NATO-DRDC Science and Technology Climate Change and Security Workshops

Canada

Workshop I Report

Please note, the views expressed in this report are those of each organization's representative(s) and do not necessarily reflect the official policy or position of the country's defence department/ministry or government.

Overview:

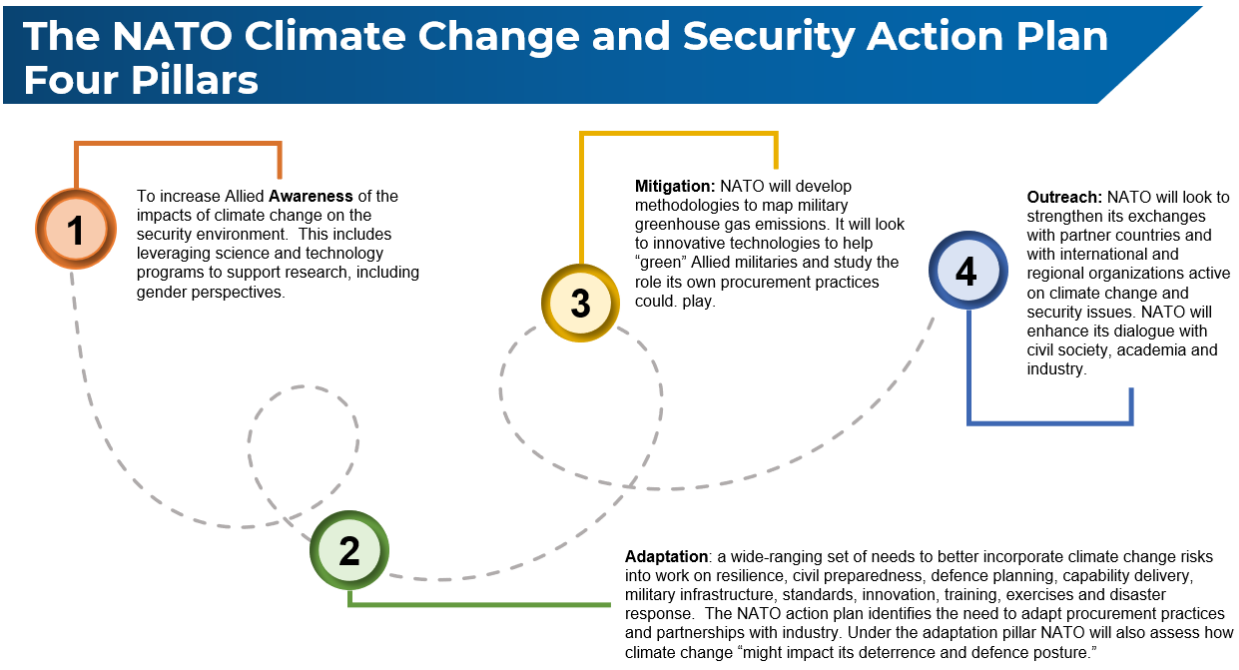
Climate change is shaping our security environment and acting as a threat multiplier. The accelerating effects of climate change will have a substantial impact on global security, as extreme weather events and climate pattern changes stand to threaten human security, political stability, and critical infrastructure – including military installations. NATO recently announced a Climate Change and Security Centre of Excellence (COE) that will be established in Canada. This effort is being jointly led by Global Affairs Canada (GAC) and the Canadian Department of National Defence (DND).

DRDC, in cooperation with NATO's Office of the Chief Scientist, hosted its first workshop in the series on June 27th, 2022. **The interactive virtual workshops sought to advance the conversation on defining and enabling strategic science and technology (S&T) priorities on climate change and security (CCS), in advance of a larger Fall / Winter workshop**. The workshop program is supported by the Centre for International Governance Innovation (CIGI).

Objectives for Climate Change & Security S&T Research:

Following introductions led by Aaron Shull and Guy Vézina, Kurtis Simpson offered a short presentation that emphasized the Defence Research and Development Canada's (DRDC) mission, vision, and role; a summary of the Defence and Security Science and Technology (DDST) program; the strategic focus areas that seek to advance Canada's Strong, Secure, Engaged defence policy, as well as the importance of strategic partnerships.

The speaker emphasized that Canada has three key drivers tied to the NATO agenda. The first is the **interlinkages to Canada's National Defence Climate S&T aspirations and the NATO Security Action Plan**; the second is to enable the development and implementation of **Canada's NATO Centre of Excellence on Climate Security (CCASCOE)** and programme of work; a third driver is for Canada to support and apply **NATO's pillars of excellence** –specifically, increased awareness, adaptation, mitigation, and outreach.



The objectives for the workshop were explained as follows:

With respect to **knowledge sharing**, the workshops will profit from learning about opportunities on Climate and Security (CaS) topics and individual nations sharing national CaS programs and goals. The workshops will **promote synergies** by isolating target areas where nations can work together (NATO Technical Activity Proposals (TAPs), Exploratory Teams). It will align efforts of the contributing NATO nations and encourage NATO cross-panel awareness and participation.

Lastly the workshop will **identify themes** by working through the NATO Climate and Security Action Plan to identify the themes of shared interest and address goals collaboratively. It will also identify 'pilot themes' (such as maritime operations, coastal impact, and polar issues) to trial and test how we can collectively work together to advance aspects of the CaS agenda.

The results of the first Workshop are given in this report and are shaping the agenda for subsequent workshop meetings.

In terms of the **methodology** for this series, there will be,

A) **Three smaller virtual workshops** (June, September, October) to promote knowledge sharing, increased synergies, and to identify themes of common interest. These will be definitional and inform the agenda of larger Fall/Winter conference.

B) The results of these interactions will **enable scientists to formulate research activities** as technical activity proposals or for exploratory teams to investigate research potentials.

C) **Coordinate our efforts with NATO's Office of the Chief Scientist** as an advisor and potential funding source for specific initiatives.

D) As we develop shared targets of interest and build relationships, **promote close dialogue with the CCASCOE to provide its leadership with potential options to consider for its forthcoming program of work.**

E) Develop a **high-level communication plan**.

F) **Leverage and access new sources of expertise** for NATO's CaS ambitions.

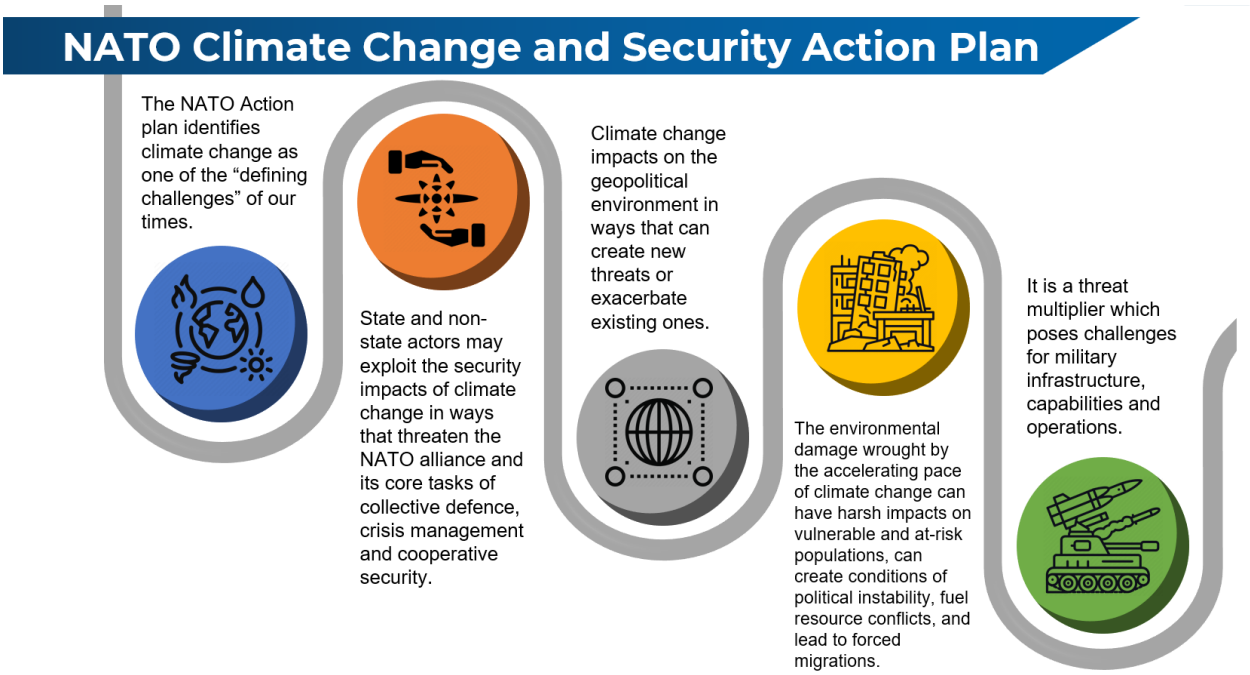
The NATO Action Plan: S&T Pillars Opportunities and Challenges:

There were two presentations given under this topic. The first was led by Pervaiz Sannan, NATO: Energy & Environmental Security and Science for Peace & Security, Climate & Energy Security Section, Emerging Security Challenges (ESC) Division, and the second was by Dale F. Reding, Scientific Advisor, NATO Office of the Chief Scientist.

A) Emerging Security Challenges (ESC) Division NATO HQ

- In June 2021, **NATO heads of state and government agreed that NATO should become a leading organization when it comes to understanding, responding, and adapting to climate change**. NATO recognizes that although it is not the first responder to every challenge related to climate change, NATO still has a vital role to play in responding to the impacts, particularly on the security perspectives.

- This comprises of two elements: **1) NATO 2030 actions –primarily focused on the political and military structures and facilities of the NATO Enterprise**, and **2) NATO Climate Change and Security Action Plan, which is for both Allies and NATO to take forward.** The two processes are complementary yet feature different levels of ambition.



- **NATO recognizes climate change as a threat multiplier that impacts allied security**, not only in the Euro-Atlantic area, but also in the Alliance's broader neighborhood. We are all witness to rising water at our coasts. We are impacted by weather hazards, and an increase in temperature extremes across the world. In the context of security, we all know what could happen if droughts

or floods trigger migration flows, or that disputes over land, water and food could lead to an already fragile region. The implications will get a lot worse.

- The Alliance is not immune to this. **We have witnessed the operational challenges for our armed forces –whether threats posed by rising seas to alliance naval bases, or the big degradation of aircraft performances due to rising temperatures.**

- We have particularly witnessed the second part. NATO transports planes and helicopters in Afghanistan and Iraq, where the military there is not equipped to deal with such high extreme temperatures for such a lengthy period of time. These challenges will not subside. The Alliance now has an even more important role going forward not only from a military perspective, but we are continuing to provide a lot more effort on things such as disaster relief. **NATO as a whole and our militaries will have important work going forward in tackling climate change.**

- In a nutshell, climate change has become a security threat and a new reality that our security institutions have to grapple with. **We need to understand that climate change is a global issue that threatens global security –we must play our part in responding to these challenges.**

- **The Climate Change and Security Action Plan is essentially based on four pillars that will serve as guiding principles:**

    1. **Awareness:**
       NATO prioritizes building a comprehensive understanding about the impacts of climate change and security. This new strand of work started with conducting a thorough impact assessment on climate change and security with the entire NATO enterprise. **The purpose of this was to essentially understand the impact of climate change on the NATO strategic environment, NATO's assets and installations, operations, and missions, as well as NATO resilience and to table preparedness.** It is a comprehensive assessment of how climate change is impacting each of these collectively, but also at the individual-level. The results of this assessment are sobering. The forward and the executive summary of this will be made public at the Madrid Summit.

       It raises questions about the challenges that are ahead. For instance, how will we respond to the redistribution of military capabilities in the high north, as melting ice sheets free up shipping lanes? What resources are required to respond to dried-up water reserves and shrinking agricultural land? How will the Alliance respond to migratory pressures – considering that environmental migration has already become an intrastate flashpoint in many parts of Africa, the Middle East, and the Indo Pacific? These are all issues the Alliance will need to consider as we continue to develop our understanding on the impacts of climate change insecurity.

    2. **Adaption:**
       This element focuses on assessing how NATO needs to respond, given the changing environment in which it operates. It is important to highlight for the adaptation pillar that

the key for NATO is to always maintain military and operational effectiveness. Any approaches need to have this embedded in any tasking. We have to ensure that the measures taken do not lead to further dependencies for the Alliance. **We need to guarantee that the evidence led approach is based on regular impact assessments that are integrated into all major work strands –be it defence planning, capability, delivery, procurement, innovation, training and exercises or resilience work.**

Adaptation measures can come in many shapes and forms. They can range from retrofitting of infrastructures with climate resilient materials, to the use of simulations that stress test entire supply chains, to the impacts of climate change. While allies are ultimately responsible for the individual adaptation plans, and many of the allies have already published a lot of their national strategies on this, the Alliance collectively has an important role, particularly from a coordination point of view.

3. **Mitigation:**
   As one of the largest international organizations in the world, **NATO has a responsibility to play an active role in mitigating the impact of climate change.** Militaries are one of the largest contributors to greenhouse gas emissions.

   At the Madrid summit this year, the Secretary General for the NATO enterprise will be sharing the mapping and analytical methodology of measuring greenhouse gas emissions for military activities and installations. This will be the first time that NATO has published on this for the enterprise. **The goal is to help allies in emission assessment programs for their own nation states and essentially contribute to formulating voluntary goals to reduce greenhouse gas emissions from the military.**

4. **Outreach:**
   NATO has worked with several member states to develop a best practices approach, which highlights the key activities that are being taken by Member States to enhance knowledge sharing between the allies, and to further develop dialogue on mitigating the impacts of climate change. **Specifically, NATO is trying to understand what the key elements are that many countries are doing within the alliance that have worked for them and how this knowledge can be shared with the rest of the Alliance.** For all of this to succeed, the climate agenda has essentially moved to the center stage at NATO.

   This year, NATO has led a series of meetings bringing together over 100 leading private sector stakeholders to prioritize features substantially across all agendas. In April this year, climate change also featured prominently in various discussion sessions. The 2022 NATO youth summit recognized how climate change will impact future generations. NATO is continuing to expand its digital outreach regarding climate change, working with industry to highlight climate related information. Even though it has not defined the full role of partner countries, NATO aims to build a sustained climate dialogue seeking the views of those countries leading the fight on climate change.

- At the Madrid Summit, the first annual high-level conference on climate security will take place, bringing together key stakeholders on the climate issue. This dialogue is a testament to **NATO's ambition of becoming the leading international organization in terms of understanding, adapting, and mitigating the impacts of climate change on security.**

- To make progress on the greening of NATO's militaries, we must also leverage our distinct national experiences. One approach to achieve this is through a compendium of national best practices. At a time when NATO allies and EU member states face many other challenges, climate change could be seen as a lesser problem, something that will not have serious impacts until later in the 21st century. This could not be further from the truth. We already see the implications. We feel them and we know they are getting a lot worse. **Climate change threatens global security and NATO must be a part of the response. Everyone will have to play their part in making sure NATO sets the gold standard on climate change insecurity, as climate change shapes our strategic environment and acts as a threat multiplier.**

B) An Emerging and Disruptive Technologies Perspective:

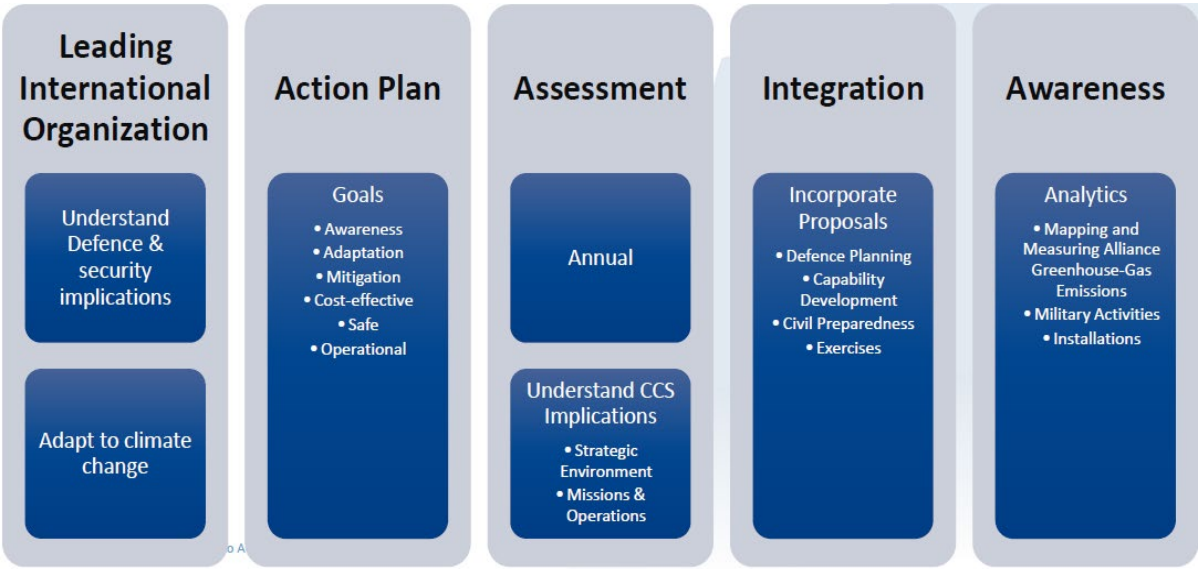
- NATO 2030 is a way of looking at producing an organization that is **more globally oriented, with stronger political and military alliance.**

- **Climate change was flagged as being important because it impacts our ability to conduct operations, whether those be collective defence, crisis management, or cooperative security.** It changes the geopolitical environment, leading to more conflict. It leads potentially to more migration issues as climate migrants flee areas that will become inhospitable for human habitation.

- It has impact with regards to the production of greenhouse gases and changing operations –whether that be the **issues of desertification, the changing Arctic, the melting of sea ice or just the changing environment in the high Arctic around the world.**

- **NATO wants to lead, it wants to reduce, and it wants to incorporate climate change and security (CCS) issues across its full spectrum of activities, and it wants to discuss with other like-minded**

nations and organizations on how we can come together to reduce or mitigate and understand climate change.



- The NATO Science and Technology Organization (STO) has done a lot of work to understand climate change, **developing techniques for mitigation, and supporting the important efforts** that are going forward with the data.

- **The impact and developments of electronics, electromagnetic sensors, weapons, and information communication technologies are also being monitored**. All of these have or are impacted by climate change and security considerations and need to be looked at from a synergistic perspective (not from an individual perspective) for how these collaborate, coordinate, and reinforce the other emerging and disruptive technologies. We need to look at them both from a human physical and information perspective, or more critically, from a human information and physical science perspective.

- We need to understand that **the future battlespace is going to be driven by the change in emerging technologies –which are increasingly intelligent, distributed, and interconnected.** While the changing battlespace will be one of the bigger challenges for NATO, it also provides tools to help us understand climate change and security implications. It provides us a constraint within which we are going to have to operate, in such a way that is respectful and reduces our carbon footprint. The new environment will demand more of us as we operate across the five critical domains of NATO – air, land, sea, space, and cyberspace, as well as cognitive space (or information space), which is sometimes referred to as the sixth domain.

How Can Emerging Technology Help us in Terms of our Ability to Understand and Mitigate Climate Change and Security Issues

ARTIFICIAL INTELLIGENCE	ROBOTICS & AUTONMOUS SYSTEMS
• Improve energy efficiency and usage (i.e., optimal battery usage / management, intelligent industrial & home infrastructure, faculty / generation operations); • Support development of new "green" science and technology (i.e., fossil fuels, renewable, fusion and diffusion); and • Enable increased autonomy (i.e., sensing, monitoring, and automation).	• Increased autonomy (i.e., sensing, monitoring, automation, and operation; • Human-machine teaming and effectiveness (i.e., vehicles, transport networks); and • Reduce / increase energy usage (i.e., robotics and autonomy, hybrid/electric/biofuels).
BIG DATA & ADVANCED ANALYTICS	**QUANTUM**
• Energy optimization (i.e., batteries, energy networks); and • Understanding security implications (i.e., improved modelling and simulation).	• Greatly improved M&S capabilities (i.e., climate, security, materials, and energy research); • Low power sensing and computing (i.e., photonics); • Improved PNT & mapping; and • New power technologies.
SPACE	**HYPERSONIC**
• Improved sensing (i.e., environment and climate change tracking); • Alternative power sources (i.e., microwave); and • Reduced launch pollution and impact (i.e., hybrid launch, mass drivers, centrifuge, space elevators, alternate propellants).	• Improved propulsion (mixed modes); • Reduce harmful emissions; and • Improved fuel use.

BIOTECHNOLOGY	HUMAN ENHANCEMENT TECHNOLOGY
• Green biofuels (i.e., air and maritime); • Carbon capture; • Living biosensors; • Reduced energy usage (i.e., cement, agriculture, and biomonitoring); • Low power data storage and computation; and • Improved crop production (i.e., meatless meat, new crops, optimize production).	• Social augmentation (i.e., working at home, less travel, social action); • Bioengineering (i.e., adaptation to climate change); and • Behavioral and social changes (i.e., population reduction and smart technologies and behaviour).
NOVEL MATERIALS & MANUFACTURING	**ENERGY AND PROPULSION**
• New battery and energy storage technologies; • Lighter materials; • Local production and shorter supply chains (i.e., 3D-4D printing); and • More efficient manufacturing (i.e., biomanufacturing).	• Green & novel energy (i.e., biofuels, renewables, fusion, fission, hydrogen, supercapacitors, and batteries); • Vehicle propulsion (i.e., air, land, maritime & space, hybrid/electric); • Improved efficiency (i.e., data farms); and • Carbon capture.
ELECTRONICS & ELECTROMAGNETICS	**SENSORS**
• Improved efficiency and reduced energy usage (e.g., Apple M1 versus Intel Core i9); • Increased M&S capabilities; and • Low power smart devices and wireless communication.	• Improved monitoring of climate (i.e., low power and wide distribution); and • Improved forecasting, M&S, and prediction accuracy.
WEAPONS	**INFORMATION & COMUNICATIONS TECHNOLOGIES**
• Green munitions (ranges); and • Environmental stewardship.	• Low power networks; • Low power distributed ledger technologies and crypto mining; and • Increased supercomputing capabilities (i.e., M&S of climate change and S&T support / enhancement).
Science and technology are a means, not an end. Technology will allow NATO nations to better understand, adapt and mitigate climate change and security issues but it is not a panacea –rather a critical place to start.	

Following the presentations, workshop participants were invited to ask questions. The following captures some of this conversation:

- **Question: Is awareness a one and done? How does NATO plan to maintain awareness and inform planning?**
  This is an agile process –geopolitical implications will evolve. There is a recognition that you must continue to monitor and understand how this will change / how operational environment will change.

- **Question: How will NATO communicate assessment plans in the future to increase awareness, which is necessary in order to adapt the plan, pedagogical tools that are important, considers society's "information overload" – how does NATO work with this?**
  NATO understands that it must continue to have dialogue with other nations to increase awareness and communicate what NATO is doing in these areas. All we can do is continue to reinforce that NATO is taking measures and mitigating – not just talking but actually doing. Hitting targets and keeping their eye on the ball. The accounting process developed with nations – if it is not already released, is releasable.

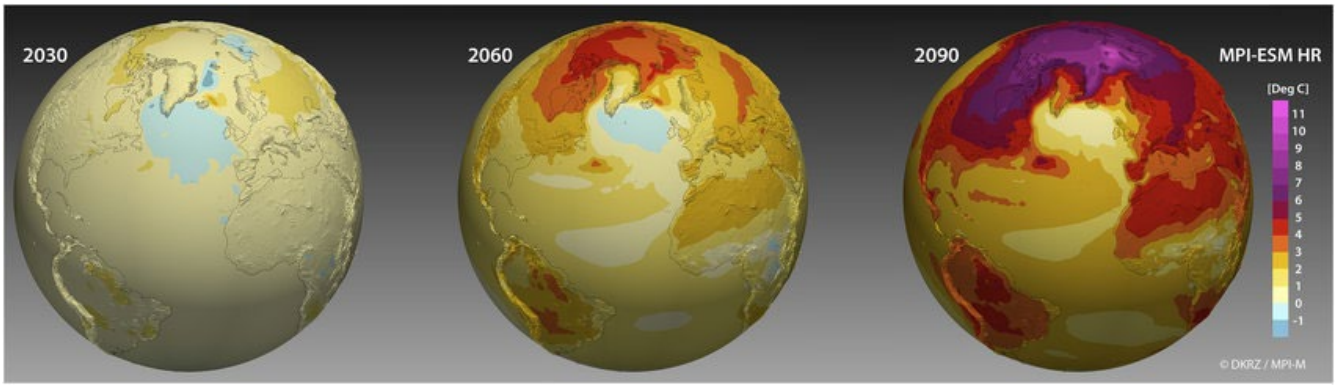
- **Question: Since all actors on the battlefield will face the same environment, and the same climate, could climate adoption in some respect also be a potential "force multiplier"?**
  It is important for us to look at the point of view of how to mitigate. If we can reduce the amount of diesel by using renewals / fewer containing sources, there is a huge cost, but we can reduce risks and become more effective in the long run. We need to come up with ways to impact operational effectiveness.

- **Question: How can NATO ensure interoperability as nations adopt different technologies to adapt and to mitigate?**
  STO will be critical in collaborating on early science and standards and ultimately interoperability. We will need to think about this and the science as we develop these technologies and have conversations so that we can be interoperable, and so that it can be supported by the NATO alliance.

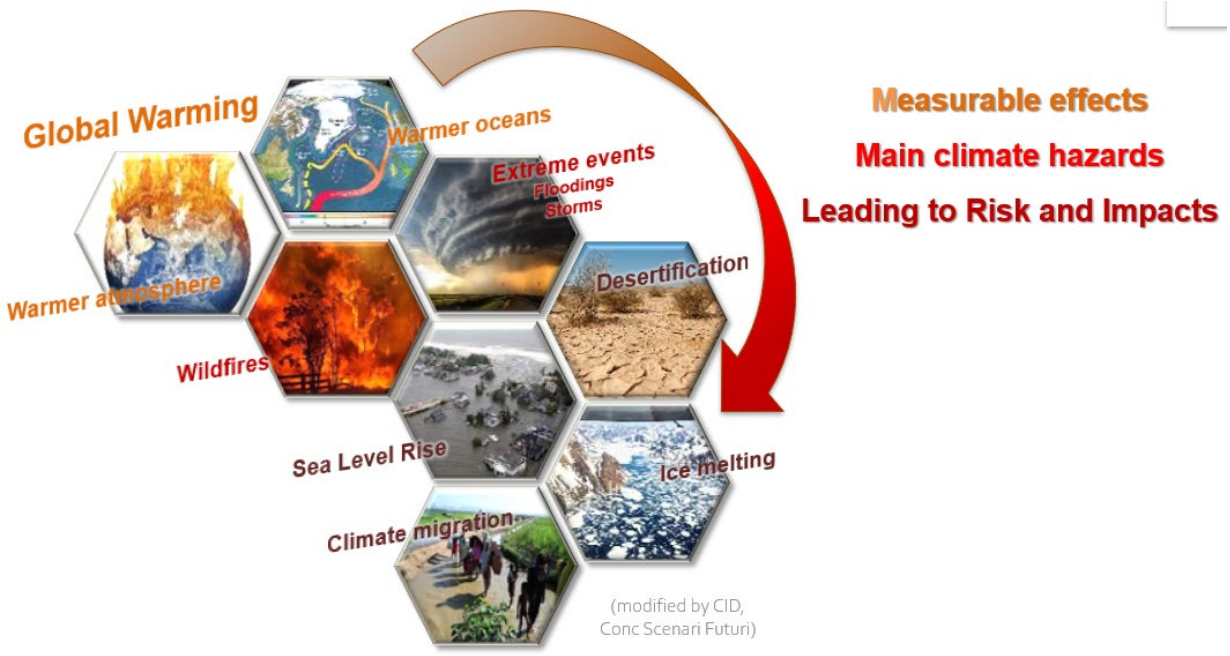
Maritime S&T Challenges and the Potential for Collaborative Work in this Domain:

In the next segment of the workshop, Professor Sandro Carniel, Head of Research provided a presentation on **the Strategic Role of Changing Oceans**.

The planet is warming, and we have to face the reality given the data.

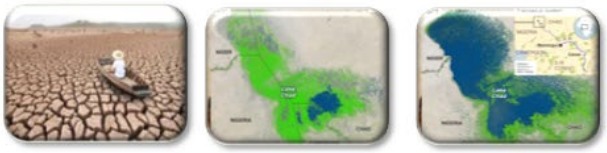


The main consequences will be a warmer ocean, an increase of wildfires, a warmer atmosphere, and of course, sea level rise, among other examples.



What is the overall risk effect of this changing situation on our lifestyle, depending on the vulnerability of that exposure? It will impact the food chain, fishing capabilities, the water that is pure, climate stability –the list goes on. Some of these ecosystem services are related to the activity of NATO.

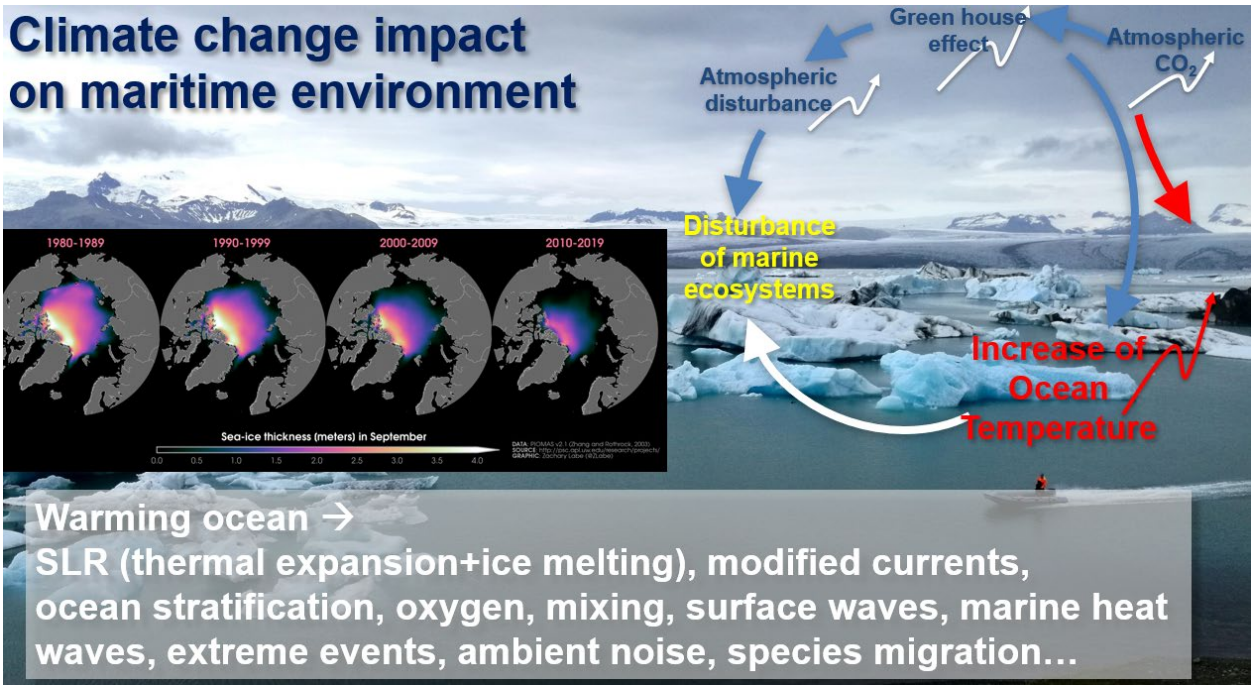
Environmental modifications cause contraction, loss or displacement of ecosystem services, (productivity, water availability, purification, bio-sanitary, climate regulation) **with direct/indirect effects on empowerment and migrations**



Plans need to address climate resilience and adaptation through a warfighting lens, to increase combat effectiveness and readiness

In terms of the expected "direct" operational impacts on military effectiveness and security:

AIR OPERATIONS	LAND OPERATIONS
• Aircraft performance, stronger turbulences, increase of sandstorms; • Sensor performances; • Overheating of military aircraft and airbases; • Adapting runways directions in airports; • Modification of Arctic airfields and supply routes, communication links; and • Adaptation of search and rescue procedures.	• Operating in increasingly extreme climatic conditions; • Exposure of operational bases to flooding, extreme temperatures, wind, drought, wildfire; • Faster 'wear and tear' of equipment; • Cooling of people and electronic equipment; and • Impact on logistics (Arctic melting).
MARITIME OPERATIONS	**SPACE OPERATIONS**
• Impact on supply chain/logistic operations; • Impact on coastal military infrastructures; • Challenging and changing Arctic conditions (e.g., extreme temperatures, ship routes); • Physical-chemical changes (salinity +/-, temperature +, acidification +); • Changes in oceanographic processes and impacts on above surface warfare (ASW); • Sensor performances; • Underwater cables threats; and • Traffic flow changes impact Maritime Intelligence, Surveillance and Reconnaissance.	• Impact of sea level rise (SLR) on launch facilities; • Unpredictable wind gusts and alterations to wind patterns impact launch trajectories; and • Changes in the upper atmospheric layers impact planning of new space missions.

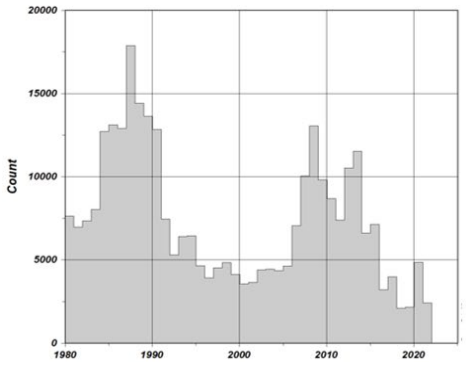


Climate Change and Security Research at CMRE:

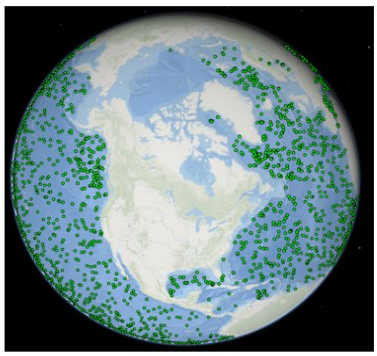
A) CMRE Arctic Observatory

- NATO needs a leading hub to drive more collaborative efforts and long-term observatories.
- CMRE assembled an Arctic oceanographic dataset from publicly available sources (over 300,000 casts).

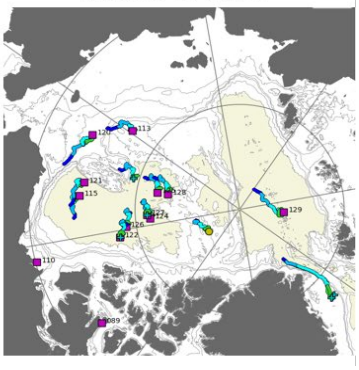
Arctic dataset yearly count (CTDs, ARGO, ITP…)



June 19th, 2022 – ARGO floats



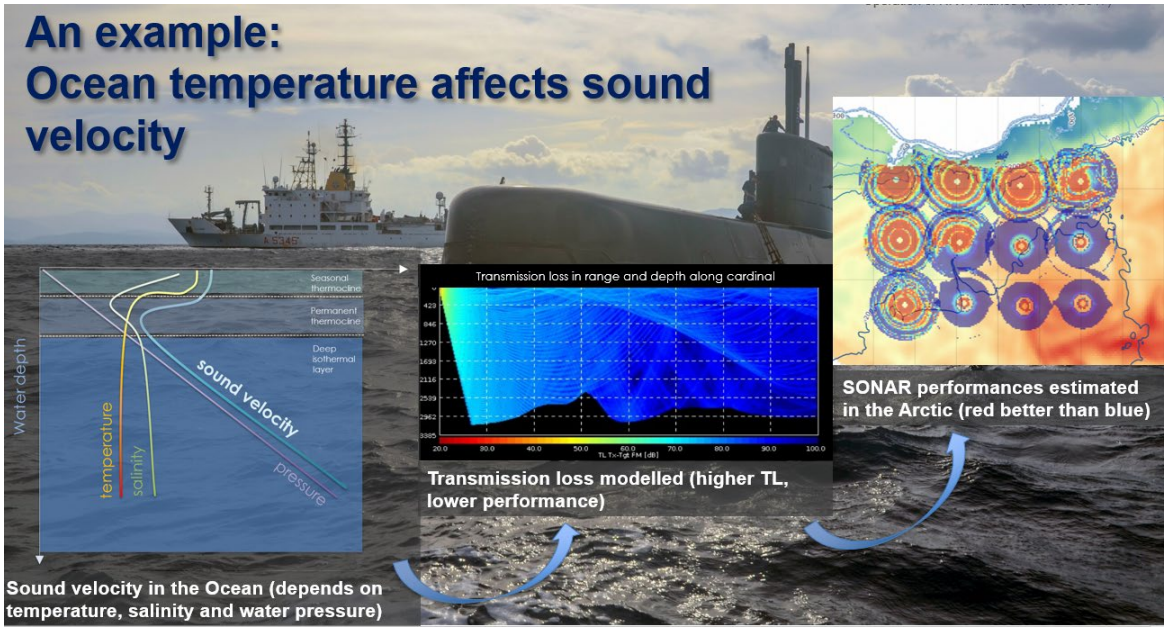
ITP, June 19th, 2022



B) Impact on Infrastructure

- Satellite and underwater autonomous vehicles monitor the Arctic Ocean sound scape.
- Data is ingested into CMRE "Ocean Digital Twin" to better forecast ocean properties. This helps to better understand the changing Arctic, and the identification of underwater targets.

C) Climate Impact on Above Surface Warfare (ASW) Operations



Considerations and Way Forward:

- Significant maritime climate changes are impacting NATO operations, infrastructure, underwater sonar performance, etc.

- CMRE has considerable expertise in the science of oceanographic conditions. Current research is focussed on impacts on the High North Atlantic and Mediterranean basin.

- CMRE example of customer funded body dealing with emerging disruptive technologies (EDTs) to improve monitoring and predicting ocean conditions, to support NATO's Climate Change and Security Action Plan.

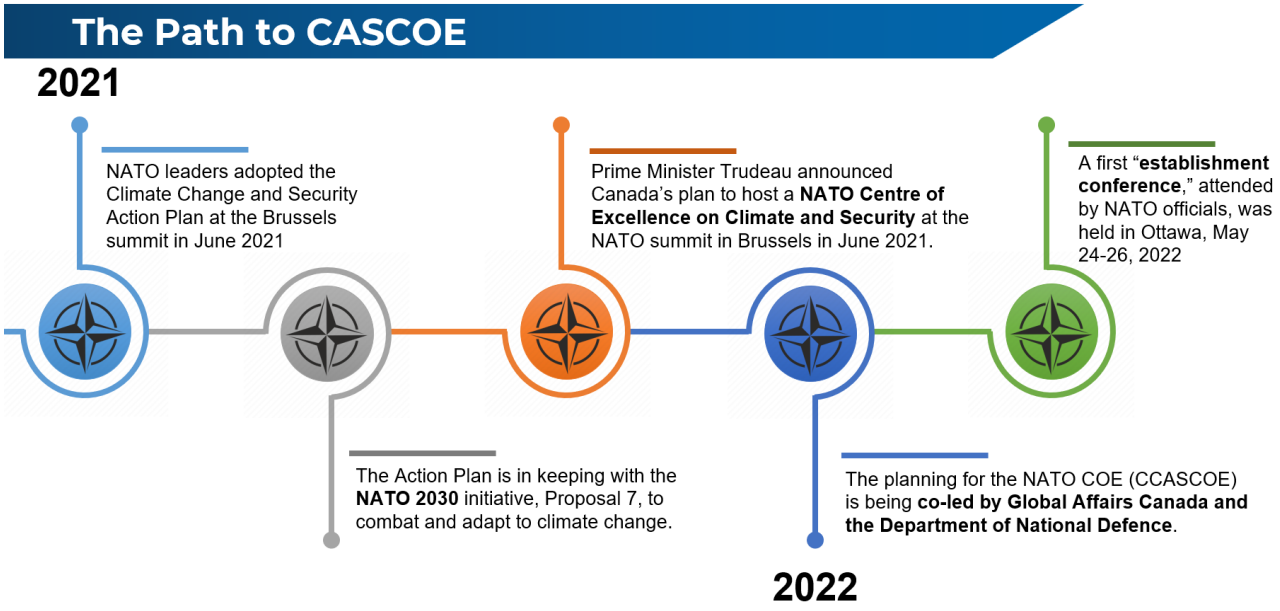
- Within the activities related to CCASCOE, STO Office of Chief Scientist (OCS) tasked CMRE to assess key maritime security climate and security issues (scoping paper, Winter conference).

- All Nations are invited to join this research effort in support of climate change and security collaborative research, to inform new NATO Technical Activity Proposals (e.g., topics, approach, shared data, standard, interoperability).

Update: The Establishment of the Climate Change and Security Centre of Excellence (CCASCOE)

Blair Brimmell, Interim Director of the CCASCOE and Section Lead of Climate and Security Policy at Global Affairs Canada, provided an update on the establishment of the CCASCOE –which is summarized as follows:

- **The initiative to develop and launch the NATO Climate Change and Security Centre of Excellence was first announced by Canada's Prime Minister Justin Trudeau at the June 2021 NATO Summit**. The joint partnership between Global Affairs Canada and the Department of National Defence developed a high-level concept document for what a NATO Climate Change and Security Center of Excellence could look like.



- This was delivered to NATO along with an official offer to host the Centre of Excellence in November 2021. NATO assessed the initial draft concept and the offer, and officially accepted it just recently in May 2022.

- Some of the main activity includes working with our allies, as well as other stakeholders to develop, refine and negotiate this concept and other high-level foundational documents for the Centre of Excellence itself. **The operational launch of CCASCOE is expected no sooner than spring/summer 2023.**

- When CCASCOE does eventually launch and the initial programs of work are developed, it will be **essential to develop a map of the work that is ongoing, necessary, and the actors that are doing the work and with whom the Centre can work or partner with.**

- NATO Centres of Excellence need to **uphold this idea of non-duplication of effort.** In the fast-developing field of climate change and security, it will remain important that we are all devoting our efforts in areas that will be most useful.

- **CCASCOE can contribute, share, amplify, and really serve also as a means to connect actors who are working on this topic** in support of climate change and security work.

- **Although Canada is the nation for the CCASCOE, we will not dictate the program of work for the Centre**. We will not have a direct command and control relationship with the Centre itself. Rather, the program of work and the functioning of the Centre of Excellence will be decided by the CCASCOE steering committee that will be composed not only of Canada, but also representatives of the other NATO nations that join us as sponsoring nations of the Centre of Excellence.

- NATO Centres of Excellence work across **four distinct pillars of activity.** Briefly, those are **education and training, research and analysis, concept development and experimentation, and doctrine, development, and standards.**

- Having a knowledge of the work that is ongoing can help answer questions such as **how the CCASCOE can incorporate the latest knowledge and expertise into things like training courses or exercises that the CCASCOE might design, run, or contribute, to further research and potential analyses gaps.** It can also **help to understand the best practices and standards that are being identified**.

- When we talk about climate change and security impacts**, the intent for the Centre of Excellence will be to help NATO, its allies, (and hopefully) the globe better understand, adapt, and limit the security impacts of climate change.**

Summary Presentation from Pre-Meeting Survey:

Next, Wesley Wark provided a brief presentation of the findings from the pre-meeting survey that was distributed to all workshop participants.

The survey sought to identify the top theme priorities for future S&T research.

According to the responses, the following top priorities were identified as follows:

- Climate change threats to the resilience of military installations, especially naval bases, which might be impacted by rising sea levels, surge flooding, and powerful coastal storms;
- Exploring the application of new green energy sources, including EDT, for military installations and activities;
- Concepts for increased energy-use efficiencies, including energy storage systems, logistics, energy use management;
- Climate change impacts on military infrastructure in the High North;
- Impacts of extreme weather on naval operations;
- Impacts of extreme weather on land operations;
- Mapping requirements for Humanitarian Assistance and Disaster Recovery (HADR) and operational impacts across NATO;
- Forecasting HADR missions and requirements;
- Generating coordinated domain awareness in the High North;
- Climate change impacts on supply chains and military logistics; and
- Developing partnerships with industry on EDT relevant to climate and security.

Breakout Groups: Key themes for Future NATO S&T Research on Climate and Security:

Following the summary of the pre-workshop survey, all participants were split into small breakout groups to further identify top priorities for future S&T research.

Breakout Group A – Risk Assessment, Forecasting and Domain Awareness

Group A discussed where to focus efforts to advance the work, as well as what could be done effectively from a NATO standpoint to demonstrate usefulness globally.

- Overall, the conversation highlighted that theme #1 "Advancing global risk assessments and forecasting on climate change impacts" and #5 "Identifying at-risk populations most vulnerable to climate change impacts," resonated with the group the most. It was also suggested that perhaps we look at these two themes together to not only advance global risk assessments and forecasting on climate change impacts, but also look at this from the lens of at-risk populations most vulnerable to climate change.

- The group noted that a number of themes are being taken care of by other nations. Canada has an approach, although not a plan, and needs a multi-sectoral methodology.

- In terms of what stakeholders would need to be involved in attaining these goals and what means could be employed to mobilize shared interests, defence are not the only actors, humanitarian actors and the military and defence S&T community should work with actors in particularly vulnerable regions of the world.

Breakout Group B – Defence Greenhouse Gas Emissions, Energy Management, Innovation

According to the conversation:

- Theme #6 "Building a model using data analytics to measure greenhouse gas emissions from military installations and activities in a national context," and theme #7 "developing a comprehensive NATO map of military greenhouse gas emissions" was highlighted as most important. There needs to be a common platform for data standardization for accountability.

- When considering how the themes resonate within our countries, energy use and efficiencies was discussed – energy storage systems, logistics, energy use and management.

- An understanding of where our nation's defence organization fits into the greenhouse gas emission contribution spread spectrum is an important one, as well as the need to consider industrial activities and others.

- When we are considering stakeholders that need to be involved in attaining these goals and in what means, there was a general consensus and agreement that we need to consider the civilian industry stakeholders' expertise and to look beyond the defence industry.

- Existing S&T capabilities that could be immediately employed to address these concerns, and areas that are promising for development included existing examples in Canada or greenhouse gas inventory. However, concerns included accuracy reporting and tracking. There is a lot of data required, and much to be gained from modeling and simulation in this area.

- In terms of obstacles faced in advancing these goals and strategies developed to overcome them, this included current political situations, as well as limited human resources and strategies to overcome data sharing, especially given emerging and disruptive technologies for use in the military as this is a key for interoperability.

Breakout Group C – Defence Resilience and Adaptation

The conversation was summarized as follows:

- Research theme #11 - Climate change threats to the resilience of military installations was of interest, especially naval bases, which might be impacted by rising sea levels, surge flooding, and powerful coastal storms.

- As an example, DRDC is interested in adaptation and resilience of military installations (theme #11), and in nature-based infrastructure protection rather than concrete sea walls. There is a need to adapt, not just gain awareness or "admire the problem." Impact is repeated a lot, but an awareness of impact is just the first step. DRDC is conducting research on infrastructure on coastal erosion with National Research Council and is seeking multinational collaborations.

- Research theme #14 on supply chains and military logistics also stood out. Forecasting is important because we need to understand the issue properly before addressing it. Likewise, other participants have mentioned the importance for modelling and simulation, and forecasting.

- It is important to do climate modeling and impact forecasting, to inform proactive adaptation. There is a need for improvements in our ability to forecast regional extreme weather and climate change, with reduced uncertainty, to better assess current and future risks and inform proactive adaptation planning. When it comes to coastal infrastructure resilience both green (nature-based) and grey interventions should be evaluated.

- Research themes #16 and 17 on naval and land operations, respectively, will share prioritization - force resilience, infrastructure and especially in the high north where the geopolitical and social considerations must be considered.

Breakout Groups D & E – Climate Change Impacts on Military Aid Missions and Health, as well as Engagement and Outreach were combined.

To summarize the discussion:

- Almost all of the conversation focused on the original topic for Breakout Group D: "climate change impacts on military aid missions and health."

- The top two thematic priorities were identified as: # 18 “Mapping HADR requirements and operational impacts across NATO” and #19 “Forecasting HADR missions and requirements.”

- The discussion around these priorities included issues of how to focus work on HADR—domestic vs. international; what regions of the world?; focus on urban coastal environments?

- A strong point was made about the interrelationships between climate change impacts on military infrastructure, such as naval ports, and the ability to operationally deliver HADR missions.

- There was some discussion of health impacts on military personnel from climate change (theme 23), with an emphasis on the need for greater research, more collaboration and better education.

Summary From Breakout Sessions:

Overall, the thematic priorities that emerged from Moderators’ presentations across all Breakouts included:

1 Global risk assessment and forecasting;
5 At risk populations;
6 Data analytics for military greenhouse gas emissions;
7 Comprehensive NATO map of military greenhouse gas emissions;
11 Resilience of military installations especially naval bases;
13 Climate change impacts on military infrastructure in polar regions;
14 Climate change impacts on supply chains and military logistics;
18 Mapping HADR requirements and operational impacts; and
19 Forecasting HADR missions and requirements.

Closing Remarks and Priorities for Next Workshop:

As the first workshop came to an end, Kurtis Simpson offered the following concluding remarks:

- The **climate security agenda is opaque**. We need to come together as a community to think through and identify priorities in an iterative way.

- With the workshop objectives of **knowledge sharing, promoting synergies and identifying themes,** we have shared great successes in this first workshop.

- As part of the scoping exercises happening with the workshops, we will continue to **narrow down the theme focus areas** –to sift through and find tangible targets. **Prioritization, however, will be a challenge.**

- Another positive aspect of the workshop discussion was the **leadership on the maritime domain** – which is being sponsored by the Office of the Chief Scientist. It was put forward in this workshop as one theme area that individual nations should think about. **We now have a catalyst, there are expectations on us working together.** This is one area that is an easy target because a lot of good work has been started, there is expertise that exists, and we should think about how to connect and move forward.

Next Steps:

- **We will solicit topics for the next workshop** –this is very much a collaborative exercise, as a group, we want to work together to set the agenda, identify topics, and proposed speakers.

- The **workshops should focus on action items and coming together with specific proposals not just talking and debating and developing high-level pictures**. We want to find concrete project areas for S&T to work on. We want to encourage leaders in each of the countries to be thinking about initiatives to pose and push for the next set of workshops.

- This work is going **to set the stage for being able to guarantee the collective success of the CCASCOE**. We all have a shared stake in this. Another action item will be **to continue reaching out to other NATO members that have expressed an interest in climate security – to harmonize our vision and build momentum.**

Appendix

I. Workshop I Participants:

1. Gisele Amow, Defence Scientist, Department of National Defence (Canada)
2. Cathy Boscarino, Programme Manager, Energy, Environment & Climate and Security, DND/DRDC, Strategic Focus Area, Institution (Canada)
3. Blair Brimmell, Interim Director CCASCOE and Section Lead, Global Affairs Canada (Canada)
4. Deborah J Campbell (United States), Executive Director of the Climate Resilience Early Warning System Network, MIT Lincoln Laboratory
5. Sandro Carniel, Research Department, Head, NATO, Center for Maritime Research and Experimentation (Italy)
6. Albert Chan, Portfolio Manager, DND/DRDC, Engagement Strategies (Canada)
7. Bruno Charbonneau, Professor, Director of the Centre for Security and Crisis Governance (CRITIC), Canadian Defence Academy, Royal Military College Saint-Jean (Canada)
8. Wojciech Czarnecki (Major) (Poland)
9. Tom Deligiannis, Instructor, Global Studies, Wilfrid Laurier University (Canada)
10. Thomas Drake, Head of Ocean Battlespace for the US ONR, Office of Naval Research (United States)
11. Ella Fleming, Defence Science and Technology Laboratory (DSTL) (United Kingdom)
12. Giovanni Fusina, Defence Scientist, DRDC (Canada)
13. Sally Garrett (Observer), Science Researcher, Defence Technology Agency, New Zealand (ICE-PPR), New Zealand Defence Force (New Zealand)
14. Trevor Hammond (Participant), Director, Future Force Development, New Zealand (ICE-PPR), New Zealand Defence Force (New Zealand)
15. Michael Hosken, Policy Officer, DND/ DRDC, R & D Science Policy Integration (Canada)
16. Chris Hough, Director, DND/ DRDC, Strategic Focus Area, Institution (Canada)
17. Niels Karup-Hansen (Denmark)
18. Debbie Kemp, Senior Advisor, DND/DRDC, Engagement Strategies (Canada)
19. Rune Lausund, (Norway)
20. Dahlia Lavoie, Junior Policy Analyst, GAC (Canada)
21. John MacKay (Canada)
22. Patrick Mason (United States)
23. Heather Morrison, A/Ex. Dir. Canadian Centre for Climate Services, Environment and Climate Change Canada (Canada)
24. Jan Muijs, National Co-ordinator, MOD NLD, The Hague (Netherlands)
25. Aidan Oliver-Burgess, Climate Change Advisor, DND/DRDC, Engagement Strategies (Canada)
26. John Osler, Chief Scientist, DND/DRDC (Canada)
27. Christian Pedersen, Chemist, Danish Ministry of Defence - Acquisition and Logistics Organisation (Denmark)
28. Sannan Pervaiz, Climate Change and Security Advisor, NATO HQ (United Kingdom)
29. Dale Reding, Scientific Advisor, NATO Office of the Chief Scientist (?)
30. Kurtis Simpson, Director, DND/DRDC, Engagement Strategies (Canada)
31. Louise Sköldback, Sweden (ICE-PPR) (Sweden)
32. Fabian Taube, Scientific research advisor (associate prof.), Swedish armed forces center for defense medicine (Sweden)
33. Guy Vezina, Director General Strategic Partnerships, DRDC (Canada)
34. Øyvind Albert Voie, Norway (ICE-PPR) (Norway)
35. Annica Waleij, Swedish Defense Research Agency (FOI) (Sweden)
36. Wesley Wark, Senior Fellow, CIGI (Canada)
37. Nina Wesch, Senior Analyst, DND/DRDC, R & D Science Policy Integration (Canada)
38. Katie Woodward, UK nominee, Defence Science and Technology Laboratory (DSTL) (United Kingdom)