# National Security Significance of a Changing Climate

## Naval Climate Engagement

Leading international action

**Science and Technology**

**Contingency Engineering**

**Health of the Force**

## Conference Program with Report and Slides

**Online Conference**
January 19, 2023, 0900 - 1200 EST

CHSG
Climate & Human Security Group

THE UNITED STATES NAVAL WAR COLLEGE
VIRIBUS MARI VICTORIA

# Letter from the Host

On behalf of the U.S. Naval War College, we welcome you this virtual conference about the "**National Security Significance of a Changing Climate: Naval Climate Engagement**."

This is our third conference **National Security Significance of a Changing Climate** online conference. The first conference, "Risk and Resilience in the 21st Century," was a call to action exploring solutions about what a changing climate means for your country, your service, your career field, and each of you personally. The second "Operationalizing Climate Security," asked how geographic combatant commands (GCCs) are integrating climate change into their mission, strategy, planning, and operations. We are excited to host the next installment—looking deeper at foreign partner engagement with navies.

The progress in the last two years derives from national and defense strategies. Building on the DoD Climate Risk Analysis (DCRA) and DoD Climate Adaptation Plan (DCAP), each service has released their own approach to climate. The Department of the Navy's Climate Action 2030 seeks to build a climate-ready force by through climate resilience and reducing the climate threat. The Plan pursues climate change efforts that strengthen maritime dominance, empower our people, and strengthen strategic partnerships. To accomplish these goals, we will work internally across the Department of the Navy as well as with naval allies and partners around the world.

We are proud to continue our tradition of hosting open and free events exploring the national security significance of a changing climate. This event is made possible through the generous funding of the William B. Ruger Chair of National Security Economics, Professor Peter J. Dombrowski, and the Naval War College Foundation. Thanks to all for their support of this event.

Sincerely,

Andrea H. Cameron

CDR Andrea H. Cameron, Ph.D., Ed.D.
Permanent Military Professor
National Security Affairs Department
Director, Climate & Human Security Group
U.S. Naval War College

This is an interactive PDF.

All navigation links are active.
Speaker names on agenda link to speaker bios with return links.

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= USNWC Alumni | = USNWC Faculty

# Contents

# Agenda

◌ **9:00 – 9:30 AM EDT** (1300 – 1330 UTC)

**Introduction** – Watch on **YouTube**

**Commander Andrea H. Cameron, Ph.D., Ed.D.**, Permanent Military Professor, National Security Affairs Department; Director, Climate & Human Security Studies Group, U.S. Naval War College

**NWC Welcome** – Watch on **YouTube**

**Stephen J. Mariano, Ph.D.**, Provost, U.S. Naval War College

**Keynote Speaker** – Watch on **YouTube**

**Vice Admiral Ricky Williamson**, Deputy Chief of Naval Operations for Fleet Readiness and Logistics, N4, Office of the Chief of Naval Operations

◌ **9:30 – 10:10 AM EDT** (1330 – 1410 UTC)

**High Level Discussion** – Watch on **YouTube**

- **Rear Admiral Paul Beattie**, Director of Naval Staff, Royal Navy
- **Ms. Deborah Loomis**, Senior Advisor to the U.S. Secretary of the Navy (Climate Change)

◌ **10:10 – 10:20 AM EDT** (1410 - 1420 UTC) – **Break** –

◌ **10:20 – 11:20 AM EDT** (1420 – 1520 UTC)

**Panel: US Naval Areas of Focus** – Watch on **YouTube**

- Science and Technology: **Mark S. Spector, Ph.D.**, Office of Naval Research, Advanced Naval Platforms
- Contingency Engineering: **Robin O'Connell**, Director of the Climate Change Program Office at the Naval Facilities Engineering Systems Command Headquarters (NAVFAC HQ)
- Public Health: **Ian W. Sutherland Ph.D., MSPH; CDR, MSC, USN**, Officer in Charge; Navy Entomology

- **11:20 – 11:30 AM EDT** (1520 – 1530 UTC)

**Closing Remarks** – Watch on **YouTube**

**Commander Andrea H. Cameron, Ph.D., Ed.D.**, Permanent Military Professor, National Security Affairs Department; Director, Climate & Human Security Studies Group, U.S. Naval War College

# Biographies

## Event Chair

### Commander Andrea H. Cameron, Ph.D., Ed.D.

Chair

Permanent Military Professor, National Security Affairs Dept.; Founding Director of the Climate and Human Security Studies Group, U.S. Naval War College

Commander Andrea H. Cameron is a Permanent Military Professor teaching policy analysis in the National Security Affairs Department at the U.S. Naval War College and the founding director of the Climate and Human Security Studies Group. She also teaches on climate change and national security. Her academic interests explore non-traditional and transnational security threats and their impact on U.S. strategic, national security and economic interests. These research interests include climate change and security, climate and energy policy, human security topics, and civil-military coordination during humanitarian assistance/disaster relief. Andrea Cameron holds a B.A. degree in Political Science from Marquette University, a M.A. in Human Resource Development from The George Washington University, a M.S. in Military Operational Art and Science from the Air Command and Staff College, an Ed.D. in Educational Technology from Pepperdine University, and a Ph.D. in Security Studies from the Naval Postgraduate School.

Andrea Cameron is selected as a Fulbright Scholar in NATO Security Studies in Belgium for academic year 2022-2023. She will be teaching at the College of Europe and continuing her research in climate security.

andreahcameron.com

## Opening Remarks

### Stephen J. Mariano, Ph.D.

Opening Remarks

Provost, U.S. Naval War College

Provost Stephen Mariano, Ph.D. most recently served as the deputy commandant and dean of the NATO Defense College in Rome, Italy. He also served on the faculties of the School of International Service at American University, National Defense University, the Royral Military College of Canada and the U.S. Military Academy. He holds a B.A. in mathematics and economics from the University of California, Santa Barbara, an M.A. in national security affairs from the Naval Postgraduate School, and a Ph.D. in war studies from the Royral Military College of Canada.

usnwc.edu

## Keynote Speakers

### Vice Admiral Ricky Williamson

Keynote

Deputy Chief of Naval Operations for Fleet Readiness and Logistics, N4, Office of the Chief of Naval Operations

Vice Adm. Rick Williamson is a native of Jacksonville, Florida. He is a 1985 graduate of the U.S. Naval Academy, where he received a Bachelor of Science in Computer Science. He earned a Master of Business Administration from the Naval Postgraduate School in 1990 and is a graduate of the Armed Forces Staff College in Norfolk, Virginia.

His early sea assignments include tours onboard USS Dewey (DDG 45), USS Briscoe (DD 977), USS Enterprise (CVN 65) and executive officer of USS Rodney M. Davis (FFG 60). He commanded USS Simpson (FFG 56) during NATO's Standing Naval Forces Atlantic 2004 deployment to the United States, the first such visit by NATO to the United States after 9/11. Under his command, Simpson won two

Ashore, his assignments include tours in the Washington, District of Columbia. area as executive assistant to Commander, Navy Installations Command, and deputy director of Plans and Policy. Additionally, he served as a lead examiner of both the steam and gas turbine branches at the Propulsion Examination Board at Commander in Chief, U.S. Atlantic Fleet. In May 2006, he served as executive officer of the Command Leadership School at Newport, Rhode Island. From 2008 to 2011, he served as commanding officer of Naval Base San Diego. During this tour, Naval Base San Diego was selected as the 2010 Presidential Installation Excellence Award and the 2011 Presidential Green Government Award. From March 2016 to June 2019, he served as commander, Navy Region Europe, Africa, Southwest Asia /

Maritime Air Forces, Naples. Williamson assumed duties as deputy chief of naval operations for fleet readiness and logistics June 27, 2019.

Williamson's decorations include the Legion of Merit, Defense Meritorious Service Medal, Meritorious Service Medal, Navy and Marine Corps Commendation Medal, Navy and Marine Corps Achievement Medal and various other unit and campaign awards.

## High Level Discussion

### Rear Admiral Paul Beattie

High Level Discussion

Director of Naval Staff, Royal Navy

Rear Admiral Paul Beattie joined as the Director Naval Staff in May 2021, following assignments as Chief of Staff to Navy Command, and Head of Naval Staff. He is a graduate of the US Naval War College and the UK Higher Command and Staff Course, holds a MSc in Leadership and Management, and is an advocate for Social Mobility in Defence.

Paul joined the Royal Navy in 1989 and spent his early years conducting maritime embargo enforcement in the Persian Gulf (Op Granby), Northern Ireland (Op Banner) and the Adriatic (Op Sharp Guard) before completing a second Northern Ireland tour as the Commanding Officer of the Patrol Boat HMS Arun. After warfare training, he returned to sea as the Operations Officer of HMS York (Op Veritas) and then HMS Edinburgh (Op Telic). From 2004-2006 he served as the Military Assistant to the Navy Capability lead before returning to sea as the XO (Second in Command) of HMS Westminster, and then as the inaugural XO of the first Type 45 Destroyer, HMS DARING. This was followed by Command of HMS Manchester.

Paul the ventured across the Atlantic. Firstly, completing the US Navy Senior Command Course at Newport, Rhode Island, before serving in the Pentagon on the USN Strategy Staff. He returned to the UK in 2013 to work in Head Office supporting the preparations for the 2015 Strategic Defence and Security Review, during which he authored the UK's first National Strategy for Maritime Security. Promoted to Captain in 2014, he served first as Chief of Staff to the UK Maritime Battle Staff, during a time when the Royal Navy held both NATO Response Force and CJEF Command, and subsequently as the Principal Staff Officer to Commander Joint Forces Command (now UK STRATCOM).

royalnavy.mod.uk

### Ms. Deborah Loomis

High Level Discussion

Senior Advisor to the U.S. Secretary of the Navy (Climate Change)

Deborah Loomis received a commission in the Navy upon graduating from the University of Pennsylvania with dual degrees from the Wharton School and the College of Arts and Sciences. She began her career as a surface warfare officer, deploying on USS GONZALEZ (DDG 66) and USS KINKAID (DD 965) before serving as a Navy Liaison to the U.S. Senate.

Ms. Loomis then attended Georgetown Law School on a Navy Law Education Program scholarship. After receiving her law degree, she joined the Navy JAG Corps

where she advised senior Navy leaders including the Chief of Naval Operations and Judge Advocate General.

She returned to Georgetown to earn a master's focused on energy and environmental law and served tours as an environmental counsel at U.S. Fleet Forces Command, OPNAV N4, and the Assistant Secretary of the Navy for Energy, Installations and Environment. In those roles she worked with federal partners across the interagency and in the Department of Defense on projects spanning from the Arctic to Guam.

Ms. Loomis has been working at the nexus between climate change and national security for many years. While stationed in Norfolk, she was an early contributor on a pilot project that brought together representatives from the federal, state and local governments to address sea level rise using a whole of government approach. She has also contributed to several articles and publications on climate and security including the 2020 World Climate Security Report and Climate 21 Project. In her personal capacity she is a Public Voices Fellow on the Climate Crisis through the Yale Program on Climate Change Communications and a member of the Board of Directors of Washington, DC's Green Bank..

## Panel: US Naval Areas of Focus

*Moderator:*

**Commander Andrea H. Cameron, Ph.D., Ed.D.** Panel

Permanent Military Professor, National Security Affairs Dept.; Founding Director of the Climate and Human Security Studies Group, U.S. Naval War College

Photo and Bio are listed as Event Chair.

andreahcameron.com

*Panelists:*

**Mark S. Spector, Ph.D.** Panel

Office of Naval Research, Advanced Naval Platforms Division

Dr. Mark S. Spector is a Program Officer in the Advanced Naval Platforms Division at the Office of Naval Research where he manages research in thermal science, metamaterials, energy conversion, and climate resiliency. In addition, he sits on the Steering Committee of the Department of Defense Energy and Power Community of Interest, the US Navy Climate Working Group, and the NATO Applied Vehicle Technology Power and Propulsion Systems Technical Committee. Previously, he

worked as a Research Physicist at the Naval Research Laboratory. He received his doctorate in Physics from the Massachusetts Institute of Technology and bachelor degrees in Physics and Applied Mathematics from the University of California at Berkeley. Dr. Spector has coauthored 56 journal publications, 3 invited book chapters, and holds 3 patents.

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## Robin O'Connell

Panel

Director of Climate Change Program Office at the Naval Facilities Engineering Systems Command Headquarters (NAVFAC HQ)

Robin O'Connell is currently serving as the Director of the Climate Change Program Office at the Naval Facilities Engineering Systems Command Headquarters (NAVFAC HQ) in Washington DC. Prior to this appointment, she served as the Director of Sustainability & Land Use and Senior Climate Change Advisor. During her 11-yr tenure as the Sustainability & Land Use Director, her focus was to develop a land use approach that struck a balance between sustaining military readiness, resource conservation and renewable energy development. Robin also served as the Director of Global and Strategic Planning, helping to expand NAVFAC's planning portfolio to address the infrastructure needs of new weapons platforms and integrated global logistics. Prior to joining Headquarters, Robin lived and worked in East Asia and the Pacific for more than 20 years, where she held environmental policy and regional development positions in the US Federal government, private industry, academia, and international organizations. Robin received her AB in Asian Studies from Dartmouth College with a major in Chinese and a minor in Geography. She later received her MA in Geography and Regional Planning from the University of Hawaii while serving as a degree fellow at the East-West Center, Environment and Policy Institute.

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## CDR Ian W. Sutherland, Ph.D., MSPH, MSC, USN

Panel

Office in Charge; Navy Entomology

CDR Ian W. Sutherland is the Officer in Charge of the US Navy Entomology Center of Excellence, responsible for the global vision of the DoD's only Command dedicated to preventing mission-stopping diseases spread by the six-legged soldiers that have determined the fate of empires during both war and peace. For nearly 2 decades, he has been seasoned on the unsung intersectional frontlines of global health and national strategic interests: leading humanitarian assistance, outbreak response operations, and research across 25 countries, including Afghanistan, Laos, Vietnam, Ghana, Haiti, Honduras, the Marshall Islands, and has previously served as both the

BUMED Deputy Director for Global Health Engagement and Director of NAMRU-2 Phnom Penh, Cambodia. CDR Sutherland holds a PhD in Microbiology from Colorado State University, an MSPH in Parasitology from Tulane's School of Tropical Medicine, and a Bachelor's degree from the Louisiana Scholars' College.

ian.w.sutherland.mil@health.mil | med.navy.mil

# Recommended Resources

## Naval War College (NWC) Climate Change Library Guide

https://usnwc.libguides.com/climatechange

This research portal available to all—organizing materials in over ten subpages focused on categories like international climate change and DOD Climate Resources as well as human security issues like water security, food security, and migration. The guide features countless open-source resources from U.S. Government, international, and academic organizations and books, journals, and databases accessible to those with NWC credentials.

## Climate Security Think Tanks and Centers:

- Center for Climate and Security https://climateandsecurity.org
- International Military Council on Climate and Security https://imccs.org
- Wilson Center—Environmental Change and Security Program (ECSP) https://www.wilsoncenter.org/program/environmental-change-and-security-program
- American Security Project (ASP) Climate Security https://www.americansecurityproject.org/issues/climate-security
- Center for a New America Security—Climate Change https://www.cnas.org/research/energy-economics-and-security/energy-exports/climate-change
- Stimson Center Climate Security https://www.stimson.org/project/climate-security
- International Institute for Strategic Studies (IISS)—Environmental and Climate Change https://www.iiss.org/topics/environmental-and-climate-change
- Stockholm International Peace Research Institute (SIPRI)—Climate Change and Security https://www.sipri.org/research/peace-and-development/climate-change-and-risk/climate-change-and-security
- Stockholm International Peace Research Institute (SIPRI)—Climate Change and Risk https://www.sipri.org/research/peace-and-development/climate-change-and-risk
- Planetary Security Initiative https://www.planetarysecurityinitiative.org
- Center for Climate and Energy Solutions (C2ES) https://www.c2es.org

## Climate Science Research Organizations:

- NASA Climate Change and Global Warming https://climate.nasa.gov
- NOAA Climate https://www.noaa.gov/climate
- Woods Hole Oceanographic Institution—Climate & Ocean https://www.whoi.edu/know-your-ocean/ocean-topics/climate-ocean
- Woodwell Climate Research Center https://www.woodwellclimate.org
- World Resources Institute Climate https://www.wri.org/our-work/topics/climate
- Union of Concerned Scientists (UCS)—Climate Change https://www.ucsusa.org/climate
- American Meteorological Association—Climate Change https://www.ametsoc.org/ams/index.cfm/about-ams/ams-and-climate-change
- Center for Climate Systems Research (Columbia University Earth Institute) https://ccsr.columbia.edu
- The Energy and Resources Institute (TERI) https://www.teriin.org

# Thank You

Thank you to the U.S. Naval War College staff and faculty who helped support this event:

**President RADM Shoshana Chatfield, Ed.D.**
U.S. Naval War College

**Provost Stephen Mariano, Ph.D.**
U.S. Naval War College

**Prof. Peter Dombrowski, Ph.D.**
William B. Ruger Chair of National Security Economics

**The Naval War College Foundation**

**Prof. Michael H. Bush, Ed.D.**
Technology & Innovation, College of Distance Education

**LCDR David Nostro**
Student, College of Naval Command and Staff

**CDR Gary Ross** – Public Affairs Office
**Christin Redding** – Office of Alumni Programs

**Karen Sellers** – Director, Special Events
**Carolyn Sarmento** – Special Events

**Dean DePalma** – Media Services
**Marc Cardillo** – Media Services

**Isabel Lopes** – Librarian

And many thanks to the speakers and moderators who worked so hard to make this an incredibly successful event!

# Conference Report

**CDR Andrea H. Cameron** introduced the third National Security Significance of a Changing Climate virtual conference with a theme of Naval Climate Engagement conference.

## Conference Framing

Executive Order 14008, Tackling the Climate Crisis at Home and Abroad, launched the U.S. government's action on climate change on January 27, 2021—almost two years before this conference. The progress in the last two years has been driven by our national and defense strategies. For example, the National Security Strategy mentions climate more than 60 times. The National Defense Strategy states that "climate change and other transboundary threats will increasingly place pressure on the Joint Force and the systems that support it." Recurring climate themes like agility, resilience, adaptability, and sustainability are meant to keep our forces at peak performance.

Within the Department of Defense, the DoD Climate Risk Analysis (DCRA) and DoD Climate Adaptation Plan (DCAP) are building on this national-level guidance. Since those were published, each service has released its own approach to climate. The Department of the Navy's Climate Action 2030 seeks to build a climate-ready force through climate resilience and reducing the climate threat. Our climate vision aligns with The One Navy-Marine Corps Team Strategic Guidance from Secretary Del Toro, the Chief of Naval Operation's Navigation Plan, and the Commandant of the Marine Corps' Planning Guidance. All are intended to enhance the readiness and capabilities of the DON as a global maritime power and Climate Action 2030 is an important step forward in how we think about operating the naval force in a climate-altered environment.

The Climate Action 2030 pursues climate change efforts that **strengthen maritime dominance, empower our people, and strengthen strategic partnerships**. To accomplish these goals, we work internally across the Department of the Navy and with naval allies and partners worldwide.

This year's conference has a theme of naval climate engagement for several reasons. First, being part of the Navy climate Working Group and at the U.S. Naval War College—CDR Cameron thought this was an excellent time to share the progress over the last two years. Second, we have the persistent recognition that our progress must be in sync with allies and partners—all of us moving in a similar direction while we adopt our climate strategies. For this reason, **not only do we highlight our developments but**

**also the essential foreign partner engagement that is occurring in the respective areas**.

## Keynote Speech and High-Level Discussion

### Keynote Speech

The Naval Climate Engagement conference kicked off with a keynote address with **VADM Rick Williamson, who has been the Deputy CNO for Fleet Readiness and Logistics since 2019.** VADM Williamson spoke extensively about climate resilience, the environment, and how it affects our Navy. With climate change, he focused not only on how we look at problems but how we innovate, share, and collect information to ensure we are **always protecting mission and our people**. Additionally, **we cannot do anything without our allies and partners,** and climate matters when we are building, training, and operating our navy. Through several examples experienced throughout his career, he recognized that different areas have critical impacts and that there is no one-size-fits-all **solution**. Therefore, we need to understand these things, and **planning ahead is imperative for the navy**.

VADM Williamson talked about great power competition and the climate impacts on sea lanes of communication and our platforms. Notably, we need to look at how we develop the platforms based on the environments they operate in and do not want those platforms to contribute to the problem. In his experience, when we talk about climate we should **"always finish the sentence with the impact to operations."**

In his current role, he highlighted both fleet logistics and installation resilience. Within logistics, the demonstrated weaknesses within the supply chain are operational vulnerabilities. As a result, **climate, endurance, and logistics all go hand in hand**. With the concept of endurance, he asked how we can look at the problem in a way to allow fuels that give a greater range, burn cleaner, and helps the ship's captain not be dependent on the logistics chain so they have more freedom of maneuver. Those things should be in harmony because it gives us an operational advance. We must articulate the problem to industry, universities, and other government agencies so they can help us solve these problems. In addition, we have to be smarter because we do not want to contribute to greenhouse gases if we can avoid them. Therefore, we will maintain or improve our capability.

For base infrastructure, VADM Williamson noted that "**The sea, on a good day, is a challenging environment,"** and many of our bases are on the sea. We need to build

our bases better with the unified facility criteria. Every one of the navy regions has a Region Master Plan, which is informed by the Defense Climate Assessment Tool (DCAT), the Naval Facilities Command, local government, industrial base, and universities. If we can combine our money with partners, we will get more buying power and innovation in building back better. Now, we have cradle-to-grave project management that considers the environment, energy consumption, and innovative ways to solve problems.

To do all this, **"we need a culture change" where climate resilience must be embedded in everything we do.** When we see the opportunity to increase our operations and protect our people, particularly the climate, we used to have to fight for resources. Now, we can prove the benefits through our plans and show why we are taking the actions we are.

To summarize VADM Williamson, we gain operational advantage and protect our people by working toward climate resilience within the Navy.

## High-Level Discussion

The high-level discussion included RAdm Paul Beattie of the United Kingdom and Ms. Deborah Loomis from the United States.

**RAdm Paul Beattie is the Director of Naval Staff leading the Royal Navy's actions on climate change.** He framed his talk by answering a frequently asked question: **Why does the Royal Navy care about climate change and sustainability? The answer: It's all about operational advantage.** He broke this down into four areas. First, the Royal Navy is a global navy that wants to retain the ability to operate anywhere in the world—to do that, they need to understand what is happening and be ready for the future. Second, climate change will increase demand for navies, and we need to understand the how, where, and when as well as have the right capabilities going forward. He cites the First Sea Lord, Admiral Sir Ben Key:

> *"The Royal Navy's primary purpose is to protect the UK's security and prosperity. This requires us to confront a range of factors which drive human instability and insecurity at and from the sea, the greatest of which is a more dynamic and testing climate. The impact of this will increase the demand signal for Navies across the spectrum of operations, from conflict prevention and maritime security to humanitarian assistance and disaster relief, while the warming of the seas will further expand the geographic scope of our activity.*

> *At the same time, the Royal Navy is itself a consumer of environmental resources – on operations, on and below the sea, on land and in the air. So we must also adapt our technology and processes to mitigate and reduce our impact on the environment, and to embrace the opportunities this way of thinking and behaving offers. We cannot wait a day longer to secure a better future, to mitigate the risks of climate change, and to realize the benefits of sustainability. The Navy must and will be part of the solution to climate change."*
>
> *-Admiral Sir Ben Key KCB, CBE, ADC, First Sea Lord*

Third, we must adapt to operate effectively in that changed world and embrace new technologies to retain that operational advantage. Finally, we need to consider our people. To attract and retain the best of society, we have to play an active role in dealing with climate change and not contributing to it.

The Royal Navy has developed a three-phased plan. The first is a 'build phase' to 2025, laying the foundations for action while remaining agile enough to changes in the climate, technology, and legislation. The second is an 'embed phase' to 2035, followed by the 'accelerate phase' looking toward 2050.

The 'build phase' has nine Lines of Operations: data; culture and behaviour; governance and HQ; estate; operational capability and force development; support, maintenance, logistics; research, development, innovation; allies and partners; and finance and commerce. In giving a description of these efforts, he makes a particular note reflecting that 'culture and behaviour' are that **"the climate change and sustainability program is the UK's biggest change program—it just hasn't realized it yet."** This is not about the amount of money, but because it touches everything we do. The networks of people are bringing forward ideas of what they need to change. This is an area where they're not making changes to our people, because the people are driving the change in the organization. It is not an area where there's a "frozen middle [among the people]," adding that if he were being critical, it would be an area of **"frozen leadership."**

For force development and planning—we need to be clear about what environment we are planning for next generation. For force development, we must be careful that we are not developing platforms that are not designed to operate in that environment and have a command standard with allies and partners. Essential that we do not get that wrong. In addition, **we have to work bilaterally, multilaterally, and regionally to find the appropriate solution.**

**Ms. Deborah Loomis is the Senior Advisor to the Secretary of the Navy for Climate Change.**

She quoted VADM Williamson's keynote call to action: "This is good. Can we do great?"

This spring, the Department of the Navy published Climate Action 2030. Ms. Loomis highlighted many examples of climate change impacts around the world and that we are spending billions recovering from climate change-related events. Because climate change impacts so many things we do across the department, everyone has a role to play, and everyone can make a difference. In Navy speak, this is an all-hands-on-deck evolution. As a result, in our strategy, we built a big tent.

Strength in warfighting and preparing for climate change go hand in hand. **Everything we do must make us a stronger force and make use more secure**. She gives several examples of new technology that makes us less reliant on fossil fuels and the vulnerabilities they represent. These make us better warfighters while also reducing our climate footprint. In addition, we are more secure by being more resilient. At the end of the day, it comes down to force modernization and risk management.

M.s Loomis highlighted three key lenses the Navy can do about climate: 1) reduce our own carbon footprint, 2) improve resilience around bases and surrounding defense communities, and 3) work **with allies and partners to increase resilience and reduce the potential political instability that climate change represents**. The SECNAV and Ms. Loomis are working diligently, especially on working with allies and partners. In an engagement at the University of South Pacific, a region where climate change is an existential threat, SECNAV spoke to an audience that wanted to hear that the United States takes this seriously and was listening to their regional concerns. This international engagement will be briefed in the three panels after the break.

**Questions and Answers:**
*Speakers are asked to give tangible examples of supporting allies and partners.* VADM Williamson, RAdm Beattie, and Ms. Loomis gave many examples. One highlight included the importance of interoperability. RAdm Beattie thought it would not be a single fuel transition but multiple fuels, and we have to ensure we're aligned with our allies and partners and make those decisions together. Ms. Loomis also mentioned the interoperability of facility sharing and forward basing. She added the innovations about using local materials in situ. This reduces the logistics burden and the carbon footprint.

*What's next in the climate policy?*

Ms. Loomis previewed the upcoming Department of the Navy Campaign Plan coming out soon, including specific measures of what we are doing and by when. RAdm Beattie announced the UK Strategy on Operational Energy that will be released this year. They are looking across the joint force and examining the operation needs. VADM Williamson noted that the policies must be agile enough to adjust. He sees his position as embedding the policy into the processes. We need to understand how the policy and processes will work together to move the needle across the dashboards that are being built within the Naval force.

## Panel-U.S. Naval Areas of Focus

### Science and Technology

**Dr. Mark S. Spector** is a Program Officer in the Advanced Naval Platforms Division at the Office of Naval Research (ONR). He spoke on "Science and Technology Opportunities to Support Navy Climate Action 2030." His talk focused on the climate change pillars of mitigation and resilience.

His primary focus is on **Mitigation** which he describes as reducing our environmental impact by reducing emissions of greenhouse gases. This is through energy efficiency, low-carbon technologies, and refrigerants. Dr. Spector is on the Power and Energy focus area team, where they work on the various energy needs of naval platforms and sensors. ONR is working on gas turbine efficiency to reduce greenhouse gas emissions, where 95% of emissions come from the exhaust from burning fuel. In addition, ONR and the Department of Energy are looking at alternative fuels like green hydrogen. For example, ONR-funded research is looking into a hybrid hydrogen-powered vessel. Also, Direct Air Capture and Blue Carbon is also part of the research portfolio. Finally, ONR looks at low GWP (global warming potential) refrigerants to be used on ships.

The other focus is Climate **Resilience** – Earth system modeling and forecasting of extreme events for operational resilience, environmental sensing resilience, naval energy resilience, and military platform resilience to climate change. ONR has basic research in marine meteorology and space, littoral geosciences, and physical oceanography. There is a lot of interest in forecasting extreme weather events that affect how we operate.

International partnerships are key in climate sciences. In addition to many examples, he specifically mentions the NATO Science and Technology (STO) Applied Vehicle Technology (AVT). The AVT Panel's mission is to improve the performance, affordability, and safety of a vehicle, platform, propulsion, and power systems operating in all environments for new and aging systems by advancing appropriate technologies. Dr.

Spector concludes with an exploratory team with Canadian partners for mitigating the impacts of climate change on platforms.

## Naval Contingency Engineering

**Ms. Robin O'Connell** is the Climate Change Program Office Director at the Naval Facilities Engineering Systems Command Headquarters (NAVFAC HQ). NAVFAC's primary function as a SYSCOM is to design and deliver infrastructure for the US Navy and Marine Corps. This includes military construction, acquisition of design and construction, and acquisition and program management of expeditionary engineering and logistics. **Most work abroad is expeditionary engineering and logistics, particularly for disaster response, done by the contingency engineers and naval construction forces (Seabees)**. The authorities allow them to work with allies and partners around the world, and they have a particular focus on the INDOPACIFIC. Ms. O'Connell cites that 13 of the 30 countries most vulnerable to climate change impacts are in East Asia and the Pacific region. These regions have huge, dense populations in deltas, atolls, islands, and many in developing countries with limited resources and capabilities.

Ms. O'Connell described the U.S. government process when responding to an affected state's request for Foreign Disaster Relief.

NAVFAC's engagement is not only for emergency services—they also have exercise-related construction and technical exchange. This can include training and security cooperation in disaster risk resilience. NAVFAC will do the engineering, design, and possibly the contract management while partners provide the labor and supplies. This builds partner capability through on-the-job training or subject-matter expert exchanges. The result is the delivery of improved infrastructure and greater adaptive capacity of our partners and allies. It enables the civil and military authorities and communities to be effective first responders.

## Vectorborne Disease

**CDR Ian W. Sutherland** is the Officer in Charge of the US Navy Entomology Center of Excellence, responsible for the global vision of the DoD's only command dedicated to preventing mission-stopping diseases—primarily due to their close association and on-the-ground support of the Marine Corps.

**Vectorborne diseases are exceptionally well-known mission-stopping operational threats.** Viruses and bacteria continue to plague the personnel we and our allies worldwide must face. CDR Sutherland describes this climate change as a poly-crisis—

changing the biology of mosquitos and other vectors and referring to them as '**climatically enhanced insurgents'** spreading into new zones. Both vectors and pathogens are spreading into new areas of the world. There is a limited tool kit of pesticides to manage this public health issue. Even with restrictions, the frontline insecticides of choice are leading to enhancing the spread of insecticide resistance. However, resistance is not inevitable—it will require changing our training, modernizing our surveillance, and no longer paying lip service to carefully monitoring and rotating our insecticide usage. This must be at the forefront of how we train and operate with our allies and partners.

The Navy Entomology Center of Excellence is engaged in **24 projects in 15 countries across all geographic combatant commands**. They are actively bringing technologies out of the lab and into the field to identify and respond to insecticide resistance and vectorborne threats. He specifically mentions the 'Gator Dawn FTX' foreign partner engagement. Finally, in the Q&A, CDR Sutherland mentioned that we're all in this together to address "**winged-borne weapons of mass destruction**."

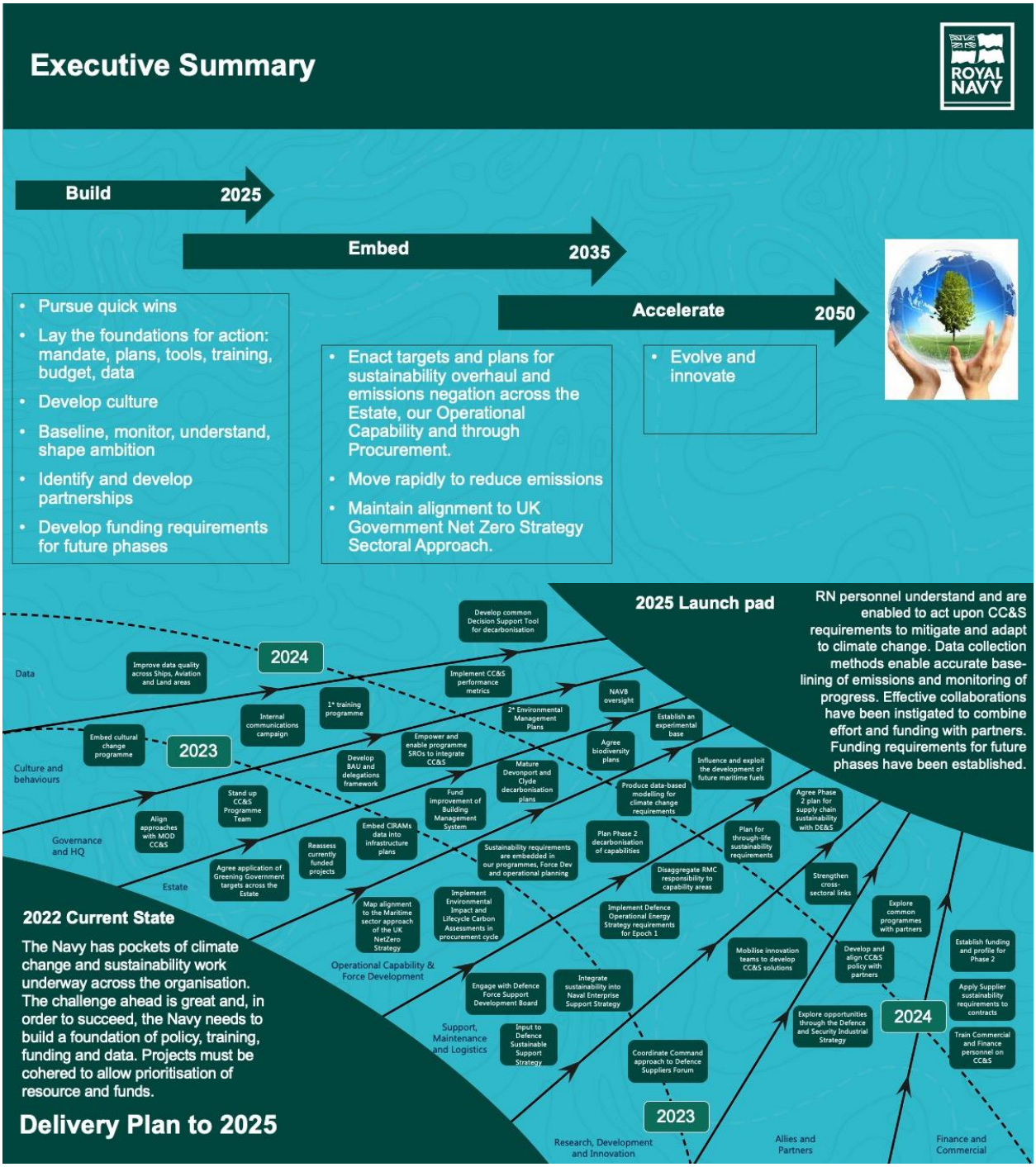
## Questions and Answers:

There are a variety of questions on the video directed to each of the speakers. Please note the additional speaker: Mr. Vince Sobash, the NAVFAC Chief Contingency Engineer.

# Presentation Slides

## High Level Discussion

**Rear Admiral Paul Beattie**, Director of Naval Staff, Royal Navy

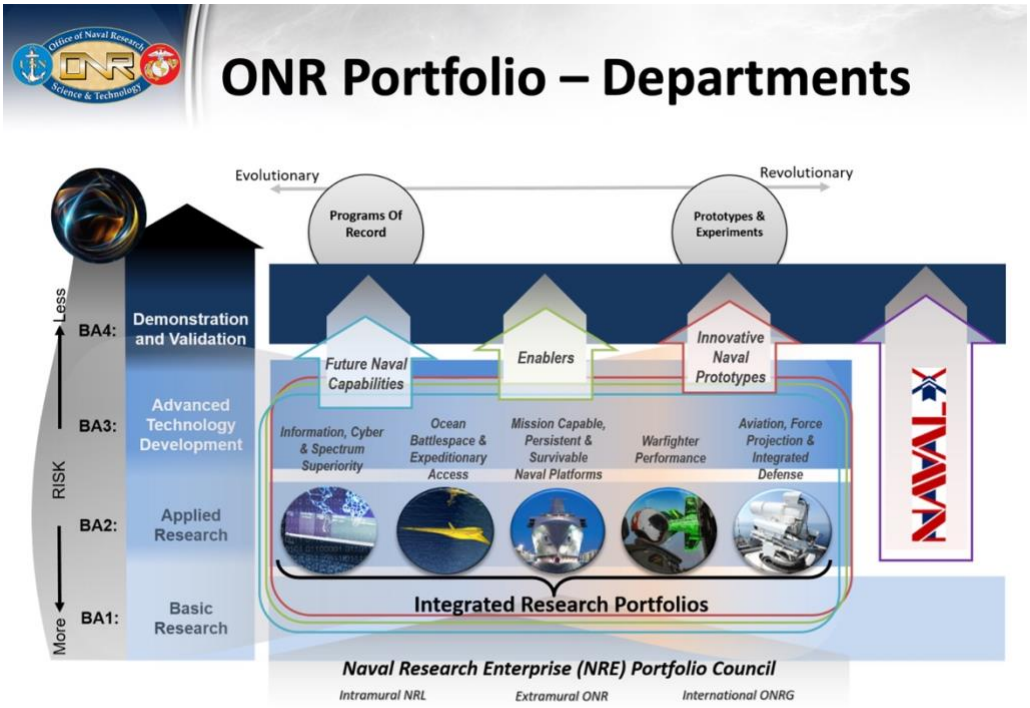

Executive Summary
ROYAL NAVY
Build
2025
Embed
2035
Accelerate
2050
Pursue quick wins
Lay the foundations for action: mandate, plans, tools, training, budget, data
Develop culture
Baseline, monitor, understand, shape ambition
Identify and develop partnerships
Develop funding requirements for future phases
Enact targets and plans for sustainability overhaul and emissions negation across the Estate, our Operational Capability and through Procurement.
Move rapidly to reduce emissions
Maintain alignment to UK Government Net Zero Strategy Sectoral Approach.
Evolve and innovate
2025 Launch pad
RN personnel understand and are enabled to act upon CC&S requirements to mitigate and adapt to climate change. Data collection methods enable accurate base-lining of emissions and monitoring of progress. Effective collaborations have been instigated to combine effort and funding with partners. Funding requirements for future phases have been established.
2022 Current State
The Navy has pockets of climate change and sustainability work underway across the organisation. The challenge ahead is great and, in order to succeed, the Navy needs to build a foundation of policy, training, funding and data. Projects must be cohered to allow prioritisation of resource and funds.
Delivery Plan to 2025
2024
2023
2024
2023
Data
Culture and behaviours
Governance and HQ
Estate
Operational Capability & Force Development
Support, Maintenance and Logistics
Research, Development and Innovation
Allies and Partners
Finance and Commercial
Develop common Decision Support Tool for decarbonisation
Improve data quality across Ships, Aviation and Land areas
Implement CC&S performance metrics
NAVB oversight
1* training programme
Internal communications campaign
2* Environmental Management Plans
Establish an experimental base
Embed cultural change programme
Empower and enable programme SROs to integrate CC&S
Agree biodiversity plans
Develop BAU and delegations framework
Mature Devonport and Clyde decarbonisation plans
Influence and exploit the development of future maritime fuels
Stand up CC&S Programme Team
Fund improvement of Building Management System
Produce data-based modelling for climate change requirements
Agree Phase 2 plan for supply chain sustainability with DE&S
Align approaches with MOD CC&S
Embed CIRAMs data into infrastructure plans
Plan Phase 2 decarbonisation of capabilities
Plan for through-life sustainability requirements
Reassess currently funded projects
Sustainability requirements are embedded in our programmes, Force Dev and operational planning
Disaggregate RMC responsibility to capability areas
Strengthen cross-sectoral links
Agree application of Greening Government targets across the Estate
Map alignment to the Maritime sector approach of the UK NetZero Strategy
Implement Environmental Impact and Lifecycle Carbon Assessments in procurement cycle
Implement Defence Operational Energy Strategy requirements for Epoch 1
Explore common programmes with partners
Establish funding and profile for Phase 2
Mobilise innovation teams to develop CC&S solutions
Develop and align CC&S policy with partners
Apply Supplier sustainability requirements to contracts
Engage with Defence Force Support Development Board
Integrate sustainability into Naval Enterprise Support Strategy
Explore opportunities through the Defence and Security Industrial Strategy
Train Commercial and Finance personnel on CC&S
Input to Defence Sustainable Support Strategy
Coordinate Command approach to Defence Suppliers Forum


9 Lines of Operation to 2025
ROYAL NAVY
1
Data
Data is enabling the Royal Navy to actively manage sustainability targets and plan the decarbonisation decisions of future phases. Robust and accurate data collection has been implemented.
2
Culture and Behaviour
A sustainable behaviour improvements programme has yielded clear cultural change and resulted in action that has reduced emissions and is benefiting the Defence environment. Sustainability is business as usual.
3
Governance and HQ
The Navy has a robust leadership, management and accountability structure, aligned with the MOD CC&S approach.
9 Lines of Operation to 2025
ROYAL NAVY
4
Estate
The Royal Navy is supporting and prepared for implementation of Defence's ambitions for climate change mitigation and adaptation across our estate. The disaggregated targets for Greening Government Commitments are met. Plans are in place to improve the biodiversity of the estate.
5
Operational Capability & Force Development
The future threats in a climate-changed world are defined and understood. Sustainability requirements are embedded in our procurement programmes, Force Development and operational planning: ensuring climate change mitigation and adaptation are considered as a priority, to assure operational advantage.
6
Support, Maintenance, Logistics
Working with stakeholders and our delivery agents, the Navy understands its dependencies and has influenced the approach on cleaner, resilient energy options. The opportunities for greater self-sufficiency in deployments are being realised.


9 Lines of Operation to 2025
ROYAL NAVY
7
Research, Development, Innovation
The Royal Navy is engaged with relevant external research and applying viable findings. Government Departments and other UK science and technology stakeholders are aware of the Navy's CC&S priorities and are seeking ways to support.
8
Allies & Partners
The Royal Navy is working collaboratively with partner nations on climate security issues and adaptation measures. Progress within inter-naval collaborations contributes to the UK's global credentials on climate security.
9
Finance & Commerce
The Royal Navy awards contracts with integral sustainability requirements: working with the supply chain to improve sustainability. The Navy is planning CC&S requirements such that the costs can be understood, prioritised and resourced.

## Panel Slides: US Naval Areas of Focus

**Mark S. Spector, Ph.D.**, Office of Naval Research, Advanced Naval Platforms

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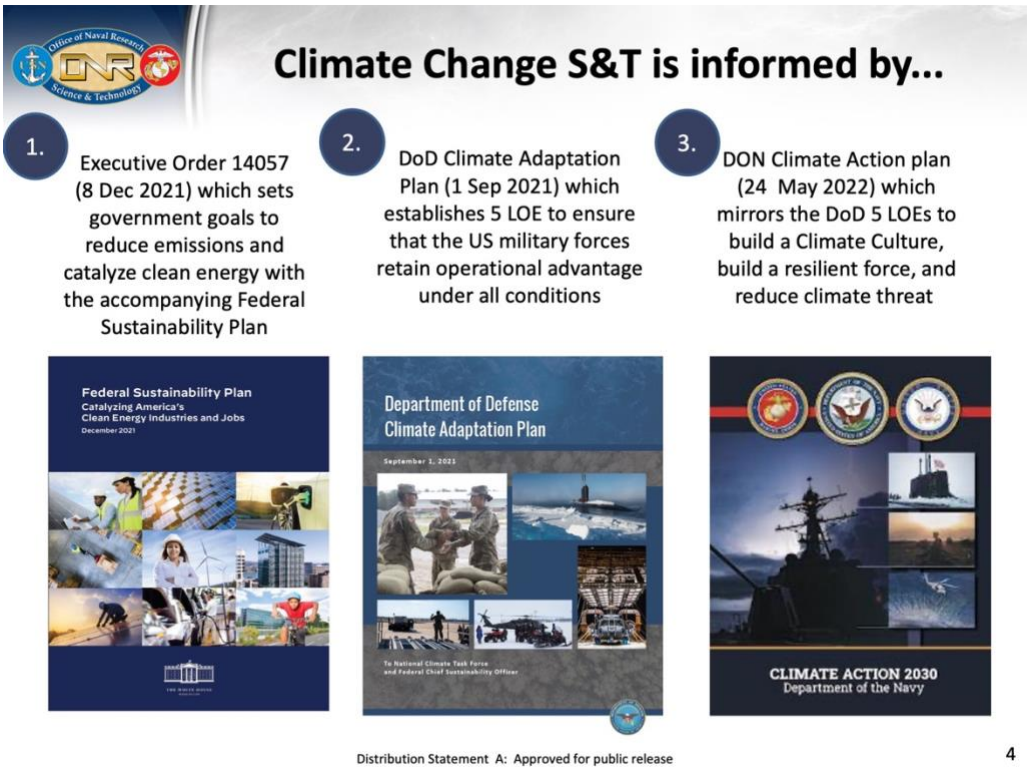


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## Climate Change Pillars

- **Mitigation:** Measures to reduce the amount and speed of future climate change by reducing emissions of greenhouse gases or removing carbon dioxide from the atmosphere.
- **Resilience:** The ability to anticipate, prepare for, and adapt to changing conditions and withstand, respond to, and recover rapidly from disruptions.

-DODD 4715.21, Climate Change Adaptation and Resilience.

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## Mitigation S&T

- Energy Efficiency
  - Gas Turbine Efficiency
  - Energy Recovery
  - Hybrid Systems
- Low Carbon Technologies
  - Renewable Power Generation
  - Alternative Fuels
  - Carbon Capture
- Low GWP Refrigerants

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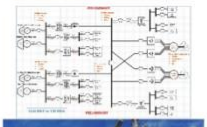
# Power and Energy S&T

Focus Area Lead: H. Scott Coombe

- Primary goal: Increase the effective use, conversion, storage, distribution, and control of energy to enable integration of future weapons and sensors onto platforms and extend operational reach.
  - *Energy efficiency is a byproduct*
- Major Programs:
  - Power Electronics and Electromagnetics
  - Electrochemical Materials
  - Functional Polymeric and Organic Materials
  - Electric Power Components and Control
  - Power Generation and Energy Storage
  - Thermal Science and Engineering
  - Energy Resiliency
  - Efficient Electromechanical Machinery
  - Materials for Carbon Neutral Energy and Resources
  - Expeditionary Power & Energy
  - Advanced Power Systems for Undersea Applications



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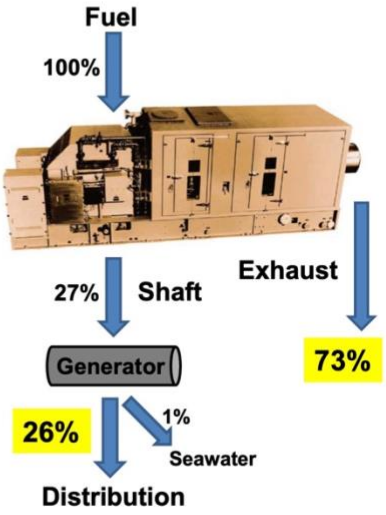
# Gas Turbine Efficiency

- Two-thirds of the energy from DoN's fuel is exhausted.
  - By far the largest carbon emission
- Not all 'waste' heat
  - Thermodynamics dictates maximum engine efficiency
- Pathways to improve efficiency
  - Higher temperature operation
  - Combined cycles to increase efficiency
    - Commonly used in commercial power plants to achieve efficiencies up to 65%
    - *Come with serious size, weight and integration challenges.*

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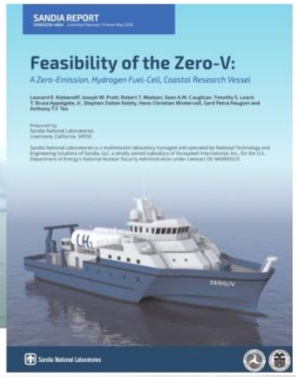
# Alt Fuel: Hydrogen

- Green hydrogen, produced from renewable energy, produces no greenhouse gases when burned
  - DOE Hydrogen Shot program seeks to reduce cost of green hydrogen to $1/kg
  - Infrastructure bill contains $9.5B for DOE hydrogen initiatives
- Scripps Institute of Oceanography plans to build a hybrid hydrogen powered research vessel
  - ONR plans to leverage vessel for engineering studies
- GM developing portable electric vehicle recharge stations using H2 fuel cells
  - Potential use on USN installations for vehicle recharge and energy resiliency

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9

# Direct Air Capture & Blue Carbon Removal Technology Program: Roadmap

Program Officer: Heather Willauer

## State of the Art

DOC Prototypes

DAC Prototypes

Fuel Synthesis/Lubes Prototypes

## "Proof of Concept" Technology Integration Testing 2022 - 2023

Blue Carbon $CO_2/H_2$ Capture Skid

Direct Air $CO_2$/Capture Skid

- Solid sorbent efficiencies
- Catalyst efficiencies
- Energy recovery
- Water recovery
- Lighter, deployable blue carbon units
- Electrical efficiencies
- Fuel production
- Fuel evaluation
- Process evaluations

Gas Processing Skids

Fuel Synthesis Skids 1gpd to 84 gpd

Synthetic Fuel

## Scale 2022 - 2023

Engineering and Development Models (EDM) for Integrated 100 gal/day Chemical Process from DAC, DOC, and fuel synthesis technologies

- Determine number and size of chemical units needed to produce 100 gpd of fuel from DOC and DAC $CO_2$
- Evaluation cost, footprint, and total power requirements
- Determine systems and platform integration
- Determine all system components (Bill of Materials) for integrated synthesis process

Proof of concept and larger scale testing of systems and integrated processes for efficiencies, scaling and deploy ability

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10

## Low GWP Refrigerants

Program Officer: Mark Spector

- All in-service and future ships use HFC refrigerant chillers
  - R236fa (GWP = 9810) and R134a (GWP 1430)
  - 2021 Consolidated Appropriations Act (Sec. 103) calls for an 85% reduction of HFCs over 15 years
- Evaluating next generation refrigerants with low global warming potential (GWP <750) for use in Navy chillers.
  - New FY22 program
- Evaluating alternative cooling technologies:
  - Magnetic refrigeration
  - Thermoacoustics
  - Thermoelectrics
  - Adsorption/Absorption

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11

## Climate Resilience S&T

- Earth system modeling and forecasting of extreme events for operational resilience
- Environmental sensing resilience
- Naval Energy resilience
- Military platform resilience to climate change

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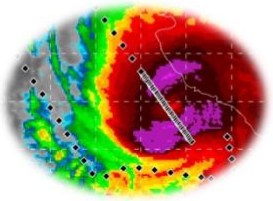
12

## Climate Change S&T Programs

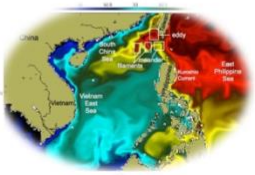
Department Head: Thomas Drake

**Marine Meteorology & Space**



**Littoral Geosciences**

**Physical Oceanography**



**A subset of Code 32 programs focus on understanding and prediction of the environment. Basic research in these areas supports the forecasting systems of both the DoD and the larger climate science community.**

**This work provides the foundation for understanding and quantification of climate change projections and associated uncertainty. Thus, Code 32 S&T spans across mitigation, adaptation, and resilience providing an avenue to inform the DON's Climate Action LOEs.**

**The convergence of previous and ongoing basic research at ONR with the DoD's Climate Adaptation Plan and the DON's Climate Action plan is an example of the strength of the Naval Research Enterprise.**

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13

## International Partnerships in Climate Sciences

Program Officer: Scott Harper & Emily Shroyer


For example, the DYNAMO(2010-2014), ASIRI (2013-2018), and MISO-BoB (2018-2022) initiatives have improved our understanding of the ocean and atmosphere in the Indian Ocean, enhancing our ability to model weather extremes (e.g., cyclones & monsoons). These programs have involved partnerships with India, Singapore, the Maldives, and Seychelles. FY23 start in the Arabian Sea will continue these partnerships.

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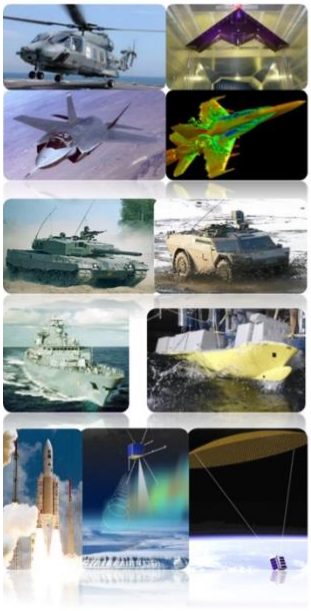
14

## NATO STO AVT



The mission of the NATO Science & Technology Organization (STO) is to help position the Nations' and NATO's S&T investments as a strategic enabler of the knowledge and technology advantage for the defence and security posture of NATO and partner Nations

- Conduct and promote S&T activities that augment and leverage the capabilities and programmes of the Alliance, of the NATO Nations and the partner Nations, in support of NATO's objectives.

The Applied Vehicle Technology (AVT) Panel's mission is to improve performance, affordability, and safety of vehicle, platform, propulsion and power systems operating in all environments for new and ageing systems through advancement of appropriate technologies

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15

## AVT-ET-227 Mission

- This exploratory team is assessing climate change impacts on military platforms along with technologies for greenhouse gas emissions reduction and energy efficiency improvement within member nations. The ET will provide recommendations for further work under NATO AVT.
- Impact of climate change on military platforms (climate resilience)
  - Methodologies to assess the impact of climate change on military platforms (sea, land, and air).
  - Science and technology gaps to improve platform resiliency to rapidly changing climate conditions.
- Impact of platforms/operations on climate (mitigation)
  - Data analytics to assess GHG emissions from military platforms.
  - Technologies to improve energy efficiency and reduce GHG emissions.

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16


https://www.onr.navy.mil
An official website of the United States government
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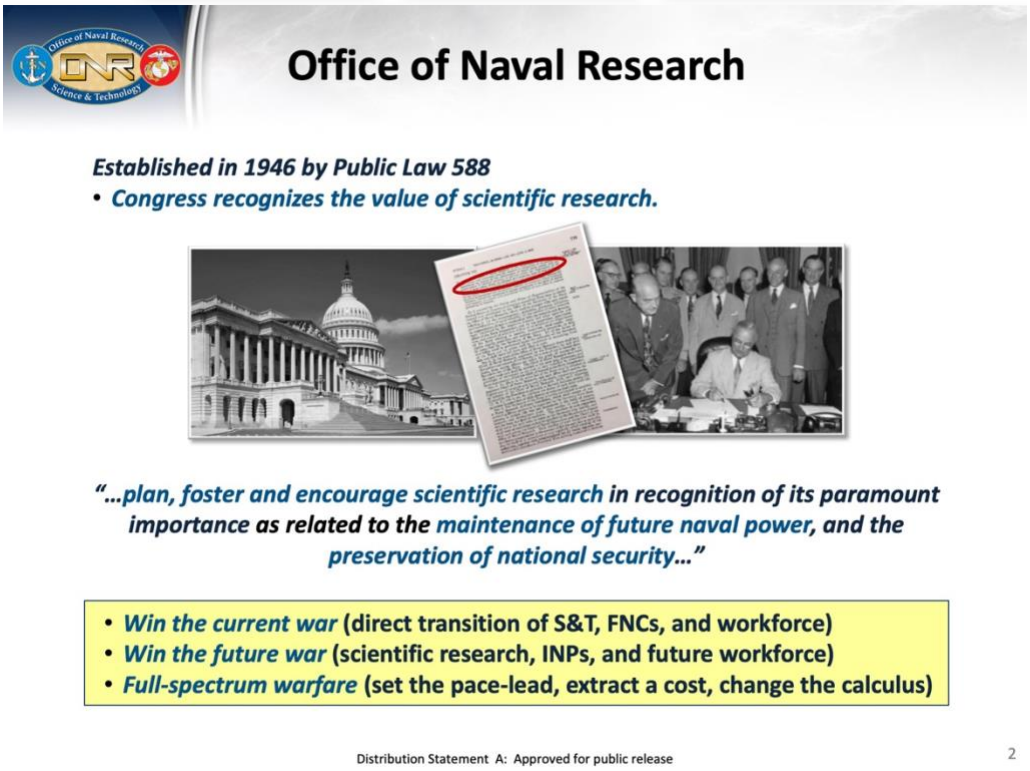
Office of Naval Research
Established in 1946 by Public Law 588
• Congress recognizes the value of scientific research.
"...plan, foster and encourage scientific research in recognition of its paramount importance as related to the maintenance of future naval power, and the preservation of national security..."
• Win the current war (direct transition of S&T, FNCs, and workforce)
• Win the future war (scientific research, INPs, and future workforce)
• Full-spectrum warfare (set the pace-lead, extract a cost, change the calculus)
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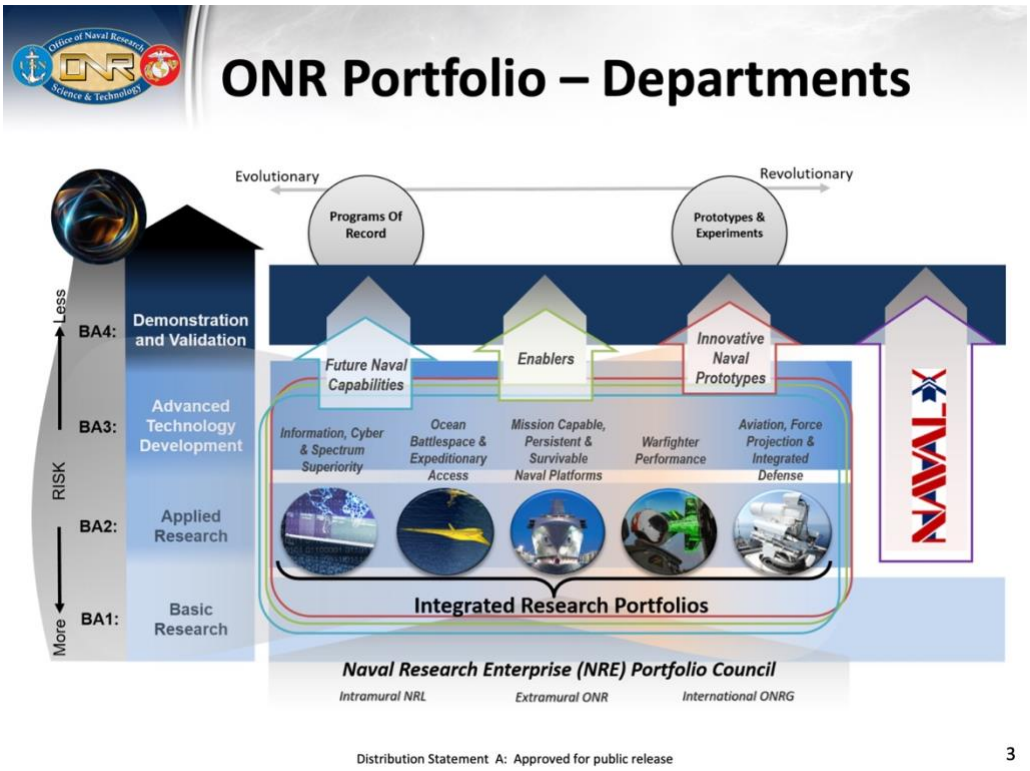
ONR Portfolio – Departments
Evolutionary
Revolutionary
Programs Of Record
Prototypes & Experiments
Less
RISK
More
BA4:
Demonstration and Validation
BA3:
Advanced Technology Development
BA2:
Applied Research
BA1:
Basic Research
Future Naval Capabilities
Enablers
Innovative Naval Prototypes
Information, Cyber & Spectrum Superiority
Ocean Battlespace & Expeditionary Access
Mission Capable, Persistent & Survivable Naval Platforms
Warfighter Performance
Aviation, Force Projection & Integrated Defense
NAVAIR
Integrated Research Portfolios
Naval Research Enterprise (NRE) Portfolio Council
Intramural NRL
Extramural ONR
International ONRG
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**Robin O'Connell**, Director of the Climate Change Program Office at the Naval Facilities Engineering Systems Command Headquarters (NAVFAC HQ)

Naval Facilities Engineering Systems Command

## National Security Significance of a Changing Climate: Naval Climate Engagement

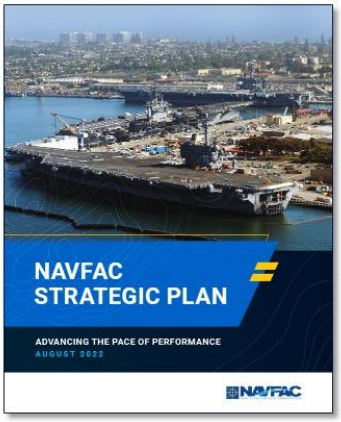
### Contingency Engineering

19 JAN 2023

## NAVFAC SYSCOM

- NAVFAC's primary function as a SYSCOM is to design and deliver infrastructure for the US Navy and Marine Corps

- Authorities
  - Department of Defense (DoD) design and construction agent for military construction (MILCON) - *10 U.S.C. Chapter 169, DODM 4270.5*
  - Acquisition of design and construction, maintenance and facility operations, facility cybersecurity, real estate, environmental conservation and remediation, and non-tactical vehicles - *SECNAVINST 5400.15D*
  - Acquisition and program management of expeditionary engineering and logistics, and ocean facilities - *SECNAVINST 5400.15D* , 10 USC 333, 10 USC 2561, 10 USC 2805




2

## Climate Change Vulnerabilities


Concerns Include:

- Sea level rise threatens coastal & island infrastructure and freshwater availability
- More frequent & more intense tropical cyclones, flooding, and droughts
- Increased ocean acidity and temperature threatens food web
- Disruption of agriculture/aquaculture, food, and water access
- Population Displacement
- Competition for resources



Australian Bushfires



Feeding Displaced Persons in India

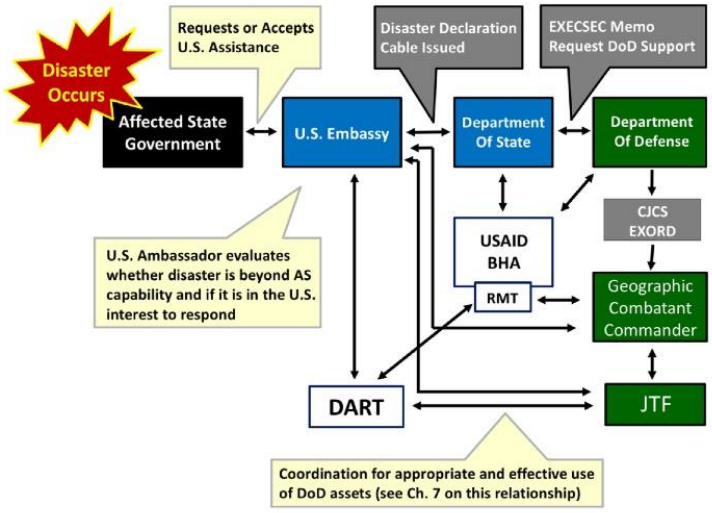


Sea level rise in Vanuatu

**Indo-Pacific had record number of climate-related disasters in 2020**

**13 of the 30 countries most vulnerable to climate change impacts are located in the East Asia and Pacific Region according to World Bank Group brief date May 27, 2022**

## Request for Support




Outline of the interagency coordination flow from the U.S. Ambassador's Disaster Declaration to an Executive Secretary Memo (EXECSEC Memo) from USAID to DoD requesting DoD support for Foreign Disaster Relief.

The grey boxes represent key actions and documents:
1. Disaster Declaration Cable
2. USAID EXECSEC Memo to DoD requesting support
3. CJCS issues an EXORD to the GCC to conduct FDR

Source: CFE-DM (2021) *Handbook for Responding Forces*

4

## Exercise Related Construction & Technical Exchange

Subject Matter Expert Exchange (SME), Indonesia

- Seismic Construction Practices
- Post Damage Building Assessment
- Coastal Protection and Erosion Control
- Flood Mitigation

Fuel Storage Facility

Ship-to-Shore

Underwater Pier Testing

Multipurpose HADR Warehouse and Maintenance Facility

5

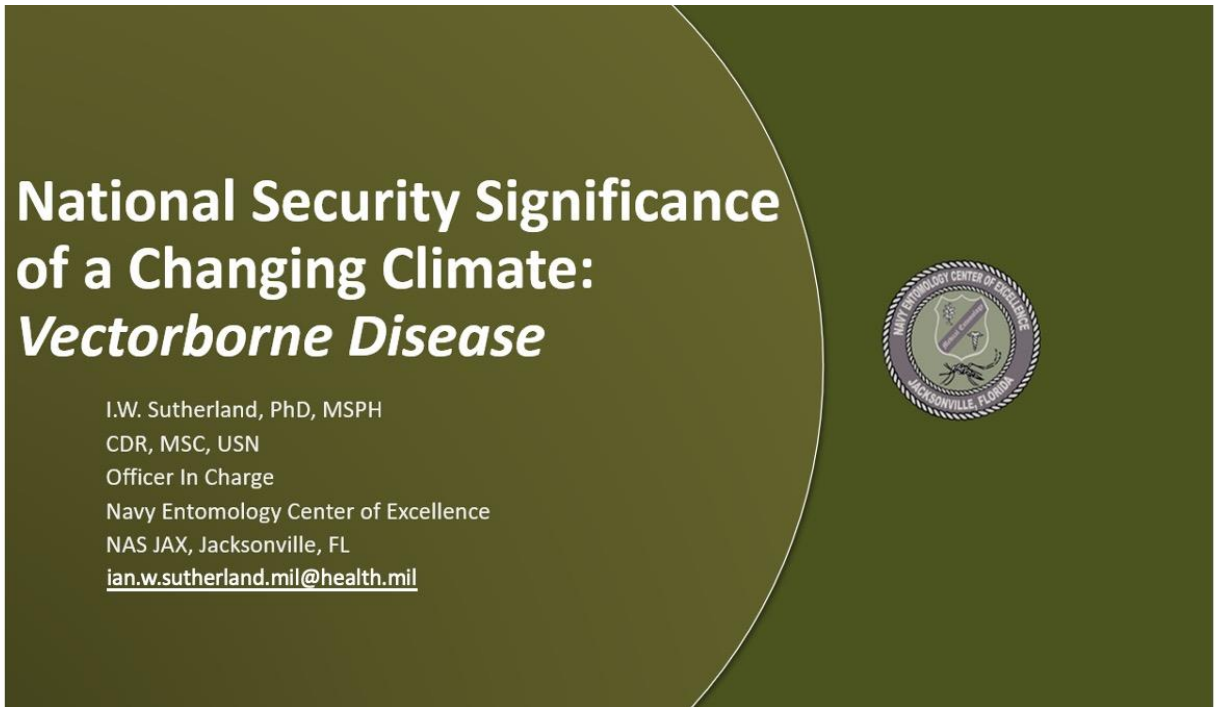
## Thank You

Robin O'Connell

Director, Climate Change Program Office

6

**Ian W. Sutherland Ph.D., MSPH; CDR, MSC, USN**, Officer in Charge; Navy Entomology

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# Vectorborne Disease Burden

- 17% of all infectious diseases
  - Parasites, bacteria, viruses
- ~700,000 deaths per annum
- ~700,000,000 infections per annum
- ~4,000,000,000 at risk of infection

| Vector | | Disease caused | Type of pathogen |
|---|---|---|---|
| Mosquito | *Aedes* | Chikungunya | Virus |
| | | Dengue | Virus |
| | | Lymphatic filariasis | Parasite |
| | | Rift Valley fever | Virus |
| | | Yellow Fever | Virus |
| | | Zika | Virus |
| | *Anopheles* | Lymphatic filariasis | Parasite |
| | | Malaria | Parasite |
| | *Culex* | Japanese encephalitis | Virus |
| | | Lymphatic filariasis | Parasite |
| | | West Nile fever | Virus |
| Aquatic snails | | Schistosomiasis (bilharziasis) | Parasite |
| Blackflies | | Onchocerciasis (river blindness) | Parasite |
| Fleas | | Plague (transmitted from rats to humans) | Bacteria |
| | | Tungiasis | Ectoparasite |
| Lice | | Typhus | Bacteria |
| | | Louse-borne relapsing fever | Bacteria |
| Sandflies | | Leishmaniasis | Parasite |
| | | Sandfly fever (phlebotomus fever) | Virus |
| Ticks | | Crimean-Congo haemorrhagic fever | Virus |
| | | Lyme disease | Bacteria |
| | | Relapsing fever (borreliosis) | Bacteria |
| | | Rickettsial diseases (eg. spotted fever and Q fever) | Bacteria |
| | | Tick-borne encephalitis | Virus |
| | | Tularaemia | Bacteria |
| Triatome bugs | | Chagas disease (American trypanosomiasis) | Parasite |
| Tsetse flies | | Sleeping sickness (African trypanosomiasis) | Parasite |

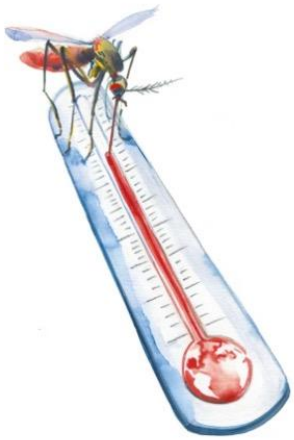
https://www.who.int/news-room/fact-sheets/detail/vector-borne-diseases

# Climate Change Implications for Vectors

ENVIRONMENT
- Changes in temperature, rainfall patterns, and floods
- Causes displacement to new, more favorable regions

VECTOR
- Extrinsic Incubation Period (EIP): *infectious faster*
- Larval development, biting behavior, fecundity

NEW TRANSMISSION ZONES
- Away from the equator
- Immunonaive populations, communities, herds
- Sandflies in Central Europe, ticks range expansion in Canada



https://www.nature.com/articles/s41590-020-0648-y , Chris Sharp

# Climate Change Implications for Vectorborne Disease

- Spread of vectors and pathogens:
  - Milder seasonality increasing interactions between humans, vectors, hosts; increasing exposure events/bites
    - Novel tickborne viruses: Bourbon virus (US), Heartland virus (US), Beiji nairovirus (CN), Songling virus (CN), Alongsham virus (MY), Yezo virus (JP)
    - Invasive Asian Longhorned tick *Haemaphysalis longicornis*
    - Chikungunya virus spread in Asia
    - *Anopheles stephensi* emergence in Africa


The relationship between rising temperatures and malaria incidence in Hainan, China, from 1984 to 2010: a longitudinal cohort study

Zengmiao Wang*, Yonghong Liu*, Yapin Li*, Guangze Wang*, José Lourenço, Moritz Kraemer, Qixin He, Bernard Cazelles, Yidan Li, Ruixue Wang, Dongqi Gao, Yuchun Li, Wenjing Song, Dingwei Sun, Lu Dong, Oliver G Pybus, Nils Chr Stenseth, Huaiyu Tian

**Summary**

**Background** The influence of rising global temperatures on malaria dynamics and distribution remains controversial, especially in central highland regions. We aimed to address this subject by studying the spatiotemporal heterogeneity of malaria and the effect of climate change on malaria transmission over 27 years in Hainan, an island province in China.

Lancet Planet Health 2022; 6: e350–58

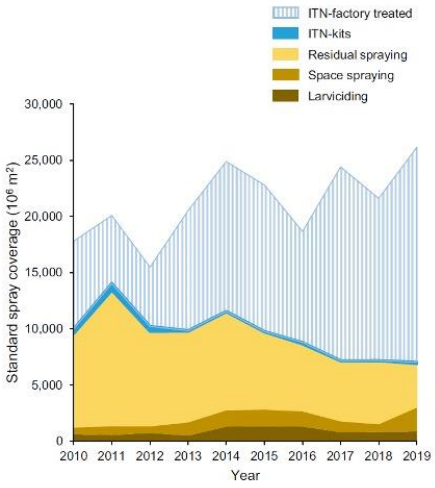
*Contributed equally

State Key Laboratory of

# Implications for Management

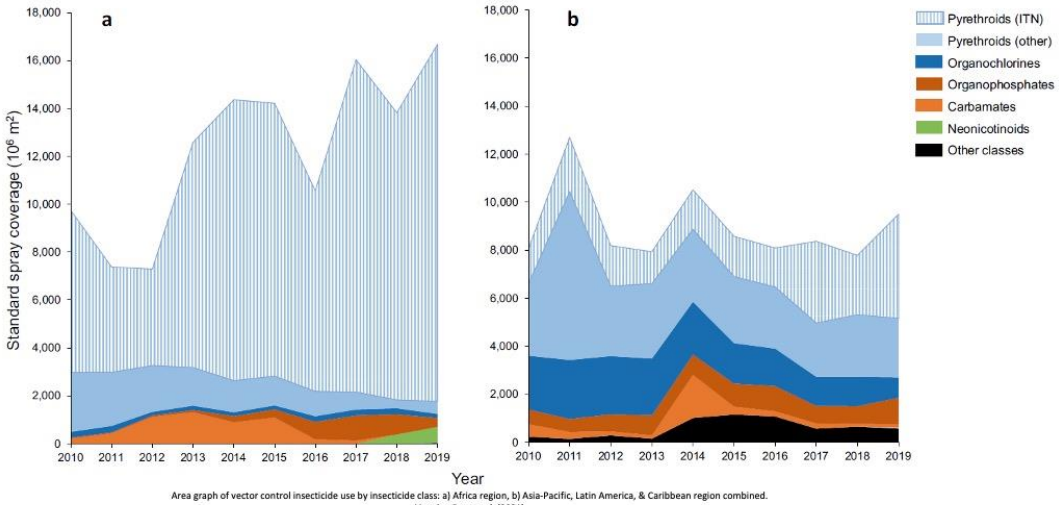
- Dwindling selection of public health pesticides
- The mainstay of vector control worldwide has been the use of insecticides to kill or deter vectors
  - Insecticide Treated Nets (ITNs), Indoor Residual Spraying (IRS), space spraying, larviciding
- Handful of existing insecticide classes:
  - Pyrethroids, Organochlorines (DDT), Organophosphates, Carbamates, Neonicotinoids, other*

# Implications for Management

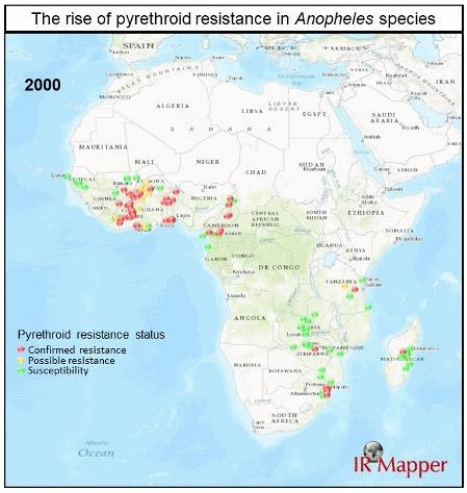



Area graph of global use of vector control insecticides by intervention type.
Van den Berg et al. (2021)

# Implications for Management




Area graph of vector control insecticide use by insecticide class: a) Africa region, b) Asia-Pacific, Latin America, & Caribbean region combined.
Van den Berg et al. (2021)




https://www.irmapper.com/

# Global Implications

- *Resource-limited regions will continue to be the most vulnerable, hardest hit, and destabilized by climate change mediated spread of vectors, insecticide resistance, and vectorborne disease.*

- NECE efforts to address force health concerns and support allied partners:
  - R&D
    - Insecticide Resistance & Response System (IRRS)
    - Lightweight Insecticide Resistance-detection Kit (LIRK)
    - Vector surveillance and eradication feasibility proposals at key force sites/facilities
    - Co-detection of vectors for malaria drug resistance markers & insecticide resistance
  - International Partnerships
    - Global Health Engagement activities (SOUTHCOM, AFRICOM, INDOPACOM)
    - Cross-training: mil-mil, mil-civ (OPMET)
    - Gator Dawn FTX

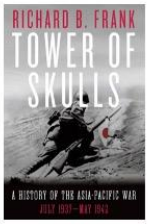
# Closing

"The fate of besieged Bataan was determined not by Japanese arms, but by malaria and malnutrition."

- Richard B. Frank, Pacific War Historian, Tower of Skulls (2020)

"This will be a long war, if for every division I have facing the enemy, I must count on a second division in the hospital with malaria, and a third division convalescing from this debilitating disease."

- Gen. Douglas MacArthur, Commander, Allied Forces, SW Pacific Theater, World War II




# For Additional Information

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