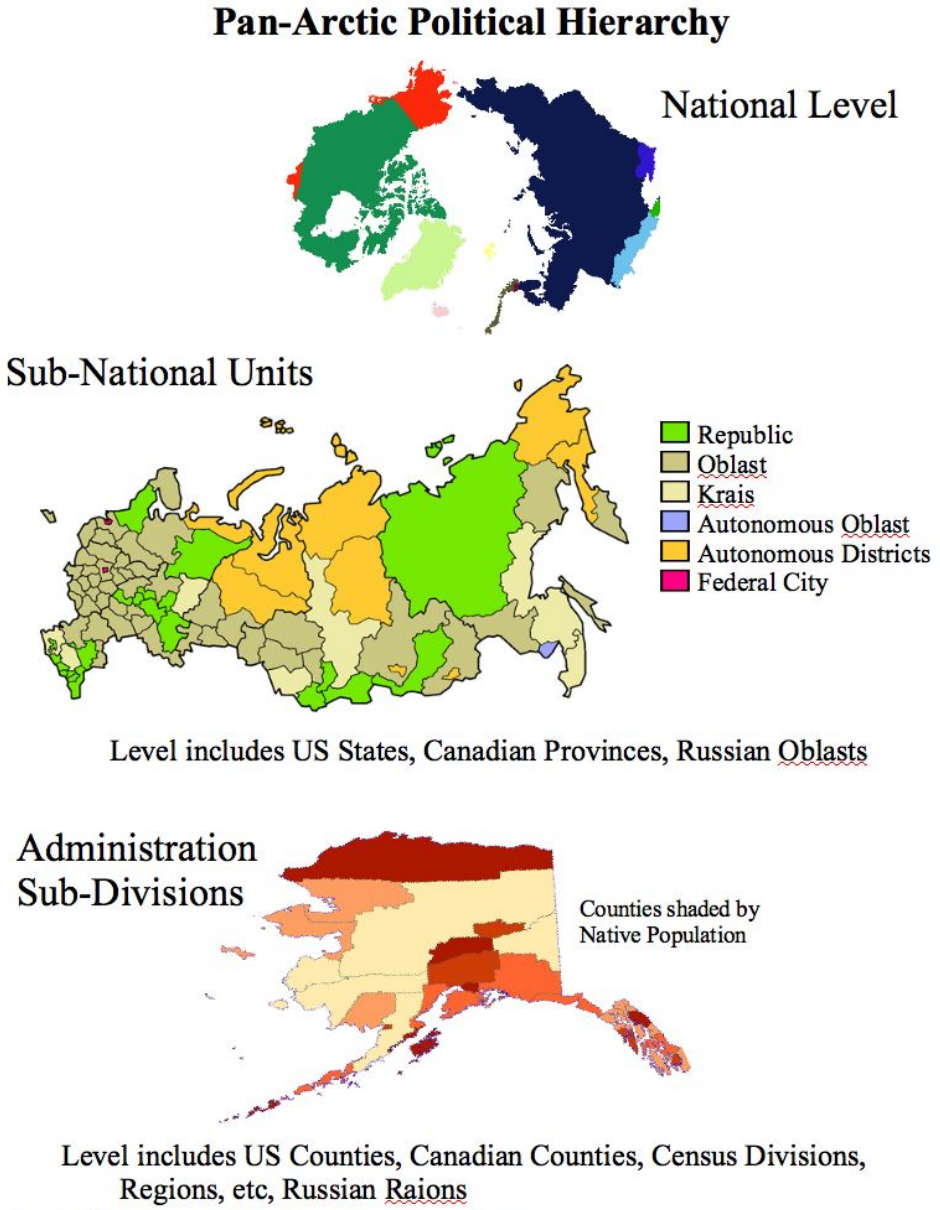


H^3L Summary

Intersection of hydrology and humans

Interested to know current state of water resources across the pan-Arctic

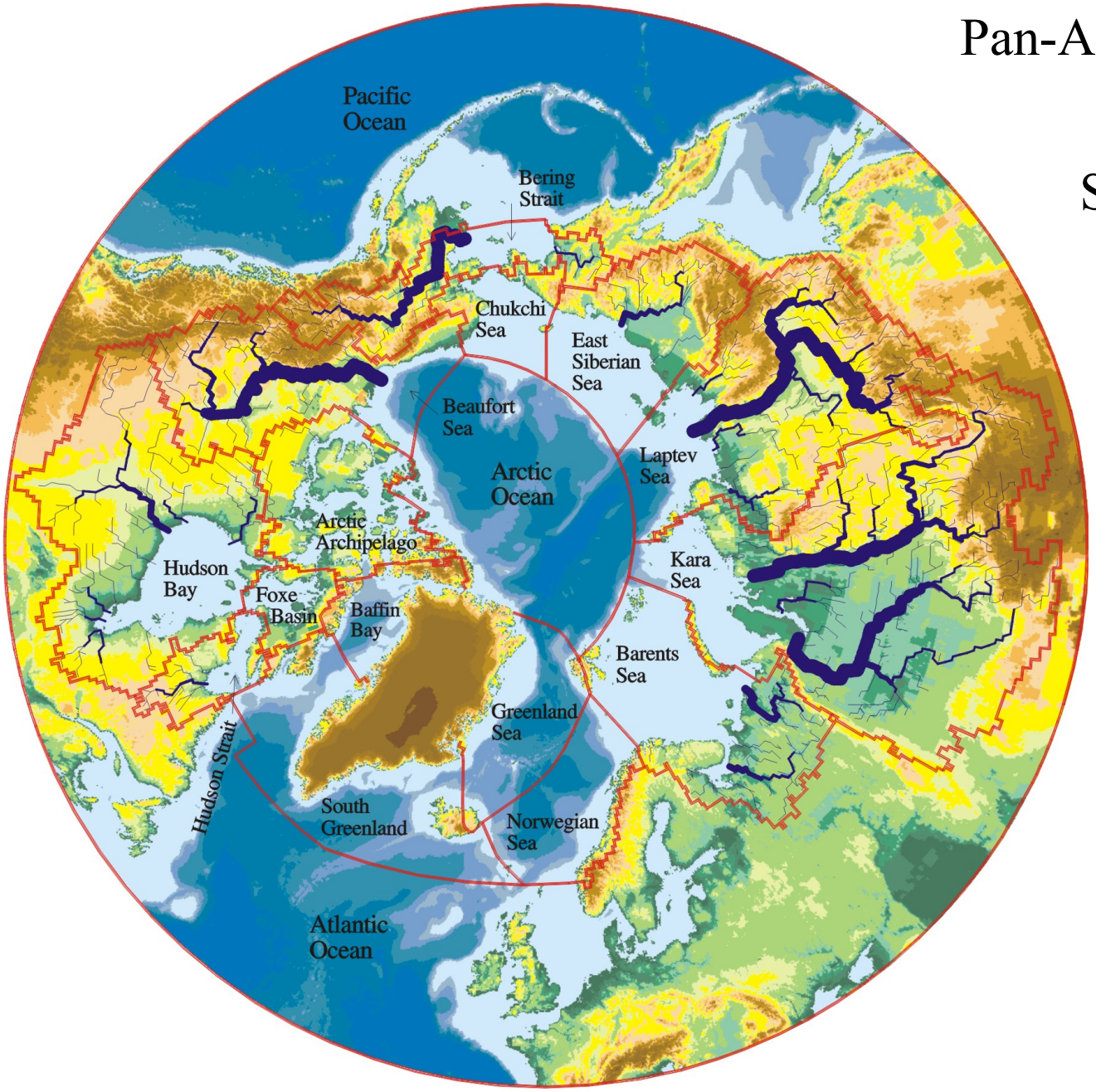
Understand how to link local and macro scales

Extend analysis into the future

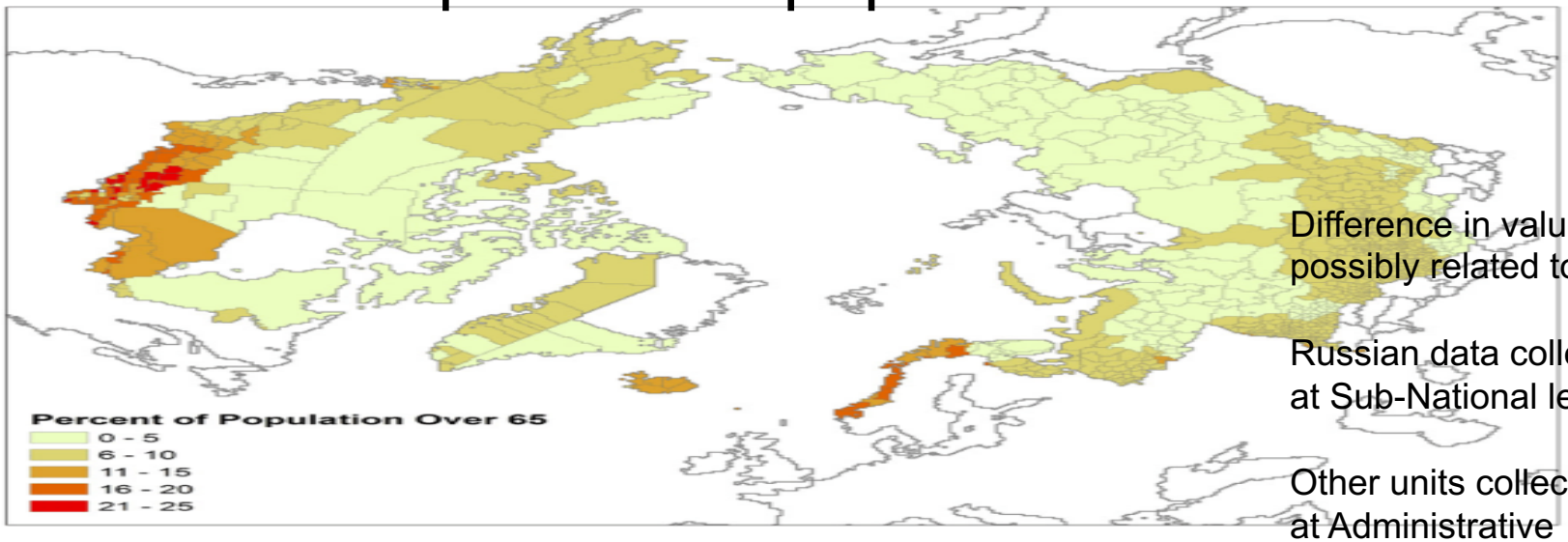
Identify vulnerable regions

Pan-Arctic Drainage

South to 45°N



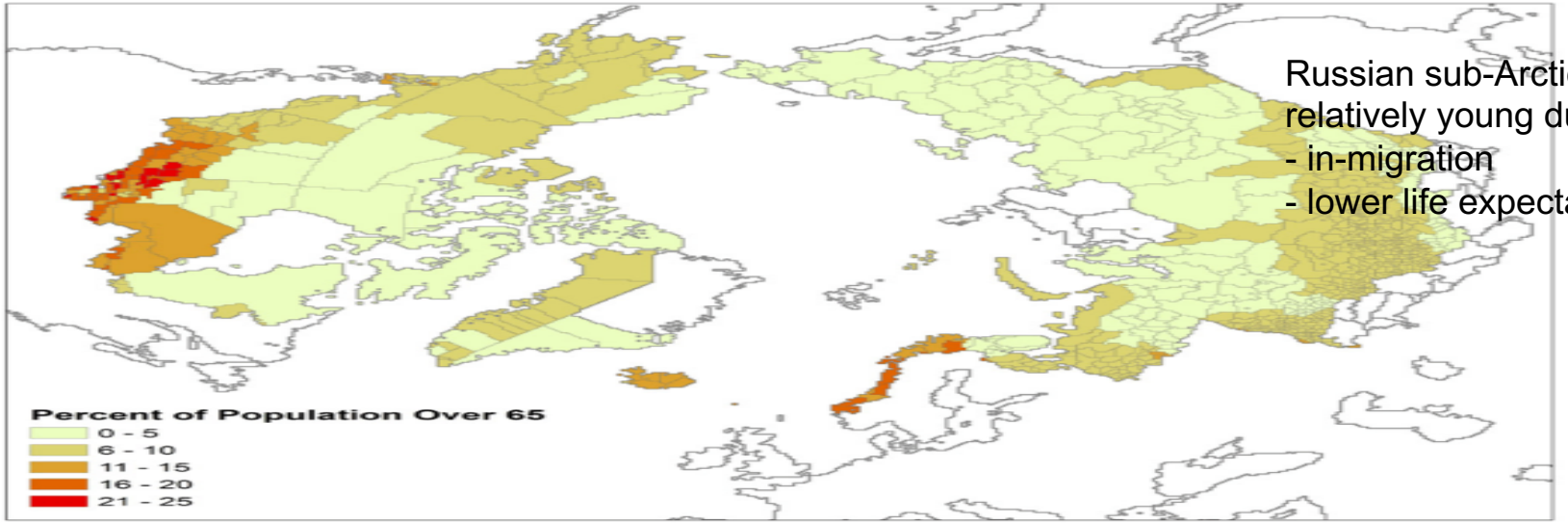
Percent pan-Arctic population 65 and older



Difference in values possibly related to scale

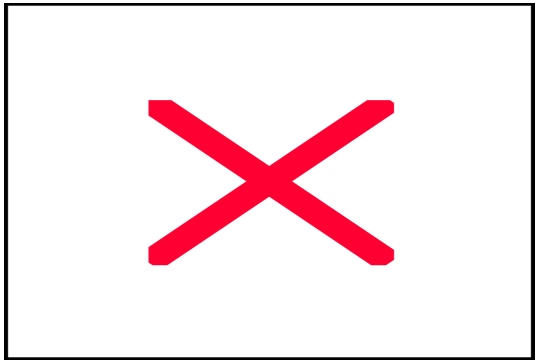
Russian data collected at Sub-National level

Other units collected at Administrative Sub-Division Level



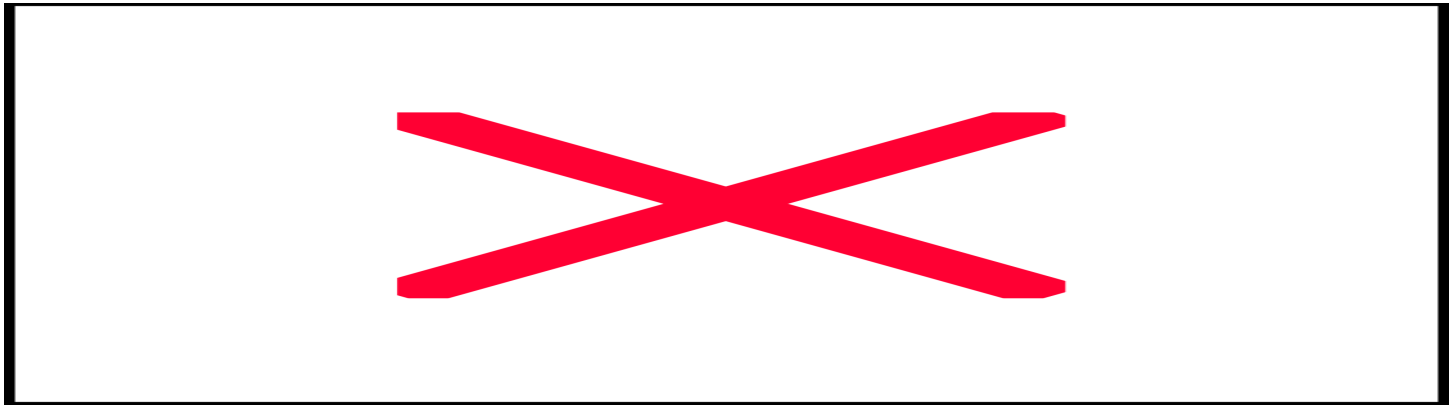
Russian sub-Arctic is relatively young due to
- in-migration
- lower life expectancy

Calculating Water Use



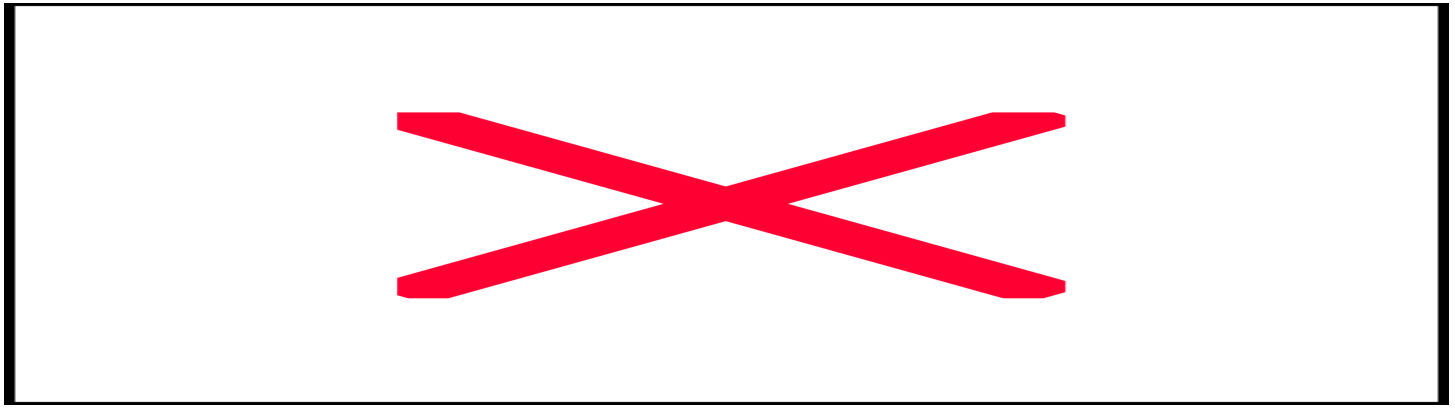
Level I
Lumped values when data is limited

(*Mongolia, China, Kazakhstan*)



Level II
Resolve by economy type

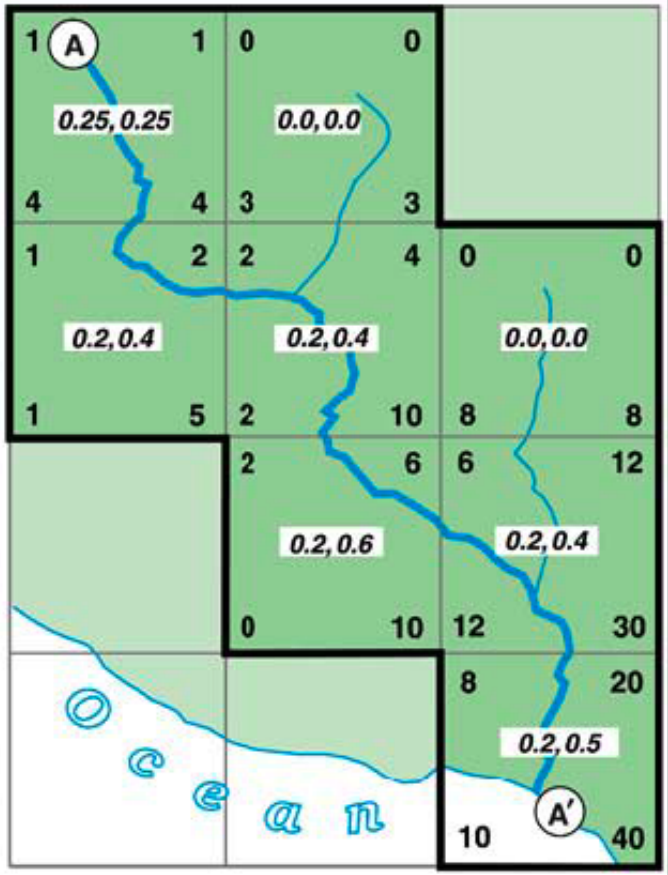
(*Russia, Scandinavia*)

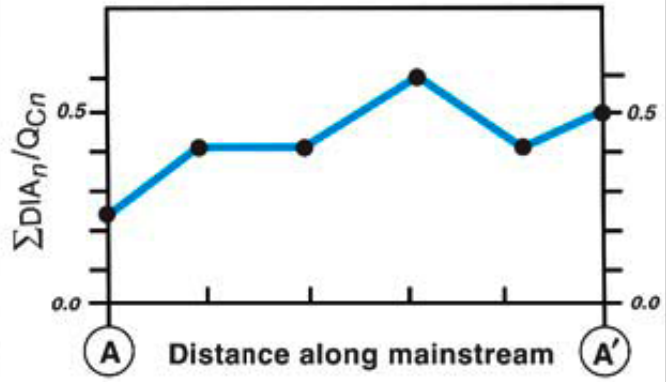


Level III
Resolve Commercial and Industrial water use

(*Canada, Alaska*)

CALCULATION OF KEY WATER INDICATORS





DIA_n = domestic, industrial, agricultural water use ($km^3\ yr^{-1}$) in cell n

$\sum DIA_n$ = DIA in cell n plus all upstream cells ($km^3\ yr^{-1}$)

$$= \sum_{i=1}^{n} DIA_i$$

R_n = locally-generated runoff (mm/yr)

A_n = area of cell n (km^2)

$Q_{Ln} = 10^6 * R_n * A_n$ = locally generated discharge ($km^3\ yr^{-1}$)

$$Q_{Cn} = \sum_{i=1}^{n} Q_{L_i}$$ = river corridor discharge ($km^3\ yr^{-1}$)

DIA_n/Q_{Cn} = local relative water use (unitless)

$\sum DIA_n/Q_{Cn}$ = water reuse index (unitless)

n = position of cell in river network = total number of upstream cells plus cell in question

Key (cell *n*)

Arctic Water Resources Vulnerability Index (AWRVI)

$$\mathbf{AWRVI} = \mathrm{AWRVI}_{\mathrm{physical}} + \mathrm{AWRVI}_{\mathrm{social}}$$

Physical sub-index:

$$\mathbf{AWRVI}_{\mathbf{physical}} = \mathrm{AWRVI}_{\mathrm{natural_supply}} + \mathrm{AWRVI}_{\mathrm{municipal_supply}} + \mathrm{AWRVI}_{\mathrm{water_quality}} + \mathrm{AWRVI}_{\mathrm{permafrost}} + \mathrm{AWRVI}_{\mathrm{subsistence_habitat}}$$

Constituent sub-indices:

$\mathrm{AWRVI}_{\mathrm{natural_supply}}$ = f (precipitation, surface water, river runoff)

$\mathrm{AWRVI}_{\mathrm{municipal_supply}}$ = f (yield, source diversity, treatment technology, hydraulic gradient, permafrost risk)

$\mathrm{AWRVI}_{\mathrm{water_quality}}$ = f (upstream modification, water quality testing)

$\mathrm{AWRVI}_{\mathrm{permafrost}}$ = f (permafrost distribution)

$\mathrm{AWRVI}_{\mathrm{subsistence_habitat}}$ = f (aquatic habitat, terrestrial habitat)

Social sub-index:

$$\mathbf{AWRVI}_{\mathbf{social}} = \mathrm{AWRVI}_{\mathrm{knowledge}} + \mathrm{AWRVI}_{\mathrm{economic}} + \mathrm{AWRVI}_{\mathrm{information_capacity}} + \mathrm{AWRVI}_{\mathrm{sensitivity}}$$

Constituent sub-indices:

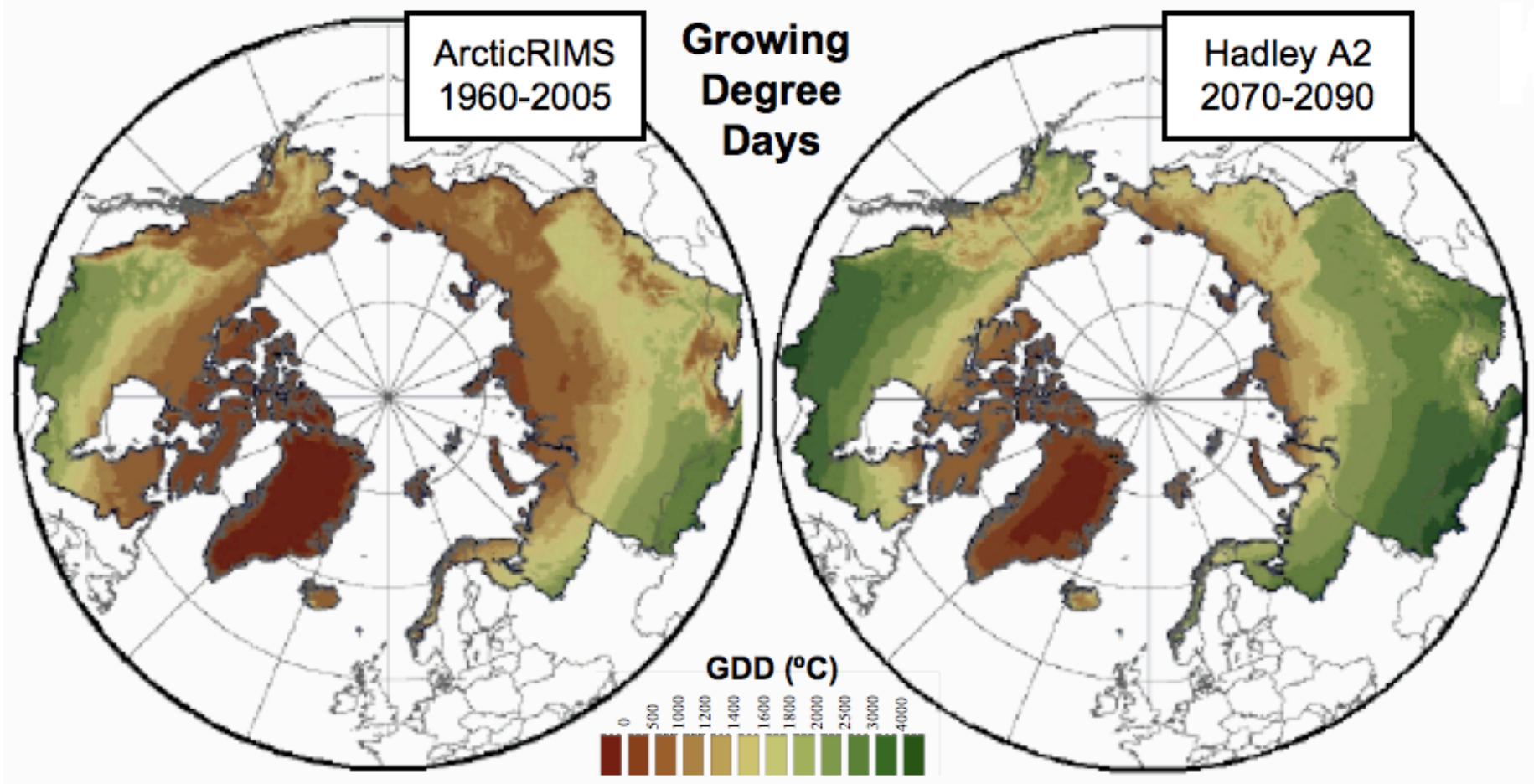
$\mathrm{AWRVI}_{\mathrm{knowledge}}$ = f (traditional knowledge, Western knowledge, residency time)

$\mathrm{AWRVI}_{\mathrm{economic}}$ = f (community wealth)

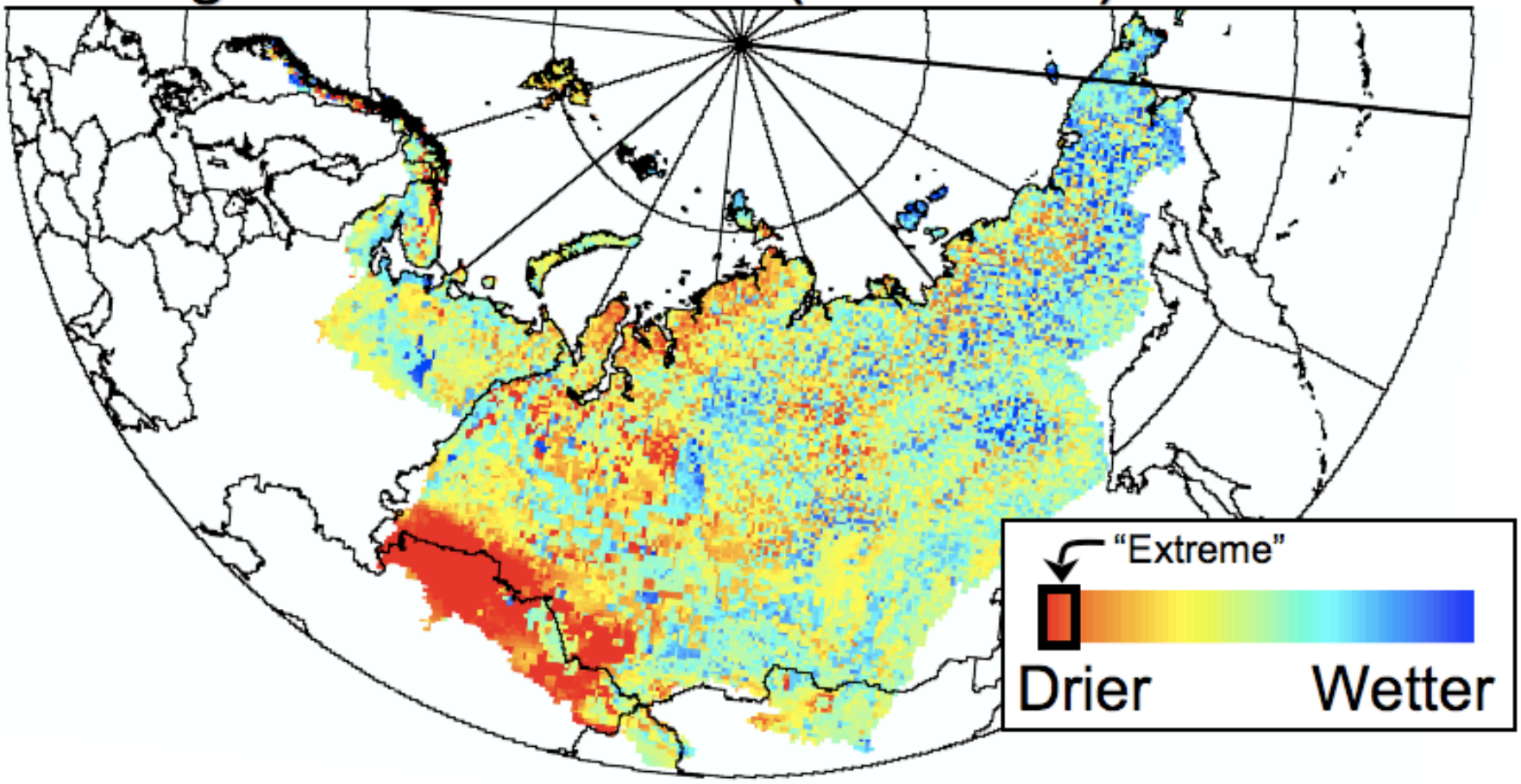
$\mathrm{AWRVI}_{\mathrm{information_capacity}}$ = f (land tenure)

$\mathrm{AWRVI}_{\mathrm{sensitivity_change}}$ = f (subsistence values, social network diversity, perception of change)

Opportunities to downscale from future climate change scenarios and macro-scale georeferenced data sets to asses the resilience of communities to change.


ArcticRIMS
1960-2005
Growing
Degree
Days
Hadley A2
2070-2090
GDD (ºC)
0
500
1000
1200
1400
1600
1800
2000
2500
3000
4000

Change in Water Stress (AET/PET) 1980-2080

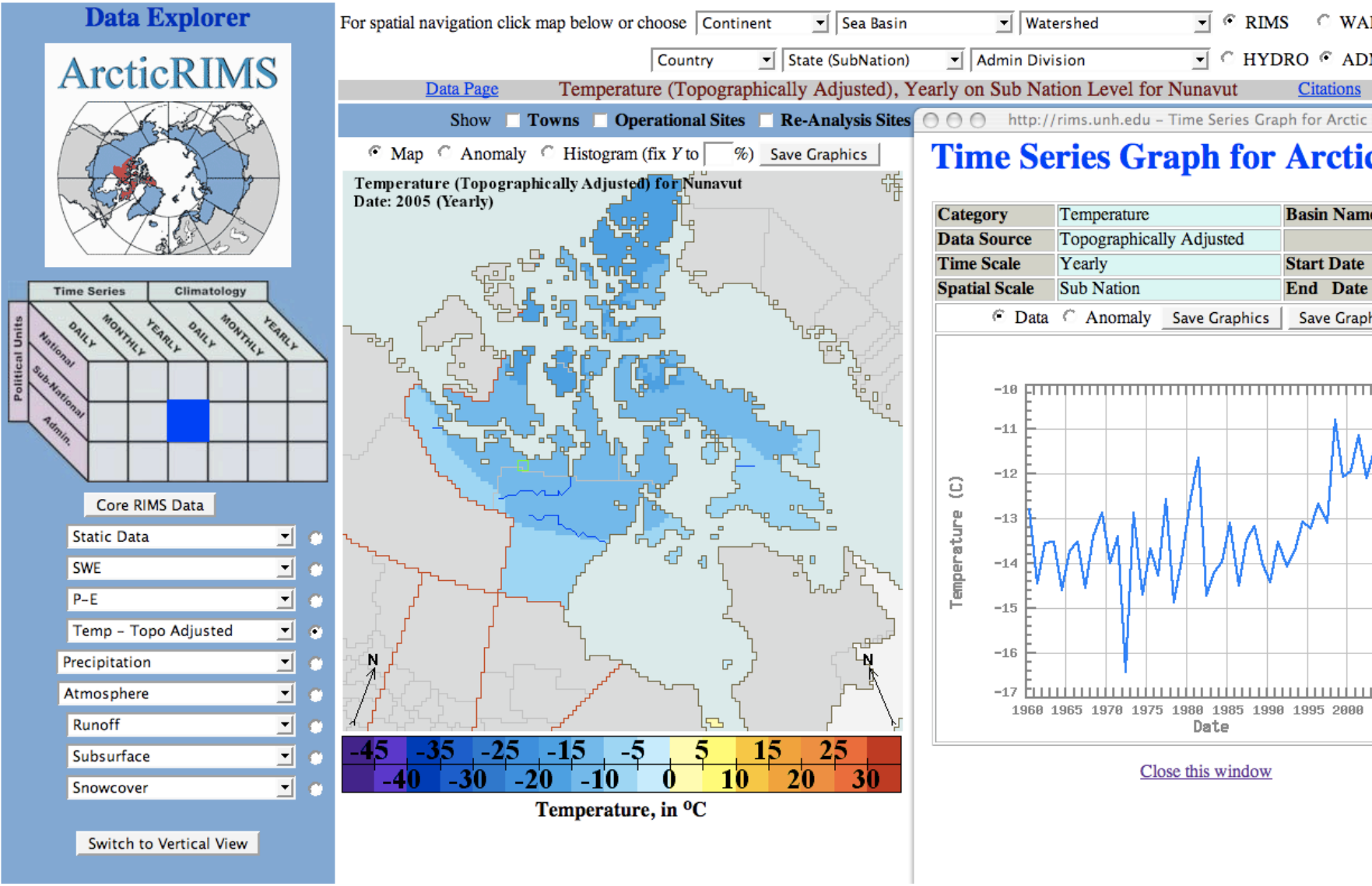


AET = Actual evapotranspiration

PET = Potential evapotranspiration

Unifying framework for data

ArcticRIMS - http://RIMS.unh.edu



Now has political hierarchy.