

Boreal - Arctic

- While there can be some iterative feedbacks between research and practice in the design of data and information collection programs, its not always present. Therefore, a big issue is how to use the research basin data over which you had no control in collecting, for your purpose. To take information from data rich areas you need to consider why the original data was collected. This is not to say that all research should have a final practical purpose identified a priori; there is value in conducting research that will reveal things that may be of use in the future.
- There is an obvious disconnect in the methodologies used by researching and practicing hydrologists. So there needs to be a bridge in methodologies. Perhaps a decision tree would be of use for practitioners that depends on the question being posed, the level of acceptable risk and the time and financial budget. Do not necessarily limit the decision to one approach, but perhaps use multiple approaches.

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- Precipitation
 1. Reanalysis tools; numerous gridded products; NARR, ECMWF, UC Irvine, CANGRID and CAPA. They are available for both data rich and data poor areas, so you can assess quality over your area of interest. There are resolution issues, but that only becomes an issue for smaller basins. The importance research becomes evaluating the product. These products could be improved with more collective efforts for data sharing. Put all the data in the mix of the reanalysis.
 2. Improve upon interpolation tools such as kriging and Thiessen polygons for gauges, snow courses and snow pillow data
 3. There is certainly a role in deterministic models for distributing snowfall.
 4. Distributed snowmelt modelling. There are requirements for data in sparse areas useful in applying something besides degree day methods.

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- Evapotranspiration
 1. Reanalysis tools are again available; with comparable issues for this water budget term.
 2. NDVI online products also need testing.
 3. Development of indices of ET or empirical relationships could continue to be pursued.
 4. Pursue the acquisition of Lidar to estimate canopy density and other useful parameters within the treeline.
 5. The vegetation diversity above the treeline is much lower, and could be simplified for the purposes of ET estimation, except where there is soil moisture limits. Is it soil moisture limited or energy limited? DEM's would be useful to maybe discern topographic indices of soil moisture. Feedbacks between ET and soil moisture storage may be a research topic.

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- Storage
 1. Remote sensing tools need to be further developed to improve estimates of surface wetness.
 2. Even more Lidar for the examination of surface depressions.
 3. Improved geologic mapping, especially more detailed permafrost mapping; this includes aerial photos and remote sensing of both vegetation and persistent snow cover. Use land cover / vegetation type as a surrogate for permafrost mapping. Find which types can be used to indicate frozen ground regime. Can you figure out the thickness of the active layer based on near infrared from remote sensing? Are there other geophysics possibilities?
 4. Estimating soil parameters in data rich sites (research basins) for use elsewhere to parameterize models.
 5. Attempt tracer studies to learn residence times.
 6. Glaciers; lots of remote sensing data available for glaciers. Lots of areal change, but not volume change. Laser altimetry approaches would do. There are some very data rich areas (ie Devon and Greenland and Svalbard) that can be used to extrapolate to some parts of the Arctic.

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- Streamflow
 1. Continue research into flow paths, being sure to apply geochemical methodologies.
 2. Traditional knowledge could be used to act as a bound for estimates and extremes. Same with hydraulic geometry (large scale gradients) and paleo records. Vegetation can also be an indicator of floodplains; even animal species diversity regimes.
 3. Collaboration with local communities. Look across the circumpolar region for information.
 4. Drainage area relationships as a starting point; to get within an order of magnitude. Regression techniques are dodgy, so additional research into indices (e.g. Quinton) is required.
 5. The installation of short term gauges with telemetry is common, and the datasets that are produced are valuable for use in developing relationships with operational gauges. Be sure to go back in time to QA/QC your own data because the knowledge of the past improves as time progresses.