UNDERSTANDING RESPONSES TO GLOBAL CHANGE

International collaborations for practical outcomes

BELMONT FORUM

Tripartite Valorization Workshop

08-10 December 2018

Washington DC

Karim-Aly Kassam and Cyrus Samimi

Real Solutions to Global Problems

Effective and sustainable responses to global change require concerted cross-sectoral collaboration to develop reliable knowledge and equitable solutions. However, the scope of the issues faced can often exceed the capacity of individual organizations or national remits to realize these goals. Therefore, the Belmont Forum leverages investments and interest from across a breadth of institutions to spur the critical innovation and transformation that will result in a more sustainable future.

The Belmont Forum is a partnership of funding organizations from over 50 countries, international science councils, and regional consortia committed to the advancement of interdisciplinary and transdisciplinary science. Its operations are guided by the Belmont Challenge:

To support international transdisciplinary research providing knowledge for understanding, mitigating, and adapting to global environmental change.

The Belmont Approach

The Belmont Forum is committed to fostering solutions to global sustainability challenges through innovative transdisciplinary research, bringing together natural sciences, social sciences, and the humanities, as well as stakeholders in co-creating the knowledge and solutions for sustainable development that benefit the society.

Stakeholders contribute their values and priorities and the research teams contribute their technical expertise. A variety of stakeholder engagement and scientific tools were employed to produce project outputs. These outputs facilitated knowledge exchange between stakeholders and researchers for implementation into management, policy, and decision making.

Belmont Forum projects begin with collaboration between stakeholders and research teams.

Lessons Learned and Practical Outcomes

The Tripartite Valorization Workshop was convened by the Belmont Forum and facilitated by the University of Maryland Center for Environmental Science in Washington DC on 8-10 December 2018. It served as the end-term meeting for the ***Food Security and Land Use Change*** Collaborative Research Action (CRA), and mid-term meetings for the ***Arctic Observing and Science for Sustainability*** and ***Mountains as Sentinels of Change*** CRAs.

Food Security and Land Use Change*: a 14-country joint research initiative supported by the Belmont Forum and the Joint Programming Initiative on Agriculture, Food Security and Climate Change (FACCE-JPI).*

Arctic Observing and Science for Sustainability*: brought together funders from both Arctic and Arctic-interested nations from 13 countries.*

Mountains as Sentinels of Change*: fosters research on climate, environmental and related societal change in mountain regions, funding six multinational research projects in 11 participating countries.*

Project representatives from around the world met to share their results, progress and common experiences. Revealing real solutions for informed and deliberative decision making about sustainable resource use and development, the results provide further evidence that intense stakeholder engagement to co-develop locally based solutions is an approach that should be continued, expanded and refined. This Workshop report provides a brief overview of each project, identifies common themes that emerged, and provides recommendations for future Belmont Forum projects.

Stakeholders engaged:
Over 30M

Next generation training:

- **K-12 students** 898
- **Undergraduates** 170
- **Graduates** 281
- **Post-docs** 56

Workshop participants estimated stakeholder engagement and academic training provided by the project representatives.

Vanessa Vargas-Nguyen and Sky Swanson

The December 2018 Tripartite Valorization Workshop served as an excellent medium for managers from a diverse set of projects to learn from each other.

Benefits and Challenges

Workshop participants identified the benefits and challenges presented by Belmont Forum's unique transdisciplinary and transnational approach to research. Presented here are visual representations of the keywords that emerged.

Benefits

Challenges

A transdisciplinary and transnational approach leads to global collaboration that is focused on action-driven solutions through the integration of interdisciplinary research and local knowledge.

- Coordinated funding enables global collaboration and transnational synergy.
- Engaging stakeholders integrates indigenous and local ecological knowledge with interdisciplinary knowledge.
- Knowledge co-production and sharing can lead to solutions and applications.

Tackling global issues presents grand challenges and cross-cultural differences that results in difficulty in communications, coordination, and lack of accountability.

- Varied procedures and expectations present data challenges and lack of effective feedback.
- Problem complexity, often with legacy issues and other unexpected issues that has not been accounted for, require constant design change.
- Funding constraints can lead to lack of incentives for stakeholders to collaborate.


Dirk S. Schmeller

Common Themes

Several common themes that address the challenges of climate change impacts on the ecosystems and human communities in the arctic, in mountains, and in food security emerged from the synthesis of the three Collaborative Research Actions (CRA). These themes represent systems that are vulnerable to climate disruption and can serve as important models for a broad diversity of other coupled human and natural systems.

Boundaries are shifting for biogeographical and cultural regions.

- Organisms, species, and biological communities shift their biogeographical boundaries in response to climate changes at different rates. This can lead to species mixing and altered ecological interactions.
- Local human communities are forced to relocate or adapt to altered resources leading to stress on management and governance at various scales.

Unprecedented transformations challenge ecosystems and human communities.

- Accelerated rates of biophysical changes result in large ecological responses at the species, community and ecosystem levels.
- Individuals, communities and various levels of government are required to rapidly respond to accelerated change.

Multigenerational perspectives are needed for planning and implementation.

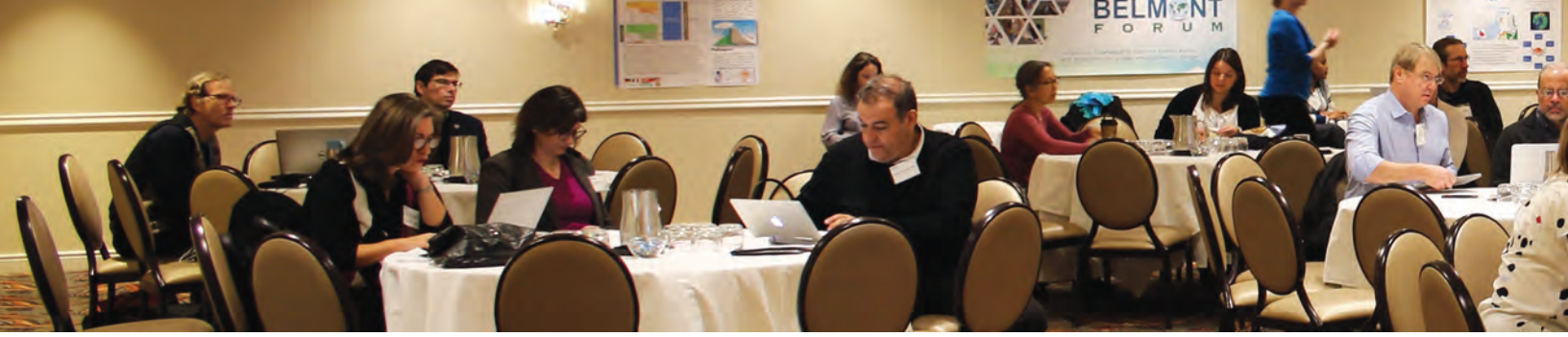
- The immediacy of media reporting and weather events can obscure long-range perspectives needed for effective planning and implementation.
- A seven generation perspective can lead to more balanced decisions with long range consequences.

Resilient communities are needed for adaptation to changing conditions.

- Integrated assessments and lessons learned from a broad range of adaptation strategies will help inform communities and organizations facing similar challenges.
- Global nature of the problems and potential solutions make international efforts crucial for widespread adaptation.

Knowledge co-production and sharing are critical for meeting societal challenges.

- Expanded monitoring capabilities through technological advances and citizen scientists can help develop broad scale environmental intelligence.
- Merging knowledge systems requires integrating and developing shared principles and values.



Workshop Recommendations

The Belmont Forum works to increase the visibility and impact of research toward solutions to global environmental challenges. This requires careful planning and long-term commitments on the part of funders, research teams, and stakeholders. One of the greatest challenges faced by Belmont Forum research teams is coordination among multidisciplinary and international partners and stakeholders. To address this and other challenges while enhancing ongoing successes, the following priority actions were identified during our synthesis workshop:

- Create a data management plan to facilitate the long-term storage of and accessibility of data.
- Continue communication workshops and enhance communication pathways among and between researchers and stakeholders.
- Focus on building trust among stakeholders through long term commitments.
- Support capacity-building to ensure the success of research efforts and partnerships.
- Identify avenues to foster behavior changes.

Sky Swanson

Sky Swanson

e-Infrastructures and Data Management

Open data maximizes impacts of collaborative, transdisciplinary research on global change. A vital component of compelling research is the ability to share outputs. Organizing research products so that they are available to a wide audience can increase their visibility and foster further collaboration. In 2015, Belmont Forum adopted its Open Data Policy & Principles and funded a CRA called the e-Infrastructures and Data Management Project (e-I&DM) to guide researchers towards effective data sharing and maximize the impact of Belmont's funded research. At this valorization workshop, the e-I&DM team asked teams representing the Food Security, Arctic and Mountains CRAs to provide feedback on their biggest data management challenges and on e-infrastructures (data sharing platforms, repositories, data collection apps, etc.) used or developed to manage project data. Among the key challenges identified by these teams were:

- A lack of shared and recognized data standards;
- Ensuring and funding long-term data storage;
- Sensitivity of data ownership in the context of local stakeholders;
- Disparate data collection methods across countries, disciplines, and individual projects;
- Interpretation of model outputs that may be culturally specific;
- Connecting ethnographic data with remote climate and phenological data;

The e-Infrastructures and Data Management Project is integrating a Data and Digital Outputs Management Plan template into the CRA process. Credit: Belmont Forum e-I&DM Team.

- Finding computational tools that less experienced researchers could access and use; and
- The need for shared collaborative online workspaces and analysis tools.

Belmont Forum e-I&DM Team

The Belmont Forum, through the resources and efforts of the e-I&DM Project, will use this input to inform Belmont Forum's future goals and guidelines for data sharing and expand the portfolio of resources available to its transnational and transdisciplinary research teams. These resources can be found on the e-I&DM website, *www.bfe-inf.org*.

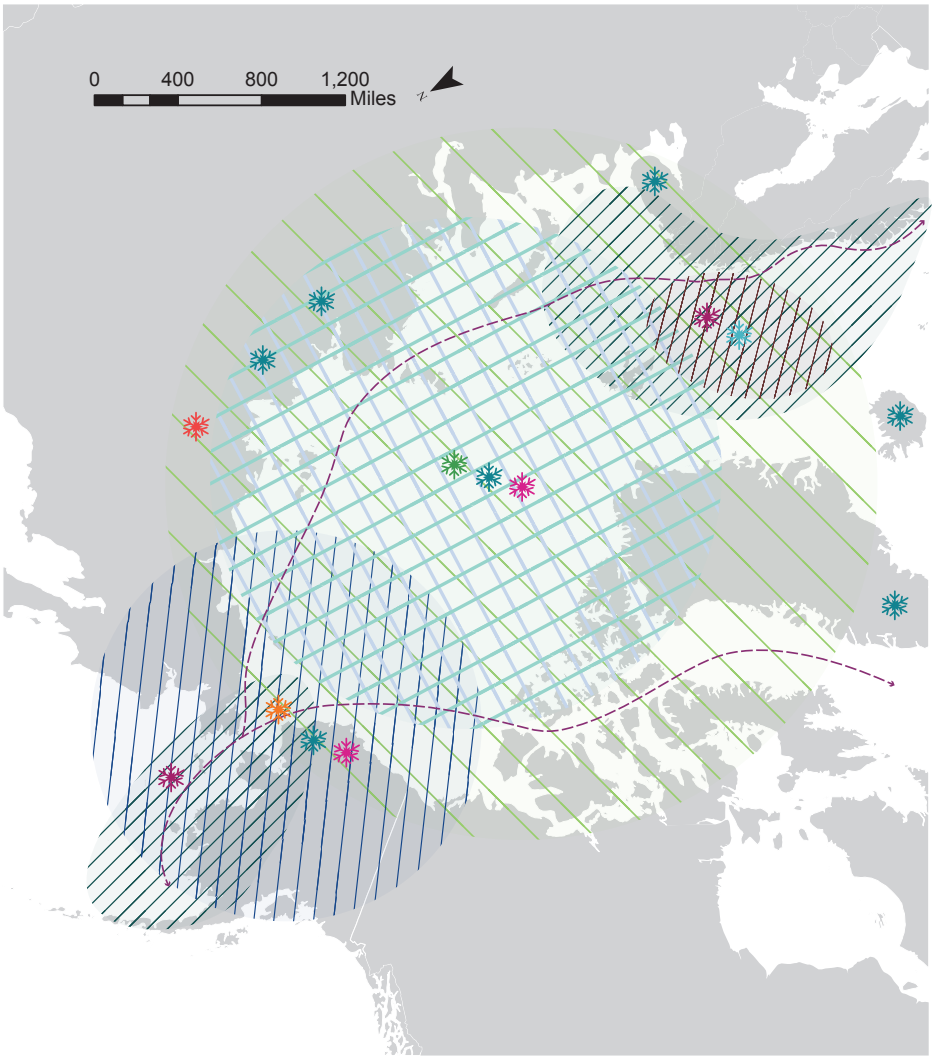
Project Research Reached Communities Across the

Arctic Observing and Science for Sustainability

- ASUS
- AFV
- BAAMRGP
- RACArctic
- PAN ARCTIC
- COPERA
- ARCTIC ERA

Mountains as

- P3
- ECCAP
- CLIMTREE



Belmont Forum research is taking place throughout the Arctic.

Belmont Forum projects under the Mountains as Ser

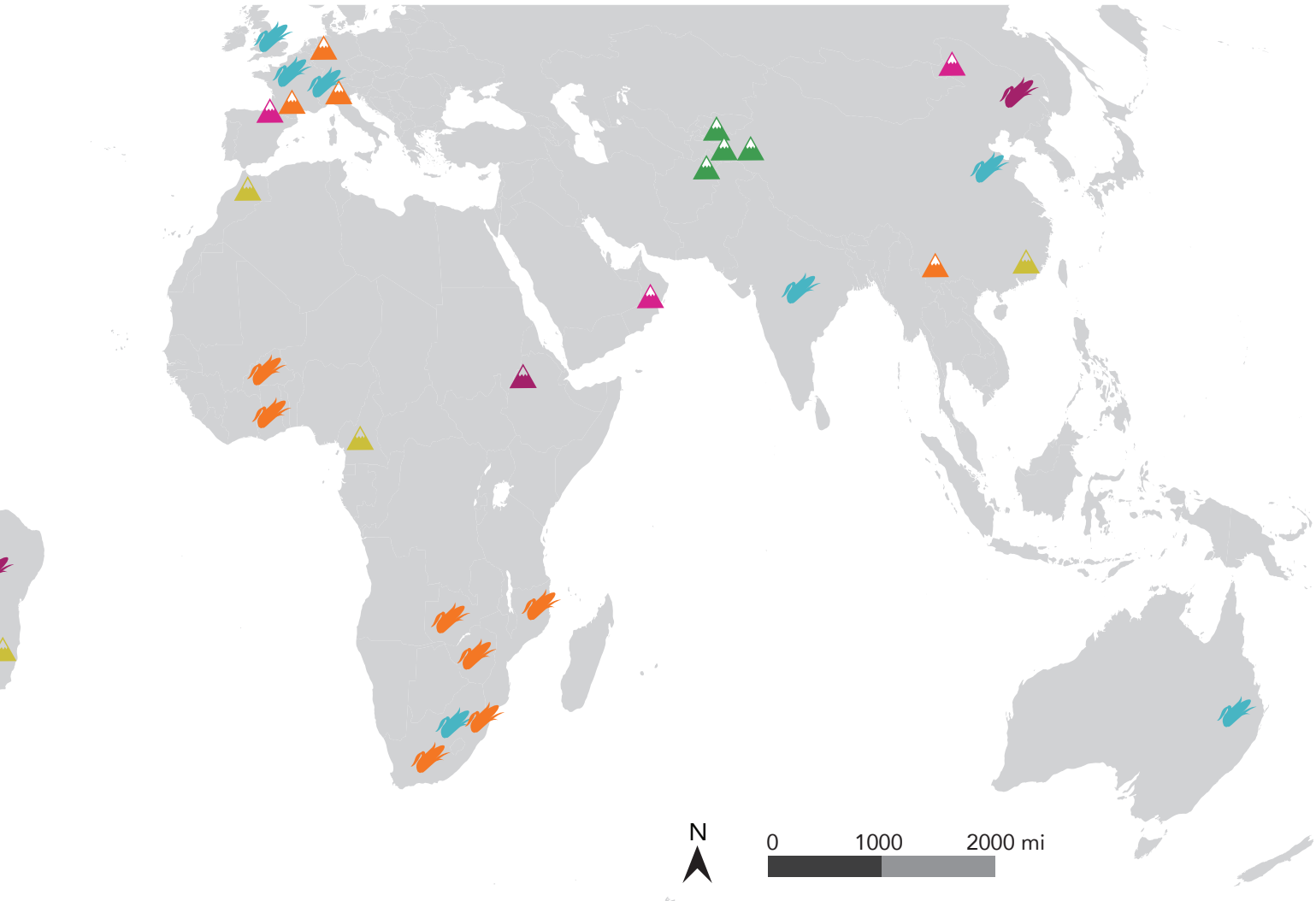
Globe

Sentinels of Change

- VULPES
- NILE-NEXUS
- ClimateWIse

Food Security and Land Use Change

- ABC Telecoupling
- DEVIL
- FICESSA

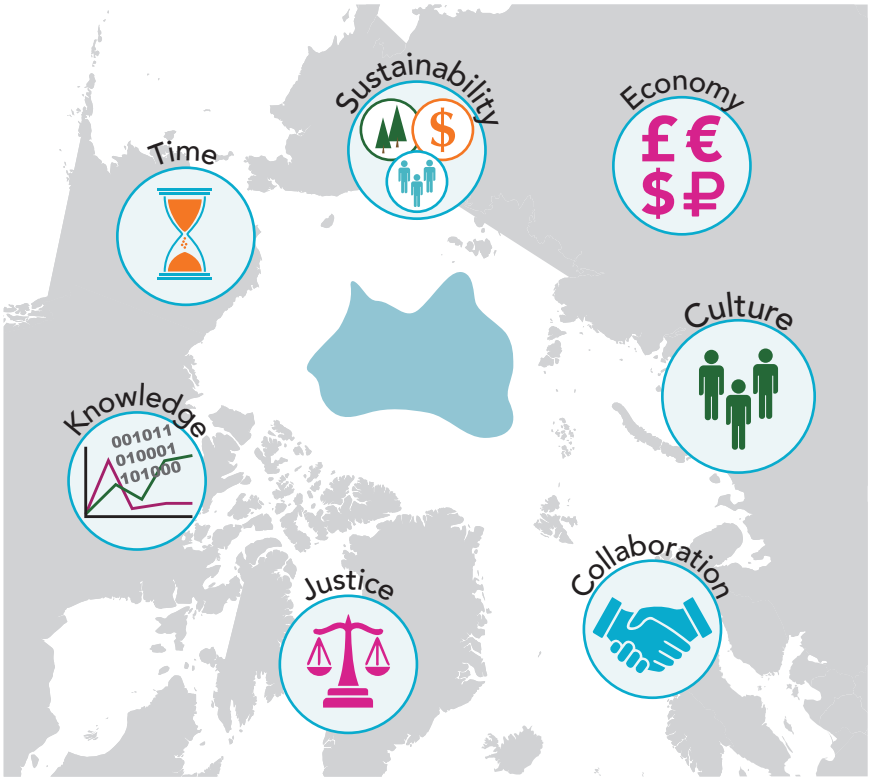


ntinels of Change and Food Security and Land Use Change CRAs.

Arctic Observing and Science for Sustainability

The magnitude and pace of environmental, societal, and economic change in the Arctic is unprecedented and has global relevance, but our knowledge of the change is insufficient, and our ability to respond is shortsighted. Therefore, working across knowledge systems is needed to understand the change and develop informed and responsible solutions in order to achieve sustainability. These CRA projects leverage existing investments and spur new multinational partnerships to advance and innovate sustainability science theory and approaches.

Shifting boundaries of ice, flora, fauna, and people bring unprecedented challenges for legal, cultural, scientific, and economic institutions and require a new model for cooperative Arctic stewardship.



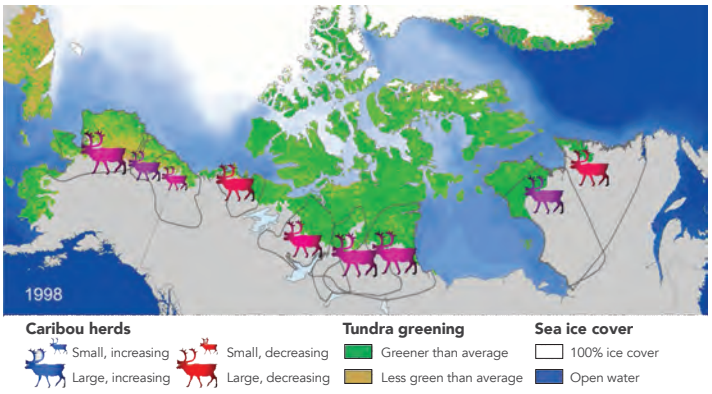
Starting top right and following clockwise:
a) Economy, a dynamic and changing Arctic system that includes outside actors and interests; b) Culture, vibrant and transforming Arctic cultures; c) Collaboration, peace and partnership among Arctic countries; d) Justice, equity and rule of law; e) Knowledge, observations across disciplines, methods, and knowledge systems; and, f) Time, understanding and preparing for change requires a long-term perspective.

Arctic Sustainability: A Synthesis of Knowledge activities (ASUS)

ASUS unites a team of diverse expertise from Canada, Denmark, Greenland, Iceland, Norway, Russia, Sweden, and the US to develop a framework that highlights the state of current understanding, best practices, and metrics for achieving sustainability in the Arctic. It takes into account the social, demographic, economic, and environmental aspects of resilience across a range of scales using an inclusive process that engages a breadth stakeholders. Synthesis will be conducted through a managed constellation of centers and a committee structure to ensure continued communication and coordination.

ASUS Project Team

Community knowledge sharing meetings and dissemination to stakeholders and the public.



Per Fauchald

The annual change in sea ice concentration, greening of pastures and the size of the caribou populations from 1982-2011.

Global Connections and Changing Resource Use System in the Arctic (CONNECT)

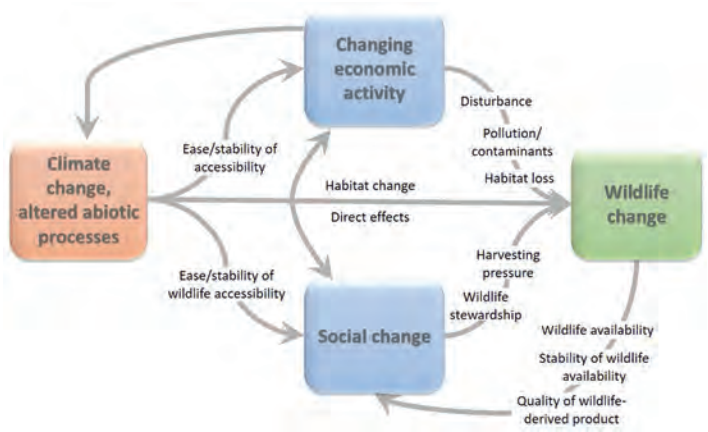
Global warming is rapidly changing the Arctic tundra. Climate-induced shrub expansion can negatively influence wild caribou, but socio-economic development also change land use in all regions. There is a particular need to handle the tourism boom that are changing the socio-ecological dynamics in parts of the Arctic.

Anthropogenic Heat Islands in the Arctic: Windows to the Future of the Regional Climates, Ecosystems, and Societies (HIARC)

The largely overlooked phenomenon of ecosystem and societal adaptation to warmer micro-climates has been created by the anthropogenic heat pollution in the Arctic urbanized areas over the last 30-40 years. Understanding the environmental impact will help produce more accurate and more policy relevant projects of the Arctic changes on the adaptation time scales up to 2050 and beyond.

A. Soromotin (IEC).

Human-burned tundra site near Tazovskiy, Siberia.



TAMANI

Pressures on Arctic wildlife.

Towards a better involvement of local communities in Arctic monitoring (TAMANI)

How, where and why we monitor wildlife affects our perception of wildlife change, the stressors driving change and who is responsible for addressing it. Through spatial analysis of pan-arctic monitoring sites and in depth interviews, we have been identifying the increasingly complex objectives for monitoring. We highlighted a disconnect between goals related to capacity building and community participation and decision-making related outcomes, which need bridging to improve local agency in decision making.

Arctic climate change and its impact on Environment, infrastructures, and Resource Availability (ARCTIC-ERA)

Climate change is especially pronounced in the Arctic and requires immediate attention due to diverse impacts on the environment, economy and human activities in the region and beyond. ARCTIC-ERA focuses on comprehensive analysis of internal factors and external drivers of the Arctic change. It utilizes best available climate scenarios in order to develop better understanding of future Arctic, its environment, economy, and resource availability. The project outcomes support data-driven decision-making at community, regional and circumpolar scales.

Dmitry Streletskiy and Nikolay Shiklomanov

Norilsk, Russia is one of the largest industrial centers in the Arctic, and is at a forefront of changing climatic conditions and socio-economic transformations.

Kenji Yoshikawa

Ice cellar in Evenk indigenous village, Sakha Republic, Russia.

C budget of Ecosystems, Cities and Villages on Permafrost in the eastern Russian Arctic (COPERA)

The eastern Siberian ecosystem of the Sakha republic is established on the largest and deepest permafrost region in the world, where much of the earth's carbon dioxide is sequestrated. The environmental impacts of population and emission growth in this environmentally vulnerable region and the need for viable low carbon energy solutions for Arctic residents drive the COPERA project. The project will start by focusing on the carbon budget within typical biomes such as Boreal forest and tundra, and ultimately results into publicly accessible materials to educate its local people.

Bioeconomic Analysis for Arctic Marine Resource Governance and Policy (BAAMRGP)

Arctic living marine resources are threatened by invasive species and the threat is exacerbated by climate change. But our integrated system of information, including biology, economic incentives, and institutional aspects, creates context to understand the dynamic and spatial challenges. Therefore, our integrated bioeconomic analyses help decipher strategies to address marine invasive species through transboundary Arctic vigilance and incentives. These strategies include broader inclusion of global values in decision-making over not only targeted removals of species but also international governance structures.

GlobalFishingWatch.org

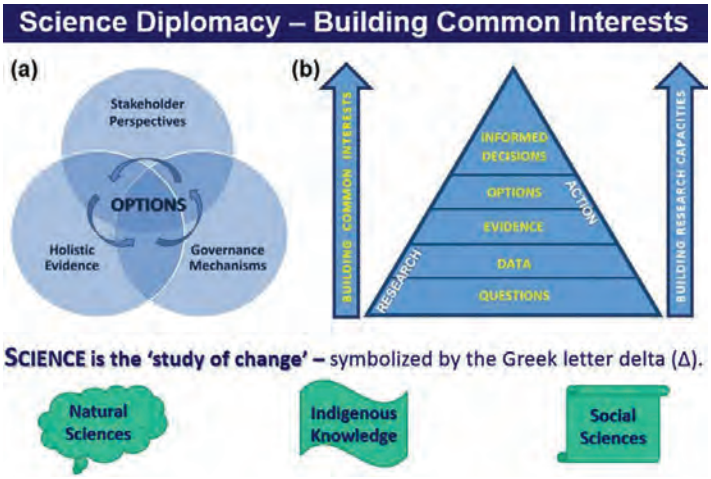
Non-Norwegian and Russian vessels 2012-2016.

Resilience and Adaptive Capacity of ARCTIC marine systems under a changing climate (RACArctic)

Climate change is more pronounced in the Arctic and has led to a loss of sea ice, warmer ocean temperatures, and more corrosive waters. However, the impacts of these changes on marine ecosystems, including fish populations, fisheries, and the communities that depend on them are poorly understood. Therefore, RACArctic developed a set of plausible scenarios for future change that were presented to stakeholder to explore opportunities, threats and options for adaptation. These will form the basis for recommendations to improve the resilience of fishery management institutions across countries.

Franz Mueter

Workshop participants from Japan, Norway, and the United States explore the inside of the rapidly melting Mendenhall glacier in Juneau, Alaska.



P.A. Berkman

Science diplomacy involves building common interests.

Holistic Integration for Arctic Coastal-Marine Sustainability (Pan-Arctic Options)

Six thousand years ago, human populations began to stabilize and grow on a planetary scale, but we now have more than 1000% increase in human population in just the last three centuries, therefore our shared challenge is to survive as a globally-interconnected civilization.

In the Arctic—as elsewhere in our world—the challenges and opportunities are international, interdisciplinary and inclusive (holistic), requiring informed decision-making to achieve progress with sustainable development for the benefit of all across generations.

Arctic Fog Variability in a Warming Arctic and Its Impact on Maritime Human (AFV)

The rapid increase in open water surface area in the Arctic, resulting from sea Ice melting during the summer as a result of global warming, allows new marine traffic routes and create new business activities in the otherwise inaccessible polar region. However, the increase in open water surface area also increase the formation of fog, which may imperil ships and small aircraft transportation in the region. Therefore, there is a need for better understanding of fog formation and better forecasts of fog in the Arctic.

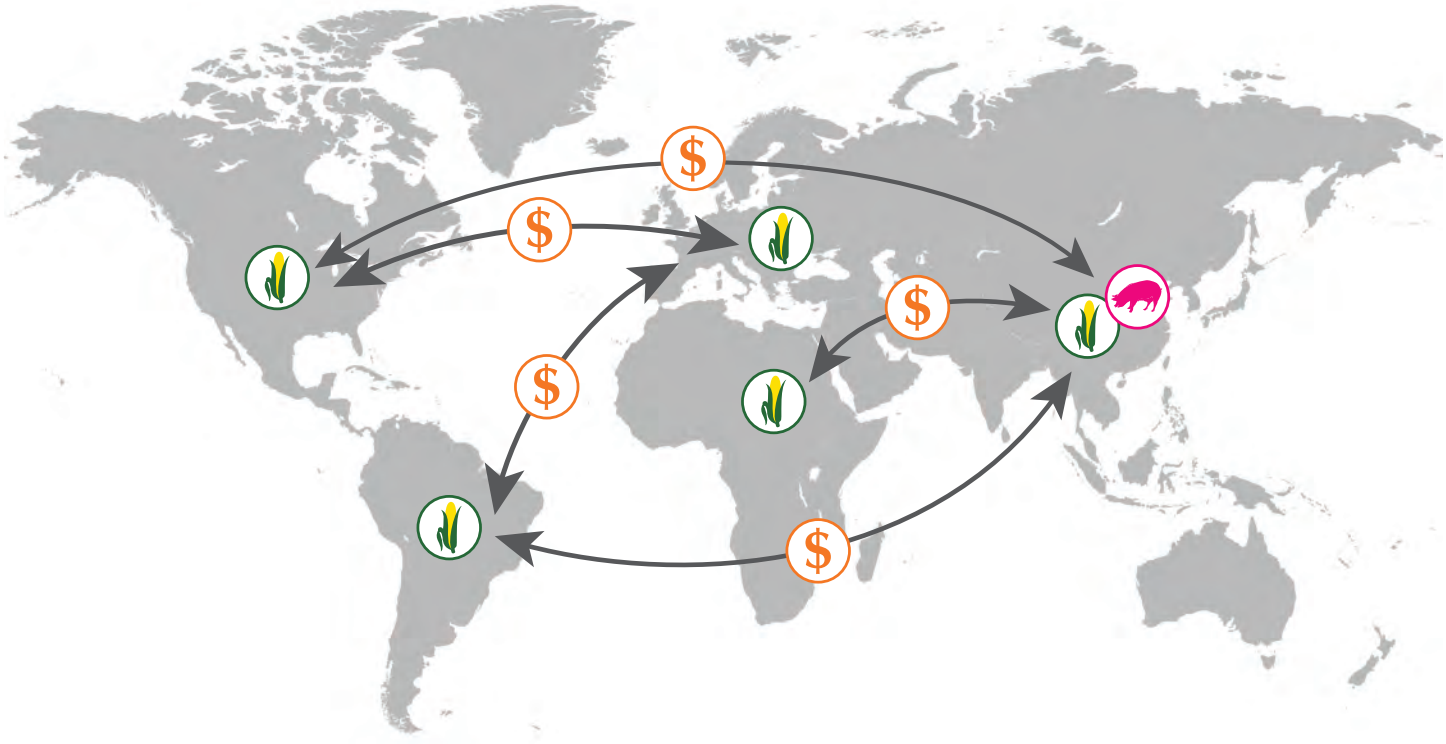
Xianyao Chen

Tethersonder balloon fog observation off Utqiagvik, Alaska.


AFGROLAND project

Food Security and Land Use Change

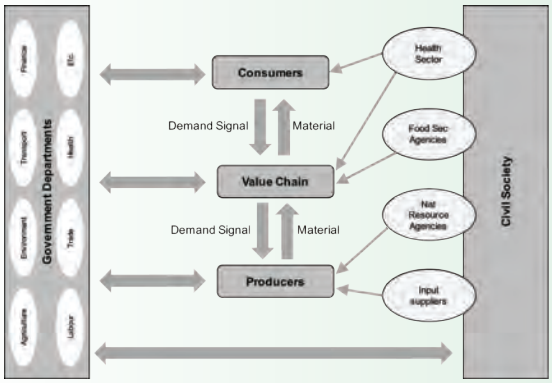
Global demand for food in a hyperconnected changing world coupled with climate change, are drivers for local and regional land use changes and this has strong impacts on humans, biodiversity and the environment. Although efforts have been made to address these challenges, we are far from meeting global needs for food access and thus food security. Therefore, the Food Security and Land Use Change CRA research projects were funded to increase scientific understanding of the dynamic spatial scale interactions between food security and land use in the context of global change, and the consequences of these interactions for climate, ecosystems and social systems, including their economic and cultural dimensions.



Flows of capital and agricultural goods vary among different regions of the world. The figure illustrates flows of capital and agricultural goods among different regions of the world. Sending and receiving systems are connected by telecoupled processes affecting food security and land use change.

Food System Governance, Food Security and Land Use in Southern Africa (SAFGOV)

The role of private companies and other institutions is of growing importance in food security and land use issues in southern Africa and all are ultimately influenced by consumers. There was therefore a need to understand better how different arrangements of food system governance affect land use and natural resource management. The project built a community across policy and practice which identified a number of critical knowledge gaps.



John Ingram

Main interactions between public and private 'actors' involved in the maize value chain in South Africa.

Tim Hess

Irrigation of sugarcane uses large amounts of water, but can bring economic and social benefits to Sub-Saharan communities.

Hydro-Social and Environmental Impacts of Sugarcane Production on Land Use and Food Security (THESIS)

Sugarcane is an important crop globally, but significant expansion is likely to have impacts on land use and water resources, livelihoods, food security and ecosystem services, while potentially providing infrastructure and economic benefits. Therefore, we critically assessed the hydro-social and environmental impacts of sugarcane development in Sub-Saharan Africa. Our findings can help in understanding the environmental and social impacts associated with alternative sugar economy models.

Sustainable Management of Agro-ecological Resources for Tribal Societies 2 (SMARTS2)

SMARTS2 project has shown that a climate-smart conservation agriculture production system approach increases productivity and income for rural Indian farmers The project engaged in community building resulting in a long-lasting partnership based on trust between tribal villagers, our NGO partner and interdisciplinary project partners from USA, India, Japan and the Netherlands.

Catherine Chan

Employing climate-smart agriculture has increased productivity and income at the village farm level.

AFGROLAND Project

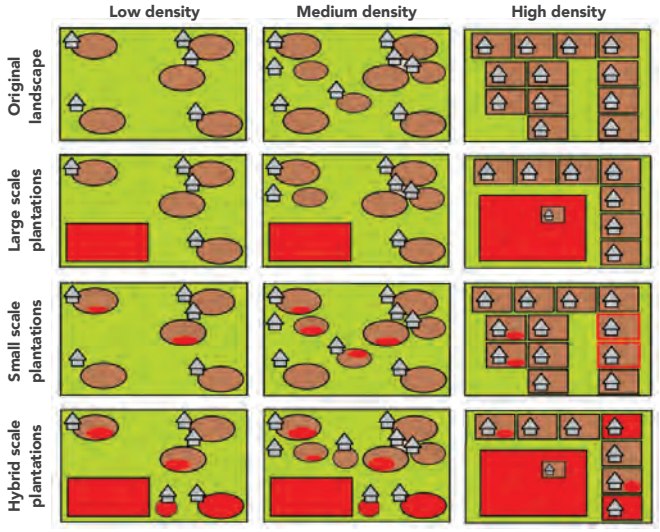
AFGROLAND Project in Mozambique.

African Food, Agriculture, Land and Natural Resource Dynamics (AFGROLAND)

Afgroland analyses the broader regional impacts of large-scale agricultural investments, in Kenya, Madagascar and Mozambique. It shows how international drivers can have divergent impacts, with local-level outcomes varying significantly in terms of land use change, ecological impacts, food security, and livelihoods. These divergences are determined by national politics and policy frameworks, land tenure rights, business models, land and water resource endowments, and path-dependencies regarding investment and business practices.

Assessing the food security outcomes of industrial crop production in Sub-Sahara Africa (FICESSA)

Industrial crops such as sugarcane, oil palm, and cocoa have underpinned the economies of many African countries. They have been major engines of economic growth through foreign exchange earnings and rural development. However, their expansion can have important implications for food security at the local and the national level. FICESSA includes comprehensive case studies of different operational industrial crop projects in Ghana, Malawi, Mozambique and Swaziland. FICESSA will also undertake scoping surveys in Burkina Faso, Guinea and Ethiopia that focus on institutional issues related to industrial crop production and its linkages with food security.



Industrial crop production in plantations and smallholder schemes (red) converts different configurations of agricultural land (brown) and ecosystems (green) in Sub-Sahara Africa. Credit: FICRESSA Team.

ETH Zurich World Food System Center

Students participating in a two-week summer school program in Stellenbosch, South Africa.

Delivering Food Security on Limited Land (DEVIL)

The green revolution dramatically increased crop yields over the past half century. However, production trends are not on track to meet the food and nutrition security needs of 9 to 10 billion people by 2050. New solutions are needed to sustainably feed a growing population on a warming planet. This project aims to identify multiple pathways for creating a sustainable and nutritious food system, both globally and regionally.

Looking for distant connections to solve local land use challenges (ABC Telecoupling)

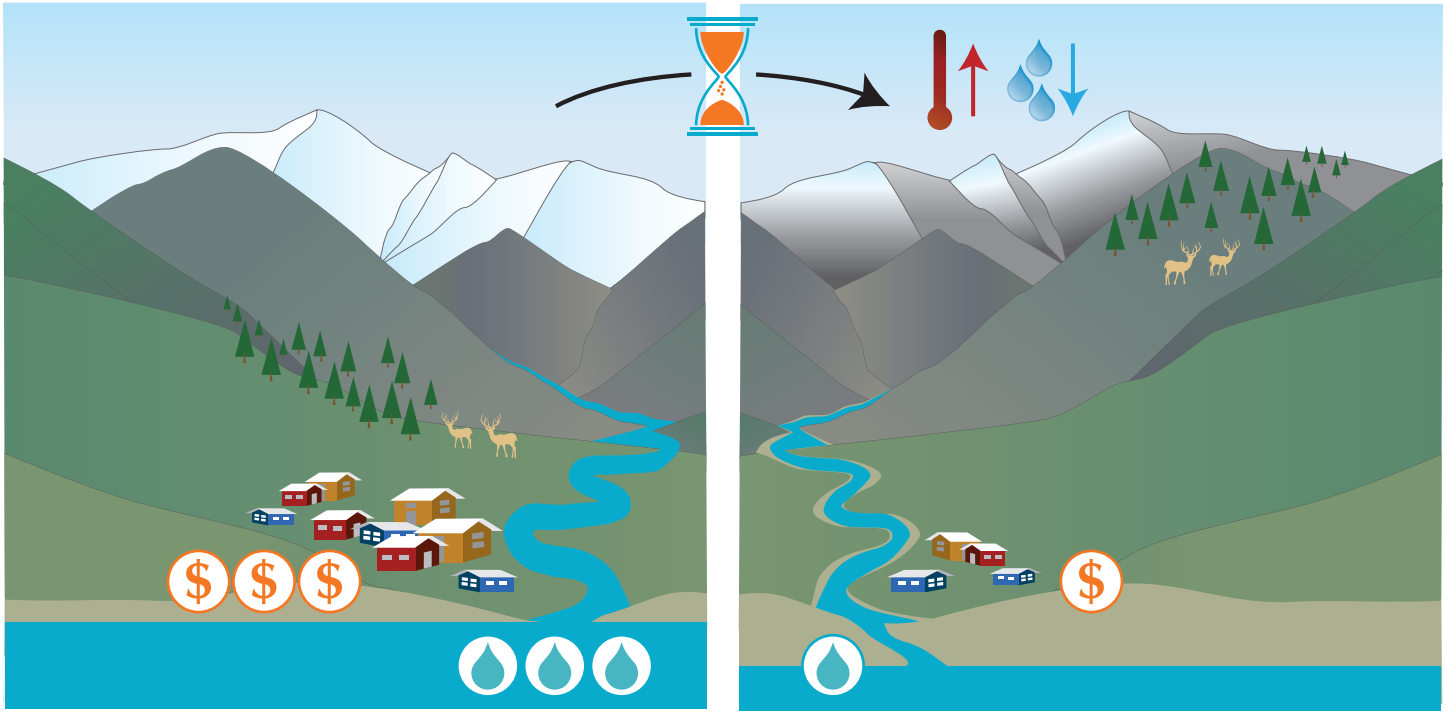
Everyone recognizes globalization is increasing trade of agricultural commodities. There are positive effects on food security but also potential unintended consequences on land use. Therefore, we are simulating future dynamics in Brazil under a range of scenarios to inform stakeholders about possible actions to be taken.

Ramon Felipe Bicudo da Silva

A maize field in Brazil, affected by El Niño conditions.

Mountains as sentinels of change

Mountain environments are essential to local communities and global biodiversity, and they are sensitive to global change. Local knowledge, in combination with multidisciplinary science, can inform and improve adaptation strategies, so transdisciplinary, outcome-oriented research is necessary. The Mountains as Sentinels of Change CRA aims to design and evaluate adaptation measures and sustainable development strategies in mountain environments.



Mountain communities depend on local resources for subsistence and economic development. Some of these resources, depicted here, are timber, pollinating insects and birds, game animals, and water. Climate change, particularly rising temperatures and shifting weather patterns, puts these mountain environments and communities at extreme risk due to extirpation, population reduction, and/or emigration among montane species, dramatically changing the makeup of natural communities, as well as dramatic short and long-term changes in water regimes.

Siyu Guo

Wakhi herders in the Kongur Shan Mountains of Xinjiang, China discussing climate change impacts on livelihood and food systems.

Building Anticipatory Capacity for Climate Change (ECCAP)

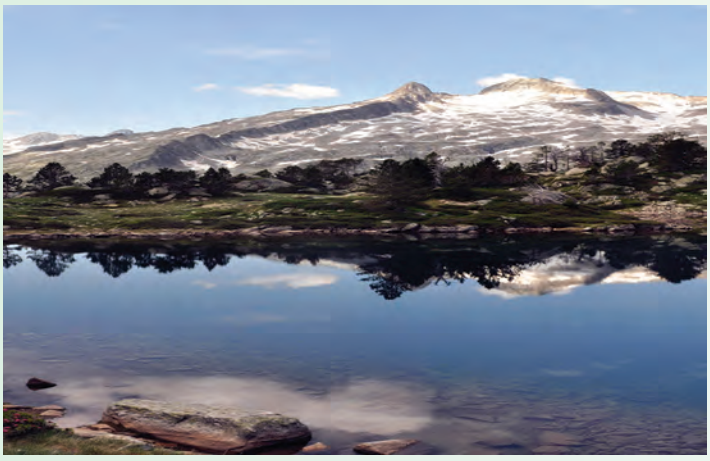
Indigenous and rural societies who have contributed least to anthropogenic climate change are facing its harshest consequences and for them climate change is one of the greatest challenges. But an estimated 70-80% of the world's food is produced by the same smallholders with less than two hectares of land. Therefore, climate variability is disrupting food systems and generating a debilitating anxiety. Consequently, anticipatory capacity—the ability to envision possible futures and develop a plan of action to deal with uncertainties—is needed urgently.

Assessing the ecological and socioeconomic impact of tree mortality in mountain forests (CLIMTREE)

Rapid climate change in mountain forests causes tree mortality, risking biodiversity and local timber economy. Adaptive forest management tries to minimize financial losses, but rarely considers ecological impacts because biomonitoring is slow and expensive. ClimTree develops high throughput molecular techniques to study biodiversity changes along dieback gradients in Bavarian forest, French Pyrenees and Chinese Yunnan mountains. Biodiversity conservation needs acceptance by local populations, so parallel qualitative and quantitative surveys on socioeconomic impacts of diebacks are conducted. Thus, Climtree transdisciplinarity integrates biodiversity and socioeconomical stakes for efficient forest management.

Heiner Müller-Elsne

Forest dieback in Bavarian Forest National Park.



Dirk S. Schmeller

Lake Gourg de Rabas, Pyrenees, is one area being studied.

People, pollution and pathogens: mountain ecosystems in a human-altered world (P³)

Mountains are found on every continent in the world, provide services to a significant proportion of the world´s population and support irreplaceable biodiversity. But mountains are very fragile environments and are extremely sensitive to climate change and human disturbance. To better understand the impact of global change on mountain environments, the project P³ aims to identify ways of mitigating the effects of global change based on research in four mountain ranges: Sierra Nevada, USA; Pyrenees, France; Dhofar Mountains, Oman and Great Hinggan Mountains, China.

Jeremy Foltz

Homestead in the Blue Nile Mountains.

Finding opportunities for a sustainable food-energy-water future in the Blue Nile Mountains of Ethiopia (NILE-NEXUS)

Sustainable development offers the opportunity to build resilience and healthy ecosystems in climate vulnerable communities of the Blue Nile Highlands. But these communities face a range of resource challenges at the nexus of food, energy, and water systems, ranging from local, on-farm resource limitations to basin-wide and, politically, global issues of transboundary water management. Therefore, we need to approach climate resilience from a transdisciplinary perspective that integrates diverse stakeholder perspectives and engages with the complexity of nexus dynamics across scale.

Climate-Smart Watershed Investments in the Montane Tropics of South America (ClimateWIse)

Compensating upstream residents to manage their land in beneficial ways is one way to improve downstream water resources. But the hydrology of changing landscapes in tropical mountains is understudied, as are the impacts of climate change. To evaluate whether Investments in Watershed Services (IWS) projects increase water quality and availability, ClimateWIse is working with partners affiliated with the Latin American Water Funds Partnership and the Brazilian Water Producer Program to measure and model impacts of land use and climate change on high-elevation páramo grasslands and Andean and Atlantic forests of South America.

Leah Bremer

Discussing growth and sustainability opportunities for watershed management with managers and participants at the Camboriú watershed in Brazil.

Rachid Cheddadi

Scientists and foresters took an excursion to see a cedar forest in Morocco following a VULPES conference, October 2018.

VULnerability of Populations under Extreme Scenarios (VULPES)

Mountain forests are important biological and socioecological resources used by local stakeholders for millennia. But they are unusually susceptible to climate change. The VULPES project is an international transdisciplinary project that seeks to evaluate climatic and social forces that have shaped these forests, genetically and compositionally. Of particular concern are small, isolated, forest populations that are vital to future successful migrations in response to warming climates. Humans have chosen to allow these populations to persist in the past, but education is needed to ensure that future generations understand the disproportionate value of their local woodlands.

Workshop Participants

Collaborative Research Action Projects

Food Security and Land Use Change

ABC Telecoupling—The Telecoupling Challenge. *Mateus Batistella* (Unicamp and Embrapa, Brazil).

DEVIL—Feedback Loop Interactions Between Land Use Change and Food Securities Dynamics. *Paul C. West* (University of Minnesota).

FICESSA—Food Security Impacts of Industrial Crop Expansion in Sub-Sahara Africa. *Alexandros Gasparatos* (University of Tokyo).

Participants of the Belmont Forum Tripartite Valorization Workshop. Washington DC, December 2018. Credit: Sky Swanson

Arctic Observing and Science for Sustainability

AFV—Arctic Fog Variability in a Warming Arctic and Its Impact on Maritime Human Activities. *King-Fai Li* (University of Washington and University of California, Riverside).

ARCTIC-ERA—ARCTIC climate change and its impact on Environment, infrastructures, and Resource Availability. *Pavel Groisman* (Hydrology Science and Services, Inc.); *Dmitry Streletskiy, Nikolay Shiklomanov, Nina Feldman, Tanni Sarker* (George Washington University).

ASUS Arctic Sustainability—A Synthesis of Knowledge. Andrey Petrov (University of Northern Iowa). *Rasmus Ole Rasmussen* (Nordregio); *Vera Kuklina* (George Washington University).

BAAMRGP—Bioeconomic analysis for Arctic Marine Resource Governance and Policy. *Linda Fernandez* (Virginia Commonwealth University).

COPERA—C budget of Ecosystems, Cities and Villages on Permafrost in the eastern Russian Arctic. *Kenji Yoshikawa* (University of Alaska).

HIARC—Anthropogenic Heat Islands in the Arctic: Windows to the Future of the Regional Climates, Ecosystems, and Societies. *Marlene Laruelle* (George Washington University).

Pan-Arctic Options - Holistic Integration for Arctic Coastal-Marine Sustainability. Paul Berkman (Tufts Science Diplomacy Center).

RACArctic - Resilience and Adaptive Capacity of Arctic marine systems under a changing climate. Franz J. Mueter (University of Alaska Fairbanks).

Mountains as Sentinels of Change

CLIMATEWISE—Climate-Smart Watershed Investments in the Montane Tropics of South America. *Kate Brauman* (University of Minnesota).

CLIMTREE—Ecological and socioeconomic impacts of climate-induced tree diebacks in highland forests. *Elisabeth Herniou* (Centre national de la recherche scientifique-Université de Tours).

ECCAP—Ecological Calendars and Climate Adaptation in the Pamirs. *Karim-Aly Kassam* (Cornell University); *Cyrus Samimi* (Bayreuth University).

NILE-NEXUS—Opportunities for a sustainable food-energy-water future in the Blue Nile Mountains of Ethiopia. *Ben Zaitchik* (Johns Hopkins University), *Belay Simane* (Addis Ababa University), *Temesgen Yimanie* (Jimma University).

P3—People, pollution and pathogens: mountain ecosystems in a human-altered world. *Jan Friesen and Dirk Schmeller* (Helmholtz-Centre for Environmental Research, Leipzig).

VULPES—Vulnerability of Populations under Extreme Scenarios. *Mark Bush and Rachel Sales* (Florida Institute of Technology).

e-Infrastructures and Data Management (e-I&DM)

Robert Samors, Tina Lee, Rowena Davis (University of Arizona).

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