CANADIAN MOUNTAIN NETWORK | RÉSEAU CANADIEN DES MONTAGNES

NETWORKS OF CENTRES OF EXCELLENCE COMPETITION
LETTER OF INTENT

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cmn-nce.ca

November 2017

A. NETWORK VISION

The vision for the **Canadian Mountain Network** (CMN) reflects both the urgency and ambition of the challenges we will address: *Providing Canadians with state-of-the-art tools and knowledge, based on multiple ways of knowing, that are essential for informed decision-making to sustain and manage mountain places in the face of unprecedented environmental, economic and societal changes*.

Canada is a country of mountains. They watch over a quarter of our landmass and are essential for the environmental, economic, social, spiritual, and cultural well-being of Canadians living in, near and far from these elevated places. However, mountain landscapes, communities, and places downstream are facing numerous changes, pressured by climate and other environmental processes; local or globally driven shifts in industrial, economic or recreational activities; and the increased movement of people within and through mountains. The CMN, a collaborative alliance of researchers, governments, communities and other diverse organizations from across Canada, will coordinate world-class expertise to discover, share, and apply new knowledge required to ensure that Canada's mountain environments and communities remain vibrant and resilient in the face of rapid and uncertain change. Importantly, these efforts have been planned and will be conducted in close partnership with mountains communities and Indigenous Peoples, and serve as a meaningful contribution to the ongoing process of Reconciliation in Canada. The CMN will focus on four immediate **Challenges** that are described in more detail below:

1. Expose the **socio-cultural, economic and ecological relationships** between people and mountain places that have shaped Canada's settler and Indigenous cultures and communities, in order to provide a larger context for making decisions about future planning and investments;
2. Revolutionize our understanding of the role of mountains in providing **essential ecosystem services** (e.g., water, biodiversity, forests, recreation, hazard mitigation) so that they are fully accounted for and appropriately valued in future development of Canadian mountain communities and economies;
3. Accelerate the development of innovative solutions and strategies to support **sustainable community development** and strengthen the resilience of local economies and cultures in mountain regions; and
4. Create an accessible toolkit of technologies, policies and best practices to enable new **multi-jurisdictional partnerships** that connect people and communities across Canada's mountain regions, promote and inform new investment in mountain infrastructure, and educate and train the next generation of interdisciplinary mountain researchers, practitioners and leaders.

Two years of consultations have resulted in this focused research agenda, with partners committed to transforming research into meaningful actions. Initial CMN members include five provincial and territorial governments; three Indigenous Organizations; 25 universities and colleges; and numerous businesses, non-profits and foundations, mountain municipalities, and international partners. New collaborations fostered by the CMN will immediately add significant value to decades of investments in mountain research, and maximize the impact of future research by building effective, respectful, and long-term partnerships. Within the first five years of NCE funding, CMN will become the partner of choice for addressing and solving complex social-environmental and economic challenges in Canada's mountain regions, by embracing multiple ways of knowing through robust interdisciplinary research and cross-sectoral partnerships.

B. MANAGEMENT OF THE NETWORK

The CMN management and governance structure (*Figure 1*), informed by the NCE experience of our many partners, is based on four principles: 1) Equity, diversity, and inclusion in the selection of network leadership, governance, management and participants; 2) Innovative research, training, and knowledge mobilization

that addresses local needs; 3) Broad and inclusive decision-making and engagement; and 4) Integration of Indigenous world views and knowledge, ensuring inclusionary research and outcomes.

The *Board of Directors* will direct strategic planning, finance/audit and human resource functions; approve the research program and annual reports; and support linkages to (inter)national opportunities and partners. Meeting three times per year, the ~15 members will represent a balance of post-secondary, government, business, non-profit, Indigenous partners, and geographic regions. The Board will be served by the *Finance & Audit Committee* - a majority of the 3 to 6 members will be independent – and the *Ethics & Conflict of Interest Committee*, responsible for resolving potential conflicts of interest and implementing a code of ethics and research principles. The *Indigenous Advisory Council* will provide a majority-Indigenous voice to advise on strategic planning and CMN communications.

Two *co-Research Directors*, reporting to the Board, will lead and develop CMN's strategy. Dr. David Hik will foster interdisciplinary research programs and collaborations across Canada and internationally. He was previously CRC in Northern Ecology, led Canada's International Polar Year Secretariat, and has 30 years of mountain research experience. Norma Kassi will develop protocols and processes to incorporate Indigenous research methodologies, create partnership agreements, and engage Indigenous representatives in the Network's governance and activities. She served as a Yukon MLA, Chief of the Vuntut Gwitchin First Nation, and co-founded the Arctic Institute of Community-Based Research.

Hik and Kassi will co-chair the 20-seat *Research Management Committee* (RMC), which will include Theme Leaders, Support Team chairs, and Indigenous knowledge holders. It will meet at least three times per year to guide strategy and calls for proposals, monitor projects, and foster research linkages. Eminent arms-length national and international experts will be integrated into the RMC, eliminating the requirement for an Expert Advisory Committee. *Theme Leaders* (see *Figure 1*) have been recruited to help develop the initial call for proposals. **Theme 1** (Places for Life – Ways of Being) is co-led by Dr. Lael Parrott, Professor in Sustainability at UBCO and Director of the Okanagan Institute for Biodiversity, Resilience and Ecosystem Services; and William Snow, Consultation Manager for the Stoney Tribal Administration in Morley, AB, with extensive experience building Indigenous-led environmental projects. **Theme 2** (Elevating Opportunities – Ways of Doing) is co-led by Dr. Courtney Mason, CRC in Rural Livelihoods and Sustainable Communities, Thompson Rivers University; and Dr. Laurent Bourdeau, Chaire de recherche sur l'attractivité et l'innovation en tourisme (Québec-Charlevoix), Département de géographie, Université Laval.

The RMC will also oversee five *Support Teams*: 1) *Training and Education:* academic and non-academic capacity building; 2) *Research Data Management:* design, create and manage CMN's information platforms; 3) *Knowledge Translation & Mobilization:* develop collaborations that facilitate awareness and practical application of mountain research; 4) *Canadian Mountain Municipalities Consortium*: connect municipal officials to researchers and identify priorities for co-funded projects; 5) *Mountain Observations*: develop new field station capacity, new instrumentation, enhanced citizen-science, and assist with the integration of Indigenous Guardians and cultural monitoring programs.

During the initial call for proposals, additional project and activity leaders/co-leaders will be identified, with emphasis on continuing to ensure diversity of gender, knowledge systems, and career stages.

The third member of the leadership team is current Executive Director, Christy Urban. She leads the Network's *Administrative Centre* (AC) and will report to the Board. The AC will coordinate day-to-day operations, schedules, administration, communications and events; develop and manage budgets and partnerships; and track Network progress and reporting. CMN will be incorporated as a federal non-profit, with the AC staff based in a mountain community (see Town of Canmore letter), at UofA, and hosted by regional partners (Regional Liaison positions).

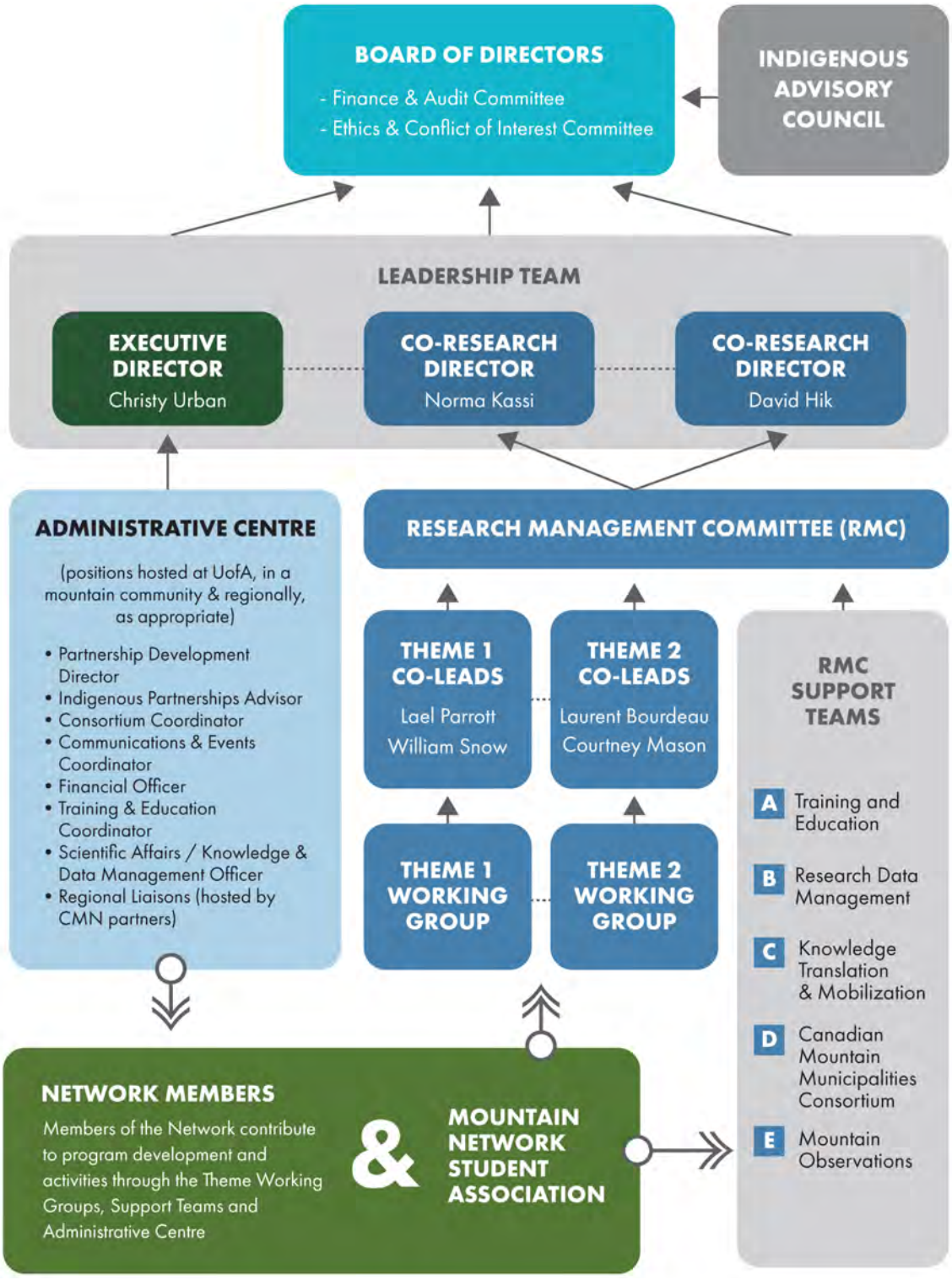

Figure 1. Schematic description of the CMN governance model once incorporated as an NCE. Members of the Network (researchers, practitioners, trainees, partners organizations) contribute to program development and activities through the Theme Working Groups and Support Teams, and with access to resources provided by the CMN Administrative Centre (represented by double arrows).

C. EXCELLENCE OF THE RESEARCH PROGRAM

I. CURRENT STATE OF KNOWLEDGE IN MOUNTAIN RESEARCH

Mountain ranges in Canada cover more than 1.5 million km^2, seven times the area of the European Alps (*Figure 2*). People living in, near and distant from mountains depend on them for livelihoods and a wide range of critical ecosystem services, including water, energy, forestry, mining, the maintenance of biodiversity, recreation opportunities, and spiritual connection. Mountains are also homelands for many Indigenous Peoples and places where traditional activities have been conducted for generations.

Canada's extensive mountain ranges are experiencing rapid and often worrying changes. However, our capacity to comprehensively observe, study, forecast and ultimately adapt to sudden and diverse socio-economic, cultural and environmental change remains limited. There is insufficient baseline observing information and research capacity in almost every region, and the knowledge required to respond to these changes is largely lacking or difficult to access. Recent estimates suggest that over 80% of mountain glaciers, the source of many of Canada's great prairie, Pacific, and northern rivers, will disappear this century. Globally, mountain glaciers are contributing over 30% of the volume of current sea level rise. There is also growing evidence that rates of climate warming will increase with elevation, so mountain ecosystems will experience longer snow-free periods, warmer summer temperatures, and shifts in the elevational distribution of species (e.g., rising treeline), with unknown consequences. How society uses mountains is changing too, with more and more people and goods traveling to and through mountains in Canada: for example, over the past decade traffic volume on the Trans-Canada highway through Rogers Pass, BC has grown by 25% over the past decade, and the number of visitors to Banff National Park increased 23% to over 3.8 million people in 2016. There is a pressing need to better understand options for diversifying local economic opportunities in many mountain communities beyond activities based on natural resources, such as mining, forestry, hydro generation, or as transportation hubs (road, rail, pipelines). Looking forward, mountains are places where the next generations of Canadian leaders are emerging. Both Indigenous and non-Indigenous youth require opportunities to develop and receive new skills and knowledge, especially as Indigenous governments and communities become full partners in Canada's governance and economic and social growth. Simply put, mountains affect everyone, everywhere.

Figure 2: Map of major Canadian mountain ranges and highlands; prairie and northern rivers with headwaters in mountains; and partner institutions, organizations or jurisdictions involved in the CMN NCE application: universities and colleges (red), municipalities (pink), Indigenous communities (green), cultural organizations (white). Some other CMN partners are listed if not geographically specific. More than 38 Partner Letters of Support can be found at: cmn-nce.ca

II. RESEARCH THEMES AND CHALLENGES

The CMN Research Program is built on the foundation of existing excellence in mountain research across Canada. The current academic members of the Network (see *Figure 2*) include numerous Centres, Institutes, and individuals at universities and colleges that share a strong commitment and capacity to expand and lead CMN activities. Over 200 researchers, including 20 Canada Research Chairs, 8 Provincial Chairs and several industry chairs have participated in CMN planning. The entire Research Program has been co-designed, through an open and inclusive dialogue, in partnership with provincial and territorial governments, Indigenous communities and organizations, NGO and private sector partners, and international collaborators. Partners associated with specific research activities are referenced below.

The initial 5-year integrated CMN Research Program (*Figure 3*) is structured under two core **Research Themes**, four initial **Challenges** and nine **Research Program Areas** (RPAs). Existing programs will be enhanced through stronger collaboration, and new knowledge about Canada's mountains will be applied through CMN-supported initiatives to deliver socio-economic benefits for Canadians.

THEME 1: Places for Life – Ways of Being

Research will seek to understand how peoples live in and with mountains: as homelands, transportation corridors, spaces of recreation and labor, sacred places, and sources of inspiration. Research outcomes will provide baseline knowledge and an understanding of dynamic relationships among mountain people, plants, animals and landscapes, enabling CMN partners to identify and define values that underlie the characteristics of resilience in the face of change and uncertainty.

Challenge #1: Expose how changing socio-cultural, economic, and ecological relationships between people and mountain places have shaped settler and Indigenous cultures, histories, and communities in Canada.

(RPA -1) Mountains as a source of Canadian identity: Humanities researchers will critically examine the wealth of historical and contemporary literature, music, film, and art that tell the stories of Canada's mountains from divergent perspectives. They will consider interpretations of how Canada's colonial past has remade mountain places (as parks and protected areas, sites of intensive resource activity, and natural playgrounds), while subordinating historical Indigenous relationships with these places. The persistence and reassertion of Indigenous lifeways in the mountains as a step towards Reconciliation will be considered in different regions. Key partners include the UofA Mountain Initiative, Banff Centre, and Whyte Museum of the Canadian Rockies. *Outcome: Enhanced understanding of the historic and contemporary role of mountains in the development of Canadian identity and the process of Reconciliation.*

(RPA -2) Mountains as the foundation of vibrant cultures: Indigenous and non-Indigenous mountain communities have interrelationships with dynamic mountain ecosystems (plants, animals, waters, forests) that sustain both local and distant economies and communities. Research questions will emphasize factors leading to the preservation of cultural values in changing mountain environments, for example: How can historically resource-dependent communities reinvent themselves in response to external economic changes? What factors strengthen processes for restoring Indigenous geographical place names? New methodologies for improving the mobilization of Indigenous knowledge will be developed based on approaches adopted by the Arctic Institute of Community-Based Research (AICBR), Indigenous Communities Engagement Initiative (Mitacs), Labrador Institute (Memorial U), the Sahtu Renewable Resources Board (SRRB), Aurora College, Yukon College, and other partners. *Outcome: Transform our understanding of mountains in sustaining Indigenous ways of knowing and being, and the diversity of connections that non-Indigenous residents have with mountain environments.*

Figure 3: The CMN Research Program is driven by four Challenges that will be addressed through nine core research program areas (RPA's), supported by integrated activities for implementing innovative Network processes, that will realize tangible outcomes with social and economic benefits for Canadians.

Challenge #2: Catalyze research that revolutionizes our understanding of the role of mountains in providing essential ecosystem services that support Canadian communities and economies.

(RPA - 3) Mountains as cradles of biodiversity: Mountains are home to diverse ecosystems and species adapted to harsh conditions. Issues of concern include changes in ecosystem functions (nutrient cycling, carbon sequestration) in response to climate drivers and extreme events; detection of biodiversity hotspots; and identification of invasive species. A "*Canadian Mountain Biodiversity Mission*" coordinated by the Centre for Biodiversity Genomics (UGuelph CFREF) will provide access and training for low-cost, high throughput sequencing resources. Other partners include UBC (Biodiversity Research Centre), Alberta Biodiversity Monitoring Institute, UNBC (Natural Resources and Environmental Studies Institute), UCalgary (Biogeoscience Institute), Yukon College (Yukon Research Centre), NWT Government, and the Canadian Museum of Nature. *Outcomes: Establish a world-class mountain biodiversity and biosurveillance system and characterize the dynamics of unique mountain food web interactions - knowledge essential for developing local food security and conservation strategies.*

(RPA - 4) Mountains as dynamic and complex landscapes: The topography and climate of mountain landscapes means that these ecosystems are naturally fragmented. Humans and wildlife tend to concentrate in the same areas, leading to cumulative effects on landscape structure from recreation, transportation, natural resource development, and forest management. This activity affects wildlife and traditional economies. Research efforts will be coordinated by the UBC Okanagan Institute for Resilience, Biodiversity & Ecosystem Services (co-Theme 1 Lead Dr. Lael Parrott), in collaboration with provincial and territorial departments (BC Ministry of Forests, Lands, and Natural Resource Operations; Alberta Environment and Parks; Parks Canada; Miistakis Institute (Mount Royal); our Indigenous partners, and NGOs. *Outcomes: Development of new dynamic models across spatial scales, to inform natural resource and human-use management and policy decisions, and quantification of ecological-social-economic trade-offs.*

(RPA - 5) Mountains as water towers: Unprecedented warming is changing the amount and quality of water that mountain landscapes provide to downstream communities, with consequences for health, safety, and livelihoods. CMN is working with Global Water Futures (GWF - USaskatchewan CFREF) and other research groups (e.g., Campus Alberta Innovates Chair; Future Water of the Mountain West Initiative) to identify opportunities for complementary studies. For example, by mobilizing resources at the Canadian Ice Core Archive (UofA) and the Water Institute (UWaterloo), CMN researchers will examine fluxes of contaminants from the atmosphere, glaciers and water into mountain and downstream food webs. CMN will also catalyze the expansion of water-related research into the Mackenzie Mountains in collaboration with Northern Water Futures (WLU), the SRRB, Aurora College and NWT Government. *Outcomes: Integrating a comprehensive understanding of changing water resources across all CMN-supported activities.*

THEME 2: Elevating Opportunities – Ways of Doing

This theme is focused on research to identify new opportunities for mountain communities and businesses to respond to future change and support local sustainable development, innovation and well-being.

Challenge #3: Accelerate the development and implementation of solutions that will lead to sustainable development and increased resilience of mountain communities.

(RPA - 6) Mountains as complex socio-ecological systems: Canada's mountain parks, protected areas, and resorts are growing (inter)national tourism destinations. Hiking, biking, skiing, and adventure tourism are economic drivers that also impact distinctive and potentially fragile elements of the mountain landscape. An understanding of the likely trajectories of environmental and socio-economic changes is required to

guide strategies that support the adaptation and resilience of mountain communities. Partners with world-class expertise to conduct this work include the Chaire de recherche en partenariat sur l'attractivité et l'innovation en tourisme (Québec-Charlevoix) (ULaval), Centre for Tourism Policy & Research (SFU), Faculty of Adventure, Culinary Arts & Tourism (TRU), and expertise at other institutions. *Outcomes: An integrated understanding of the evolution of mountain socio-ecological systems, including the economic, cultural and social impacts of tourism, infrastructure needs, and other land uses.*

(RPA - 7) Mountains as hazardous places: Communities and infrastructure are exposed to natural hazards such as landslides, snow avalanches, earthquakes, fires, and flooding. The ability to anticipate and respond to catastrophic events is restricted by remoteness and limited local capacity to monitor, assess and mitigate mountain hazards. CMN partners will develop a new approach to risk management that is community-based, harnesses local knowledge and builds capacity in communities. Existing geotechnical science perspectives will be integrated with Indigenous and non-Indigenous local knowledge, citizen-science monitoring initiatives, and modern technology to develop a multifaceted perspective on mountain hazards. An interactive Mountain Risk Database (integrated with other CMN data systems) will be developed by the Centre for Natural Hazards Research (SFU & Natural Resources Canada), and supported by existing world-class capacity (GWF, Avalanche Canada, Avalanche Québec). *Outcomes: Guidance to small communities and industry for recognizing mountain hazards, engaging professional support, and communicating risk awareness to reduce costs of exposure to mountain hazards.*

Challenge #4: Strengthen multi-jurisdictional partnerships and development of policies that benefit and connect communities and economies across Canada's mountain regions.

(RPA - 8) Mountain peoples as keepers of traditional land management practices: Canada's mountains are homelands of Indigenous Peoples, who have historically been displaced to facilitate park and resource developments. The ability to create and access the knowledge required to manage, conserve or develop resources is a central aspect of nationhood. The Indigenous Leadership Initiative and other CMN partners will collaborate on research focused on management of traditional lands, building on recent success stories (e.g., the Dehcho First Nations contributions to expanding the Nahanni National Park Reserve). *Outcomes: New mechanisms for Indigenous communities to lead land use planning and conservation, and the impact of conservation policies on the design of future protected areas, including Indigenous Protected Areas.*

(RPA - 9) Mountains as the foundation of local economies: Mountain regions attract diverse industries and skilled labor that benefit from their landscapes and distinctive business opportunities. Sustainable and resilient economies bring prosperity and a high quality of life to mountain communities and residents. However, the relationship between communities and their economic drivers can change over time, due to both local and external influences (e.g., rapid population growth in Whistler, BC or Mt. Tremblant, PQ, compared with population decline in Grande Cache, AB). Mountain communities are especially challenged by issues related to access, control, and jurisdiction over the landscape and natural resource base upon which many communities depend, or upon which they could build more diversified economies. Existing world-class capacity includes the Alberta Centre for Sustainable Rural Communities (UofA), the Community Development Institute (UNBC), the Columbia Basin Rural Development Institute (Selkirk College), and the Centre for Northern Innovation & Mining (Yukon College). *Outcomes: Strategies for rural and remote communities to enhance their quality of life (in the context of local aspirations) and creatively repositioning themselves in a global economy.*

III. INTEGRATIVE ACTIVITIES SUPPORTING THE CMN RESEARCH PROGRAM

Five Integrative Activities across the CMN provide common elements for facilitating interdisciplinary and inter-epistemological research, knowledge synthesis, training, and decision-making (*Figure 3*).

1) Three research modes: CMN will allow for funding to be accessed by a diversity of partners: (*Mode 1*) Academic and institution-based researcher-led projects may be co-designed or implemented with partners; (*Mode 2*) Partners outside universities initiate projects that are co-designed and jointly implemented; and (*Mode 3*) Indigenous and/or community partners design and implement projects, increasing local capacity and respect for Indigenous and local knowledge and research methodologies, as well as uptake of locally relevant solutions. CMN partners already have experience implementing Mode 3 research. For example, the Stoney Nakoda First Nations (AB) are leading studies of grizzly bear management through cultural monitoring; and the Kluane First Nation (Yukon) has invested in community-based monitoring of headwater lakes to understand climate change impacts on fish and contaminants.

2) Observing data systems and infrastructure: Mountains are places for observing and assessing the state, predictability, and associated uncertainties of environmental and socio-economic conditions. CMN will work with partners to optimize approaches for quantifying the drivers of change that influence mountain environments, including socio-economic factors (urbanization, land-use), government policies, population demography and lifestyle, and biophysical conditions, including the underlying challenge of climate change. Additional monitoring and observing infrastucture will be co-developed through future funding opportunities (e.g., CFI) with partners that have made significant investments, including two recent CFREF programs (Global Water Futures [USask, McMaster, WLU, Waterloo]) and Biodiversity (UGuelph), the Alberta Environmental Monitoring and Science Division, the Pacific Climate Impacts Consortium, UNBC Geospatial Hub, and the US NSF-funded National Ecological Observatory Network (NEON). Priority will also be placed on responding to objectives of the Indigenous Guardians programs' objectives for monitoring ecological health, protecting cultural sites and species, leading land-use planning, and promoting intergenerational sharing of Indigenous Knowledge. New technologies will be developed for improving observations, including next-generation autonomous platforms (coordinated by Campus Alberta Innovates Chair in Terrestrial Ecosystem Remote Sensing [Chris Hopkinson, ULethbridge] and industry partners such as TECTERRA, Lightship, and Campbell Scientific). A key goal of this investment in monitoring infrastructure will be to identify ecosystem and social indicators that reveal early warning of significant systemic state change, and to evaluate their scientific, management, and communication potential. The *Canadian Digital Mountain Observatory* will be established as a hub for access to knowledge (Section 2F).

The three remaining Integrative Activities include **3) Cross-sectoral Partnerships** (Section 2D); **4) Innovative HQP Training** (Section 2E); and **5) Knowledge Translation - KTEM** (Section 2F).

IV. CONTRIBUTIONS TO CANADA'S REPUTATION AS AN INTERNATIONAL LEADER

Among the world's mountain nations, Canada is conspicuously absent from international initiatives focused on sustainable mountain research, such as the UN Mountain Partnership. Over the past 25 years, mountains have been increasingly recognized as critical elements of the planet's life support systems, from the Rio Earth Summit in 1992 to the adoption of the UN Sustainable Development Goals in 2016. CMN will position Canada among the leading partners in global mountain research and has already attracted the interest of international partners, in Asia, Europe, and the USA (see Letters of Support).

V. ANTICIPATED INCREMENTAL VALUE OF THE NETWORK

Investment in research infrastructure, programs and people to address critical social, economic and environmental issues is lacking for most of Canada's mountain regions. Current observational networks in mountains are limited, and provide further reason to incorporate place-based local and Indigenous knowledge to understand change. Many separate initiatives study pieces of the mountain landscape, but these investments will have a greater impact through the Network, which will also maximize future

investments. CMN specifically leverages investment in two CFREF consortia (Global Water Futures, Centre for Biodiversity Genomics) and several provincially-funded Chairs in BC, Alberta, and Quebec. This network approach to support mountain research can reduce the risks to individual projects and accelerate the application of knowledge to meet diverse requirements.

VI. SOCIAL AND ECONOMIC CONTEXT AND BENEFITS FOR CANADIANS

Canada's commitment to mountain research has not matched the scale and importance of its mountain regions. Challenges related to environmental change, Reconciliation with Indigenous Peoples, and sustainable development demand a change. Ecosystems, economies, and communities are in transition, and finding solutions to a range of problems requires innovative approaches with a national scope. The Canadian economy derives significant benefits from ecosystem services derived from mountains. In some cases we have a good estimate of the impacts - for example, over 4.5 million people visit the Canadian Rockies each year, and spend almost $2 billion on tourism-related activities. But in most cases the value of these ecosystem services (e.g., water, wildlife, cultural values) are unknown. A key outcome of the first 5-year term is an initial accounting of the ecosystem services (provisioning, regulating, cultural and supporting activities) in Canada's mountains as a foundation for making better decisions for land-use and to guide socio-economic investments. CMN will deliver new resources to document natural hazards, biodiversity, and strategies for economic diversification. Another set of social and economic benefits will focus on strengthening Indigenous leadership and capacity through cultural monitoring and application of Indigenous research methodologies. See *Figure 3* for Network-wide objectives during the first 5-years.

D. NETWORKING AND PARTNERSHIPS

The CMN facilitates effective collaboration between diverse partners to apply knowledge through evidence-based management and policy decisions. Key partners in these efforts include:

1) Provincial/Territorial and Municipal Governments: Yukon, NWT, Alberta, BC, and Québec governments have provided Letters of Support and will contribute to governance, administrative, and support local HQP and research. Municipalities will commission projects and gather annually as the Canadian Mountain Municipalities Consortium. Informed policy development by governments in mountain regions is a key CMN objective. These governments also offer access to diverse local and regional networks.

2) Indigenous Governments and Representative Organizations: The Sahtú Renewable Resources Board (NWT) and the Stoney Tribal Administration (AB) have participated in the CMN since January 2016 and sit on our Steering Group. They will contribute to community-led research, policy development, and ensure knowledge mobilization is inclusive of multiple knowledge systems. In addition, we have partnered with the Indigenous Leadership Initiative to help empower Indigenous governments, communities, and Nations to fulfill their cultural responsibility to the land.

3) Mitacs: CMN will collaborate with Mitacs on their Indigenous Communities Engagement initiative to support research projects based on the self-identified needs of community partners (see Letter of Support). CMN's private sector partners will co-fund eligible research projects/internships through the Mitacs Accelerate program. Mitacs will share its best practices as a former NCE and leader in HQP development.

4) Businesses and Non-Profits: Blue chip companies (CP Rail, Teck Resources) and networks (TECTERRA, National Ski Council) have provided Letters of Support, and will be key CMN partners to inform business decisions and processes, and technology commercialization. Non-profits, such as the Yellowstone to Yukon Conservation Initiative, will bring research assets, networks of policymakers, and public engagement to the Network's efforts to facilitate research and knowledge exchange and mobilization.

5) International Partnerships: CMN will collaborate internationally to leverage additional funding and knowledge mobilization (e.g., Mountain Research Initiative, Bern; Mountain Sentinels, U Colorado). For example, collaboration with the University of Central Asia may enable co-funding from Aga Khan Foundation, Global Affairs Canada, and the Government of Alberta International Development Office.

History and growth of existing partnerships and the development of new linkages: The CMN team, including a full-time partnership development officer, and network partners will develop new connections with sectors currently under-represented, including Indigenous organizations, businesses, community foundations and professional associations. Partnership development strategies include proactive outreach, webinars, and mobilizing existing connections. We plan to secure partner contributions of $2.77M (cash/in-kind) in Year 1 and a 1:1 NCE to partner contribution ratio over 5 years ($20M).

E. DEVELOPMENT OF HIGHLY QUALIFIED PERSONNEL (HQP)

The CMN's partners have identified a variety of innovative training opportunities that will expose HQP to the full range of the Network's activities from fundamental research to its practical applications. The CMN has adopted a broadened definition of HQP and mentors that builds on NCE precedent and federal recommendations for academic research to be inclusive of Indigenous youth and work with elders and traditional knowledge holders. This braiding of different knowledge systems and methodologies is possible by leveraging the diversity and structure of the CMN. The Network will develop training opportunities that will enhance HQP capacity and career options and address current knowledge and experience gaps.

1) Reconciliation & Research Partnerships Courses: Available to all HQP and co-developed by Indigenous and non-Indigenous academic partners, these courses will cover the cultural histories of Canada's mountain people and places and the role of strong research partnerships in supporting Reconciliation. CMN will also develop Massive Open Online Courses (MOOC's), available to global audiences, focused on mountain society, culture, and environments. These courses will build on the success of UofA's *Mountains 101* (ranked as the #1 science MOOC in the world) and *Indigenous Canada*.

2) The CMN's **Orientation Program** will provide funding for local liaisons to orient academic HQP to the communities where research occurs, better connecting them with people and services and encouraging the multi-directional flow of knowledge that builds local capacity and trust.

3) Internships will enable HQP to work directly with Network partners in government, industry, and local agencies to apply research. These investments build skills, networks, and employability for mountain-related careers. A key partner for CMN internships will be the Mitacs Accelerate program.

4) A series of portable **Mobile Research and Teaching Labs** will be developed during the first five years. These will include applications of leading-edge technologies (e.g., hazard mapping, biodiversity assessment, analytical methods), summer and winter field schools, a 3-D Map of Canada's Mountains (produced with the Royal Canadian Geographic Society and Alpine Club of Canada), and a Multi-Media Storytelling Lab to share their knowledge and experiences among CMN partners and the public.

5) Grants for Training & Certification Programs. Courses will offer essential skills necessary for participation in CMN projects and subsequent employment. Topics include field safety, mountaineering, backcountry first aid, data management, GIS & remote sensing, museum curation, and communication.

6) The **Network AGM and Students Association**. HQP will have opportunities to organize and participate in workshops and symposia, to learn from experts and peers, and develop connections to projects, employers, and mentors. CMN will also provide resources to support a student-led association where HQP can acquire additional leadership skills and interact closely with CMN leadership and mentors.

F. KNOWLEDGE AND TECHNOLOGY EXCHANGE AND MOBILIZATION (KTEM)

Effectively mobilizing research outcomes through diverse approaches is essential to provide social and economic benefits to Canada through informed access to data and analysis, risk management, and evidence-based decision making. Where required, CMN partners will establish formal benefits and data sharing agreements informed by OCAP (Ownership, Control, Access and Possession) principles that recognize the rights of Indigenous Peoples, who own and control their data and the knowledge derived from it. The priority that CMN places on KTEM activities is reflected in the proposed budget allocations.

1) The **Mountain Portal** (www.canadianmountainnetwork.ca) is Canada's first bilingual mountain research network and information exchange service. This website already offers mountain research news and plain-language research summaries; leverages social media and a newsletter to share content; co-produces podcasts and other digital material; and hosts a Directory of researchers and organizations.

2) The **Canadian Digital Mountain Observatory** (CDMO) will be Canada's first major effort to bring together decades worth of mountain research. Building on the UVictoria-based Mountain Legacy Project (mountainlegacy.ca) and inspired by the Neptune and Venus observatories of Ocean Networks Canada, it will: integrate temporal and spatial data; provide access to raw and processed data sets; link knowledge across scales (from individual projects to national and international initiatives); work across sectors; and provide access to research, training and knowledge mobilization resources by offering access to customized analytic outputs. Visual and data-based modules will make research and analysis publicly available. The CMN Research Data Management (RDM) Committee has articulated a Statement of Data Principles and started to develop a CMN RDM Toolkit. The CMN is also developing its relationships with existing data centres and resources, including the Portage Network (Canadian Association of Research Libraries), Research Data Canada (RDC), Polar Data Catalogue; Compute Canada and other existing state-of-art research data management infrastructure (e.g., GWF, NEON).

3) The **Canadian Mountain Municipalities Consortium** will address local capacity gaps and put knowledge into active service through evidence-based decision making. Priorities for research identified by these partners include tourism destination development and mountain hazards mitigation. We have Letters of Support from Haines Junction, Golden, Revelstoke, Squamish, Fruitvale, Jasper, Banff, Pincher Creek, and Canmore. Many more communities have indicated their interest in joining during the Full Application process.

4) Facilitate annual knowledge exchange events, including the **AGM/Annual Conference** that will engage CMN partners through workshops, presentations/panel discussions, and networking events. CMN will also continue to work with the UN-sponsored Mountain Partnership to support knowledge exchange events across Canada for **International Mountain Day** (11 December). In 2016, the CMN worked with six communities to facilitate events that connected over 2,735 participants.

5) The CMN's leadership and other partners (e.g., Arctic Institute of Community-Based Research) will create formal **research policy and processes** to respect knowledge ownership and empower mountain peoples and communities. Academic knowledge will be translated into appropriate language and consider every level within a community, including schools, youth out of school, elders and leaders. Local activities that encourage knowledge sharing approaches will include storytelling, beading, and on-the-land camps.

6) New sensing technologies and modeling/forecasting software that offer an improved understanding of mountain environments will be commercialized through the development of a **Technology Cluster** that facilitates collaboration between the CMN's academic partners, companies and networks such as Campbell Scientific, Lightship, and TECTERRA, and government economic development agencies. CMN partners (e.g. Water Institute, UWaterloo) will support technology development by providing resources for incubators and/or crowd-sourcing approaches (e.g., mountain data synthesis hackathons) for driving innovation.

3. EXPLANATION OF OVERLAP

CMN is Canada's first interdisciplinary mountain research network, focused initially on connecting independently-inspired mountain research initiatives across Canada into a broad and supportive Network of expertise, partners, and information. CMN will serve as the **connective tissue** that brings together researchers and partner organizations to build new multi- and trans-disciplinary initiatives. This coalition building is the main ingredient for our approach to fostering innovation. CMN will also directly co-fund efforts to broker knowledge between researchers and knowledge end-users (e.g., mountain municipalities).

During the Network's planning stage, we have attempted to ensure CMN activities will complement, rather than overlap with, existing mountain-related investments and programs. This complementarity will be achieved through direct collaboration, as well as by enhancing the interface between different initiatives. Many of these relationships have been confirmed through Letters of Support (see cmn-nce.ca), and we will detail specific collaborations in greater length as part of our full application. Current initiatives that will directly or indirectly complement CMN priorities and capabilities include:

1) **The Mountain Legacy Project** (UVictoria) is fully integrated into the CMN. This SSHRC-funded project is the foundation of the Canadian Digital Mountain Observatory, led by Dr. Eric Higgs (Professor and past-Director, School of Environmental Studies, and Chair, CMN Research Data Management Committee).

2) **The Canadian Water Network** (NCE), **Global Water Futures** (CFREF), and the **Water-Climate Impacts Consortium** (Environment Canada-UVictoria partnership) are focused on diverse aspects of the changes taking place in mountain watersheds. However, they also have larger mandates and only a limited capacity to directly support mountain-related research and knowledge mobilization. We have already identified several areas where GWF can support CMN (hydrological models, data management) and where CMN can extend opportunities for collaborative water research in Canada's mountains.

3) Canada has provided nearly $100M to build the **Centre for Biodiversity Genomics** (UGuelph) research infrastructure and personnel. This CFREF investment has created an unrivaled capacity for biosurveillance, augmented by new high-throughput sequencing platforms with low analytical costs. This capacity to evaluate biotic change through space and time in mountain ecosystems will allow CMN researchers to open up new ecological dimensions by accessing world-class genomics tools and expertise.

4) The **University of Waterloo** and **Ouranos** (Consortium on Regional Climatology & Adaptation, Quebec) are leading the development of an NCE proposal focused on Climate Adaptation from a range of perspectives spanning social science, natural science and engineering, and health science. This NCE would complement work included in the CMN proposal, and we anticipate extensive collaboration if both NCEs are funded. Several researchers involved in both NCE groups will assist with developing these partnerships.

5) The **ArcticNet NCE** is a model for environmental research in Canada, focused on coastal and marine issues in the Arctic. The CMN has and will continue to benefit from the experiences of ArcticNet and its partners, as well as the expertise within Arctic communities located in the mountains of Nunavut, Nunavik and Nunatsiavut. These will be connected into CMN in the future, but we have not yet fully engaged these eastern Arctic regions given their present relationship with ArcticNet programs.

6) Several groups are focused on Indigenous and community-based environmental leadership and research program development. For example, the Government of Canada included an initial investment of $25M over 5 years in the 2017-18 federal budget to support the creation of a National Indigenous Guardians Network in response to a proposal from the **Indigenous Leadership Initiative** (ILI - see Letter of Support). The ILI is working closely with Indigenous Nations and communities, and the Government of Canada to implement the vision of a National Indigenous Guardians Network. CMN will seek opportunities to collaborate with ILI and other groups with shared goals (e.g., Community-Based Research Canada).