Summary of the 3ʳᵈ Global Water Futures Operations Team Meeting

November 19–20, 2019
Art Gallery of Hamilton
Hamilton, ON

Meeting Overview

The GWF Operations Team and Strategic Management Committee (SMC) met in Hamilton in November 2019 to review collective progress towards our goals, discuss the science directions and operations of the GWF program, and to plan special initiatives. The meeting focused on the following broad issues:

- Next phase of GWF and the 2020 CFREF mid-term review of GWF.
- GWF's Planetary Water Prediction Initiative – structure and links to current and future projects, global initiatives and other research
- Indigenous community water research – what are the projects doing, what more can be done, how to share best practices across other projects and the program in general?
- UN Sustainable Development Goals – linkages to the United Nations University - Institute for Water, Environment and Health (UNU-INWEH); announcement of the Water Portal for the UN Water Action Decade: Water for Sustainable Development, 2018–2028; update on GWF contributions to the UN SDGs, and further activities we can pursue in that area.
- Coordination with core teams on prediction (core modelling, computer science, IMPC, others), adoption of new components for models, remote sensing, testing models on GWF observatory data, visualisation.
- Observations and data – what is being done across observatories, what gaps are there to fill? What is the status of our data archive?
- Knowledge mobilisation best practices and capabilities – coordinated regional (provincial level) multi-project KM planning – the "GWF travelling road show".

The first morning of the meeting involved overview presentations on status and progress from each of the GWF core teams, as well as presentations on Canada's contributions to the UN water Action Decade and GWF opportunities for research, practice, and leadership in achieving UN sustainable development goal six. This was followed in the afternoon by a series of rapid updates from each of the GWF projects, focussed on major accomplishment, challenges, aspirations, and need for connections. The second morning involved café-style moderated, rapporteured breakout discussions to assess progress and needs on specific topics: 1) modelling & prediction, 2) observations, remote sensing & sensors, 3) Indigenous community water, 4) visualization, computing & apps, 5) water in cities, 6) water quality & ecosystems, 7) social science, policy & governance, and 8) cold regions processes. Summaries from these discussions took place before the close of the meeting, and after the meeting the GWF SMC met to summarize the outcomes and next steps, and review other business.

The meeting agenda and presentations can be found on the GWF website at https://gwf.usask.ca/news-events/past-events/ocm-nov19.php.

Outcomes and Next Steps

- There is a need for a water quality data assessment at the national scale and a scoping workshop to frame out how to advance this (similar to the flood forecasting workshops held in Vancouver, bringing in provincial and federal government agencies). This should be organized centrally through the SMC and engage the right people and organizations. This can help inform a national water strategy.
- A pilot project/exercise should be undertaken to bring together data users, data originators, and the DM team. Various data sources (e.g. from UAVs and satellites) that have not yet seen much use can be combined. There is a need to understand needs for cleanup and archiving, benchmarking against observations and model results, and development of a catalogue of sites—our observatories can be used as focal points for science, KM, outreach and communication of results.
- Publication of datasets in a special issue of Earth System Sciences Data (ESSD) is a good way forward and this should be explored. A new special issue for GWF was suggested.
- A call for proposals for new Pillar 1&2 proposals will be forthcoming. The needs and strategic issues identified during the breakouts here will help inform some of the priorities, opportunities, and gaps to be addressed.
- There are further areas of common development and connections. Visualization is developing and needs to connect with KM and data management efforts. Also, Indigenous traditional knowledge is something to further explore in terms of linking this with visualization. The visualization task force may need to have a workshop or reach out to flesh out user needs.
- We will have the GWF annual science meeting in May—groups within the network may recommend sessions or breakouts or side events to the SMC.

Rapporteur Summaries from Café Discussions

1) Modelling & prediction

Lead: Martyn Clark
Rapporteur: Hayley Carlson

Synthesis
- Generally happy with Core Modelling restructuring, understand the importance of generalizable pan-Canadian tools and standardizing workflows and processing to improve efficiency.
- Some issues
   - Connection with projects
      - in terms of how they can access deliverables of Core Modelling, and also how the Core Modelling team can work with projects that have modelling work of their own.
      - Some solutions we discussed: joint workshops, contacting faculty leads of the core modelling themes to start a conversation.
   - Communication across network
1) About what is being done and when it will be done – this is still under development (Projects needs info about what core modelling is doing in terms of models, versions, etc. so that they can "plug and play.")

2) Maybe some modelling 101. Some solutions: We wondered if perhaps the KM team would be interested/available to help with this. Maybe having a KM rep on the Core Modelling team would be helpful. An infographic.

- o Needs to continue to be strong links between Core team – particularly Core Data, Core Computing and Core Modelling. Already through the Core Modelling Exec., hopefully also a KM rep.
- We heard that access to training and modelling expertise would be appreciated – so this might look like a student exchange across campuses, series of seminars, taking Martyn's class, etc.

Next Steps: Core Modelling Executive needs to meet again and decide on a way forward.

2) Observations, remote sensing & sensors

Lead: Dave Rudolph
Rapporteur: Marie Hoekstra

Overall points (presented at meeting by Dave Rudolph)
Data management points
- there is a need to define what is an observatory, and what is a data 'product' ie is hydromet data a product or is rainfall data the product, this will be something to consider when publishing datasets
- there is a need for researchers to be able to know what data is out there and lots of strides being made using the geonetwork website or other sites to house metadata
- **lots of discussion, how to access data, and a need for a place to search what data is available.**

RS and sensors points
- There is a real need for sensors which can function in cold regions, in places where it is sub zero for a large part of the year. This is causing gaps in data right now.
- Need to know what rs data is being collected – either by plane or drone, by gov, Canadian, or international groups, so those doing ground level work can possibly connect, or use the data, act as ground truth acknowledgement that the observatories can function as ground truthing sites)
- How does social science data fit into an 'observatory' framework
- Challenge for observatories who don't have a remote sensing expert – they don't know what is being observed or how it might complement or expand their research eg. Looking at land cover change – how do we make those connections
- Being able to integrate datasets from other parties (gov, industry) so they are available or useful for GWF researchers.
- How do we operationalize remote sensing methodologies? Have these science breakthroughs able to be used by other groups in a meaningful way in their research – not just proving that it works but using it
  - o how will govt and stakeholders use this to their advantage
- How can we leverage historical RS data to complement current projects? A lot of data is available (eg. Radarsat 1, landsat, etc.) there is a problem getting funding to do old science
- Question of what happens after GWF ends? Who is responsible for sensors, maintaining them, maintaining the data being collected
- Opportunity to work with Trans port canada on beyond line of sight drones – right now RGB imagery is collected byt there is interest in collaborating on the deploying other sensors
  - o How do we connect and reach out to other groups developing RS techniques

- Possibility of having a contact list of experts (maybe this could come out of the deliverables of the RS task force)

In remote communities (Matawa Water futures, Sarah Cockerton)
- Technology can provide an excellent way to bridge traditional knowledge with western science
- For satellite data, Overall lack of access to data, because community members are not RS experts, they struggle to know what is available or what is most useful
- For ground sensors, there are just not enough, and not enough funding to have enough sensors. Struggle with sensors not robust enough work in harsh climates
- Need equipment and sensors that are easy to work with so community members can set up and maintain them, and then they also need connections with trained scientists who can work with the community to help analyze the data.
- Weather, climate, and extreme event data is some of the most important data needed by this project
- Visual outputs are very valuable, maps and charts

3) Indigenous community water

Lead: Dawn Martin-Hill
Rapporteurs: Matt Myke, Colin Gibson

Summary from Matt Myke
- In regards to community engagement, it is important to ask:
  o How does the research benefit the people?
  o What resources can be provided to the community?
  o How can the work help strengthen the community with respect to treaty rights and water governance?
  o How will traditional knowledge be kept sacred and protected?
  o How will the knowledge be demonstrated in the research, how will it be shown (e.g. values, morals, ethics)?
- In bringing together western science and traditional Indigenous knowledge, credit for Indigenous expertise and knowledge must be given and recognition of the equality of the two streams must occur to gain the mutual respect.
- For workshops in future, it would help to bring in Indigenous knowledge in the same settings [as at this meeting] to offer a diversity of perspectives, whether through cultural art, different beliefs, and governance systems. This will help demonstrate the spectrum of Indigenous knowledge that can benefit the GWF program.
- The communities themselves should determine who should work with university researchers, engage with the project, and who holds the relevant expertise and knowledge. This ensures the community has vouched for the individuals to speak on their behalf and helps with mutual respect and communication.
- An important next step in GWF is to hold an Indigenous Community Water Research workshop and First Nations gathering, providing an opportunity to work together and share knowledge and ideas, strategies, and best practices. Dawn Martin-Hill noted her team will develop a briefing on "Best practices in Research with and or by Indigenous People's", which might help move us forward with GWF colleagues and administration.

4) Visualization, computing & apps

Lead: Kevin Schneider
Rapporteur: Stephen O'Hearn

There have been several pockets of development efforts in Visualization and Apps
Reason:
Constrained by resources, "newness" [of GWF and Visualization], difficulty in coordination between needs of GWF and Research Computing before coordinator
Solutions:
Visualization Task Force (Data, Researchers, and Research Computing)
Stephen is committed to liaising between Research Computing and Research Groups

Outputs from GWF research are highly complex.
It is a lot to understand and remember (from the Apps perspective)
Visualization (especially interactive visualization) helps to explain [these complex outputs] and make this complex information memorable.

There are widely varied types of uses
For example, needed are:
- decision support systems for municipalities,
- decision makers (politicians)
- Crowd sourcing (data collection)
- General public (viewing)

Visualization bridges language barriers:
    English (preferred modality is decidedly visual)
Technical language between different teams (Visualization, Apps, Modelling, etc.)
For Indigenous, any visualization is very helpful in explaining outcomes
It aids in the ability to interact e.g., giving reports to chiefs, boards of directors
acoustic recordings associated with mapped locations are being created to help illustrate findings to the community
Ties to KM and Core Modelling

Users need to be informed by e.g. Visualization Team about what is possible
Interactive visualization, e.g.,
- Augmented reality
- Virtual reality
- Visualization apps used for:
- 3D
Visualization needs to be aware of what gaps persist (what is needed)
So "What is needed" by GWF should be associated with "What is possible" from Visualization, Apps, and new Data Management Systems like GWFNet

Issues:
Open source visualization support (sustainability),
versus Commercial (ArcGIS by Esri) expensive but sustainable

Access to Copernicus computing
Separate from Compute Canada
Faster turnaround
Things more interactive (e.g., realtime back-ending the web apps)

Visualization Team:
Prioritization of Limited Resources
try to represent all groups
Std outputs from modeling to visualization
standard visualization packages
build a visualization libraries

Focus groups around themes areas by stakeholder group

5) *Water in cities*

Lead: Bruce MacVicar
Rapporteur: Stephanie Merrill

Common question – what work in cities is being done
- urban land use change – erosion and ecological change, including development of tools to help predict degradation based on modelled hydrologic change.
- wastewater impacts on Grand River – M. Servos
- lake water futures – urban impacts
- indigenous-led research projects – 'urban' problems of source water protection, community flooding, security of drinking water supply
- boreal – implications for urban water – drinking water source protection

What is within our scope?
Should we expand the scope in this area?
Some projects disqualified as 'too engineering' or something that a consultant would do.
Conscious decision to stay away from drinking and wastewater treatment technologies.
Cities are maybe harder to work with on a national scale because of the governance and social differences. Results are less 'transferable'.
Need to find questions that research can answer that cities and management authorities can do or maybe can't even say without us without upsetting their constituents.

Opportunities
1. land use change fringe – similar to the boreal fringe, the urban fringe is changing, impact on hydrology and water quality is well established, but what is happening on a pan-Canadian scale? Better describing the situation of the cities in Canada
2. source-water protection allocation – will there be enough water for urban growth/ waste water treatments and investments, boreal research on fire
3. urban resiliency – can we inform hydrologic manipulations in developing areas in order to improve resiliency, grey water recycling, storage cisterns, re-use of rainwater
4. governance barriers – multi actors – developers, municipalities, provinces – research on what the human systems are doing and whether they are effective – implementation problems, site specific.

5. Is the (urban) water safe to drink – lots of questions from public, renewed interest in the quality of tap water (lead)

6. urban flooding – National Flood Forecasting Platform – opportunity to tailor for cities. Maybe focus on basin driven floods such as Fraser and Ottawa, St John rivers vs engineering related (impervious land surface and routing changes within cities – too complicated? beyond our scope?). Lake Ontario and other high water levels/cycles?

7. cumulative impacts on water quality – salts, other effects. Recreation use, Drinkable swimmable fishable.

8. security of other resources that cities rely on – e.g. electrical grid – freezing rain and hail, hydropower

6) Water quality & ecosystems

Lead: Nandita Basu
Rapporteur: Kirsten Grant

Summary of Water Quality and Ecosystem Discussions

- The main nugget that came out of our discussions is idea of creating a national water quality data platform that could be used by people to understand processes about what controls water quality in various regions. Currently this doesn't exist at the national scale, so that is a challenge.
- Some regional databases already exist – for example the Gordon Foundation, hosting data for the Mackenzie basin and others
- Discussed how drivers of water quality are extremely different by region, but still space to discuss bigger picture controls on water quality at a national scale
- We talked of a conceptual framework creating workshop where we bring in core GWF researchers from different basins across Canada as well as other people in key regions of Canada to look at what are the various water quality issues in different ecoregions and what are the controls on these issues. For example in the north – permafrost might be a driver, where in the south agriculture might be a main driver, and how do all of these change with climate
- This will be a focused scientific framing workshop that will be followed by a larger national scale synthesis workshop bringing in all provinces something similar to a national flood workshop to see if we can create a national water quality data portal
- Could start with data available within GWF first and make this as a template to pitch to a larger Canadian water quality community
- Also discussed how we can include other types of knowledge in a database like this – including remote sensing data, and traditional knowledge, and how data from different sources could be included together be of the most value
- Near the end of our discussions we also talked about linking a national database like this to water equity and boil water advisory database, and what problems and what solutions have worked in some regions and not others and have that information also available

7) Social science, policy & governance

Lead: Philip Loring
Rapporteur: Lori Bradford

Introduction: We ran this breakout group as a discussion table that was guided by three questions that we asked participants to think about as the discussion ensued:

1. Tell us about a water governance challenge that affects your research areas...
2. What I would like to know most about social science/governance is..., and
3. Bringing a focus on governance ot my work could ...

The questions were designed to be open-ended in nature and thus elicit conversation. The discussion points are explored next in order at which they emerged during the flow of the breakout groups.

Data management and governance of data were of concern. The challenges brought up included how do we first, obtain sensitive data, particularly health data, given the complexities of ethics requirements and data sharing agreements, and second, report on that data. It was noted that free and prior informed consent processes were designed to help protect individuals as well as research enterprises and not meant to restrict or delay projects. Though ethics boards may seem like moralistic overlords, they are actually there to support researchers and protect human rights – and to make sure we get to live out those human rights – especially in the case of water – as a nation, Canada had water crises before there was the climate crises, but the rights to water haven't been achieved yet – especially in Indigenous communities, and that means that we have to be even more delicate in our co-creation of data sharing agreements with Indigenous communities around water. When it comes to sensitive data that is gathered with free, prior informed consent processes (which in many cases are collected via oral consent in Indigenous communities – contracts are traditional oral in nature and legal contracts written on paper are often phrased via risk or in militaristic tones which are red flags for Indigenous community members), there is still the challenge for data managers of reporting on this data to SMC. It was recommended that the data managers should be able to state to SMC that the data is not available to be reported on because of OCAP – and that should be enough – SMC has to just accept that. Governance of data could be measured to report on indicators of data co-creation and co-management instead of relaying exact counts of interviews, data points etc... for Indigenous communities. But those indicators themselves need to be co-created and represent the values that are deemed important to each project. Data stewardship is an integral part of traditional knowledge – the data management team could learn more about that from traditional knowledge keepers in communities. Writing ethical protocols themselves with communities should count as data for these types of projects. The act of doing so is transactional in nature and has specific intent. Ethically, each community wants it's own protocol and set of project rights – that includes the right that talking with community members comes from a collective agreement. Otherwise, we risk creating division in Indigenous communities (i.e., if we share information and gather data from one faction in a community, we are acting unethically because we are providing sources of power to the community members that are included, versus those that are not or are not informed of study results). We can inadvertently damage relationships – that's why the decision to be allowed to interview community members comes from a collective decision making body in a community – not just individual people agreeing to be interviewed, etc. On a related note – we need to give data back right away (i.e. interview transcripts, WQ measurements etc), and then ask communities what it is okay to do with that data.

The language of ethics needs re-examination – invitation letters, consent forms are wordy and sound too contractual. It scares away people from being involved – not just Indigenous communities, but say you were interviewing Premiers or people on the street – letting them know ahead of time that this interview about water issues might result in them needing psychological counselling and here's the number to call if you need that, is frightening to people. Some flexibility there would be great. The research process is about relationships but the consent process is not relational. Tri-Council guidance on these issues is becoming more progressive – would encourage GWF data managers and SMC to pressure Tri-Council to allow flexibility in ethics processes on water with Indigenous communities.

A water governance challenge that was suggested was the need to identify gaps in the GWF program. A few key main points were raised – one, there are existing networks across Canada of policy and governance researchers involved in water – the SSHRC WEPGN at Brock, the SSHRC Decolonizing Water at UBC, several other programs – why were these not included in a meaningful way in GWF at the outset? Next, lack of social scientists and governance scholars in general. The few that are involved are tapped constantly to investigate challenges that are really not in our specific wheelhouses but we do it to support the overall program. A participant also mentioned that most of the natural scientists are open to investigate governance and social science issues, and may actually do it themselves in an informal way in their local contexts, but the historical push in the GWF program is on modeling. We appreciate the shift and the learning that is occurring which is allowing more work to connect with policy and governance research. There is openness to doing more now that the Ottawa event occurred and people were able to witness one example of how science is turned into policy. Some mentioned that to do so, there needs to be public involvement early in the projects. That way they can be informed and vote for governments that move science to policy.

We next discuss policy windows and how they emerge – two general ways – crisis-driven change where a huge event opens up a short window for quick policy change in response to that event, and then there's the long-term incremental change pathway where the evidence builds over a long time towards the need for policy change. Seems like that since GWF is a project of 7 years – we should have train-spotters or ambulance chasers looking for those crisis windows and GWF should be prepared with sets of recommendations of ways to more forward – so as to provide evidence-based solutions, not lobbying. This means that someone in communications should be keeping there eye on issues, communicating with SMC to advise of upcoming opportunities, and then SMC should be connecting with project leaders to contribute when these windows open up. An ambulance chaser or 'train-spotter'-so-to-speak.

The commitment to SDG's offer a great opportunity for science to policy translation – but we want to do so proactively, preventatively, promotionally rather than reactively. An example is in the case of transboundary water agreements – can learn from Great Lakes, Great Lakes Water Act 2015, and NWT/Alberta. Recommendations includes a push for a sustainability and water value person put into every provincial, federal, territorial, and Indigenous government agency and institute. Canada signed on to SDG – now we see section 35 coming up in everything – and UNDRIP. BC really showing leadership in this as a province, GWF could provide leadership as a research institute. A participant reported that in his experience (30+ years with federal government) – "most decisions are made politically". Section 35 now changing that – providing a route to hold governments accountable – which is what some participants said GWF needs to do. Example discussed – drinking water in Indigenous communities. It's fixable, we have the will, money and tech to do so, but instead we're an international embarrassment. But – unclear as to why GWF not studying potable water and wastewater/sanitation. The question for governance people then is to provide a fundamental understanding on why governments can't solve the problem and how GWF as an entity with privileges and power, can support policy change for that specifically, and for evidence-based (rather than political) decision making more generally.

The availability bias has really put all Canadians at risk – yes we have freshwater, but potable water is an issues for all Canadians – policy change can happen via pushing section 35 and UNDRIP, but we need to recognize that the benefits of doing so will spread to all Canadians. Some examples of how section 35 / UNDRIP issues have been resolved should be ready on the shelf for GWF SMC and Communications people for when section 35 or UNDRIP is triggered in contexts that GWF works.

Boreal water futures discussion about sensors and 'empowerment' ensued. Demonstration of what happens when you put science tools in the hands of Indigenous communities. See the value to two-eyed seeing approaches – but a pre-requisite to designing better empowerment that should be included in GWF meetings in the future is 'fit' and empowerment. Fundamentally, if we try and 'empower' Indigenous communities with western tools, we are really saying that we have more power and we are giving it to

them from our position of power. There needs to be equal recognition that Indigenous communities can also share their tools with us - given respect relationships are nurtured and trust is established – and can thus empower scientists – i.e., in Boreal WF they know have learned how to better do 'on-the-land' water science camps. We have to leave room for this learning in our programs.

It was also brought up that we can learn from the NWT example about the important roles of intertribal councils (having these 'middlemen' or 'middlepeople' that community across scales) and how to successfully manage transboundary relationships for water. The NWT water strategy would be a good example to work towards for a national water strategy.

On the National Water Strategy there was interest in knowing what is happening, and how GQF can position itself to provide support to that if it goes ahead. Questions that arose was whether a strategy is relevant – point was made that the national act was so old it was badly in need of modernizing and that anything having to do with Indigenous water agreements was based around the Indian Act which has so many built-in policy failures. It was brought up that we should become more aware of international examples of national-scale strategies. Australian and New Zealand strategies were brought up as exemplars – but even problems there (i.e., between Australian States). Closer to home, the Great lakes agreements, and the Lake Winnipeg agreement are other examples to learn from. Need to pay heed to potential turf wars – what is provincial versus federal responsibility? Could learn from public health – i.e., there are SARS strategies and surveillance systems that cross boundaries and scales from local to international. There's also the push to create a national food strategy or at least a national food council to direct policy decision making. Maybe a policy council is a better idea – like the CCME? The idea then is to make sure we are AGILE so we can act when the opportunity arises to provide information, act on panels, appear before committees etc, with our results-driven policy recommendations. It would be good to catalogue existing documents, acts, action plans, policies etc. around water and be prepared with sets of recommendations for each giving our findings – these should also include any information we have about context-specific values around water that are mapped across Canada. There should also be an advocate for these values who is deeply aware of the reasoning for considering specific values and is ready to push for them among policy makers so decisions are not overwhelmingly political in nature.

Would be nice if incentives and disincentives for adhering to agreements were more meaningful – had traction among actors in water challenges. Even though UNDRIP and SDG really push for the public good and national investment in ecosystem health and economic systems that water providers, the sanctions are not effective – if the agreements had more public values entrenched the sanction would have more effect.

Next we discussed how much of these ideas need effective knowledge mobilization – the work GWF is doing should play a role in shaping governments for the future. Right now there's a disconnect between those who do field, lab or computer-based work and the policy makers – but there are governance and policy dimensions in all of the work. Cross-disciplinary engagement can help to build recommendations - the how do we make the changes we want to see – but hasn't been a focus of the first three years. Most of us just went off and got our projects established – now we need to connect the dots – problem is, we don't have the people who are experts at connecting those dots invested in every project. A personnel gap in GWF. There is no one on SMC that is a policy person. Also need someone to help translate hat work into language that everyone can understand. And example is how policy makers confuse forecasting and prediction. So, there's also need for better translation and identification of audiences. KM / science translation / policy connect-the-dot-ers are needed urgently as personnel in the program – in hindsight, a core group in GWF should have been the policy connector group so these kind of conversations happened at the outset.

Question came up that there are problems that we know how to fix out there – but how do we fix them – or rather how do we convince people to fix them? How do you get someone to own up and pay for remediation, or invest in better infrastructure, or take the time to act meaningful for engagement of

Indigenous people? How do you actually fix those problems? Most project leaders in the program want to do that, but are not equipped to push or don't know how to create the opportunity and atmosphere to do the relational work needed to bridge those diverse views (i.e. community members, industry reps, and policy makers). Question was "How do we know which buttons we need to push to create action?" without jeopardizing GWF as a program? Has a bit to do with identifying the practical fit between the problem, the way the science can be framed and presented, and the decision making bodies mandates. So, we need to spend time upfront examining the current context pof ythe policy makers and decision makers, sit at the table, build capacity beyond the individual or community level (more on that later), and be equipped with concrete examples of success in other contexts. About capacity building – we can do so at the individual and community level – i.e., fish examples – we can show individuals metal results in fish from certain lakes and help them to set limits on how much fish or what species to fish and what size of fish to eat in certain lakes, and we can do that on a community level, but changing provincial or federal policy about upstream pollution or climate change that is leading to increased mobility of metals through ecosystem webs is much harder to do. There is a capacity building need for affecting change at scales bigger than individual behaviour and community subsistence levels.

Some ways to overcome that would be to have a collection of policy maps where we have traced the inclusion of science into policies from the scientists through 'middlepeople' to policy makers – this will also help us to prevent situations where the science is not taken up in the future because we'll better understand how and when it has been successfully included.

Co-management in the NWT has provided very useful lessons on how to engage Indigenous people and groups meaningfully – it works. It is successful because of the effort of the middlepeople which removes the centralization of policy work.

Changing tack – we discussed how GWF can play a role in encouraging funding agencies to not dictate what they deem is important in water research by limiting funding calls to very specific categories and approaches. Shifting funding foci from these agencies do not align well with community needs and values. More open calls should be made available. That way, the ideation power of what's important in water in Canada isn't being dictated by a small group – instead grassroots and value-based research can start to emerge. We can identify funding strategies for the future that are responsive to community needs. What Indigenous groups want to explore doesn't always fit into the funding calls – i.e., CIMP in the NWT. Top down needs to change – the tendrils of colonialism reach into funding agencies – even into GWF. But GWF is in the position to recommend that the Tri-Council continues it's move towards open calls for water research. One participant said that decolonized research is actually better for everybody.

8) Cold regions processes

Lead: Fereidoun Rezanezhad
Rapporteur: Sarah Irvine

- Precipitation
    - Lots of hydrometric data available, but there are gaps
        - Solid precipitation is difficult to measure and unlikely to be supported by alternative sources
        - Largely stems from precipitation uncertainty (wind speed, fall velocity, phase etc.)
        - Difficult to determine when precipitation changes phases without a full station in place, no standardized way to determine when a phase shift occurs
        - Quality of data in the winter is largely the issue, not necessarily quantity
        - Some monitoring stations are only kept working during periods of interest

- Difficult to collect data through the winter, discussion between groups who are able to collect data in the winter and groups who are not to increase data collection/availability across projects
  - o Also need higher resolution data during extreme events
    - Difficult to get long term precipitation datasets
    - Corrections on precipitation amount vary widely and not standardized, not sure how model uncertainty changes based on variability in precipitation inputs
    - microphysics in precipitation models are uncertain
      - Could use model microphysics, and microphysics data to correct for surface observations as opposed to bringing surface observations to correct for model first
    - Micro-rain radar network could be beneficial to suggest to Environment Canada
- Cryosphere
  - o Blowing snow in complex terrain not well understood, but avalanche and blowing snow dynamics beginning to come together
  - o Very few systematic glacier measurements
  - o Snow data inconsistent across all of Canada
    - Inconsistent measurements and collection is not standardized across the country, highly dispersed and has yet to be collated in any way
  - o Meltwater is largely heterogeneous as well, and dependent on freeze/thaw processes which impact both ion and water movement
    - Meltwater flow can have large effects on chemistry but has not been captured in many data sets therefore models have a difficult time capturing this effect
  - o Permafrost not well represented at all, depth/changes in active layer is represented at the observatory scale but not by systematic measurements, critical for closing the energy balance, runoff generation
    - This includes seasonally frozen soils
    - Groundwater interactions with permafrost are also important to understand
    - How changes in permafrost may change surface connections i.e. stream networks, surface runoff
    - Infiltration during the thawing process is also highly heterogeneous, some work on this but not well documented on a micro-scale
  - o Ground surface elevation changes (i.e. through subsidence, groundwater level changes, freeze/thaw) changes domains in modeling is not applied in the environment even though it occurs frequently
  - o Upscaling these fine-detail processes into larger-scale scales models is always going to be difficult but is necessary
- Biogeochemistry
  - o Biogeochemical dynamics largely missing, carbon dynamics and hydroclimatology are well studied
    - Implications of climate change on cold region water quality not as well understood either
    - Permafrost impacts on lake, peatland biogeochemical dynamics difficult because permafrost not well mapped
    - Modeling capabilities of biogeochemistry in this region are limited as a result
  - o Catchment delineation, runoff in non-mountainous terrain not as defined
    - Biogeochemical processes in this region difficult to define because lack of geographical delineation

- Ecology/Human perspectives
  - Effects of sparse forests, shrubification on snow distribution, blowing snow, melt dynamics, interception, albedo still needs to be investigated
  - Ice formation on water bodies in the form of ice jams, air pockets, multiple ice layers are difficult to predict and affect both local communities and animal populations
    - Snow on lake ice has changed behavior, first nations communities in the north have noticed that ice is thinner, and snow infiltrates lake ice instead of flowing over the ice
    - Huge gaps in ecology in winter b/c tend not to measure during cold i.e. water over ice events can have large impacts on fish species
      - Frequency of freezing/thawing events will impact ecological processes strongly
  - Partnering between ecologists and hydrologists is beginning to occur in northern Canada but linkages between hydrology and animal behavior/success i.e. fish, beavers not as well established
  - Can we use understanding of lower latitudes to predict how processes may shift in the north or will they become novel ecosystems?