INTERNATIONAL MARITIME RESCUE FEDERATION

LR Foundation

IMRF #FutureSAR

Tides of Change:
Adaptive Strategies for Maritime SAR in a Changing Climate

Report
March 2024


1924 - 2024
IMRF
centenary

Photos front cover: (top left), DIALO Photography; (top right), MRCC Rabat; (bottom left), SSRS; (bottom right), FLBI/Jaakko Heikkila

INTERNATIONAL
MARITIME RESCUE
FEDERATION

Foundation

The International Maritime Rescue Federation is a registered company limited by guarantee in the United Kingdom and registered as a charity in England and Wales. Charity Registration Number: 1100883. Company Registration Number: 4852596.

https://www.international-maritime-rescue.org/contact-the-imrf

International Maritime Rescue Federation, PO Box 80585, London, SW19 9RT, UK.

Contents

Photo: SSRS

Introduction

Foreword

This report is the final report of the first phase of International Maritime Rescue Federation's (IMRF) #FutureSAR initiative. The aim of the initiative as a whole is to identify the key challenges the global maritime search and rescue (SAR) industry will face as a result of climate change and propose guidance and best practices that will aid rescue operations in the future. The report separately looks at adaptations required by SAR services to climate change, and mitigation measures that these services could do to alleviate climatic change. However, the emphasis of this stage of the project and the report is on adaptation. While the report focuses primarily on maritime SAR in oceans and seas, it also covers SAR operations conducted in inland lakes.

The report is divided into impacts on different sectors of the SAR organisation, including administration, vessel design and building, equipment, operational personnel and training, operations, stations, and units. The division is designed to assist the reader in looking into impacts relevant for them: for instance, a person responsible for training might be primarily interested in impacts on operational personnel and training, and only secondarily on, for instance, vessel design. Therefore, there is no need to read the entire report, just the sections the reader finds relevant for them.

The report comprises of 85 identified impacts climate change may have on SAR services globally. Each of the impacts is presented in the report, and further broken down into more detailed impact mechanisms. Some of them are likely to influence all SAR organisations, whereas others will only be applicable to some. Therefore, organisations are encouraged to go through the impacts and the associated checklist items to assess which impacts are relevant for them either now or in the future. These checklist items can be used to improve the organisation's readiness for climate change.

The list of impacts or the associated impact mechanisms is not exhaustive, and given an uncertain future, it can probably never be. However, we believe we have captured most of the significant impacts that SAR organisations can expect from climatic transition. It is worth noting that some points are speculative and there are varying probabilities and severities associated with them. The next phases of the #FutureSAR initiative will hopefully assess these uncertainties as well as provide further solutions, tools and support in finding appropriate responses to these challenges.

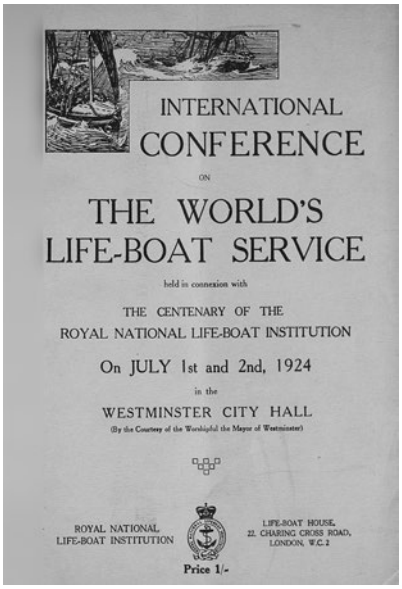
We hope that this report will not just sit on your shelf but will be a concrete tool and a reference document that can be acted upon and built upon. We also acknowledge that while several viewpoints have been presented, all possible notes and views globally are not reflected on the report. It is work in progress, a living document that updates as we learn more of the phenomenon. Therefore, we invite the readers to actively provide feedback on the report.

The report has been supported by an IMRF Working Group on #FutureSAR, comprising of SAR experts from all continents except for Antarctica. The organisations being represented in the working group include Canadian Coast Guard, HM Coast Guard (UK), National Sea Rescue Institute (South Africa), New Zealand Search and Rescue, Nigerian Maritime Administration, Para Marine SAR (Canada), Royal National Lifeboat Institution (UK), Shandong International Ocean Engineering Training Center (China), Surf Life Saving New Zealand and the Swedish Sea Rescue Society. The IMRF would like to thank the organisations and the working group for their efforts in taking this initiative forward. The IMRF also wishes to thank Lloyd's Register Foundation for providing funding for the project.

Photo: KNRM

International Maritime Rescue Federation

The International Maritime Rescue Federation (IMRF), established in 1924 and previously known as the International Lifeboat Federation, is an international, non-governmental organisation (NGO) that supports search and rescue (SAR) organisations with the development and improvement of maritime SAR capacity around the world.



This is done by providing guidance, facilitating training and enabling SAR providers to share knowledge and expertise between members across the IMRF community. Its work spans some of the most important issues facing maritime SAR and is vital to raising and maintaining standards, as well as improving overall global SAR capability.

The IMRF currently has close to 130 members in over 50 countries, creating an engaged and passionate global SAR community. Its influence is amplified through the consultative status at the International Maritime Organisation (IMO) and its role in key IMO Working Groups such as the IMO/ICAO SAR Joint Working Group. The IMRF also leads several industry-wide programmes to tackle issues facing the international maritime SAR sector, including the #WomeninSAR initiative, the Mass Rescue Operations (MRO) guidance project and the #FutureSAR climate change initiative.

#FutureSAR

The IMRF's #FutureSAR initiative was established to identify the key challenges the global maritime SAR industry will face because of climate change and propose guidance and best practices that will aid rescue operations in the future.

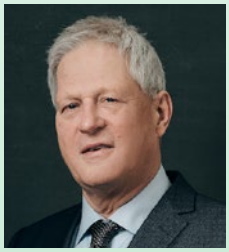
The initiative, funded by Lloyd's Register Foundation, is the world's first SAR industry-wide response to the effects of climate change on the maritime SAR sector as coastal communities, maritime activity and the infrastructure that they depend on are exposed to increasing risks.

#FutureSAR looks at how SAR services may be able to deal with climate change related challenges, such as new rescue scenarios, new rescue vessel technologies, and protection of infrastructure such as lifeboat facilities. The initiative also looks at ways the global maritime SAR community can contribute to the wider shipping industry's drive to decarbonise and achieve net zero.

The current IMRF Board members and CEO at the World Maritime Rescue Congress in 2023.

Working Group

The report has been produced by a working group convened to support the initiative. This assembly of experts, drawn from the breadth of the SAR community across various continents, brings together a wealth of experience, perspectives, and insights critical to the project's objectives. The working group members and their respective background organisations are presented below.



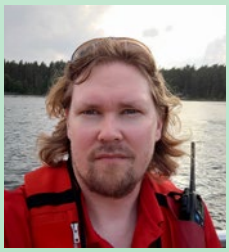
Joost Bierens is a retired anaesthesiologist and professor in the areas of emergency and disaster medicine. He has several (inter)national positions related to drowning prevention, rescue, and treatment. This includes medical advisor to the Royal Netherlands Sea Rescue Institution (KNRM) and Board of Directors of the International Lifesaving Federation (ILF).

Geoffrey Carrow is a Deputy Superintendent of Search and Rescue at Canadian Coast Guard Western Region. His duties include primarily building SAR capacity on the west coast of Canada in the remotest regions of our marine environment. This is done by bridging gaps between the professional SAR resources, the Auxiliaries and local mariners to enhance a system that must operate at all times in far reaching areas.

Duncan Ferner has led New Zealand's Search and Rescue (NZSAR) Secretariat since late 2005. On behalf of the NZSAR Council, he is responsible for the strategic coordination and leadership of the 25+ organisations that make up New Zealand's Search and Rescue Sector.

Anna Frizzell is a Sustainability Manager, a part of Business Performance & Sustainability Team, at the Royal National Lifeboat Institution (RNLI). Her role is to support the RNLI to develop, deliver and embed a robust sustainability approach within all RNLI strategies, plans and subsequent actions. She has over 23 years of experience in sustainability and environmental management. Before joining the RNLI, Anna was a sustainability advisor working with many small and medium sized businesses.

Brad Geyser is an Honorary Life Governor at National Sea Rescue Institute (NSRI) in South Africa. He started as crewman in NSRI Station 2 Bakoven in 1975 and grew to command the Station from 1993 to 2002. He then joined NSRI Station 8 Hout Bay in 2004 and served as Deputy Statcom and then Station Commander from 2005 to 2012. He has written the NSRI Station Commanders Training manual and the Aircraft Ditching Plan. He has also acted for instance in the Operations Support Committee and the Governance Board. He is now retired from active duty, but still serves on the Audit & Risk Board Committee of the NSRI.



Jaakko Heikkilä is the International Programme Manager at the International Maritime Rescue Federation (IMRF). He also serves as the Head of Training at the Finnish Lifeboat Institution and is a volunteer crewmember on lifeboats. At IMRF he has been responsible for guiding the #FutureSAR project towards its aims.

Cecilia Jönsson works on communication and sustainability at the Swedish Sea Rescue Society (SSRS). With a lifelong connection to the sea, she has a passion for maritime sustainability. Her work focuses mainly on communication to help integrate socially, economically and environmentally sustainable practices into the organisation.

David Morris is a Network Commander at HM Coastguard, where he has been serving for 13 years. Prior to his current position, he was working as a Search and Rescue Mission Coordinator and as a member of the Technology Team.

Allan Mundy is the National Search and Rescue Manager for Surf Life Saving New Zealand. He is also a member of the New Zealand Search and Rescue Consultative Committee.

Tris Newey is the Civil Resilience Lead at HM Coastguard. He has worked in both maritime coordination and coastal rescue over his twenty-year career in HMCG, at times as Search Mission Coordinator, Volunteer Rescue team manager, Technical Rescue Trainer, and Maritime Commander for the National Network of coordination centres in the UK. He is currently responsible for ensuring HMCG are prepared for the impacts of significant risks that pose a challenge to HMCG's response capability that range from severe weather, transport accidents, technical failures and natural disasters.

Engr. Ibrahim Shettima Arfo is a national and international SAR trainer. He is currently Head of SAR in Nigerian Maritime Administration and the Maritime SAR Mission coordinator of Nigeria. He has attended several IMRF programmes and trainings and immensely contributed to the development of SAR operations in Africa.

Juan Silva Araya has been a member of the Volunteer Corps of the Lifeboats of Valparaiso, Chile (CVBSV) since 1997. CVBSV was founded in 1925 and is the oldest voluntary SAR institution in Latin America. Its purpose is to safeguard human life at sea. He has served as a director, a member of the disciplinary council, and is currently an advisor to the lifeboat teaching committee in the preparation of training plans and programmes.

Colin Thomson has completed a 10-year commitment to the Canadian Armed Forces as reserve Navy officer. He served in various roles on east and west coast vessels. In parallel, he undertook a career in information technology and with Ontario Power Generation. Colin has been a volunteer with PARA Marine Search and Rescue and Canadian Coast Guard Auxiliary since 2012 and has completed over 60 SAR missions as both coxswain and crew. He has been the current Commodore (unit leader) since 2016. He also serves as a SAR instructor and the District Training Coordinator for District 1 Central and Arctic region.

Wu Yue serves as the Managing Director of the Shandong International Ocean Engineering Training Center (SIOETC) and has over 20 years of experience in the maritime safety, environmental protection, and spill response industries. SIOETC is a leading training institute in China, providing certification and skills training to marine resources practitioners. Wu Yue also holds a position as a Board Director at the International Spill Control Organisation and is honoured to serve as a Distinguished Professor at the Shandong Maritime Vocational College.

Katie Young is the Head of Performance and Sustainability at the Royal National Lifeboat Institution (RNLI) in the United Kingdom. Her role is helping to embed sustainable thinking into how to deliver lifesaving capabilities, both learning from the wider maritime SAR community and sharing learning from her experience.

Climate Change

The consensus on the state and impacts of climate change as of 2023 remains broadly consistent with previous scientific assessments, such as those by the Intergovernmental Panel on Climate Change (IPCC) (see, for instance, Roberts 2022). The Earth's climate is warming, and human activities like burning fossil fuels, deforestation, and industrial processes are mainly to blame. Global temperatures have risen by over 1 degree Celsius since the pre-industrial era, and there is a concerted effort to keep the warming well below 2 degrees Celsius, ideally at 1.5 degrees, to avert the most catastrophic effects of climate change.

The frequency and intensity of extreme weather events such as heatwaves, hurricanes, floods, and droughts are on the rise due to climate change. The relationship between climate change and large bodies of water like oceans, seas, and inland lakes is dynamic and complex, reflecting an intricate interplay of biological, chemical, and physical processes. The impacts of climate change affect ocean currents, wave power, sea level rise, wave height, wind speeds, the intensity of tropical storms, and water characteristics. These changes have significant implications for marine ecosystems, coastal communities, and global climate patterns. Oceans, covering more than 70% of the Earth's surface, are crucial climate regulators, absorbing carbon dioxide and heat from the atmosphere. This regulatory role comes with significant changes to their own systems.

The IPCC estimate for sea level rise by 2100 in their business-as-usual scenario is 0.29-0.51 metres (Economist Impact 2023). The acceleration of sea level rise from 0.6 mm/year 100 years ago to up to 4.4 mm/year is a direct consequence of global warming. The accelerated melting of ice sheets in Greenland and the Antarctic, coupled with the oceans' thermal expansion, is causing sea levels to rise at an increased rate, having observable effects on oceanic currents and global circulation patterns and posing a threat to coastal communities and ecosystems through extreme weather events such as increased flooding, erosion, and storm surges, impacting millions of people worldwide and leading to potential displacement, loss of habitat, and economic damages. (Hey et al. 2015)

Warmer oceans affect marine ecosystems, as many species are sensitive to temperature changes. Coral reefs, for instance, suffer from coral bleaching when stressed by warm waters. Fish populations migrate towards cooler areas, altering the dynamics of local and global fisheries, impacting food security, and affecting livelihoods. Inland lakes are also warming, which can alter their stratification - the layering based on temperature. This can impact the availability of nutrients and oxygen in the water, affecting freshwater ecosystems and the services they provide.

Reduced sea ice and thawing permafrost release methane, a potent greenhouse gas, which can accelerate warming in a feedback loop. These changes also influence the salinity of oceans, with fresh water from melting ice diluting sea water and affecting the density-driven oceanic conveyor belt, which plays a crucial role in climate regulation.

Warmer ocean temperatures provide more energy for storms, leading to more intense rainfall and wind speeds. 75% increase in the intensity of tropical storms in the North Atlantic and western North Pacific over the past 30 years is a particularly concerning aspect of climate change. The increase of 1.5 m/s in extreme winds over the past 30 years in the Southern Ocean can also contribute to the changes observed in ocean current speeds and wave power. These stronger winds are likely a response to shifts in atmospheric pressure gradients associated with global warming and have implications for ocean circulation patterns and global climate regulation. This increase in storm intensity can lead to devastating impacts on communities, including loss of life, property damage, and economic disruption. (Kerry 2005; Young and Ribal 2019)

Ocean currents play a crucial role in regulating the Earth's climate by distributing heat around the planet. An increase of 15% per decade in 77% of the ocean's upper current speeds suggests a significant acceleration in the movement of water masses. This acceleration can be attributed to increased wind speeds and changes in temperature gradients caused by global warming. Faster currents may alter nutrient distribution, impact marine ecosystems, and affect global climate patterns by influencing the distribution of heat and carbon in the ocean. (Peng et al. 2022)

The 31% increase in global wave power over 61 years indicates that waves are becoming more powerful, largely due to stronger winds associated with changes in atmospheric pressure patterns as the planet warms. Additionally, the largest waves are growing faster than average, increasing in height by 30 cm in the past 33 years, suggests that extreme wave conditions are becoming more common. More powerful and larger waves can lead to increased coastal erosion, impact marine ecosystems, increase the risk of flooding, and pose challenges for navigation and offshore structures. This change reflects the transfer of energy from the wind into sea-surface motion, which is intensifying as the climate changes. (Reguero et al 2019; Young and Ribal 2019; Barras 2019)

Climate change is accelerating also biodiversity loss on a global scale when combined with habitat destruction and pollution. The direct effects of climate change on human health are also alarming, including heat-related illnesses, the spread of diseases carried by vectors like mosquitoes, and the mental health consequences of climate-related disasters. In terms of economic and social implications, climate change is predicted to impact agricultural productivity, cause infrastructure damage, displace populations, and worsen poverty and inequality.

These changes underscore the interconnectedness of the Earth's climate system. Overall, the current state of knowledge underscores the profound and far-reaching impact of climate change on aquatic systems, highlighting the urgency for comprehensive global responses to mitigate and adapt to these changes. This need is backed by a broad scientific consensus, and also policy responses to climate change are advancing globally, exemplified by the Paris and the Dubai Agreements, where nations pledge to carry out national mitigation strategies aiming to limit global warming collectively.

This global nature of the issue, however, still needs each country, region, organisation and individual to undertake appropriate mitigation actions as well as prepare themselves by adapting their policies, processes and practices to the changing environment that we will face in the future.

Photo: Jean-Christophe André

Search and Rescue

Maritime search and rescue (SAR) operations are critical services provided across the world to ensure the safety of life at sea. These operations are typically coordinated efforts that involve various national and international bodies, and they are governed by a complex framework of laws, conventions, and agreements. The main international agreement governing maritime SAR is the International Convention on Maritime Search and Rescue (SAR Convention), which was adopted at a conference in Hamburg in 1979 and entered into force in 1985. The convention was amended in 1998 and is regularly updated.

The International Maritime Organization (IMO), a specialised agency of the United Nations, is responsible for the safety and security of shipping and the prevention of marine and atmospheric pollution by ships. It provides the international legal framework for SAR operations through the SAR Convention, which designates SAR regions around the world and requires countries to establish and maintain adequate SAR services in their respective regions.

The world is divided into SAR regions, where each country is responsible for providing SAR services in its designated area. There are also regional SAR agreements, such as the ones covering the Mediterranean Sea, the Baltic Sea, and the Arctic, which are established to coordinate efforts and resources among neighbouring countries. Joint Rescue Coordination Centres (JRCCs) and Maritime Rescue Coordination Centres (MRCCs) are responsible for coordinating SAR efforts in their respective regions.

They operate 24/7 and liaise with various assets like coast guard vessels, helicopters, and airplanes as well as SAR units from governmental and non-governmental agencies.

Well resourced countries typically have well funded and coordinated coast guards, navies, and volunteer organisations. Countries in the Global South, on the other hand, may rely more on support from other countries, international organisations, and non-governmental organisations due to limited resources of the SAR organisations.

In some parts of the world, private and volunteer organisations are often involved in SAR operations. These can range from large organisations with sophisticated equipment and well-trained operational personnel to small groups with limited resources.

Despite the established frameworks, maritime SAR operations face numerous challenges such as vast and sometimes remote areas, harsh weather conditions, and funding limitations. These challenges are often magnified in regions with significant maritime traffic or migrant movements. Climate change poses an additional challenge to many, or all, of these organisations.

This report also accounts for lifeguard services, and therefore the term 'crew' has been replaced by 'operational personnel' throughout the report. The terms SAR services and SAR organisations are used interchangeably in this report.

Photo: Shutterstock

Adaptation: Impacts of Climate Change on SAR Organisations

The impacts of climate change on SAR services are in this report listed according to different categories in the SAR organisations. Therefore, the report will separately address impacts that affect primarily SAR Organisations':

- Administration
- Design and Building of Vessels and Aircraft
- Equipment
- Operational Personnel and Training
- Operations, which are further subdivided into:
  - Operation Volume
  - Operation Location
  - Operation Targets
  - Operation Types
- SAR Stations
- SAR Units

Within each of these **Impact Categories** there are primary **Impacts** with several **Impact Mechanisms**.
These impact mechanisms provide more details for the impact. So, as an example:

Impact Category:

Design and Building of Vessels and Aircraft

Impact:

Designing, building and retrofitting vessels

Impact Mechanisms:

Extended Operational Range: Climate change may prolong the SAR operational seasons and expand the operational areas, leading to longer missions. SAR vessels might need larger fuel capacities, improved operational personnel living quarters, improved communication or navigation systems, and better onboard facilities to sustain extended operations.

Each Impact and the associated Impact Mechanisms are presented on the following pages.. The impacts are numbered such that it is easy to refer to a specific impact without using the page numbers.

Also, a list of **Checklist Items** is provided. They represent key factors that should be checked when assessing whether the organisation is prepared for that particular effect of climate change. Finally, where applicable, a few references to further reading on the topic are provided under **Read more**.

Photo: SSRS

1. Administration

1-1 International coordination, cooperation and assistance

Climate change is amplifying the frequency and severity of natural disasters, such as hurricanes, typhoons, flooding, and wildfires. These in turn increase the complexity and scope of SAR operations. As such extreme events become more common and intense, SAR organisations are facing new challenges that often require enhanced coordination and cooperation at the international level. This increases the complexity of operations, as different countries have different laws, capabilities, and levels of preparedness.

Impact mechanisms:

- Collaborative Response: Climate-induced disasters are not confined by national borders. Floods, storm surges, and wildfires can easily spread across countries, requiring a collaborative response from neighbouring nations.
- Coordination of Mass Migration: Climate change can lead to mass displacement as areas become uninhabitable due to sea-level rise or persistent drought. SAR organisations might be called upon to assist in the mass migration of populations, which would require coordination across multiple countries and agencies, including humanitarian organisations.
- Shared Resources: A single nation may find its resources overwhelmed by a climate disaster. International cooperation can provide additional equipment, expertise, and personnel to augment the affected country's SAR capabilities.
- Shared Expertise: Some SAR operations, like those in response to arctic conditions or chemical spills exacerbated by extreme weather, may require specialised expertise that is not available in every country. International cooperation allows for sharing of knowledge and skills that are critical in these complex scenarios.
- Shared Critical Information: Rapidly changing environmental conditions require advanced technologies for real-time monitoring, forecasting, and communication. International cooperation ensures that critical information and technology can be shared, leading to more effective response strategies.
- Shared Response Protocols: Climate-related emergencies might necessitate the creation of unified response protocols to ensure that when multiple countries are involved, efforts are not duplicated, and resources are used efficiently.
- Shared Training and Preparedness: International coordination is necessary for training and preparedness programmes that can be shared across organisations, ensuring a uniform level of readiness against uncommon or unprecedented events. Such training includes for instance leadership, hazard identification, risk assessment and decision-making.
- International Assistance: Many nations, particularly in the Global South, lack the financial resources to respond adequately to climate-induced crises. International assistance and funding become essential to support the SAR operations in these regions.
- Legal and Political Frameworks: New legal and political frameworks might be needed to facilitate international SAR operations, including agreements on jurisdiction, mutual aid, and the sharing of sensitive information.

The escalating impact of climate change on global weather patterns and sea levels necessitates robust international coordination and cooperation. SAR organisations must adapt to this reality, ensuring they are equipped not only in terms of human resources, rescue craft, equipment, and training but also in their ability to work alongside international partners to mitigate the effects of climate disasters and assist those regions most affected.

Checklist items:

- Evaluate and enhance international collaboration, focusing on emergency response coordination, expertise sharing, and processes for information and resource sharing, response protocols, and training programmes.
- Establish and refine a framework for coordinating mass migration responses, involving partnerships with multiple countries and agencies to address large-scale population displacements due to climate change.
- Assess the feasibility of creating a shared resource pool with international partners, which can include equipment, expertise, and personnel for rapid mobilisation in response to climate disasters.
- Actively engage in joint training programmes and preparedness exercises with international SAR entities.

Photo: Pixabay

1-2 Coordination of national actions

Climate change is also reshaping the national environment in which SAR organisations operate, presenting novel and complex challenges that necessitate new approaches to coordination, administration, and preparedness. In time of disaster, availability of human and financial resources to support maritime SAR may be limited, and therefore preparedness and emergency planning are essential.

Impact mechanisms:

- Strategic Planning: Strategic planning within SAR organisations must take into account the projected impacts of climate change on their operational environment. This involves long-term planning for infrastructure development, such as building or retrofitting resilient SAR stations and acquiring, building or retrofitting vessels capable of operating in harsher conditions or in previously inaccessible areas. It also includes planning for emergency response in the face of more frequent and severe events, requiring robust and flexible contingency plans. This strategic planning should be done in parallel with government agencies and relevant industry sectors that are planning for similar scenarios to ensure the plans are compatible and complementary, and also reflected in the associated budgets.
- Coordination of Preparation: Besides strategical alignment, as climate change leads to more frequent and severe weather events, national preparation actions must become more cohesive and proactive. Additional, new working environments and new types of rescues are created as climate change shapes our natural landscapes. This means that SAR organisations must work closely with meteorological services, disaster management agencies, rescue services, and government bodies to develop integrated response plans and protocols. Coordination of preparation should consider sharing of response protocols, expertise and resources.
- Multi-Agency Exercises: The preparation actions by national organisations need to be rehearsed to increase the probability of their successful execution in practice. Therefore, coordination of preparation should include common training exercises that simulate the conditions expected to become more common due to climate change, such as extreme heat, floods, or hurricanes.
- New Type of Administration: Traditional administrative structures and processes may not be adequate to deal with the dynamic nature of climate change impacts. SAR organisations together with government agencies may need to develop new administrative frameworks that allow for proactive approach, as well as rapid decision-making and flexibility. This might involve establishing dedicated cross-agency climate change adaptation units or co-operation teams as well as integrating climate risk assessments into all levels of planning and operations.
- Shared Critical Information: Changing environmental conditions require advanced technologies for real-time monitoring, forecasting, and communication. Cooperation between different organisations, including the meteorological services, ensures that decisions can be made based on best currently available information and technology.

Climate change is forcing SAR organisations to reconsider and reconfigure their coordination efforts, administrative structures, and preparation strategies in connection with other agencies and organisations. This includes fostering inter-agency collaboration, adopting new technologies and methods, and ensuring that personnel are trained to work together and cope with the changing nature of rescue scenarios. Adapting to this new reality is essential to maintain the effectiveness and efficiency of SAR operations in the face of a rapidly changing climate.

Photo: Valdemaras D

Checklist items:

- Conduct a thorough evaluation of existing collaborations with other national agencies and organisations, focusing on aligning plans and preparations for climate change related scenarios, as well as mapping expertise and resources that could be potentially shared.
- Organise and participate in regular multi-agency training exercises that simulate various climate change related conditions to ensure operational readiness and effective inter-agency cooperation.
- Assess the state of advanced monitoring and communication technologies, and advocate for sharing these resources across agencies to enable real-time, informed decision-making in emergencies.

1-3 Jurisdiction affecting operations in new contexts

Climate change can have a significant impact on the operational jurisdictions of SAR organisations.

Impact mechanisms:

- Lead Responsibility in International Operations: As the geographic and environmental context of SAR operations changes due to climate change, determining lead responsibility can become complex. For instance, new sea routes opening in the Arctic and the Antarctic or transnational river basins might fall outside of traditional national SAR areas, necessitating the establishment of new jurisdictions or international agreements to ensure coverage and define which nation or agency leads in specific scenarios.
- Lead Responsibility in National Operations: Similarly, for instance a climate change induced mass migration combined with a breakout of an exotic disease, environmental pollution and increased cases of drowning due to flooding may blur traditional lines of lead responsibility. Such scenarios must, to the extent possible, be included in preparation plans and exercised in diverse tabletop exercises to identify potential problems when they are still easier to rectify. Also, as tourism and holiday locations are moving to new areas, required preparedness, practices and responsibilities may not yet be in place.

Climate change introduces a myriad of jurisdictional challenges for SAR organisations. Addressing these impacts requires adaptive management and governance, re-evaluation of legal and operational frameworks, and increased international and national collaboration.

Checklist items:

- Plan and conduct simulations of diverse yet plausible SAR scenarios, including multi-agent leadership tabletop exercises, to identify potential challenges in early stages. Incorporate complex scenarios, such as climate-induced mass migrations or large-scale storm surges coupled with public health emergencies, into strategic planning and tabletop exercises to refine jurisdictional responses.
- Enhance collaborative networks with international and national agencies to ensure a unified approach to SAR operations, fostering cooperation beyond traditional jurisdictional boundaries.

Read more:

- Sydnes Are Kristoffer, Sydnes Maria and Antonsen Yngve. 2017. International Cooperation on Search and Rescue in the Arctic. Arctic Review on Law and Politics 8: 109-136. Available at: https://www.jstor.org/stable/48710583

1-4 Increasing political and socio-economic instability

There can be many reasons for political and socio-economic instability. Climate change is, however, recognised as a threat multiplier, exacerbating existing political and socio-economic instabilities that can lead to significant challenges for SAR organisations. For instance, instability can be induced by mass migration, or exclusive economic zone boundaries may become more contentious because of rising sea levels (Economist Impact 2023).

Impact mechanisms:

- Mass Migration: One of the direct consequences of climate change is the displacement of populations due to factors such as sea-level rise, desertification, increased frequency and intensity of extreme weather events, and resource scarcity. The impacts of migration are already felt in many places, including Europe, but climate change may take this to another level. Mass migration can create large-scale humanitarian crises, with people moving both within and across national borders, often under perilous conditions that increase the demand for SAR services. For example, as sea levels rise and weather events become more severe, coastal and island populations may be forced to relocate, leading to an increased risk of maritime emergencies as people attempt to cross waters in search of safe havens.
- Strains in International Relations: As climate-induced migration often involves crossing borders, SAR operations can become international in scope, requiring coordination with agencies from multiple countries. International SAR efforts may be hampered by geopolitical tensions, varying levels of response capability, and bureaucratic hurdles.
- Political Instability: The socio-economic pressures of climate change can lead to political instability, as governments struggle to cope with the internal displacement of populations and the resulting social and economic stresses. SAR organisations may find themselves operating in politically volatile environments, where governance may be weak and coordination among agencies is challenging. This may also be reflected in the public response towards the rescue crews, especially in the case of migrant rescue.
- Strain on Local Infrastructure: The influx of migrants can strain local infrastructure, including transportation, healthcare, and social services. SAR organisations may need to support not only the initial rescue but also the broader humanitarian response, which could include providing medical assistance, temporary shelter, and logistical support.

- Training: To cope with these challenges, SAR organisations will need to enhance their training programmes to prepare their personnel for the complex and evolving nature of operations in a climate-changed world. This includes understanding the socio-political dynamics of migration, cultural sensitivity, crowd management in mass rescue operations, and inter-agency coordination.
- Securing Sustainable Funding: The increase in operations related to migration will require significant investment in SAR infrastructure and assets. Securing adequate funding becomes even more critical in the face of political and economic instability, as traditional funding streams may be diverted elsewhere.

The intersection of climate change and political or socio-economic instability represents a profound challenge for SAR organisations. It demands not only a rethinking of operational and potentially fundraising strategies and capacities but also emphasises the need for stronger international cooperation, robust funding mechanisms, solid national planning and comprehensive training to handle the humanitarian crises that are likely to become more frequent in a changing world.

Checklist items:

- Assess and enhance cross-border collaboration frameworks to better anticipate and manage mass migration scenarios, ensuring coordinated SAR efforts and mitigation of humanitarian crises.
- Develop local infrastructure support plans, preparing SAR services not only for rescue operations but also for providing subsequent humanitarian assistance, such as medical care and temporary shelter.
- Plan for and provide cultural sensitivity, conflict resolution and crowd management training to SAR personnel, focusing on improving their ability to navigate politically volatile environments and socio-political dynamics of migration.
- Assess the need and provide tools for operational personnel to deal with political or economic instability that will allow them to concentrate on their primary task of rescuing people.
- Explore and secure diverse and sustainable funding sources to build resilience in SAR infrastructure and capacity, ensuring readiness in the face of potential redirection of traditional funding due to political or economic shifts.

Read more:

- Economist Impact. 2023. Global Maritime Trends 2050. Available at: https://impact.economist.com/ocean/global-maritime-trends-2050/

Photo: Pixabay

1-5 Advocacy and regulation

Climate change's impacts on the environment are vast and multifaceted, and as they evolve, SAR organisations may find themselves facing new administrative, operational or technical challenges that require changes in policy and support from policymakers. Climate change can necessitate a greater emphasis on advocacy, particularly for non-governmental SAR organisations. Government organisations on the other hand may need to formulate and implement direct regulation.

The content and form of advocacy and regulation may differ significantly depending on, for instance, whether the SAR agency is a government organisation, a non-governmental organisation not involved in advocacy, or a non-government organisation that is free to advocate.

Impact mechanisms:

- Escalating Demands for SAR Services: SAR organisations need to ensure that policymakers are aware of the escalating demands that climate change and the associated extreme weather events place on their services. In the context of migration, this also relates to ensuring that SAR operations are integrated into broader humanitarian response plans.
- Support for Adaptation and Resilience: Policymakers may need to allocate funding or support for SAR organisations' climate change adaptation strategies, such as updating rescue infrastructure or equipment to withstand more extreme weather conditions.
- Promoting Public Education: In the face of increasing risks of drowning and other water-related accidents, SAR organisations may wish to promote incorporating educational water safety programmes into national education and outreach initiatives.
- Influencing Policies: SAR organisations may wish to promote different kinds of policies or, if it is in their power, implement regulation on them directly. These might include construction of buildings and infrastructure resistant to extreme weather, competence requirements to operate certain types of watercrafts, technical safety requirements of watercraft and their operation, and so forth.

As climate change continues to influence the operational environment of SAR organisations, they will need to engage more in advocacy with policymakers. This is vital to ensure that they have the resources, legal frameworks, and public support necessary to effectively perform their lifesaving missions in a rapidly changing world. SAR organisations need to use wisely the opportunities for advocacy to ensure policy and industry include maritime SAR in their considerations, as well as support the industry with genuine opportunities for collaboration.

Checklist items:

- Initiate and maintain ongoing dialogue with policymakers to keep them informed about the increasing operational demands of SAR operations due to climate-related emergencies. Provide a checklist for the national (or local) government on the support (and potentially funding) requirements for the existing SAR mechanisms.
- Work towards incorporating water safety and climate change resilience into national education and outreach initiatives to proactively reduce the number of SAR incidents.

Photo: Anna Tarazevich

1-6 Educating the public

SAR organisations face a heightened need for public education in relation to impacts of climate change. As climate-related emergencies become more frequent and severe, the potential for an increase in casualties rises. Educating the public not only reduces the risk of accidents, but also enhances community preparedness and adaptation.

Impact mechanisms:

- Raising Awareness of Increased Risks: The public may not always be aware of the increasing risks posed by climate change, such as stronger storms, higher flood levels, and more intense heatwaves. SAR organisations can lead educational campaigns to inform the public about these heightened risks.
- Preventive Measures and Preparedness: By teaching people how to prepare for climate-induced emergencies, such as creating evacuation plans or building emergency kits, SAR organisations can help minimise the impact of such events. SAR organisations can also work at the community level to promote awareness and preparedness, especially in vulnerable areas where climate change impacts are more pronounced.
- Activities in New Environmental Conditions: As environmental conditions change, so do the risks associated with activities like hiking, boating, and swimming. SAR organisations must educate the public on these new conditions and the safety measures they must take when engaging in such activities. SAR organisations can offer guidance on how to behave during extreme weather events - what actions to take and what to avoid. This includes advice on seeking shelter during storms or avoiding water-based activities during dangerous conditions.
- Knowledge of Changing Wildlife Patterns: Climate change can also alter wildlife behaviour, which might lead to unexpected encounters. SAR organisations can inform the public about these changes. For instance, the RNLI lifeguards in the United Kingdom are already seeing more unusual species and the public are experiencing more and different bity or stingy creatures on beaches.
- Use of Technology and Information: SAR organisations can teach the public how to use technology, like GPS and emergency alert systems, to stay informed about potential dangers and to aid rescuers in locating them if they get into trouble.
- Global Citizenry: Education can foster a sense of global responsibility and citizenry, encouraging actions that contribute to mitigating climate change and reducing the overall need for SAR services. Educating the wider audience on the role of environmental conservation can also indirectly reduce SAR incidents.

In essence, SAR organisations have a critical role to play in educating the public about the evolving threats posed by climate change. This education is not only about immediate safety but also about fostering a culture of preparedness and resilience that can help communities adapt to and cope with the new realities of our changing environment. Through education, SAR organisations empower individuals and communities to take proactive steps to safeguard their well-being in the face of climate change.

Checklist items:

- Plan and organise campaigns and training sessions to raise public awareness about climate risks and their impact on safety.
- Plan, create and disseminate updated safety guidelines for outdoor activities, including effective use of technology and reflecting the changes in environmental conditions.
- Assess the need for providing critical alerts, warnings and notifications to the public on emerging safety issues.
- Co-operate nationally and internationally to share best practices for educating the public.

Read more:

- NSRI. Water Safety Education. Available at: https://www.nsri.org.za/water-safety/water-safety-education/.
- RNLI. Safety work. Available at: https://rnli.org/safety.

Photo: RNLI/Nathan Williams

1-7 Budget and fundraising

The impacts of climate change are expected to significantly alter the budgetary requirements of SAR organisations due to a variety of factors. Many of the impacts outlined in this report have budgetary impacts, but here's a brief summary on some of the most significant ones.

Impact mechanisms:

- Increased Incidents: With the prevalence of extreme weather events, changing public behaviour and other developments, there is likely to be an increase in SAR missions. More incidents naturally translate to higher operational costs, including fuel, maintenance, personnel costs including overtime, and the usage of resources.
- Preventive Measures: SAR organisations may need to invest more in community education, training, and preventive measures to prepare for the risks associated with climate change. While this could reduce long-term operational costs by preventing incidents, the upfront investment may be significant.
- New Rescue Craft: Changing conditions may necessitate the development and purchase of new rescue craft designed for altered operations and landscapes, such as vessels that can operate in shallower floodwaters, harsher sea conditions, or that are ice-capable for newly navigable northern waters. Also, vessels running on alternative and less environmentally harmful fuels are likely needed.
- New Equipment: Climate change may necessitate SAR organisations to acquire specialised equipment such as advanced communication technologies, long-range drones, robust and weather-resistant personal protective equipment, high-capacity pumps for floodwater removal and specialised tools for urban or swiftwater search and rescue.
- Vehicles Adaptation: Land-based rescue vehicles may need to be adapted or replaced to deal with new terrain conditions, such as increased flooding or destabilised ground from prolonged droughts.
- Infrastructure Upgrades: SAR stations and infrastructure may require upgrades to withstand extreme weather conditions, which could be a significant capital expense.
- Training for New Operations: More extensive and frequent training may be required to prepare SAR personnel for operations in a wider range of conditions, which would increase training budgets.
- Innovation and R&D: A portion of the budget may need to be allocated towards research and development for innovative SAR technologies that can handle new challenges posed by climate change, such as drones for rapid assessment of disaster areas or AI for improved prediction of incident hotspots.
- Insurance and Liability Costs: There could be increased costs for insuring SAR operations due to the heightened risks associated with more dangerous rescue missions as well as insurance risks to buildings and infrastructure due to flood, fire and extreme weather events.
- Competition for Funding: As the range and severity of climate-related disasters increase, there will be greater competition for funding from other public services also impacted by climate change, such as fire departments and healthcare providers. This could potentially lead to less funding available for SAR organisations. Similarly, SAR organisations operating as charities are more like to find more competition for the money donated to them.
- Fundraising Opportunities: On the flip side, the increasing visibility of climate change issues could lead to new fundraising opportunities. For instance, governments and international bodies may allocate more resources to disaster response, including SAR operations. There could also be an increase in funding from environmental, humanitarian and other foundations focusing on climate resilience, as well as potential partnerships with private companies investing in climate change mitigation or adaptation.

The cumulative financial burden on SAR organisations due to the impacts of climate change could be substantial. However, recognising these challenges ahead of time allows for strategic planning, advocacy for dedicated funding, and the pursuit of partnerships and grants that could help offset any additional costs. SAR organisations need to be proactive in planning, budgeting, and seeking new sources of funding to ensure they are equipped to handle the changing demands of the future.

Checklist items:

- Assess, for instance with the help of this report, the most prominent and likely changes the SAR organisation is going to face in the future. Evaluate the budgetary impacts of those changes and plan for their addition to the budget. Current budgets and adjust as necessary to accommodate potential increases in operational costs due to more frequent SAR missions related to climate change.
- Investigate new funding opportunities, including grants, partnerships, and other resources focused on climate resilience and disaster response, to supplement traditional funding streams.

Read more:

- Carty T and Walsh L. 2022. Footing the bill. Fair finance for loss and damage in an era of escalating climate impacts. Oxfam International. Available at: https://oxfamilibrary.openrepository.com/bitstream/handle/10546/621382/bp-fair-finance-loss-and-damage-070622-en.pdf

1-8 Data collection, analysis and R&D

Climate change brings about a multitude of environmental shifts, such as rising temperatures, changing precipitation patterns, more frequent and severe weather events, altering ocean currents, and sea-level rise. These changes demand that SAR organisations adapt by enhancing their data collection and analysis capabilities as well as engaging in research and development (R&D).

Impact mechanisms:

- Environmental Data Collection: The changing climate necessitates the continuous monitoring of environmental conditions. SAR organisations need detailed and up-to-date data on weather patterns, sea levels, and climate phenomena to effectively plan and execute rescue operations. The complexity of climate change effects also requires sophisticated analytical tools to interpret large data sets. These services may be done in-house in the SAR organisation, such as the Climate Change App by the RNLI Evidence and Insights Team, or they may be obtained through cooperation with meteorological services or other organisations.
- Enhanced Predictive Capabilities: To anticipate where SAR services will be needed most, organisations must enhance their predictive analytics capabilities. This could involve creating models that take into account how changing climate patterns affect human behaviour and thus the likelihood of incidents.
- Vessels for New Conditions: There might be a need for new vessel designs that can cope with rougher seas, shallower water, swiftwater, icy conditions, longer range, and so forth.
- Equipment for New Conditions: New technologies can significantly improve SAR operations. SAR equipment may need to be adapted to withstand extreme conditions or developed anew. R&D efforts might focus on, for instance, developing drones for rapid area assessment, thermal imaging equipment for locating individuals in adverse conditions, more suitable personal protective gear for the operational personnel, or new communication devices that are more resilient to extreme weather.
- Improved SAR Techniques: As environmental conditions change, so too must SAR techniques. R&D is crucial in developing new operational procedures to address scenarios that were previously rare or non-existent, such as widespread urban flooding or rescue operations during unprecedented heatwaves.
- Developing Training for New Skills: As conditions change, so too must the training of SAR personnel. R&D is necessary to update training programmes to include new skills required to operate effectively in a climate-altered environment.
- Advanced Data Collection: Data to support SAR operations may in future be collected from various sources. These may include, for instance, wearable devices monitoring operational personnel's physical state during rescue missions, a variety of mission-related or environmental data collected by autonomous systems such as drones, data from stations and storage facilities regarding their operational status, and energy use and carbon emission data from the stations and other facilities of the organisation. This may also include data collection from vessels on economic and fuel-efficient vessel operations, as well as different kinds of environmental data.
- Impact Assessment Studies: Understanding the long-term effects of climate change on SAR operations will require comprehensive impact assessment studies. These studies can inform how resources should be allocated and what changes are needed in SAR infrastructure. To provide a holistic and more truthful picture, however, the impacts and dynamics in the local communities should be included in cases where the personnel to operate the rescue assets come from these communities.
- Collaborative Research Initiatives: Climate change is a global issue, and SAR organisations may need to participate in international research initiatives to share knowledge, develop best practices, and leverage collective expertise.

The imperative for increased data collection, analysis, and R&D is clear: as the impacts of climate change continue to evolve, SAR organisations must remain at the forefront of understanding and addressing these changes to maintain the effectiveness and safety of their lifesaving missions.

Checklist items:

- Perform impact assessment to understand the long-term effects of climate change on SAR operations and infrastructure and participate in collaborative initiatives to exchange knowledge and develop best practices for SAR in the context of climate change.
- Explore the development of advanced predictive analytics to anticipate incident hotspots.
- Look into expanding data collection sources, including the use of wearable technology for operational personnel monitoring and autonomous systems for data collection.
- Create a plan on R&D of new SAR vessels, advanced SAR equipment and new SAR techniques as well as on updating the training programmes of SAR personnel.

Read more:

- International Drowning Researcher's Alliance (IDRA). 2022. Impact of Climate Change on Drowning: Setting the research agenda. IDRA – International Drowning Researchers' Alliance. Available at: http://idra.world/event_climate/

1-9 Supply chain disruptions

Climate change can significantly disrupt supply chains across the globe, and this includes those critical to the operations of SAR organisations. They are also important from the mitigation perspective, as supply chains host most of an organisation's carbon emissions.

Impact mechanisms:

- International Dependencies: Globalisation means that SAR equipment and medicines might be sourced from various parts of the world. Disruptions in one part of the global supply chain can have cascading effects, leading to shortages in another, affecting the SAR organisation's capacity to procure essential items.
- Infrastructure and Transportation Challenges: More frequent and severe weather events, such as hurricanes, floods, and wildfires, can damage infrastructure and transport routes or make them unreliable. Roads may be flooded or obstructed, ports may be damaged, and flight paths or airports may be affected by changing wind patterns, flooding or other interruptions, all of which can delay or completely cut off the supply of essential equipment and medicines to SAR organisations.
- Interruptions in Manufacturing: The effects of climate change, like droughts or resource depletion, can limit the availability of necessary materials used in SAR equipment or medical supplies. Factories that produce equipment or medicines may be directly impacted by climate-related events, leading to reduced production capacity or temporary shutdowns. The same scarcity and problems are faced by SAR organisations that build their own vessels or equipment. This can lead to increased costs or the need to find alternative sources or materials.
- Energy Supply Instability: SAR operations often depend on a reliable energy supply for their headquarters, stations, vehicles, and equipment. There may also be more reliance on electricity in the future, as the amount of electric land-based vehicles, and eventually boats and other watercraft, are likely to increase. Climate change may cause fluctuations in energy availability.
- Stockpiling Essential Items: The broader economic strain caused by climate change, such as increased prices for goods and services, or the budgetary challenges of the SAR organisations can lead to smaller budgets for stockpiling essential supplies or investing in backup systems.

The implications of these disruptions can be profound for SAR operations, which often need to be executed rapidly and with complete reliability. SAR organisations, therefore, must anticipate and plan for these challenges, incorporating resilience and adaptability into their supply chain management strategies, for instance by diversifying suppliers, increasing stockpiles, or developing local manufacturing capabilities, to ensure they can maintain operations during climate-induced disruptions.

Checklist items:

- Plan to diversify suppliers and find alternative sources for SAR equipment and medicines to mitigate risks of international supply chain disruptions.
- Establish backup solutions for manufacturing interruptions, including local production options or stockpiling critical equipment and essential supplies.
- Ensure energy supply stability for SAR operations, considering alternative and renewable energy sources.
- Prepare a plan of essential stock of items needed in different events.

Read more:

- Mireku Akosua. 2023. Pharma readies for climate disasters amidst supply chain concerns. Available at: https://www.pharmaceutical-technology.com/features/pharma-readies-for-climate-disasters-amidst-supply-chain-concerns/?cf-view
- Sodhi ManMohan S. and Tang Christopher S. 2020. Supply Chain Management for Extreme Conditions: Research Opportunities. Journal of Supply Chain Management 57 (1): 7-16. Available at: https://onlinelibrary.wiley.com/doi/abs/10.1111/jscm.12255

Photo: FLBI/Jaakko Heikkila

1-10 Protection of essential infrastructure

Climate change poses numerous risks to the physical infrastructure of SAR organisations, which are critical for their effective operation.

Impact mechanisms:

- Facilities: Buildings and other structures may be subject to increased wear from storms, wind, and fluctuating weather patterns, requiring more robust building materials and construction methods.
  - Overheating: Increased average temperatures and heatwaves can lead to overheating of facilities and equipment, and increased costs of cooling them. For SAR operations, this means that electronics like servers and communication devices can fail if they are not adequately cooled. Overheating can damage the components and lead to a reduction in the lifespan of critical equipment.
  - Freezing: Conversely, extreme cold events, which are also a consequence of disturbed climate patterns, can lead to freezing of facilities and equipment. This can cause mechanical failures in vehicles, disrupt fluid systems like fuel lines and hydraulic systems, and lead to a failure of electronic components.
  - Flooding: Rising sea levels and more intense and frequent rain events can lead to flooding. Especially SAR facilities located in flood-prone areas may find their operations compromised if water damages their infrastructure, like power supplies, communication networks, and rescue equipment. For instance, for the RNLI 82 out of 137 lifeboat stations in England and Wales are in flood alert areas.
- Server and Data Centre Integrity: SAR operations depend on data centres and servers for communication, coordination, and information management. These can be particularly vulnerable to climate impacts. Flooding, humidity, overheating, and power fluctuations can all pose significant risks to the integrity of these data systems.
- Communication Networks: SAR relies heavily on communication networks such as radio, satellite, and internet-based systems. Climate change can disrupt these through physical damage to infrastructure (like cell towers and satellites) and by atmospheric disturbances affecting signal clarity and reliability.
- Energy Security: SAR operations require a stable energy supply for their bases, any on-site accommodation for personnel and usually also for rescue vessels in berths. Renewable energy sources, while beneficial for reducing climate change impacts, can be variable in output. SAR organisations must ensure that they have reliable and resilient power sources that can withstand climate-induced power outages.

For SAR organisations, protecting their infrastructure against the impacts of climate change is not just a matter of maintaining operational capacity. It is also about ensuring the safety, comfort and suitable working conditions of their personnel. SAR organisations must anticipate and mitigate these risks. This could involve redesigning infrastructure with climate change in mind, using elevated buildings, improved drainage systems, and hardened emergency communication systems. It is also crucial to have robust backup systems in place. This means having redundant communication systems, power supply backups like generators, and emergency protocols. By understanding the potential impacts and implementing protective measures, SAR organisations can enhance their resilience to the increasing variability and extremes of the climate.

Checklist items:

- Review SAR facilities for weather resilience and consider upgrades using robust materials. Plan for cooling systems in buildings and for electronic equipment to manage overheating, or conversely, assess SAR infrastructure and equipment for cold weather and freezing conditions.
- Evaluate flood protection for SAR facilities, focusing on structures, power, communication networks, and equipment.
- Review energy supply and backup systems, considering renewable energy integration.

1-11 Operational station network and coverage

Climate change is rapidly reshaping the environmental and operational landscape and requirements, necessitating that SAR organisations reassess and regularly update their station network and coverage areas, both along the coast and inland.

Impact mechanisms:

- Changing Coastlines: As sea levels rise and coastal erosion intensifies, the current SAR stations may no longer be optimally located. Some stations might become vulnerable to flooding, while others may find themselves further from the coastline than before, rendering them less effective. SAR organisations may need to relocate or establish new stations to maintain quick response times.
- Increased Demand in New Areas: Climate change can lead to the creation of new navigable waterways due to melting ice or altered river paths, which may see increased marine traffic and recreational use. This new activity can result in more incidents, requiring SAR presence and capabilities in these newly active areas. This is also the case when areas further north get warmer and more suitable for water-based recreation. SAR organisations may need to consider establishing stations close to such locations.
- Inland Water Challenges: Extreme weather events like flash floods or changing river courses can create new inland water challenges. SAR operations may need to increase their inland presence with additional stations equipped to deal with such events.
- Enhanced Mobility: There may be a need for more mobile SAR units that can respond quickly to incidents in areas that were previously inaccessible or that have become hotspots for SAR incidents due to climate change.

SAR organisations are faced with the challenging task of forecasting the demands of the near future and beyond, necessitating a dynamic approach to strategy and resource allocation. Strategic decisions may involve either the relocation of existing stations or the consolidation of resources to create more robust and versatile SAR hubs that can serve larger and more climatically diverse regions. As the climate continues to change, flexibility and adaptability will be key traits for SAR organisations to maintain effectiveness and readiness.

Checklist items:

- Conduct evaluations of coastal SAR stations to determine risks associated with rising sea levels and coastal erosion, considering potential relocation and evacuation sites.
- Identify and evaluate areas where new SAR stations may be strategically needed due to increased recreation, navigable waterways or marine traffic resulting from climate change. Also assess the need to expand inland SAR capabilities to address challenges like flash floods and changing river courses.
- Consider developing and implementing mobile SAR units capable of quick deployment in newly accessible or increasingly incident-prone areas.

Read more:

- Christodoulou Anastasia, Dalaklis Dimitrios, Raneri Peter and Sheehan Rebecca. 2022. An overview of the legal search and rescue framework and related infrastructure along the Arctic Northeast Passage. Marine Policy 138: 104985. Available at: https://www.sciencedirect.com/science/article/abs/pii/S0308597X2200032X
- IMO in the Polar Environment: Search and Rescue. Available at: https://www.youtube.com/watch?v=ouc-BEFsT6U&t=334s
- Smith Timothy William James. 2017. Search and Rescue in the Arctic: Is the U.S. Prepared? Pardee RAND Dissertations. Available at: https://www.rand.org/pubs/rgs_dissertations/RGSD382.html

Photo: RCMSAR


Photo: FLBI/Jaakko Heikkila

1-12 Longer operational season and days

Climate change, with its influence on global temperatures, has led to a significant reduction in sea ice and a consequent extension of the open water season in many regions. Changes in weather patterns may extend the operational season also in other areas. There may also be prolonged days, as optimal time for water-based activities may extend towards the evening.

Impact mechanisms:

- Strained Resources: SAR organisations may find their operational seasons extended as open water persists for longer periods, especially in areas near the Arctic or the Antarctic, which have traditionally been ice-covered for much of the year. This means that SAR teams must be prepared to conduct missions over a greater portion of the year, increasing operational demands and potentially straining resources. In addition to the prolonged season, also the days may be prolonged as the optimal time of the day for boating, going to the beach, or undertaking some other water-based recreation changes, leading to longer days for operational personnel on the rescue vessels and on the beaches.
- Resource Allocation: SAR organisations must adjust resource allocation to match the prolonged season and prolonged days. This might involve budgeting for longer periods of active duty, managing the wear and tear on equipment over a longer season, and ensuring that personnel are available for the extended operational window. Weather can also fluctuate back and forth, and lead to moving a lot of equipment and vessels around as stations go in and out of operations, as has happened recently in Sweden.
- Maintenance Schedules: The maintenance schedules for SAR vessels and equipment will need to be adjusted to accommodate the longer operational period. There may be less downtime for repairs and maintenance, which could affect the longevity and reliability of equipment.

A longer open water season due to climate change requires SAR organisations to adapt in several ways, from extending their operational readiness and adjusting resource management to adapting training and maintenance schedules. These changes are necessary to ensure that SAR services remain responsive and effective throughout the expanded season of maritime activity.

Checklist items:

- Assess and adjust operational readiness plans to accommodate an extended open water season. Review the allocation of resources, including financial, human, and material resources, to ensure adequate support for the prolonged operational period.
- Consider adapting maintenance schedules for SAR vessels and equipment to maintain their reliability and effectiveness throughout the extended season.
- Considering longer active days of duty, assess crew endurance on different operational classes of rescue craft under varying conditions to provide a better understanding for operational and training planning.

Read more:

- Nunatsiaq News. 2022. Canadian Coast Guard finishes Arctic operating season. Available at: https://www.arctictoday.com/canadian-coast-guard-finishes-arctic-operating-season/

1-13 Adequate insurance cover

The impact of climate change on the frequency and severity of natural catastrophes is a growing concern for SAR organisations, which must ensure that they have adequate insurance coverage to mitigate the risks and potential financial burdens associated with these events. However, given the unpredictability associated with climate change, insurance can also serve as a crucial risk transfer mechanism, allowing SAR organisations to mitigate financial losses from unforeseen and uncontrollable events.

Impact mechanisms:

- Increased Risk Exposure: Climate change is leading to more frequent and intense weather events, such as hurricanes, wildfires, floods, and storms. SAR operations and facilities in affected areas are exposed to greater risk, necessitating comprehensive insurance to cover potential damages to their personnel, facilities, vessels, equipment, and operations.
- Rising Insurance Premiums: As the risks associated with climate change grow, insurance companies may increase premiums to cover the heightened likelihood of payouts. SAR organisations may face higher operational costs due to these increased premiums.
- Insurance Coverage Scope: Traditional insurance policies may not cover all climate-related incidents, or there may be exceptions and limitations that leave SAR organisations vulnerable. It is crucial for SAR organisations to review and possibly renegotiate their policies to ensure coverage is aligned with the actual risks posed.
- Liability Concerns: SAR operations involve significant risk, and climate change can exacerbate these risks, potentially leading to situations where SAR organisations are held liable for accidents or damages during their operations. Adequate liability insurance becomes even more essential in this context.

Photo: Johannes Plenio

- Business Interruption: Climate change can lead to natural catastrophes that interrupt commercial operations that some SAR organisations may regularly undertake, for instance commercial training or towing operations. Insurance that covers business interruption can help SAR organisations recover lost income and extra expenses during periods when their services are impacted.
- Asset Valuation: Climate change might necessitate more frequent updates of the valuation of SAR assets, as replacement costs may increase due to changes in technology, new types of vessels or equipment needed to respond to disasters, and the scarcity of resources.

As climate change alters the risk profile for SAR operations, these organisations must reassess their insurance needs, ensuring they have adequate coverage to protect against the financial impacts of natural catastrophes. This requires a thorough understanding of their risk exposure, clear communication with insurance providers, and a proactive approach to risk management and mitigation. Proactive engagement with insurance providers is necessary to ensure that insurers understand the unique challenges and needs of SAR organisations. Insurers can also often give a risk baseline picture based on their own research, complementing the view developed by the SAR organisation.

Checklist items:

- Review and renegotiate insurance policies to ensure coverage is adequate and aligns with the actual risks posed by climate change, including coverage for extreme weather events.
- Explore options for increased liability insurance to cover heightened risks during SAR operations in more severe climate conditions.
- Investigate insurance policies that include business interruption coverage, especially for SAR organisations involved in commercial activities.
- Regularly re-evaluate the asset valuation of SAR equipment and infrastructure to reflect current replacement costs, factoring in technological advancements and scarcity of resources.

Read more:

- Agence France-Presse. 2023. Climate Change Leads Reinsurers to Reduce Their Coverage. Available at: https://www.voaafrica.com/a/climate-change-leads-reinsurers-to-reduce-their-coverage/7266472.html
- Frank Thomas. 2023. Climate Change Is Destabilizing Insurance Industry. Scientific American. Available at: https://www.scientificamerican.com/article/climate-change-is-destabilizing-insurance-industry/

1-14 Reputation and public relations

Climate change presents significant challenges to SAR organisations that, if not managed properly, can have implications for their reputation and public relations. Conversely, proactive and effective management can enhance their standing in the community.

Impact mechanisms:

- Public Expectations and Trust: As public awareness of climate change increases, so do expectations for organisations to respond responsibly. SAR organisations are expected to not only adapt to the changing climate for their rescue operations but also to mitigate their environmental impact. Failure to address these expectations can lead to a loss of public trust, while meeting or exceeding them can bolster an organisation's reputation as socially responsible and responsive to global concerns.
- Operational Excellence: Climate change may lead to more frequent and intense rescue operations. Demonstrating operational readiness and excellence in these increasingly difficult conditions can enhance an organisation's reputation. On the flip side, if SAR operations are perceived as inadequate or failing to adapt to changing conditions, it could damage the organisation's standing.
- Transparency and Communication: Openly communicating efforts to combat climate change and prepare for climate change adaptation, such as adopting greener practices and equipment or engaging in public education, can significantly improve an organisation's public image. Transparency about the challenges and successes in these areas can foster trust and support.
- Adaptation and Innovation: SAR organisations that adapt to climate change through innovative practices signal their commitment to evolving with the times. Innovation, particularly in adopting new technologies that reduce the carbon footprint, can be a positive public relations move, showcasing the organisation as forward-thinking and responsible. Demonstrating responsible stewardship of resources, such as adopting sustainable procurement policies and reducing waste, reflects an organisation's commitment to social and environmental responsibility, which can be a strong point of public relations.
- Public Education and Leadership: SAR organisations often engage in community education about safety and preparedness. Including climate change adaptation in their outreach can position them as not just rescue entities but also as leaders in community resilience against climate impacts.
- Partnership and Leadership: Forming partnerships with environmental organisations and leading initiatives on sustainability can enhance a SAR organisation's reputation as a community and environmental leader. This could include participating in or even spearheading clean-up operations, conservation efforts, or sustainability programmes. There might also be a need to understand and participate in local and national climate change adaptation plans and actions. Doing so ensures that the needs and the role SAR organisations can play in helping to deliver them are considered.
- Moral and Ethical Leadership: Taking a moral and ethical stand on climate change issues can solidify the respect and trust stakeholders have in an SAR organisation, while also putting a human face to the organisation's work and values.

In summary, climate change can significantly affect the reputation of SAR organisations. These organisations must navigate the challenges posed by a changing climate, not just in operational terms, but also in how they communicate and embody environmental and social responsibility. By taking a proactive approach to these challenges, SAR organisations can maintain and enhance their reputations as vital, adaptive, and responsible public service entities.

Checklist items:

- Actively showcase the organisation's responsible actions and strategies for responding to and mitigating the impact of climate change.
- Focus on demonstrating operational excellence in increasingly challenging rescue scenarios to enhance the organisation's reputation. Prioritise the adoption of new technologies and sustainable practices as part of the organisation's response, positioning it as a forward-thinking entity.
- Engage in partnerships with environmental organisations and lead initiatives in sustainability, enhancing the organisation's role as a community and environmental steward.


Photo: Dio Hasbi Saniskoro

1-15 Compliance measures and reporting

Climate change can significantly impact maritime SAR operations through compulsory compliance measures and required reporting. For instance, reporting of carbon emissions is the type of compliance and reporting that many SAR organisations are already experiencing.

Impact mechanisms:

- Changes in Regulatory Framework: As the effects of climate change become more pronounced, there may be a shift in international and national maritime regulations to ensure safety and environmental protection. SAR organisations will need to stay informed about these changes and adapt their operations to comply with new standards. This could involve more rigorous reporting requirements, adherence to stricter safety protocols, and implementation of environmentally sustainable practices.
- Increased Reporting Requirements: SAR organisations may face more stringent reporting requirements related to their environmental impact. This could include the need to document fuel usage, carbon emissions, and the ecological impact of their operations. Ensuring compliance with these enhanced reporting requirements would necessitate robust data collection and analysis systems. For instance, already now in 2023 the RNLI in the United Kingdom is legally obligated to monitor and report on energy consumption every four years.
- Documentation of Increased Operational Challenges: As climate change impacts the nature of maritime incidents, SAR organisations might be required to provide more detailed reporting on the challenges faced during operations. This includes documenting the impact of factors like severe weather, reduced visibility, or difficult navigation conditions on their response efforts.

Overall, climate change could necessitate a significant shift in how maritime SAR services approach compliance measures and reporting, requiring them to be more adaptable, environmentally conscious, and aligned with evolving global standards for maritime safety and environmental protection.

Checklist items:

- Regularly review and stay informed about international and national maritime regulations related to climate change to ensure compliance with new standards and reporting requirements.
- Develop or upgrade reporting systems to accurately document environmental aspects of SAR operations, such as fuel usage, carbon emissions, and ecological impacts.
- Establish procedures for detailed reporting on operational challenges faced during SAR missions, including factors like severe weather, reduced visibility, and navigational difficulties.
- Implement periodic audits of SAR operations to ensure ongoing compliance with evolving regulations and standards.
- Engage in collaboration with other maritime agencies, regulatory bodies, and environmental organisations to stay abreast of best practices and joint compliance strategies in the face of climate change.

Photo: FLBI/Jaakko Heikkila

2. Design and Building of Vessels and Aircraft

2-1 Designing, building and retrofitting vessels

Climate change is significantly altering the operational landscape for SAR organisations, necessitating a fresh approach to the design and construction of their vessels and aircraft.

Impact mechanisms:

- Adaptability to New Conditions: With the increased frequency and intensity of extreme weather events and operations in new climate-affected areas, SAR vessels must be built to withstand tougher conditions. This may include for instance stronger hulls for rough seas or enhanced manoeuvrability for riverine and flood conditions. In South Africa, the challenge of navigating rivers and dams crowded with debris from floods or dense aquatic plants has necessitated innovative solutions for propulsion. The National Sea Rescue Institute (NSRI) is exploring an ingenious approach originally from Vietnam. This solution features an engine mounted on a pivot at the stern, equipped with a long shaft that extends to a propeller. This design offers enhanced manoeuvrability and effectiveness in such challenging conditions, ensuring that rescue operations can be conducted more efficiently. Additionally, there may be a need to operate efficiently in the Arctic's or the Antarctic's cold temperatures and ice-prone waters, indicating ice-class vessels with reinforced hulls, or in the extreme heat, requiring efficient air-cooling systems to ensure welfare of the operational personnel on board.
- Advanced Power and Propulsion Systems: Future requirements are likely to necessitate the design of vessels capable of using alternative, cleaner fuel sources such as electricity or hybrids. This involves integrating advanced power and propulsion systems that reduce the carbon footprint. As changes cannot be immediate, in the transition phase SAR organisations could plan to reduce fossil fuel usage through replacing internal combustion engines with smaller, more fuel efficient and more powerful propulsion units currently available. For instance, the NSRI in South Africa is experimenting with diesel electric propulsion, where diesel engines drive electric engines through a battery system.
- Extended Operational Range: Climate change may prolong the SAR operational seasons and expand the operational areas, leading to longer missions. SAR vessels might need larger fuel capacities, improved operational personnel living quarters, improved communication or navigation systems, and better onboard facilities to sustain extended operations.
- Enhanced Infrastructure Compatibility: As infrastructure evolves to accommodate new energy sources, SAR vessels must be compatible with these changes. This could mean designing vessels that can recharge at electric docks or retrofitting existing ones to handle new types of fuel being introduced at ports, all requiring standardisation of infrastructure to the extent possible.
- Increased Autonomy and Remote Operations: The changing environment might also call for increased vessel autonomy to allow operations in hazardous conditions where operational personnel safety is a concern, such as in chemical spills or areas with extreme temperatures.
- Flexibility and Modular Design: SAR vessels might need to be designed with modular components to quickly adapt to a variety of missions, from environmental clean-ups to mass rescue operations.
- Cost-Effectiveness: With possibly tighter budgets due to the wide-ranging impacts of climate change, SAR organisations will need vessels that are not only capable but also cost-effective to operate and maintain.
- Compliance with Environmental Regulations: The vessels need to comply with increasingly strict environmental regulations, which might include emissions controls, waste management systems, and noise reduction technologies to protect marine life. The vessels likely need to fulfil the requirements for circularity, factoring in design for disposal, or understanding end-of-life opportunities, as well as use of materials that fulfil the operational and technical requirements but are still deemed environmentally acceptable. The Lloyd's Register Grey Boat Code provides one model of such a code of practice, concentrating on safety assurance.
- Research and Development: The uncertainty and rapid evolution of climate change impacts necessitate ongoing research and development to ensure SAR vessels remain at the forefront of technology and capability. For instance, the RNLI in the United Kingdom operates Alternative Asset Propulsion work towards this aim.

In essence, climate change compels SAR organisations to rethink their fleet compositions and capabilities. This process is not just about incremental improvements but may involve a fundamental redesign of SAR vessels to meet the challenges of a rapidly changing environment, while also adhering to stricter environmental standards and public expectations for sustainability.

Checklist items:

- Evaluate the need for designing and constructing SAR vessels with enhanced durability and manoeuvrability to effectively operate in diverse and extreme environments, such as rough seas, floods, icy conditions, or extreme heat.
- Evaluate the need for designing and constructing SAR vessels with extended operational ranges, incorporating larger fuel capacities and improved onboard facilities suitable for longer missions.
- Explore the integration of advanced propulsion systems like electric or hybrid technologies to align with new environmental regulations and sustainability goals. Plan for compatibility with evolving marine infrastructure, such as electric charging docks.

Read more:

- Canadian Coast Guard. 2023. Government of Canada announces construction of the Canadian Coast Guard's first-ever hybrid vessel in Gaspé. Available at: https://www.newswire.ca/news-releases/government-of-canada-announces-construction-of-the-canadian-coast-guard-s-first-ever-hybrid-vessel-in-gaspe-801803176.html

Photo: RNLI/Nathan Williams

2-2 Uncertainty in design and building

The uncertainty regarding the impact of climate change on the environmental conditions of our oceans, rivers, lakes and other waterways presents significant challenges for SAR organisations in the construction of rescue vessels. So, it is not only the design for new conditions that brings challenges, but also the inherent uncertainty regarding everything.

Impact mechanisms:

- Uncertain Design Specifications: With climate change leading to more extreme and less predictable weather conditions, SAR vessels must be designed to withstand a wider range of scenarios. This uncertainty can make it difficult to finalise design specifications that will be robust enough for future conditions.
- Adaptability to Multiple Environments or Operational Situations: As environmental conditions change, vessels may need to be more adaptable to operate in different settings, such as moving from saltwater to freshwater environments due to flooding, or from open sea to more constrained riverine areas. The vessels may also need larger fuel capacities or more flexible engine designs. The required adaptations may not be fully known at the time the vessels are being designed and built. The fast pace of change in climate conditions might require vessels to be easily modifiable to adjust to future needs, which could include changing propulsion systems to accommodate new fuel types or adding capacity for additional equipment.
- Material Selection and Durability: The choice of materials for construction must factor in the new but uncertain environmental stressors caused by climate change, such as increased corrosion from saltier waters or ocean acidification, or the need for materials that can withstand higher temperatures.
- Compliance with Evolving Regulations: Environmental regulations are also evolving in response to climate change, potentially affecting vessel design. Designers must stay abreast of these changes to ensure new vessels comply with the latest standards, which may change during the design and construction process.
- Testing and Certification Challenges: Proving that new vessels are seaworthy and safe in a wider range of conditions can be more difficult, requiring more comprehensive testing and potentially new certification standards to account for environmental variability.
- Cost Implications of Complexity: The increased uncertainty, complexity and need for resilience and adaptability in vessel design likely lead to higher construction costs.
- Construction Delays: The increased uncertainty and complexity of design and the potential need for specialised materials and technologies can lead to longer construction times, resulting in delays in the deployment of new vessels. This may be further affected by problems in the supply chains.

In conclusion, climate change brings a level of unpredictability that complicates the building of rescue vessels. SAR organisations must consider a broader range of environmental conditions and ensure that their fleets are versatile, durable, and capable of responding to the evolving challenges posed by a changing climate. This complexity demands innovative design strategies, flexible planning, and possibly a re-evaluation of standard operating procedures to maintain effective SAR capabilities.

Checklist items:

- Consider developing vessel design specifications that can adapt to a wide range of environmental conditions, multiple operational situations and unpredictable weather scenarios.
- Assess and choose materials for vessel construction that are durable and able to withstand varied environmental stressors like increased corrosion or higher temperatures.
- Regularly review and stay informed about evolving environmental regulations to ensure compliance during vessel design and construction phases.

Photo: FLBI/Jaakko Heikkila

2-3 Ecological and economic use of fuel

Climate change is compelling SAR organisations to fundamentally alter their fuel consumption practices.

Impact mechanisms:

- Fuel Efficiency and Emissions: As global temperatures rise SAR operations may experience changes in dynamics of fuel usage. Higher temperatures can affect fuel volatility and efficiency, potentially altering how SAR vessels and vehicles perform. SAR organisations may need to adapt by seeking more efficient engines that consume less fuel and emit fewer greenhouse gases to mitigate climate impacts.
- Alternative Energy Sources: The ecological imperative to reduce carbon emissions is pushing SAR organisations to consider alternative, more sustainable energy sources. This might include transitioning to low-sulphur variants, biofuels, and electric or hybrid engines, which could provide ecological benefits such as reduced air pollution and economic benefits through potential long-term cost savings despite the upfront investment.
- Cooling and Heating Systems: With increasing temperatures, the demand for cooling systems on SAR vessels and vehicles may increase, leading to a higher energy draw. Similarly, in the Arctic and the Antarctic the demands for heating the vessels impose a similar impact. Organisations will have to balance the additional power requirements with the need for fuel efficiency and the move towards reduced emissions.
- Fuel Storage and Stability: Elevated temperatures can affect the storage stability of fuels, with a higher risk of evaporation and degradation. SAR organisations might need to invest in improved fuel storage technologies or adopt more stable fuel alternatives to maintain operational readiness.
- Operational Range: Altered temperatures can also lead to increased fuel consumption, affecting the operational range of SAR assets. This would require careful planning and potentially more frequent refuelling operations or the use of vessels with larger fuel capacities. Similar adjustments are needed if the operational range of the vessels needs to be increased due to shifts in the locations of rescue.
- Heat Tolerance of Equipment: Fuel systems and the equipment that run on them must be designed or adapted to tolerate higher temperatures or larger temperature ranges without a loss of performance, requiring new materials or cooling technologies.
- Fuel Price Volatility: Fuel is a significant variable cost for many SAR organisations, and fluctuating fuel prices, often exacerbated by climate change-induced disruptions, can significantly impact operational budgets. SAR organisations must develop strategies for fuel procurement that protect against market volatility.

Overall, climate change necessitates a forward-looking approach to fuel use in SAR operations, emphasising ecological responsibility and economic viability in the face of environmental changes. This impacts not only the types of fuels used but also the broader operational and logistical frameworks within which SAR organisations operate.

Checklist items:

- Conduct assessments of current engines for fuel efficiency and emissions, considering the impacts of higher temperatures on fuel volatility and operational efficiency.
- Investigate the feasibility of transitioning to alternative energy sources such as biofuels, electric, or hybrid engines, weighing ecological benefits against economic factors. For the transition period, assess the feasibility of reducing internal combustion power with smaller fuel efficient but more powerful currently available propulsion units.
- Create strategies to secure fuel procurement, protecting against market volatility and fluctuating fuel prices.

Photo: FLBI/Jaakko Heikkila

2-4 De-standardisation of SAR vessels

Climate change is poised to significantly impact SAR organisations by challenging the standardisation of vessels in several ways, particularly concerning the local availability of fuels.

Impact mechanisms:

- Fuel Availability Variations: As climate change affects global and local supply chains, SAR organisations might encounter situations where their standardised fuel types are not readily available at all, or in certain regions. This could be due to extreme weather events, changes in trade patterns, or shifts in production due to environmental policies. The infrastructure for fuel production and distribution is also being affected by climate change, with some regions potentially transferring to alternative fuel sources, such as biofuels or synthetic fuels, to adapt to these changes. SAR organisations may have to adapt their vessels to operate with different types of fuel that are available locally, leading to a de-standardisation process. There may also be operational modifications needed: if a SAR vessel leaves from one station and has to return to another, availability of different fuels in different locations needs to be considered.
- Regional Fuel Prices: The cost of fuel can vary widely by region due to climate-related factors, such as the impact of extreme weather on refineries or transport routes. SAR organisations might choose to de-standardise their vessels to use the most economically viable fuel available locally.
- Diverse Operational Profiles: The specific environmental conditions prompted by climate change – such as ice melting in the Arctic and the Antarctic or increased flooding in riverine areas – may demand SAR vessels with different capabilities and, consequently, different fuel needs. Additionally, certain operational profiles might favour for instance use of fully electric rescue vessels. Needs for diversification are not confined to just fuel: different operational requirements and type types of operations may require de-standardisation or some kind of modular design of rescue vessels.
- Innovation in Vessel Design: To cope with the varied availability of fuels, SAR organisations might invest in innovative vessel designs capable of using multiple fuel types. This could include hybrid engines that can switch between conventional diesel and alternative fuels or electric power sources.
- Logistical Complexity: Managing a fleet with different technical or operational requirements increases logistical complexity. SAR organisations will need to establish more sophisticated supply chains and storage facilities, as well as train their operational personnel to handle different types of technical and operational solutions. Such de-standardisation also complicates relocating the vessels to new areas.
- Maintenance and Technical Expertise: Diverse engine types and fuel systems will require a broader range of maintenance skills and technical knowledge among SAR personnel, adding complexity to operational personnel training and vessel upkeep.
- Adapting to Local Regulations: As local jurisdictions respond to climate change they may implement regulations that require the use of cleaner fuels or restrict certain types of emissions. SAR organisations would need to adapt their vessels to comply with these local regulations, which could differ from one region to another.

The imperative to adapt to the local availability of different fuel types could lead SAR organisations to operate a more heterogeneous fleet. The same may take place on the operational side due to different operational demands placed on rescue vessels in different areas. This de-standardisation will require careful planning and adaptation strategies to ensure operational effectiveness in the face of changing technical and operational landscapes. However, de-standardisation can also lead to increased resilience for SAR organisations. By having vessels that can operate on various types of fuel and are suitable for various purposes, SAR organisations can better cope with the uncertainties and disruptions that climate change might cause.

Checklist items:

- Establish a routine to regularly assess the availability and types of fuels in operational regions, preparing for potential fuel shortages or changes. Create flexible fuel supply chain strategies and establish versatile storage facilities to accommodate a fleet with diverse fuel requirements.
- Consider modifying existing vessels or designing new ones to operate on a variety of fuel types, such as biofuels, synthetic fuels, or electric power, to ensure operational flexibility.
- Develop and implement strategies to manage the increased logistical complexity associated with operating a diversified fleet.

2-5 Water characteristics

Climate change can significantly affect the marine environment, leading to alterations in sea temperature, salinity, and overall water chemistry. These changes can have various impacts on the materials and operational integrity of SAR vessels. This is important for many SAR organisations that keep their rescue boats afloat, as opposed to keeping them dry in boathouses.

Impact mechanisms:

- Material Expansion or Contraction: Fluctuations in temperature can cause materials to expand or contract, which may impact the structural integrity of a vessel. For instance, different expansion rates of composite materials versus metals could lead to weakening of joints or cracks in the hull.
- Corrosion and Electrolysis: Changes in salinity and temperature can accelerate corrosion, especially in metal components. Increased water salinity and temperature can both intensify the rate of metal degradation, leading to the need for more frequent maintenance and potential structural failures. Additionally, changes in pH levels due to ocean acidification can alter the corrosivity of seawater.
- Seawater Intake Systems: SAR vessels often use seawater for cooling engines. Changes in water temperature and salinity can affect the efficiency of these systems and lead to increased maintenance needs or system redesigns to ensure reliability.
- Coating and Seal Integrity: Protective coatings and seals are designed to function within certain environmental parameters. If salinity or temperature is outside these parameters, it could cause premature deterioration of these protective layers, resulting in leaks or increased fouling.
- Material Strength: Prolonged exposure to different environmental conditions than what the vessel materials were designed for can lead to changes in material properties. For example, higher temperatures can soften some materials, reducing their strength and leading to potential safety issues.
- Biofouling: Changes in temperature and salinity can affect the types of organisms present in the water, potentially increasing the rate of biofouling. This biological growth on hulls and other submerged parts can affect vessel performance and fuel efficiency, increase weight, and require more frequent cleaning.

These potential problems underscore the need for SAR organisations to closely monitor the condition of their vessels and to be proactive in design as well as in maintenance practices. They may need to invest in research and development for new materials and coatings that are more resilient to the changing marine environment, increase budgets for vessel maintenance and repairs, revise maintenance schedules to address the more demanding conditions, and re-evaluate vessel design specifications to ensure newbuilds are adapted to changing conditions.

Checklist items:

- Establish a routine to monitor vessel materials for signs of expansion, contraction, and corrosion, and plan to adapt maintenance practices accordingly.
- Assess the efficiency and reliability of current seawater cooling systems and consider redesigns to ensure optimal performance in changing water conditions.
- Plan for the procurement of coatings, sealants and other material that are effective across a wider range of salinity and temperature conditions.

Photo: FLBI/Jaakko Heikkila

3. Equipment

3-1 Increased wear and tear of equipment

Climate change is leading to more frequent and intense weather events as well as a larger amount of operations, which can greatly impact the wear and tear of equipment used by SAR organisations.

Impact mechanisms:

- Personal Protective Equipment (PPE): SAR personnel often work in harsh conditions, and their gear - for instance survival suits, lifejackets, helmets, gloves, and boots - must protect against extreme temperatures, water, wind, and in some instances chemicals. As weather events become more severe, PPE may experience accelerated degradation due to exposure to higher UV radiation, saltwater, or extreme cold and heat. This means that PPE may need more frequent replacement or require materials that are more durable and resistant to extreme conditions. Also, damage to infrastructure may lead to chemical contamination or effluent spillage, which will require vehicle, vessel and operational personnel protection. For instance, NSRI in South Africa have experienced chemical burns on operational personnel who were operating in such conditions.
- Other Equipment: Items designed to safeguard the vessel and its equipment, such as waterproof covers, seals, and anti-corrosive coatings, may fail more quickly due to harsher environmental conditions. The same is true for many other equipment used in rescue operations, such as cranes, pumps, medical transport equipment, and so on. This requires SAR organisations to invest in higher-quality equipment that can withstand such changes.
- Ropes and Rigging: Ropes used for hoisting, towing, and securing equipment can degrade more quickly due to UV exposure, saltwater, and temperature extremes, requiring more frequent maintenance, inspections and replacements.

To mitigate these impacts, SAR organisations may need to adopt a more aggressive maintenance and replacement schedule for their equipment. They might also consider investing in new types of equipment that are specifically designed to be more resistant to extreme conditions. Furthermore, the organisations will likely need to adapt their budgets and planning processes to account for the increased costs associated with more frequent equipment turnover and the need for more resilient technologies.

Checklist items:

- Review the maintenance protocols and procedures for PPE and other equipment to ensure that they are maintained as well as possible to ensure their functionality in changing environmental conditions.
- Review the budget allocation for procuring higher-quality, durable materials for PPE and other protective equipment, ensuring they are designed to withstand harsher environmental conditions.

3-2 Thermal stress on equipment

Climate change is contributing to more extreme temperature variations, which can induce thermal stress on the equipment used by SAR organisations.

Impact mechanisms:

- Material Fatigue: Repeated fluctuations in temperature can cause materials to expand and contract, leading to material fatigue. Over time, this can weaken structural components, potentially leading to failures. For instance, the RNLI in the United Kingdom has experienced thermal expansion of fuel bladders on the inshore lifeboats. This means they have to use special coverings or keep the lifeboats out of the sun, otherwise there is a risk of fuel bladders bursting. In South Africa the NSRI has already changed to internal fuel tanks partly for this reason.
- Seal and Gasket Failure: Seals and gaskets that protect sensitive components from water ingress can degrade when exposed to extreme temperatures, which could compromise the watertight integrity of equipment or the vessel.
- Adhesives and Coatings: Many pieces of equipment use adhesives and coatings for structural integrity and protection. Extreme temperatures can compromise these materials, leading to delamination and degradation of protective coatings.
- Electronics and Battery Efficiency: The efficiency of electronic devices and batteries can be significantly affected by extreme heat or cold. Extreme temperatures and increased moisture in the air can also affect the functionality and lifespan of electronic devices. Equipment that rely on batteries, such as handheld radios and other portable electronic devices, may see a decrease in performance as temperatures become more extreme, since battery efficiency can be significantly impacted by temperature fluctuations.
- Lubricants and Fluids: The performance of lubricants and hydraulic fluids that are crucial for the operation of mechanical systems can be altered by temperature changes, potentially leading to equipment malfunction or increased wear.
- Sensitivity of Sensors: SAR operations often depend on a variety of sensors for navigation and detection. Thermal stress can impact the sensitivity and accuracy of these sensors, leading to potential malfunctions or erroneous readings.
- Medical Supplies: Medical equipment and supplies can be sensitive to temperature and humidity. More extreme weather conditions might necessitate improved storage solutions or even affect the shelf life of critical supplies such as medications.

The goal for SAR organisations is to ensure their equipment remain reliable and fully operational regardless of the challenging conditions presented by a changing climate and temperature variability. This may involve additional investment in high-quality, durable materials and equipment, a more rigorous maintenance schedule, preventive measures such as thermal blankets or cooling systems, and more frequent updates to existing gear.

Checklist items:

- Establish a regular testing protocol to evaluate the resilience of equipment to thermal stress and detect early signs of fatigue or failure. Assess and identify components of equipment that are particularly susceptible to thermal stress, such as seals, gaskets, adhesives, and coatings, and plan for their upgrade or replacement. Conduct assessments of lubricants and hydraulic fluids used in equipment, and upgrade to formulations that are more suitable for extreme temperature ranges.
- Evaluate and ensure the provision of climate-controlled storage facilities for sensitive equipment and medical supplies to protect them from extreme temperature variations.

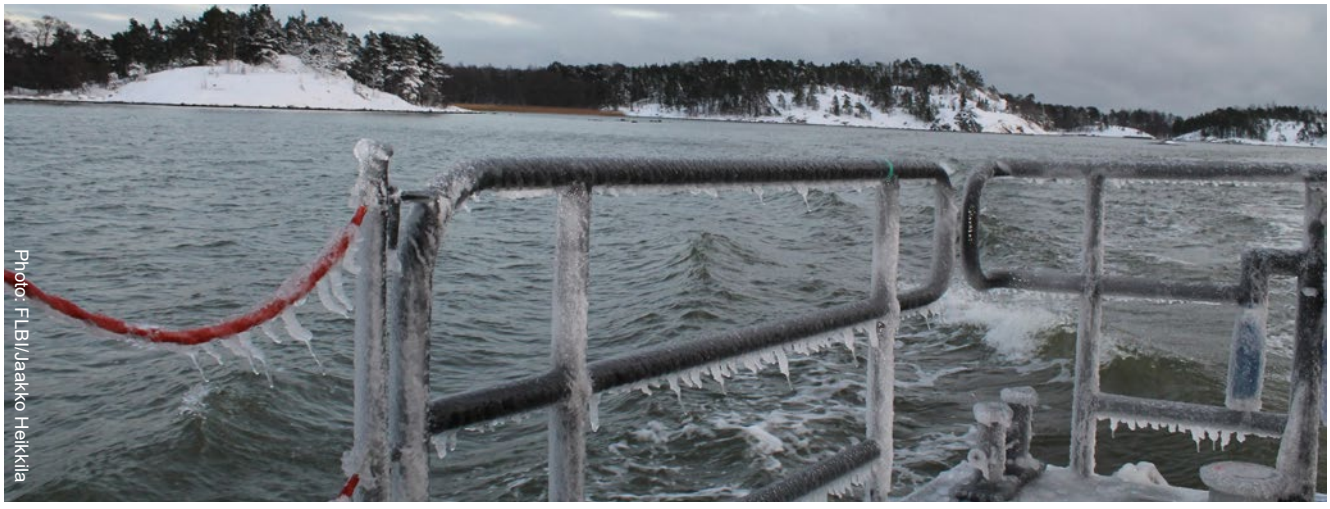


Photo: FLBI/Jaakko Heikkila

Photo: FLBI/Jaakko Heikkila

3-3 Salinity stress on equipment

Climate change has been linked to increased temperatures globally, which can result in higher rates of evaporation and consequently higher salinity in some bodies of water. This change in salinity can have several impacts on the equipment used by SAR organisations.

Impact mechanisms:

- Corrosion of Metal Components: Higher salinity can cause accelerated corrosion of any metal parts, which may include communication devices and rescue equipment such as winches, cranes, and launching systems for smaller boats. This could necessitate stronger materials or more robust design standards to withstand these conditions.
- Degradation of Protective Gear: Personal Protective Equipment (PPE) like lifejackets, survival suits, and gloves may degrade faster due to the harsher saltwater environment, affecting their performance and safety properties.
- Impact on Electronic Devices: Electronics used in SAR, such as GPS units, radios, and other sensors, could be more susceptible to saltwater damage, which can lead to malfunctions or failures during critical operations.
- Compromised Rope and Fabric Materials: Salinity can weaken ropes and fabrics, which are integral to many rescue operations. The strength and durability of these materials can be compromised, leading to a need for more frequent inspections and replacements.
- Wear on Diving Equipment: For SAR units that perform underwater rescues, increased salinity can affect diving gear, such as regulators and buoyancy control devices, requiring more frequent maintenance or replacement.

Using metals that resist saltwater corrosion, applying protective coatings to susceptible parts and thoroughly fresh water rinsing and drying of equipment after use can help prevent damage. Implementing strict maintenance schedules to inspect, service, and replace equipment that are more prone to salt-induced wear will be crucial. Also storing sensitive equipment in controlled environments to protect it from salt-laden air, especially in coastal regions, can prevent premature degradation. This means likely increased maintenance and storage costs and potential operational downtime, which can have budgetary and logistical implications.

Checklist items:

- Assess the current utilisation of materials and coatings in SAR equipment, particularly metal components, for their resistance to saltwater corrosion, and plan for necessary upgrades.
- Establish strict and regular maintenance schedules for all equipment, especially focusing on diving gear, personal protective equipment (PPE), and metal components, to identify and address signs of corrosion or wear at an early stage. Ensure protocols and procedures are in place for all equipment exposed to saltwater to be thoroughly rinsed with fresh water and dried properly, preventing salt accumulation and corrosion.
- Assess and implement storage solutions for sensitive electronics and fabric materials that minimise exposure to salt-laden air, especially in coastal regions, to prolong their operational life.

3-4 Potential need for new equipment

Climate change, with its potential to increase the frequency and intensity of extreme weather events, can have significant impacts on the need for equipment, for instance equipment suited to conditions created by floods and swiftwater incidents.

Impact mechanisms:

- Equipment for New Scenarios: Climate change may induce changes in the types of operations as well as make it more difficult to reach the SAR station or the casualty site. Therefore, equipment such as chainsaws and other demolition tools may be needed. Similarly, equipment such as high-power pumps may be required. There may also be a need for the development of new tools for navigating and performing rescues in floodwaters, such as inflatable rafts or boats designed for rapid deployment and manoeuvrability in urban environments that have been flooded.
- Specialised Water Rescue Gear: The increase in flooding may require SAR teams to acquire gear specifically designed for swiftwater rescue operations. This includes flotation devices, helmets with face guards, and special protective suits that can protect rescuers from hypothermia while allowing for mobility in fast-moving water. Traditional heavy protective gear might not be suitable for flood conditions, where rescuers need to be agile and swift. Equipment manufacturers may need to design boots and suits that are lighter, possibly with a heavier lower part for stability in water and a lighter upper part to allow for swimming and mobility. On the other hand, more robust suits that can withstand the rigors of extended flood rescue missions may be needed to protect rescuers from contaminants and prolonged exposure to water.
- Evolution of Personal Protective Equipment (PPE): There is a difference between what to wear on the rescue vessel and what to wear in the water. Earlier it has been primarily a question of keeping the operational personnel dry and warm, but more and more for instance the RNLI in the United Kingdom is in discussions on how to keep the operational personnel cool. Also issues such as changes in fuel grading may change the requirements needed from the PPE. So, the needs for PPE are changing. Additionally, there may be a need to consider equipment such as Emergency Breath Systems in water rescue for both rescuers and the casualties.
- Evolution of Personal Flotation Devices (PFDs): As floodwaters can be unpredictable and carry a significant amount of debris, PFDs might need to be adapted to offer better protection against impacts and to be more easily seen in murky water conditions.
- Enhanced Onboard Life-Support Systems: SAR vessels may need to be equipped with better life-support systems, including advanced medical equipment for treating hypothermia and heat stress, such as warming blankets, intravenous fluid warmers, or portable cooling units.
- Procurement of Durable Equipment: In addition to obtaining new equipment, existing equipment may need to be replaced with new versions made of materials that can withstand a broader range of temperatures and weather conditions, anticipating the more extreme variations in climate.

The necessity for new equipment implies additional budgetary considerations for SAR organisations, which will have to plan for the procurement, maintenance, and storage of this specialised gear. Moreover, training personnel in the use of new equipment will be an essential part of adapting to the evolving demands of SAR operations in a changing climate.

Checklist items:

- Conduct an assessment to identify the specific requirements for gear designed for swiftwater and flood rescue operations, such as flotation devices, protective suits, and specialised helmets, or other operations considered relevant.
- Review the current state of PPE and PFDs to ensure they are adapted for higher visibility and impact protection, suitable for use in murky and debris-filled floodwaters, as well as any other new environments.
- Assess and if needed, provide SAR vessels with medical equipment capable of treating climate-related health issues like hypothermia and heat stress.

Read more:

- Tipton Michael J., Abelairas-Gómez Cristian, Mayhew Adrian and Milligan Gemma S. 2019. The thermal demands of flood rescue and impacts on task performance. *Ergonomics* 63: 109-118. DOI: 10.1080/00140139.2019.1683617. Available at: https://www.tandfonline.com/doi/abs/10.1080/00140139.2019.1683617

3-5 Disruption of communication channels and routes

Climate change has the potential to disrupt communication channels and routes that are critical for SAR operations, including the satellite networks.

Impact mechanisms:

- Increased Demand on Communications During Disasters: Climate change is likely to increase the frequency and intensity of natural disasters such as hurricanes, floods, and wildfires, which can lead to a surge in emergency calls and communications, potentially overloading communication systems.
- Satellite Network Challenges: Changes in the Earth's atmosphere due to increased greenhouse gases can affect satellite operations. For instance, a warmer atmosphere can lead to more moisture, which may increase signal attenuation for satellite communications. Additionally, satellite hardware can be affected by temperature fluctuations in space caused by changes in Earth's atmospheric composition. For instance, New Zealand has experienced communication disruptions in recent years, and HF radio is therefore still considered a useful tool.
- GPS Accuracy and Reliability: Severe weather can impact the accuracy and reliability of GPS systems, which are vital for navigation and location tracking in SAR missions.
- Infrastructure Vulnerability: Communications infrastructure, such as cell towers and ground stations, may be damaged by extreme weather events. For SAR operations, this means potential delays in communication.
- Maintenance and Repair Challenges: More frequent and severe weather events and changes in temperature and salinity can lead to increased wear and tear or other damages on communication equipment, necessitating more frequent maintenance and repairs, which can be costly and time-consuming.
- Cybersecurity Risks: There's a potential for increased cybersecurity risks as more systems become interconnected to provide redundancy and resilience against the impacts of climate change. More connections can mean more potential points of vulnerability.
- Power Supply Stability: Communication systems require a stable power supply, which can be compromised by climate-induced power outages. SAR organisations may need to invest in alternative power sources such as solar or wind energy to ensure continuous operation.

For SAR organisations, these challenges necessitate strategic planning to ensure that communication networks remain robust and resilient. This includes investing in more durable and climate-resistant infrastructure, developing redundant systems to prevent single points of failure, and ensuring that there is a plan for rapid repair and restoration of services after extreme weather events. It also involves enhancing the capacity and flexibility of communications systems to handle increased loads during disasters and emergencies related to climate change.

Checklist items:

- Assess the current resilience of satellite networks against atmospheric interferences and plan for alternative or backup communication systems. Maintain capability of using VHF/HF radio communications.
- Develop strategies to maintain reliable GPS functionality during severe weather conditions, potentially incorporating complementary navigation systems.
- Review and upgrade the communication infrastructure to ensure it can handle increased loads during climate-induced disasters. Also review the durability of communication infrastructure and plan for weather-resistant and climate-proof constructions like fortified cell towers and ground stations.
- Assess and enhance cybersecurity measures to protect against the increased risks associated with interconnected communication systems.
- Plan for alternative and reliable power sources for communication systems to ensure functionality during climate-induced power failures, such as implementing solar or wind energy solutions.

Read more:

- Cooper Olivia. 2023. Climate change and space debris, a vicious cycle. *Astrobites*. Available at: https://astrobites.org/2023/01/20/climate-change-exacerbates-space-debris/


Photo: Maël Balland

3-6 Review of charts

Climate change can significantly affect water levels due to a combination of melting ice caps, glaciers, and the thermal expansion of water as temperatures rise. Additionally, coastlines may change due to storms and other extreme weather events. This has direct implications for SAR operations in the form of launch and recovery sites, station locations, and so on, but also in relation to the need for reviewing and updating nautical charts.

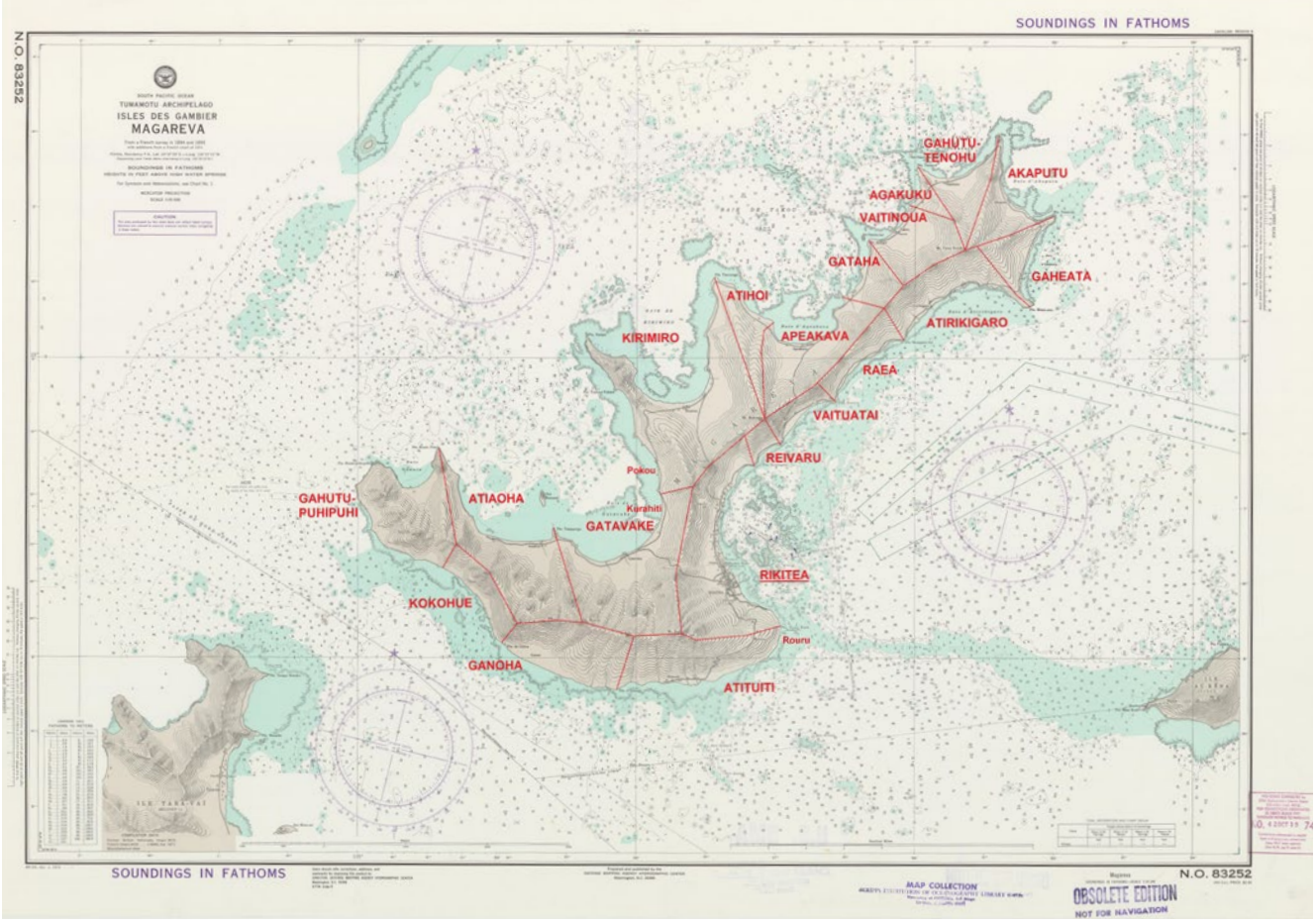
Impact mechanisms:

- Altered Coastlines and Shallow Waters: Rising sea levels can change coastlines and create new shallow-water hazards. SAR operations depend on accurate charts to navigate safely, and changes in water levels may render existing charts obsolete.
- Erosion and Sedimentation: Increased storm activity and changing weather patterns can lead to accelerated erosion or increased sediment in waterways, altering depth profiles and potentially creating new shoals or sandbars that SAR operations need to be aware of.
- Submerged Obstacles: Objects that were once visible above water, or well-documented hazards in established depths, may become submerged and not immediately evident to SAR operational personnel. This could increase the risk of vessel damage or personnel injuries during operations.
- Newly Exposed Hazards: Conversely, lower water levels in some areas, such as rivers and lakes experiencing drought conditions, may expose previously submerged hazards. SAR units must be aware of these to prevent running aground or colliding with these new dangers.

For SAR organisations, adapting to these changes means remaining updated on the charts they are using, or investing in the latest charting technology and software. It also emphasises the need for close collaboration with hydrographic offices and other agencies responsible for monitoring and documenting changes in water levels and marine environments. For instance, in the United Kingdom the Hydrographic Office plans to stop printing paper charts in 2030, and any such changes also need to be taken into account by SAR organisations.

Checklist items:

- Establish a routine for regularly updating nautical charts to accurately reflect changes in coastlines, shallow waters, and new hazards resulting from sea-level changes and extreme weather events.
- Allocate resources for investing in the latest charting software and technology to ensure access to accurate and real-time navigation data.



3-7 Land-based vehicles

Climate change is causing an increase in extreme weather events, such as heavy rainfall leading to floods, rising sea levels resulting in coastal erosion, and severe storms that can damage infrastructure. These conditions can significantly affect the accessibility of coastal sites and the operability of land-based vehicles that may be essential for SAR operations.

Impact mechanisms:

- Access to Coastal Sites: As sea levels rise and coastal erosion worsens, access to certain coastal areas might become more challenging. Roads may be damaged or submerged, requiring SAR vehicles that can navigate through floodwaters or over rough terrain. There might be a growing need for vehicles that are specifically designed or adapted for flood conditions. This could mean investing in higher-clearance vehicles, boats, or even amphibious vehicles that can travel on both land and water and that are equipped with advanced navigation systems, including GPS and other location-based technologies that can function even when traditional landmarks are no longer visible.
- Enhanced Durability: Land-based SAR vehicles may need to be more durable to withstand harsher conditions, such as driving through floodwaters, which can cause mechanical and electrical systems to fail. Regular maintenance and checks will become even more crucial to ensure reliability.
- Recharging network: As land-based vehicle fleet is transformed into electric engines, it must be made sure that electric land-based vehicles have sufficient (and sufficiently fast) recharging stations. This network is needed not only for SAR vehicles, but also for other emergency services.
- Vehicle Adaptations: Vehicles might need modifications to carry additional rescue personnel or equipment suited to flood scenarios, such as lifejackets, ropes, and inflatable rafts. Vehicles may also need to be modified for quick loading and unloading, ensuring rapid response times despite challenging conditions.
- Robust Fleet Management for Vehicles: The frequency of severe weather events may lead to an increased number of deployments, putting additional strain on vehicles and requiring more robust fleet management and rotation systems to ensure that vehicles are always available and in good working order.
- Strategic Positioning of Vehicles: SAR organisations may need to reconsider the positioning of their vehicles to ensure they can be rapidly deployed to coastal areas. This might involve setting up new bases or storage facilities closer to high-risk areas.
- Environmental Regulations: With the push for environmental sustainability, SAR organisations might be required to consider the environmental impact of their vehicles. This could mean a transition to vehicles with lower emissions, which could also be more efficient and cost-effective in the long run.

As climate change progresses, SAR organisations will need to continuously evaluate and adapt their vehicle capabilities to meet the challenges posed by the changing environment, ensuring that they can continue to perform their critical functions effectively.

Checklist items:

- Assess the need to invest in vehicles capable of navigating varied terrains and flood conditions, such as amphibious or all-terrain vehicles.
- Assess and modify vehicles to facilitate quick loading and unloading of different kinds of rescue equipment, enhancing rapid response capabilities in emergency situations.
- Assess the need for a comprehensive fleet management system that accommodates increased deployments and ensures continuous availability and maintenance of vehicles.
- Review and potentially reposition vehicles and equipment strategically, especially closer to high-risk coastal areas for quicker deployment.
- Plan for the transition towards environmentally sustainable vehicles with lower emissions, ensuring compliance with environmental standards and exploring potential cost savings.

Photo: RNLI/Nathan Williams

3-8 De-standardisation and deployment

Climate change presents a variety of environmental scenarios, each requiring specific types of equipment for effective SAR operations. The changing climate could impact SAR organisations in terms of varying and diverse equipment needs and management.

Impact mechanisms:

- Diversified Equipment and Procurement: As climate change intensifies, SAR organisations may face a wider range of emergencies, from floods to wildfires, necessitating a broader array of specialised equipment. This diversification can pose logistical challenges regarding procurement, as the need to source and purchase different sets of gear increases.
- De-standardisation Challenges: Different types of emergencies and the equipment they require can lead to de-standardisation, where multiple types of equipment might be needed for different environments. This can lead to compatibility issues, interoperability challenges, and increased training requirements.
- Training on New Equipment: Using different sets of equipment effectively requires additional training for SAR personnel. This not only increases the demand for training programmes but also requires more time from personnel to become proficient with the new gear.
- Storage Challenges: With a greater variety of equipment comes the need for more storage space. SAR units must have the means to store gear in a manner that ensures its readiness and accessibility while also protecting it from environmental factors that could degrade its performance.
- Deployment Issues: Deploying the correct set of equipment to the right location becomes more complicated as the variety of potential incidents, and potential storage locations, increases. Having to choose from an array of different equipment for different scenarios can slow down deployment unless well-practiced procedures are in place. SAR organisations must develop robust systems for managing and deploying their assets efficiently.
- Maintenance and Upkeep: A diverse set of equipment requires a corresponding range of maintenance protocols. This complexity can increase the workload for SAR organisations and may necessitate the development of new maintenance procedures or the procurement of specialised tools and expertise.
- Depreciation and Obsolescence: Equipment that is infrequently used may depreciate or become obsolete before it sees significant use. SAR organisations must carefully manage their assets to ensure that equipment is not wasted, and that investment is made in gear that will be of most benefit.
- Budget Constraints: The financial impact of acquiring a wider array of equipment could strain SAR budgets. Organisations must balance the need for specialised gear with fiscal responsibility, potentially requiring difficult decisions about priorities and the allocation of limited resources.

SAR organisations may need to adopt more sophisticated asset management systems, invest in versatile equipment that can be used in multiple types of environments, and seek out opportunities for collaboration and standardisation with other SAR or rescue organisations to streamline operations and reduce costs. The ability to adapt to these complex requirements will be critical for maintaining effective SAR capabilities in the face of climate change.

Checklist items:

- Assess and update the range of equipment necessary to address various climate-induced emergencies effectively. Develop a comprehensive maintenance plan to manage the upkeep of diverse equipment, considering factors like depreciation and technological advancements.
- Determine the optimal balance between standardising equipment and maintaining the flexibility to adapt it for different environmental and rescue scenarios.
- Create and maintain efficient storage solutions that maximise space and accessibility while preserving the condition of various equipment types. As a part of storage solutions, establish and regularly reassess deployment protocols to ensure rapid and appropriate responses with the correct equipment for varying emergencies.
- Look for opportunities to collaborate with other SAR organisations and agencies to share resources, knowledge, and best practices related to equipment usage in different environmental contexts.

3-9 Equipment procurement

Climate change is creating more extreme and variable conditions that necessitate specialised equipment for SAR operations. In a niche-market world, where demand for highly specific products can be limited, several challenges can arise for SAR organisations trying to obtain the suitable and required equipment.

Impact mechanisms:

- Limited Availability: The equipment tailored for the unique demands of climate-induced SAR operations may not be readily available or could be produced by a limited number of manufacturers. This scarcity can lead to longer wait times for procurement and potentially higher costs.
- Supplier Reliability: With a smaller pool of suppliers providing niche-market equipment, SAR organisations may face risks associated with supplier reliability. A sole-source supplier may struggle with demand surges or go out of business, which could lead to critical equipment shortages.
- Scalability: Even when niche equipment can be obtained, scaling up to ensure adequate supplies across a large organisation or for widespread deployment can be problematic, further complicating logistics and resource allocation.
- Customisation Costs: When off-the-shelf options do not meet the specific needs imposed by new rescue scenarios, SAR organisations may have to invest in custom-designed equipment. The development and manufacturing of such tailored items are typically more expensive due to the research and development and lower economies of scale. Further, the equipment must not only be suitable for current conditions but also adaptable to future changes. This requires continuous innovation, which can be challenging to sustain in a niche market.
- Quality Assurance: Ensuring the quality and reliability of equipment is crucial for SAR operations. In a niche market, with fewer competitors and products, it may be more challenging to ascertain and ensure the highest standards of quality and performance.
- Regulatory Approval: Equipment used in SAR operations often needs to meet stringent regulatory standards for safety and effectiveness. Obtaining these approvals can be a lengthy and expensive process, particularly for new or innovative products entering the market.

In response to these challenges, SAR organisations need to engage in strategic planning, establish strong supplier relationships, and seek collaborative arrangements to ensure that they can secure the equipment necessary to respond to the diverse and evolving challenges posed by climate change. International cooperation can be a key to addressing equipment challenges. SAR organisations may benefit from collaborative procurement initiatives, shared research and development efforts, and standardised equipment requirements across borders.

Checklist items:

- Evaluate and strengthen relationships with multiple equipment suppliers to mitigate risks associated with limited availability and reliance on sole-source vendors. Account also for scalability challenges in procurement processes to ensure adequate supplies for diverse and widespread operational needs.
- Establish stringent quality assurance protocols to ensure the reliability and performance of niche-market SAR equipment. Regularly review and assess the market for emerging technologies and potential new suppliers to stay informed about advancements and opportunities in SAR equipment.
- Understand and efficiently manage the regulatory landscape for the approval of new SAR equipment, considering time and cost implications in the procurement process.
- Explore opportunities for international cooperative agreements and shared research and development initiatives to address unique equipment needs and standardised requirements.
- Develop backup solutions and redundancy plans in equipment procurement to safeguard against potential supplier issues or market fluctuations.

Read more:

- World Bank. 2015. Emergency Procurement for Recovery and Reconstruction: A toolkit for the delivery of goods, services and construction in situations of urgent need and capacity constraints. Available at: https://pubdocs.worldbank.org/en/315691568908208946/Emergency-Procurement-for-Reconstruction-and-Recovery-Toolkit.pdf

3-10 End-of-life management

Climate change not only affects the operational aspects of SAR organisations but also influences their environmental policies and practices, particularly concerning end-of-life management of their equipment. Therefore, also decisions on how long to use the existing equipment and when to transfer to new equipment, need to be considered.

Impact mechanisms:

- Sustainable End-of-Life Management: As climate awareness rises, SAR organisations are likely to face increased pressure to adopt sustainable practices. This includes responsible end-of-life management of their equipment, ensuring that they are recycled properly or disposed of in a way that minimises environmental impact. For instance, retired lifeboats can be sold to other SAR organisations or even to private individuals.
- Supply Chain Integration: SAR organisations may need to work more closely with suppliers to ensure that the equipment they purchase are designed with end-of-life recycling in mind, potentially influencing procurement decisions.
- Equipment Life Span Changes: The increased frequency of extreme weather events may lead to more rapid wear and tear on equipment, shortening its life span and requiring more frequent replacement and disposal.
- Recycling Challenges: Some SAR equipment may contain materials that are difficult to recycle or are hazardous. Climate change may prompt a reassessment of materials used to make them more sustainable and easier to recycle.
- Innovation in Material Use: Climate change may drive innovation in the use of biodegradable or more easily recyclable materials in SAR equipment manufacturing, affecting future procurement and disposal cycles. This may provide increased opportunities for SAR organisations to participate in the circular economy, where equipment is designed for reuse, refurbishment, and recycling, rather than disposal.
- Training on End-of-Life Management: SAR personnel may require additional training to handle end-of-life management of equipment, including how to dismantle, sort, and recycle components properly.
- Regulatory Compliance: Governments and international bodies may introduce stricter regulations on waste and recycling as part of their climate change mitigation strategies, impacting how SAR organisations manage equipment at the end of its life.
- Partnership for End-of-life Management: There may be a need to form new partnerships with recycling firms, waste management companies, or other SAR organisations to handle end-of-life equipment efficiently and sustainably.
- Budget Implications of Recycling: Implementing robust recycling programmes and participating in circular economy initiatives may require upfront investment, which could impact SAR organisations' budgets and require careful financial planning.

In South Africa, the NSRI has implemented an efficient vehicle rotation program with one of the nation's prominent vehicle suppliers, renewing their official vehicles every three years. This program ensures vehicles retain a high retail value due to consistent maintenance and the strategic structure of the program, proving more cost-effective than extended vehicle retention. While this model is not directly transferable to boats, the NSRI has adapted by increasing boat refurbishment cycles, responding to the heightened wear from more frequent operations, ensuring operational efficiency and reliability. By incorporating such considerations into their operational planning, SAR organisations can contribute to global sustainability efforts while ensuring their practices are aligned with the broader societal push toward mitigating the impacts of climate change.

Checklist items:

- Create and implement clear policies for the sustainable end-of-life management of SAR equipment, with a focus on recycling and minimising environmental impact. Regularly review and ensure compliance with current and emerging environmental regulations.
- Collaborate with suppliers to ensure SAR equipment are designed with considerations for easy recycling or sustainable disposal at the end of its life cycle.
- Develop and provide training for SAR personnel on best practices in dismantling, sorting, and recycling equipment at the end of its service life.
- Adjust budgeting and procurement planning to accommodate potentially shortened equipment lifespans due to more demanding operational conditions.
- Investigate innovative recycling and reuse options for specialised SAR equipment, especially those with complex or hazardous components. Form partnerships with recycling firms and waste management companies to facilitate efficient and environmentally responsible disposal.

4. Operational Personnel and Training

4-1 New training requirements

Climate change is altering the landscape of emergencies and disasters that SAR organisations must prepare for in terms of training of operational personnel.

Impact mechanisms:

- Changing Environments: As the climate changes, SAR teams may encounter new environments, such as expanded maritime areas due to melting ice or regions that are now prone to flooding. Operational personnel will need training specific to these environments to operate safely and effectively.
- Operational Tactics: SAR teams will need to adapt their search and rescue tactics for environments that may have been altered by climate change effects, such as new waterways created by flooding or changed landscapes after a wildfire, or urban SAR in post-disaster scenarios including for instance navigation in urban environment and dealing with different kinds of environmental hazards. Simulation-based training can help prepare operational personnel for the challenges associated with changes in the operating conditions.
- Casualty Behaviour: In the face of disasters and the resulting stress, understanding the behaviour of casualties is crucial. Climate-related events can lead to panic, shock, and unpredictable responses from those affected. SAR personnel must be trained in psychological first aid and communication skills to effectively manage and calm casualties, ensuring their safety and the safety of the rescue team.
- Psychological Resilience: SAR operations in the wake of climate change-related events may be more distressing due to increased severity and casualties. Therefore, SAR personnel will need training to develop psychological resilience and coping mechanisms to deal with the potentially traumatic experiences encountered during rescue missions. This can include stress management techniques, mindfulness practices, and peer support programmes. The IMRF SARyouOK? guidance provides a good overview of practices available for SAR organisations.
- Health and Safety of Personnel: Operations in rough conditions can lead to a higher incidence of injuries and health issues like seasickness. Operational personnel will need training on how to minimise these risks and how to provide immediate care when such situations arise. Also training on recognising the signs of heat-related illnesses and proper hydration techniques may be necessary.
- Equipment Training: With the introduction of new gear tailored to specific environments, for instance swiftwater rescue equipment, SAR personnel will need to be trained in using them. These might range from personal flotation devices to advanced thermal imaging cameras for fire detection. There may also be a need to train the operational personnel in using sonars, remotely operated vehicle (ROVs) or autonomous underwater vehicles (AUVs) in flooded areas so they can be used to detect, locate, identify and retrieve casualties in different water environments.
- Public Health Emergencies: Climate change can also exacerbate public health emergencies, such as the spread of vector-borne diseases following floods. SAR personnel may need additional training in public health protocols, the use of personal protective equipment, and measures to prevent disease transmission during operations.

Photo: SSRS

- Marine Life: SAR operational personnel may require training to identify hazardous marine life and provide first aid for stings and bites. This could include training on how to treat jellyfish stings or how to manage allergic reactions. Additionally, they may require training on how to handle close encounters with marine life, including understanding animal behaviour and associated risks, to ensure their safety and that of the animals.
- Environmental Hazards: The increased likelihood of encountering hazardous materials during rescues, especially following storms or floods that can displace chemicals and toxins, requires SAR personnel to be well-versed in recognising and responding to environmental hazards.
- Interoperability and Coordination: SAR operations are increasingly requiring coordination with other agencies and international partners. Training must therefore include interoperability aspects, ensuring that SAR personnel can work effectively in a multi-agency response structure, understanding different procedures and overcoming any language barriers.

Overall, climate change necessitates a proactive and dynamic approach to SAR operational personnel preparedness, with a strong emphasis on adaptability to ensure both rescuer safety and operational effectiveness in new and challenging conditions.

Checklist items:

- Assess the future needs and design and prepare training programmes focused on operating in environments altered by climate change, such as expanded water areas and regions prone to flooding, including not only advanced rescue techniques but also public health emergencies and environmental hazards awareness.
- Implement processes and procedures to support psychological resilience of personnel and design and integrate training to prepare personnel for the emotional impact of severe climate change-related SAR operations.
- Focus on training for effective interoperability and coordination with other agencies and international partners in diverse SAR scenarios.

4-2 Emphasis of training

Climate change is expected to not only influence the volume and nature of SAR operations but also the emphasis placed on various training aspects within SAR organisations. SAR personnel will need additional training across a wider range of environmental and operational conditions. This necessitates modifying existing training requirements by developing and implementing diverse training programmes that include skills specific to different rescue scenarios.

Impact mechanisms:

- Water-Rescue Techniques: As flooding becomes more prevalent, there is a greater need for SAR personnel to be skilled in water-rescue techniques. This includes swiftwater rescue, operating boats in flooded urban areas, and even understanding the risks of waterborne pathogens or pollution that may be more prevalent following extreme weather events. Rescuers also need specialised training in hydrology, understanding water dynamics, and safe rescue techniques that differ significantly from those used in calm water scenarios.
- Wildfire Response: Areas that may not have been prone to wildfires in the past could see an increased risk due to drier conditions and higher temperatures. SAR personnel may need to be trained in navigating through wildfire-affected areas, understanding fire behaviour, applying safety protocols, and working alongside fire suppression teams.
- Enhanced Seamanship: The ability to handle SAR vessels in rough waters or in swiftwater areas is a critical skill that may need to be enhanced as these conditions become more common. This includes manoeuvring, docking, and maintaining stability and speed in challenging sea states.
- Navigation Skills: Operational personnel may also need advanced skills in navigation to cope with extreme conditions and changing landscapes, including the use of sophisticated onboard navigation systems. On the other hand, maintaining competence in using maritime paper charts is likely to remain necessary given uncertainties related to electronic navigation.
- Medical Training for Heat-Related Illnesses: As temperatures rise, rescuers will need to be adept at recognising and treating heat-related illnesses, both in victims and among their own teams.

- Medical Triage Training: As extreme weather events such as heatwaves, storms, and floods become more common due to climate change, SAR organisations may encounter a higher volume of casualties. Medical triage – the process of determining the priority of patients' treatments based on the severity of their condition – becomes critical in managing these situations efficiently. SAR personnel will need enhanced skills to quickly assess and prioritise medical care in situations where there are multiple casualties.
- Evacuation Procedures: Increased severity and frequency of climate events can lead to more large-scale evacuations. SAR personnel may need training in managing these scenarios, including crowd control and large-scale logistics.
- Collaboration with Other Agencies: The increasing complexity of rescue operations may require SAR teams to train alongside other emergency services, such as fire departments and emergency medical services, to ensure a coordinated response to multifaceted emergencies.

The shifting focus in training underscores the need for SAR organisations to adapt and prepare for the diverse challenges posed by climate change. It will be essential for the organisations to continually assess and evolve their training programmes to ensure their teams are equipped with the necessary skills and knowledge to respond effectively in this changing landscape. SAR organisations will likely need to invest in more rigorous training programmes that specifically address operations in harsh and unpredictable environments. This could involve simulated training environments, specialised courses, and inter-agency training exercises that focus on building the necessary skills and knowledge to respond to emergencies in increasingly common rough conditions.

Checklist items:

- Incorporate in the training plans comprehensive training in swiftwater rescue techniques, boat operations in flooded areas, and understanding waterborne hazards.
- Develop training modules for operating in wildfire-affected areas, including understanding fire behaviour and safety protocols.
- Focus on advanced training in handling SAR vessels in rough waters, challenging sea conditions and limited visibility, emphasising manoeuvrability, docking, navigation, and stability.
- Incorporate in the training plans comprehensive training for heat-related illnesses, medical triage in high-casualty situations, and large-scale evacuation procedures.

Read more:

- Escobio F , Etiennoul M and Spindola S. 2017. Rescue medical activities in the Mediterranean migrant crisis. *Conflict and Health* 11: 3 DOI 10.1186/s13031-017-0105-1. Available at: https://conflictandhealth.biomedcentral.com/track/pdf/10.1186/s13031-017-0105-1.pdf
- Marine Business News. 2023. Marine Rescue Brunswick to host flood capability training exercise. Available at: https://www.marinebusinessnews.com.au/2023/10/marine-rescue-brunswick-to-host-flood-capability-training-exercise/
- Theodosopoulou P, Tsiamis C, Pikoulis A, Pikouli A, Aristomenis E and Pikoulis E. 2021. Rescue medical activities among sea migrants and refugees in the Mediterranean region: lessons to be learned from the 2014-2020 period. Int Marit Health 72(2): 99-109. doi: 10.5603/IMH.2021.0018. PMID: 34212349.

4-3 Training to operate new craft and systems

Climate change is pushing SAR organisations to update their fleets with craft and systems that can better handle the changing conditions and reduce their environmental impact.

Impact mechanisms:

- Training for New Craft: With the emergence of extreme weather conditions, SAR operations may require vessels like hydrofoils that can operate effectively in rough waters or electric or hybrid power boats that provide a cleaner, quieter, and potentially more reliable alternative to traditional fuel-powered engines. The introduction of new types of craft, each with its unique handling characteristics and technical requirements, will necessitate specialised training for SAR personnel. They must become proficient in the operation, manoeuvring, navigation, and maintenance of these advanced systems, including for instance:
  - Electric and hybrid boats: SAR personnel will need to understand the intricacies of these systems, including energy management, charging infrastructure, and range limitations.
  - Hydrofoils: Hydrofoils, which lift the hull of the vessel above the water's surface at speed, offer high-speed travel with reduced wave resistance. They require different piloting skills and an understanding of their performance in various sea conditions.
  - Drones: Drones can provide aerial surveillance, communication, and delivery of rescue equipment and supplies. Operating drones in maritime environments also poses some challenges, such as weather conditions, signal interference, and legal regulations. Operational personnel therefore may require training in operating aerial or maritime drones to use them effectively and safely.
- Operating in New Environments: Climate change may introduce new operating environments such as the flooded urban and rural areas or previously unused arctic passages. SAR organisations will need to develop and train the operational personnel in new strategies for operational response that leverage the capabilities of new crafts in these environments.
- Maintenance Skills: The maintenance of modern, technologically advanced SAR craft, particularly those with electric propulsion or hydrofoil technology, will require updated skills. Operational personnel will need to be trained in electronic diagnostics, battery care, and the maintenance of complex mechanical systems that differ from those in conventional vessels.

Overall, adapting to new craft and propulsion systems will be a complex process that touches on every aspect of SAR operations, from personnel training to operational planning and environmental stewardship.

Checklist items:

- Develop comprehensive training programmes for operational personnel on the operation and navigation of new vessel types like electric and hybrid boats, hydrofoils, and drones, including in various environmental conditions including high seas and urban flooding.
- Provide updated training for SAR personnel on the maintenance and care of advanced technological systems unique to modern craft.

4-4 Operational personnel requirements

Climate change can significantly impact the operational personnel capabilities in SAR organisations, particularly in the context of the increasing frequency and intensity of severe weather events that result in rougher conditions.

Impact mechanisms:

- Physical Fitness: The physical demands of rescue operations in extreme conditions such as higher waves, stronger winds, and more turbulent waters, or in extreme environments such as swiftwater or active fire zones are considerable. SAR organisations may need to reassess their physical fitness requirements to ensure their teams are capable of performing under such strenuous conditions. Operational personnel must be able to perform physically demanding tasks for extended periods without compromising their safety or the success of the mission.
- Mental Resilience: The psychological impact of responding to high-stress environments repeatedly, such as in the case of large-scale floods or fires, must be addressed in the organisation. Building mental resilience and coping strategies for SAR teams will be crucial. Stress management will be vital to ensure that operational personnel can maintain their focus and decision-making abilities in high-pressure situations. The IMRF SARyouOK? guidance provides a good overview of practices available for SAR organisations.
- Team Coordination and Communication: Effective team coordination becomes even more crucial in extreme conditions, where misunderstandings can lead to critical mistakes. Operational personnel need to practice clear and efficient crew resource management, ensuring that every team member always understands their role and the current situation, and all team resources are utilised in building situational awareness and helping in decision-making.

To enhance SAR operations in the face of climate change, it is crucial to ensure that SAR personnel are not only physically prepared for more demanding rescue operations but also psychologically equipped to handle the stress of high-stakes environments. Organisations need to implement comprehensive fitness and mental health programmes, aligning with guidance like IMRF's SARyouOK?. Strengthening team dynamics and communication skills is essential for navigating complex scenarios effectively.

Checklist items:

- Monitor physical demands faced by operational personnel and, if and when needed, update physical fitness standards and training to ensure operational personnel can handle the increased physical demands of rescue operations in extreme conditions.
- Implement mental resilience training and support programmes, focusing on stress management and coping strategies for operational personnel frequently exposed to high-stress environments. Advise is available in IMRF's #SARyouOK? guidance.
- Emphasise training in Crew Resource Management, including team coordination and communication to ensure clear and efficient team dynamics during high-pressure situations.

Photo: SSRS

4-5 Operational personnel health impact risks

Climate change presents a multitude of health impact risks for SAR operational personnel, particularly from untreated sewage, contagious diseases, and hazardous animals. The changing climate affects environmental conditions, potentially leading to increased exposure to various health hazards.

Impact mechanisms:

- Untreated Sewage: As extreme weather events such as floods become more frequent and intense due to climate change, the risk of sewage systems overflowing increases. SAR operations in or near waters contaminated by untreated sewage expose operational personnel to harmful micro-organisms that can cause a range of infections. Protective measures, such as the use of waterproof and biohazard suits, will become increasingly important, as well as strict decontamination procedures post-mission. For instance, in the United Kingdom untreated sewage is a particular problem that has received a lot of media attention, and the RNLI experience this on some of lifeguarded beaches. The organisation is notified by Surfers Against Sewage if there is going to be, or has been, a Combined Sewage Outflow and recommend lifeguards stay out of the water if possible and communicate the risk to the public.
- Procedures for Cleaning Up: Following exposure to, for instance, sewage or chemical substance, there needs to be clear agreed procedures with medical authorities on cleaning up after contamination.
- Contagious Diseases: Warmer temperatures and changes in precipitation patterns can contribute to the spread of vector-borne diseases like malaria, dengue fever, and Zika virus, as the geographical range of vectors like mosquitoes and ticks expands. SAR operations in affected areas may necessitate additional medical precautions, vaccinations, and preventive measures such as insect repellent and netting. Moreover, operational personnel may need to be trained to recognise symptoms and provide immediate care, if available.
- Hazardous Animals: Shifts in habitats due to climate change can lead to SAR operational personnel encountering hazardous animals in new locations. The risk of bites or stings from venomous creatures can increase, necessitating the need for training on how to avoid dangerous encounters and manage injuries if they occur. Additionally, there may be a need for SAR vessels and equipment to be modified to protect against such risks, and for medical kits to be stocked with appropriate treatments.
- Health Surveillance: SAR organisations may need to develop or expand their health surveillance and monitoring systems to track potential outbreaks of disease that could affect both the victims and the rescuers. Health and safety protocols may require updating to address the broader range of risks presented by a changing climate.

Climate change can impact SAR organisations by necessitating enhanced health protection measures, specialised training, and strategic planning to address the complex and evolving risks posed to SAR operational personnel's health.

Checklist items:

- Plan for protective measures, operational procedures, decontamination processes and training for operations in areas with potential sewage contamination, contagious disease, hazardous animals or other hazards.

Read more:

- Ndugga Nambi, Pillai Drishti and Artiga Samantha. 2023. Climate-Related Health Risks Among Workers: Who is at Increased Risk? KFF. Available at: https://www.kff.org/racial-equity-and-health-policy/issue-brief/climate-related-health-risks-among-workers-who-is-at-increased-risk/

Photo: Helio Dilolwa

4-6 Operational personnel physical protection

Climate change can affect SAR organisations by altering the environmental conditions and new rescue situations in which operational personnel must operate, thereby impacting their safety and effectiveness. SAR organisations may need to adapt to protect their operational personnel from the extremes of hypothermia, hyperthermia, and severe weather conditions.

Impact mechanisms:

- Hypothermia and Hyperthermia: SAR organisations may need to adapt to protect their operational personnel from the extremes of both hypothermia and hyperthermia.
  - Hypothermia Protection: As extreme weather events can lead to colder, more unpredictable conditions, SAR operational personnel are at a higher risk of hypothermia during operations. Improved protective gear, such as insulated waterproof suits, heated clothing, and advanced personal flotation devices that offer better thermal protection, will become essential. Operational personnel may also need portable heat sources and enhanced onboard heating systems to maintain body temperature during prolonged missions in cold environments.
  - Hyperthermia and Heat Stress Mitigation: Rising global temperatures and heatwaves present a risk of hyperthermia. SAR organisations may need to consider adopting lightweight, breathable, and moisture-wicking uniforms that offer protection from the sun while allowing body heat to escape. Active cooling technologies, such as vests with integrated cooling systems or phase change materials that absorb heat, can also help manage core body temperatures. The vessels may need to be equipped with cooling systems that make it easier for operational personnel to function. Ensuring sufficient hydration of operational personnel in prolonged missions may prove challenging, particularly on open boats with limited storage.
- Safety Protocol Revision: Safety protocols that were effective under previous climatic conditions may no longer be adequate. As such, they must be reviewed and updated to ensure they account for new hazards, such as increased risk of heatstroke or hypothermia during extended operations. Additionally, in some circumstances where critical incidents of fire, flooding and other environmental dangers are present, it is not uncommon for the affected local population to react violently to what is occurring to them, their families and possessions. SAR operational personnel must ensure close liaison with law enforcement when operating in such areas to ensure injury and loss of life is prevented.
- Extreme Weather Gear: To safeguard against severe weather, SAR personnel may need access to specialised gear, including helmets with face shields, goggles, and enhanced hand and foot protection. This equipment must be designed to withstand heavy rains, strong winds, and flying debris while maintaining mobility and comfort.
- Shelter and Relief: Operational personnel may require improved facilities for rest and relief from environmental conditions, both on vessels and at stations. This includes sheltered areas that can provide a controlled climate, enabling personnel to recover from environmental exposure during lengthy SAR operations.
- Adaptive Work Cycles: To reduce the risk of temperature-related stress, SAR organisations might need to adapt their operational cycles, allowing for shorter exposure times in extreme conditions with more frequent rotations and breaks for operational personnel.
- Monitoring and Response Technologies: Utilising wearable technology to monitor vital signs can alert SAR personnel to the early onset of hypothermia or heat stress, enabling proactive measures to prevent serious health issues.

By anticipating the diverse range of climate-related challenges, SAR organisations can take proactive steps to ensure their operational personnel are equipped and ready to perform their duties without compromising their health or safety. Updating SOPs and safety protocols will require a significant investment of time and resources from SAR organisations. These measures not only protect the individuals involved in SAR operations but are also vital to ensure SAR teams remain prepared to respond effectively to the evolving challenges posed by climate change.

Checklist items:

- Assess the need to provide SAR operational personnel with improved protective gear for hypothermia and hyperthermia, including insulated waterproof suits and lightweight, breathable uniforms.
- Revise and update safety protocols, including work cycles, to address new hazards related to extreme temperature variations and severe weather conditions.
- Assess the feasibility of equipping SAR vessels with enhanced onboard heating and cooling systems to maintain operational personnel comfort and safety during operations.
- Assess the feasibility of equipping operational personnel with wearable technology for real-time monitoring of vital signs to proactively manage risks of hypothermia and heat stress.

4-7 Operational personnel mental welfare

Climate change is expected to increase the frequency and severity of natural disasters, which can result in a higher volume of rescue missions and more complex scenarios for SAR organisations. The mental welfare of SAR operational personnel is paramount in such challenging situations.

Impact mechanisms:

- Increased Frequency, Severity and Length of Missions: As natural disasters become more common, SAR teams may be called upon more frequently and for longer deployments. Also, the length of missions may increase due to moving locations of rescue, or in the case of lifeguards, due to longer optimal time during the day at the beach. The strain of continuous or longer operations without adequate rest can lead to burnout, fatigue, and stress-related illnesses.
- Complexity of Rescue Missions: Climate change might lead to new forms of natural disasters or exacerbate existing ones, like mass flooding events, requiring SAR personnel to operate in more hazardous and emotionally taxing environments. Operational personnel may encounter scenes of significant devastation and be required to assist large numbers of casualties, including fatalities. The psychological impact of dealing with traumatic events, potential loss of life, and the stress of high-stakes operations can be profound. SAR organisations may need to implement regular mental health check-ins and provide access to psychological support services, including counselling and stress debriefings (defusing) after intense missions.
- Rest and Recuperation: Ensuring that operational personnel have adequate downtime between operations is critical for maintaining long-term welfare. SAR organisations may need to review and adjust work-rest cycles to prevent exhaustion and ensure operational personnel are mentally fit for duty. For instance, New Zealand NZSAR has a fatigue management guidance for its operational personnel.
- Operational Personnel Availability: As operations may take place in locations further away from the stations, operational personnel availability and fatigue for longer operations may become an issue.
- Supportive Infrastructure: The provision of facilities that support operational personnel welfare, such as comfortable accommodations during standby and between missions, areas for relaxation, and recreational activities, will be important to help operational personnel recharge. Also, for instance transportation and communication services may be found increasing personnel welfare.
- Community and Family Support: Recognising the role of family and community in operational personnel welfare, SAR organisations might need to establish support systems for the families of SAR personnel who are often on-call or away from home for extended periods.

The impacts of climate change will likely require SAR organisations to put greater emphasis on comprehensive welfare protection strategies that address the mental health needs of both operational and support personnel. The kinds of things that they will see and experience are going to change, and the need for psychological resilience is emphasised. As missions potentially grow in complexity and emotional weight, investing in operational personnel welfare will be crucial to maintain operational effectiveness and the long-term sustainability of SAR operations.

Checklist items:

- Implement regular mental health check-ins and access to psychological support for SAR operational personnel.
- Adjust work-rest cycles and provide facilities for operational personnel relaxation and recuperation during and between missions to prevent exhaustion and maintain operational personnel fitness for duty. Develop a fatigue management plan and guidance.
- Develop support systems for SAR personnel's families.
- Introduce comprehensive welfare protection strategies for mental health of SAR operational personnel. Advise is available in IMRF's #SARyouOK? guidance.

Read more:

- International Federation of Red Cross and Red Crescent Societies. 2011. Protect. Promote. Recognize. Volunteering in Emergencies. Geneva. Available at: https://www.ifrc.org/docs/IDRL/Volunteers/Volunteering%20in%20emergency_EN-LR.pdf
- Morren Mattijn, Dirkzwager Anja J.E., Kessels Frans J.M. and Yzermans C. Joris. 2007. The influence of a disaster on the health of rescue workers: a longitudinal study. *Canadian Medical Association Journal* 176 (9): 1279-1283. Available at: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC1852883/
- New Zealand Search and Rescue. Health, Safety and Wellbeing – Fatigue Management Guidance. Available at: https://nzsar.govt.nz/sar-system-support/health-safety-and-wellbeing/

Photo: FLBI/Jaakko Heikkila

4-8 Retention of volunteer operational personnel

The increasing severity and frequency of incidents due to climate change are likely to place additional pressures on SAR organisations, particularly those that rely heavily on volunteers.

Impact mechanisms:

- Resource Constraints: SAR operations may face resource constraints as they try to meet the increased demand for services with a volunteer workforce. This can lead to over-reliance on existing volunteers, exacerbating burnout risks.
- Demanding Missions: More demanding missions can lead to volunteer fatigue, as individuals may have to balance their SAR commitments with personal and professional responsibilities. This can result in burnout and attrition if not managed effectively.
- Training Requirements: As the nature of SAR missions evolves with the climate, volunteers will need to undergo more extensive and perhaps more frequent training to cope with new challenges and competence requirements. This can impose additional time commitments that not all volunteers may be willing or able to meet.
- Psychological Toll: Volunteers may be exposed to more traumatic situations, which can have a significant impact on mental health. Without proper support, the emotional burden of service could deter volunteers from continuing.
- Physical Risks: More extreme weather conditions can increase the physical risks to volunteers during missions. The potential for injury or even loss of life may lead some individuals to reconsider their participation.
- Sustainability of Coastal Communities and Stations: Climate change and other socioeconomic factors may compromise the sustainability of coastal communities. As volunteer organisations are dependent on the community for providing voluntary operational personnel, there is a challenge to keep such stations operational. For instance, at the RNLI in the United Kingdom, the operational personnel have to live and work within a five-minute travel distance of the lifeboat station when they are on call. If those coastal communities are impacted by climate change, there will be less and less people available to volunteer.
- Economic Impact: Volunteers may find the economic impact of participating in more frequent and longer missions unsustainable, especially if they must take unpaid leave from their regular employment to participate in longer SAR activities.

Retention of volunteers is crucial for the sustainability of SAR operations, particularly in the face of intensifying demands brought on by climate change. Proactive measures to recruit, support, train, and appreciate volunteers will be essential to maintain a robust and ready SAR volunteer workforce. Organisations should maintain their close relationship with current volunteer personnel through different kinds of activities, such as gatherings, commendations, and trainings.

Checklist items:

- Develop strategies to prevent volunteer burnout and support volunteers in their demanding work.
- Offer comprehensive and ongoing mental health support to help volunteers cope with the emotional burden of SAR missions. Advise is available in IMRF #SARyouOK? guidance.
- Develop ways to recognise and appreciate volunteer contributions.

Read more:

- International Federation of Red Cross and Red Crescent Societies. 2011. Protect. Promote. Recognize. Volunteering in Emergencies. Geneva. Available at: https://www.ifrc.org/docs/IDRL/Volunteers/Volunteering%20in%20emergency_EN-LR.pdf

4-9 Higher demand for support personnel

Climate change is resulting in more frequent and intense weather-related disasters, such as floods, wildfires, hurricanes, and heatwaves. These incidents are becoming increasingly prevalent and severe due to the changing climate, which in turn is leading to a higher demand for support personnel for SAR organisations, including personnel working with PR, procurement, storage, logistics, maintenance, call operators, and shore crew.

Impact mechanisms:

- Stress on Support Systems: The higher demand for SAR services could strain support systems, necessitating the improvement of logistical, communication, and operational support to handle the increased load.
- Recruitment: More ground-based personnel are likely to be needed to manage the surge in climate-induced incidents. SAR organisations would have to invest in recruiting volunteers and full-time personnel for the support tasks. There may also be a need to allocate more of the existing resources, including funds, equipment, and personnel, to such tasks.
- Enhanced Preparedness: Ground-based SAR personnel will need to design preparedness protocols and maintain a state of heightened preparedness to respond quickly to sudden climate-related disasters.
- Emergency Call Operators: With climate change induced environmental disasters there will be many people calling the emergency services, much more than in a traditional accident that affects only a limited amount of people. If the SAR organisation operates its own emergency or assistance call centre, this increasing number of requests for help needs to be taken into account in preparedness planning.

Climate change is leading to more frequent and severe weather-related disasters, increasing the demand for support personnel in SAR organisations. This surge requires enhanced recruitment efforts for ground-based roles along with a focus on maintaining a state of heightened preparedness. Additionally, the heightened demand is placing significant stress on support systems, necessitating improvements to manage the increased operational load effectively.

Checklist items:

- Assess the need for recruiting additional support personnel, including both volunteers and full-time staff, across diverse roles such as PR, procurement, logistics, and maintenance.
- Implement comprehensive training programmes for support personnel, focusing on rapid response strategies and efficient handling of increased workload due to climate-related incidents.
- Evaluate and upgrade logistical, communication, and operational support systems to better handle the increased demand and complexity of SAR missions in extreme weather conditions.
- Develop programmes and strategies to support the mental well-being and resilience of support personnel. Advise is available in IMRF's #SARyouOK? guidance.

Photo: Tima Miroshnichenko

SAR Operations

Climate change is causing environmental extremes, from severe flooding to the melting of polar ice, broadening the scope of SAR operations significantly. This shift necessitates SAR organisations to re-evaluate their rescue priorities significantly. This re-evaluation may relate to the following four aspects.

Larger volume of rescues: Climate change is likely to strain the capacity of SAR organisations as they face an increased frequency of extreme weather events and disasters. This means that SAR services must assess their current capacity and anticipate future needs, possibly leading to expansion or reorganisation of their resources, assets, and operations. The emergence of new SAR zones due to changing climate conditions, such as areas exposed to higher risks of flooding or wildfires, may require organisations to reallocate or increase their resources to maintain service levels. This may lead to increased operating hours, longer open water season, multiple simultaneous activities and subsequent need for prioritisation, strained resources and greater need for scalability of response. The impacts of climate change will require SAR organisations to re-evaluate and potentially overhaul their operational structures to ensure readiness for an uptick in the frequency, intensity, and complexity of rescue missions. This will involve not only an increase in resources but also enhancements in strategic planning, collaboration, and innovation in SAR practices.

New locations of rescue: Climate change is anticipated to alter the geographical patterns of incidents that require SAR operations. For instance, the retreat of polar ice is opening up new shipping routes in previously inaccessible regions. New shipping routes may also be formed elsewhere, in places where they have not been in place to date. SAR organisations must prepare for the possibility of rescues over greater distances, in urban conditions, in colder or warmer conditions, and potentially with less infrastructure support than what is available in more temperate zones. Such long rescue missions may happen at the expense of local readiness, and the prioritisation between the two may need to be re-thought at the SAR organisations. For SAR organisations, these changes also imply a need to re-evaluate their current operation zones, deploy resources in new areas, and possibly establish new bases of operation. It also calls for SAR personnel to be trained for a wider variety of environments and scenarios.

New targets of rescue: Climate change has far-reaching implications that can affect the nature of watercraft and other items SAR organisations typically target in their rescue missions. With changing climate, SAR organisations may see a shift in the types of vessels in distress. Increased recreational use of waterways due to warmer weather can lead to a higher number of leisure crafts, kayaks, and small boats needing assistance. Meanwhile, new commercial shipping lanes opened by melting polar ice or other factors causing major route changes will introduce larger cargo ships into previously untraveled waters. The scope of SAR operations might also expand due to the diverse array of situations brought about by climate change, including for instance assistance targeting stranded wildlife or operations at windfarms. Overall, SAR organisations are likely to encounter a broader and more complex range of targets.

New types of rescue: Climate change can have a profound impact on the type of rescue missions that SAR organisations conduct, primarily because of the shifts in environmental patterns and human activities in response to these changes. SAR organisations may need to allocate more resources to preventive measures, such as community education and early warning systems, to keep people away from the most dangerous areas during high-risk periods. Climate change can cause displacement of populations, potentially leading to a rise in migration-related incidents requiring SAR interventions. SAR teams might be increasingly called upon for clean-up operations after environmental disasters, such as oil spills or chemical leaks, which can be exacerbated by extreme weather events or sea-level rise impacting industrial areas. Higher temperatures can lead to more heat-related illnesses, requiring SAR operations to focus more on medical emergencies. In essence, SAR organisations must adapt to a dynamic operating environment where the types of missions they conduct are increasingly influenced by the changing climate. This requires not only a versatile skill set but also adaptable equipment and an agile approach to training and preparedness.

These four aspects of operations (volume, location, target and type) are further explored in the following pages.

5. Operation Volume

5-1 Demand for water-based activities

Warmer summers and heat waves can have several impacts on SAR organisations related to increased demand and prolonged season for water-based activities on water and on beaches.

Impact mechanisms:

- Increased Incidents: With more people taking to the beaches and waters during extended periods of hot weather, the probability of water-related incidents can increase significantly. This can range from swimming accidents and boating mishaps to heat-related medical emergencies. Research by the RNLI in the United Kingdom shows that there is a direct correlation between air temperature and lifesaving demand. Similar relationship exists between sunshine hours and lifesaving demand, and an inverse relationship between rainfall amount and lifesaving demand. The RNLI's current projection is that by 2050 lifeboat demand could increase by as much as 15-30% compared to 2019.
- Extended Operational Season: SAR organisations may find that their typical operational seasons are lengthened. What used to be a summer peak could extend well into what were traditionally off-peak times, requiring operational personnel to be on alert and prepared for a longer duration each year. Also, the optimal time of day for water-based recreation may become longer, straining personnel resources further.
- Enhanced Resource Demand: To cope with the increased activity on waters and on beaches, SAR organisations might need more resources, including rescue boats, jet skis, drones for aerial surveillance, and additional lifeguards and lifeboat crew on duty.
- Public Education: SAR organisations might need to increase their public education efforts to inform beachgoers and boaters about the risks of heat waves, the importance of hydration, and safe practices when on or near water.

Climate change induced warmer summers and heat waves can significantly impact SAR organisations by increasing the demand for their services, extending their operational periods, and requiring adaptations in training, resources, and public outreach.

Checklist items:

- Monitor the length of the operational season and the hourly distribution of operations during the day. Prepare to extend operational readiness to cover prolonged operational seasons and days, adapting staffing and resource allocation accordingly.
- Intensify public education campaigns on water safety, heat-related risks, and responsible behaviour during peak and extended summer periods.

Read more:

- Day J, Chin N, Sydnor S. et al. 2021. Implications of climate change for tourism and outdoor recreation: an Indiana, USA, case study. Climatic Change 169: 29. https://doi.org/10.1007/s10584-021-03284-w

Photo: Dariusz Grosa

5-2 Riskier boating and shipping

Climate change is leading to an increase in extreme weather events such as flash floods, storm surges, and severe storms, which in turn make maritime activities such as boating and shipping riskier. This has several implications for SAR organisations.

Impact mechanisms:

- Increased Incidents: With the rise in extreme weather events, SAR organisations can expect a higher number of distress calls due to vessels capsizing, thrown to rocks, being swept away, or damaged.
- Riskier Behaviour: In the face of escalating extreme weather events, a rise in thrill-seeking behaviours among the public, such as storm chasing and engaging in water sports like windsurfing and kite surfing during storm conditions, has been noted. Organisations like the RNLI in the United Kingdom have reported instances where individuals, drawn by the allure of big waves, have found themselves in perilous situations, necessitating rescue operations. Additionally, there are occurrences of bystanders venturing too close to the coast, only to be swept away by powerful waves, further underscoring the need for heightened caution and awareness.
- Enhanced Readiness and Rapid Deployment: SAR teams must be on a higher state of readiness, particularly during seasons prone to such weather events, which may require additional staffing and resources. SAR teams also need to have rapid deployment capabilities, as flash floods and storm surges can occur with little warning, requiring an immediate response.
- Logistical Challenges: Access to affected areas may be hindered by the same weather conditions that necessitate rescue efforts, requiring alternative strategies for reaching victims, such as the use of helicopters or amphibious vehicles.
- Operational Risk Management: Risk assessments for SAR operations become more complex, as the safety of the rescue teams must be weighed against the urgency of the rescue mission.
- Enhanced Medical Support: The potential for more severe injuries during extreme weather incidents necessitates robust medical support capabilities during SAR operations.
- Advanced Monitoring Systems: The need for advanced weather monitoring systems and predictive analytics becomes crucial for early warning and preparation for potential rescue operations.
- Equipment: Standard rescue equipment may need to be adapted or upgraded to cope with the increased loads and stresses of operating in extreme weather. This may include stronger towing lines, waterproof communication devices or more powerful pumps.
- Operational Personnel: SAR operational personnel require specialised training to operate effectively and safely in extreme weather conditions, including high winds, heavy rains, and turbulent waters. The extreme conditions also require sufficient physical and mental fitness from the personnel.
- Public Education: SAR organisations have a role in educating the public on the risks of boating or shipping during potential extreme weather conditions, such as dangers of storm surges and flash floods, including warnings and critical safety messages.

The changing climate and resulting weather patterns require SAR organisations to adapt their strategies, equipment, and training. They must also work closely with communities and individuals to improve overall maritime safety and reduce the necessity of dangerous rescue operations. The SAR organisation may need to reassess the publication of critical weather warnings or safety messages that are given to the boaters and the public.

Checklist items:

- Revise and update SAR risk assessments, paying attention to operations under extreme weather conditions and considering both rescue mission urgency and team safety.
- Plan for heightened readiness and rapid response capabilities, particularly during high-risk weather periods.
- Plan for alternative methods and techniques to reach affected areas or affected casualty vessels during extreme weather, including helicopters, amphibious vehicles, or drones.


Photo: ISAW Company

5-3 Untrained crews on under-equipped vessels

The impact of climate change on lifestyle and recreation, coupled with potential constraints on international travel, could lead to a scenario where more people choose to take to the waters for leisure activities, often without adequate preparation or equipment. This situation would have several implications for SAR organisations.

Impact mechanisms:

- Increased Incidents: The rise in the number of inadequately equipped boats, manned by individuals lacking proper training, is poised to escalate maritime incidents. These could range from capsizing and getting lost to equipment failure and navigational mistakes. A similar trend was observed by many SAR organisations during the early 2020s, amid the Covid-19 pandemic, highlighting the urgent need for enhanced safety awareness and training among boat operators.
- Enhanced Resource Demand: SAR organisations would need to allocate more resources to respond to these incidents. This could mean more vessels, fuel, and operational personnel.
- Public Education: There would be a greater need for educational campaigns focused on maritime safety, the importance of proper equipment, and training for new boat owners. SAR organisations would also need to ensure that the new boaters are aware of how to signal for help and communicate during emergencies.
- Partnerships: SAR organisations could forge partnerships with boating clubs, retailers, and fishing associations, integrating safety training and information into the boat purchasing experience. This collaborative effort, extending to liaisons with local government bodies like fishery administrations, aims to disseminate essential water rescue knowledge. Such initiatives are designed to equip boaters and fishermen with the necessary skills for self-protection and efficient emergency response, enhancing overall safety on the water.
- Technological Enhancements: Investing in technological advancements, such as sophisticated mobile applications for navigation and distress signalling, is becoming increasingly crucial in enhancing maritime safety. These technologies not only offer precise navigational assistance but also provide a direct line for emergency communication, significantly reducing response times. By embracing such innovations, SAR organisations can proactively mitigate risks, ensuring that mariners and recreational boaters alike have the tools to stay safe and well-informed.

A trend toward more recreational boating by inexperienced and ill-equipped individuals could lead to a significant increase in maritime incidents, placing additional pressures on SAR organisations. This would require SAR organisations to enhance their capabilities, invest in education and prevention, and possibly advocate for stronger regulations and enforcement.

Checklist items:

- Launch extensive public education campaigns on maritime safety, emphasising the importance of proper equipment, training, and emergency procedures for recreational boaters.
- Develop partnerships with boating clubs, marinas, equipment retailers to integrate safety training and information into the boat rental and purchasing process.
- Develop partnerships with fishing associations and other such leisure-time clubs to integrate safety training and information into their operations.
- Enhance technological capabilities, such as developing or promoting navigation and distress signalling applications, to assist inexperienced boaters in emergency situations.

Read more:

- RNLI. Safety Resources. Available at: https://rnli.org/safety/
  - Calling for help: https://rnli.org/safety/how-to-call-for-help-at-sea
  - Know the risks: https://rnli.org/safety/know-the-risks
  - Lifejackets: https://rnli.org/safety/lifejackets

-

5-4 Weaker sea ice

The weakening of sea ice in traditionally ice-covered areas due to climate change has a direct and significant impact on SAR organisations in several ways.

Impact mechanisms:

- Increased Incidents: With diminishing ice stability, there's a projected increase in incidents, including snowmobile accidents and accidents where individuals, like fishermen or skaters, fall through thin ice. SAR organisations should brace for an increase in emergency responses to these increasingly common scenarios.
- Changing Operational Terrain: SAR operations that previously took place on stable ice may now have to be conducted in open water or on dangerously thin ice, requiring different strategies. Weaker ice increases the risk to SAR personnel during operations, and ensuring the safety of responders with proper rescue equipment and personal gear is vital.
- Training: SAR personnel need specialised training to perform rescues in icy waters and on unstable ice. This includes ice swimming, using ice picks, operating specialised casualty transport equipment, and safely navigating across weak ice.
- Technology Integration: The use of advanced technologies like drones or remotely operated vehicles (ROVs) could be integrated into SAR operations to assess ice conditions or assist in rescues without putting personnel at risk. Aerial or satellite reconnaissance may become more critical to identify safe routes through ice for SAR operations and to monitor ice conditions in real-time.
- Environmental Response: Thinner ice may lead to increased maritime traffic in the Arctic and the Antarctic, raising the risk of oil spills or other environmental damage. SAR organisations might need to be increasingly prepared for environmental disaster response.
- Public Education: SAR organisations may need to increase efforts in community education and safety campaigns to warn about the dangers of weak ice and promote safe practices.
- As ice coverage becomes less predictable and stable, SAR organisations will have to adapt quickly to ensure that they can respond effectively to emergencies in these changing conditions while also maintaining the safety of their own personnel.

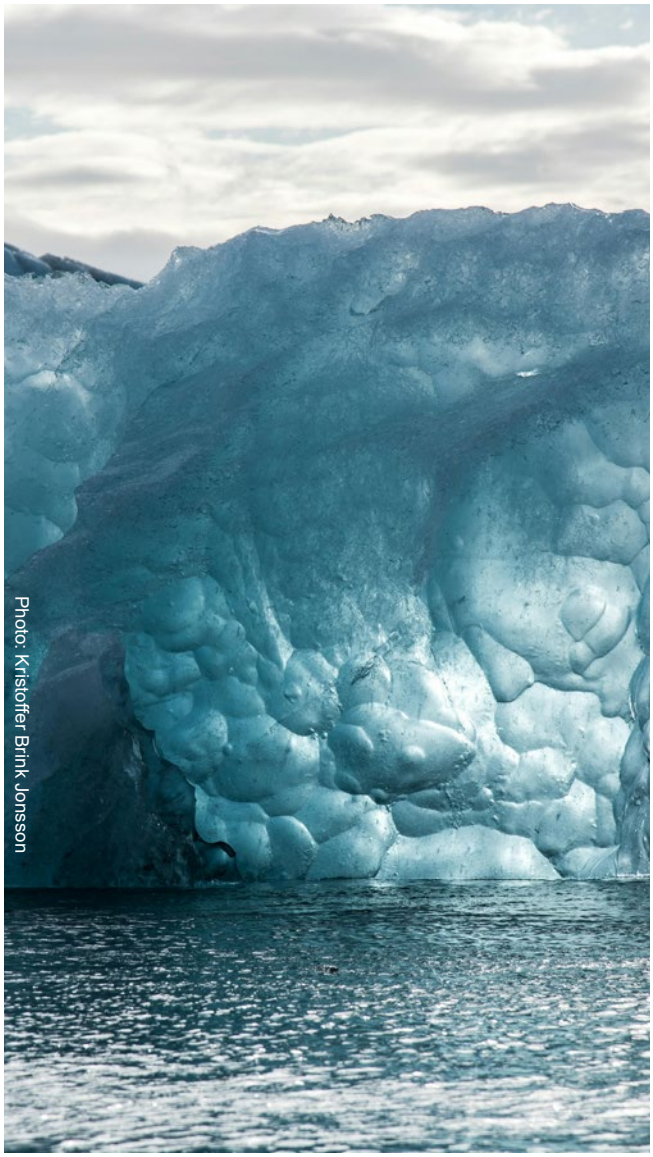


Photo: Kristoffer Brink Jonsson

Checklist items:

- Enhance training and special equipment procurement for SAR personnel in techniques specific to rescues in icy waters and on unstable ice.
- Invest in advanced technologies, such as drones and ROVs, for assessing ice conditions and conducting initial phases of rescue operations to minimise risk to responders.
- Implement comprehensive public education campaigns focusing on the dangers of weak ice and promoting safe practices in ice-covered areas.

Read more:

- Climateguide.fi. Baltic Sea ice conditions will change. Available at: https://www.climateguide.fi/articles/baltic-sea-ice-conditions-will-change
- Lea Robert. 2023. Greenland ice sheets are weaker to climate change than we thought. Space.com. Available at: https://www.space.com/climate-change-greenland-ice-sheet-sea-rise

5-5 Stronger currents on beaches

The impact of climate change on ocean currents can significantly affect the operations of SAR organisations, especially in coastal areas. Stronger and more unpredictable currents can arise due to the changing wind patterns and increased water temperatures caused by climate change.

Impact mechanisms:

- Increased Risk of Drowning: Especially people coming from urban towns and cities into coastal communities are generally not aware of the rip currents and other strong currents. Stronger currents can increase the risk of swimmers being swept away from shore, leading to a higher incidence of drowning and a greater need for swiftwater rescue operations.
- Complex Rescue Operations: Stronger currents make SAR operations more challenging. Rescuers must be highly skilled in navigating these conditions to reach and safely recover individuals in distress. SAR personnel may require advanced training to understand and operate effectively in powerful currents. Current-related incidents may necessitate the development of new rescue techniques and tactics tailored to these specific challenges.
- Strategic Placement of Assets: SAR organisations might need to re-evaluate the strategic placement of their assets (boats, jet skis, lifeguard stations) to ensure rapid response capabilities where stronger currents present the greatest risks.
- Preventive Rescue Operations: There may be a need for more preventive rescue operations, which include patrols and the presence of lifeguards in areas where inexperienced people are at risk.
- Equipment: Equipment such as tow lines, flotation devices, and personal watercraft may need to be upgraded or redesigned to perform effectively in stronger current conditions.

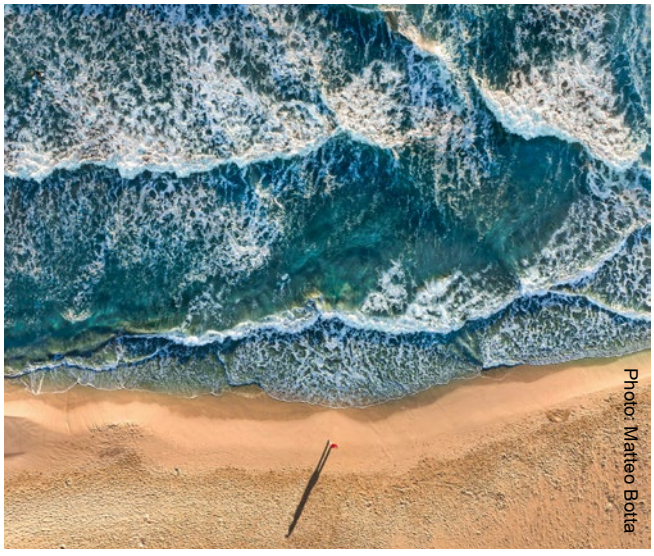


Photo: Matteo Botta

- Physical Fitness: The physical demands on SAR operational personnel increase with stronger currents, requiring a high level of fitness and readiness to perform strenuous rescues.
- Public Education: There may be a need for increased public education regarding the dangers of strong currents, including rip currents, and how to swim safely in areas where these are prevalent.
- Enhanced Surveillance and Warning Systems: Deployment of more sophisticated surveillance systems, such as drones and fixed cameras, and the development of early warning systems for detecting sudden changes in current strengths could become necessary. For instance, in Chile storm surges are an increasingly frequent problem, and scientists from the University of Valparaiso with the support of the Valparaiso lifeboat designed an early warning system for storm surges, in which they were assigned categories (from M1 to M5) in the same way as hurricanes.

Stronger beach currents are one of the many challenges SAR organisations face in a changing climate. Adaptability, ongoing training, community engagement, and investment in technology and infrastructure will be key in ensuring that SAR organisations can continue to protect public safety effectively.

Checklist items:

- Implement advanced training programmes for SAR personnel to enhance their skills in understanding and operating effectively in powerful currents.
- Ensure SAR teams maintain high physical fitness levels to meet the increased demands of rescuing in strong currents.
- Re-evaluate and strategically place SAR assets like boats, jet skis, and lifeguard stations in areas most affected by stronger currents for rapid response.
- Assess and upgrade essential equipment such as tow lines, flotation devices, and personal watercraft to ensure effectiveness in stronger current conditions.
- Increase public education efforts about the dangers of strong currents, including safe swimming practices in areas with high current risks.

Read more:

- Bierens Joost J.L.M., Webber Jonathon, Quieroga Anna C., Szpilman David, Sempsrott Justin, Barcala-Furelos Roberto and Tipton Mike. Drowning and climate change – a multidisciplinary challenge. Submitted for publication.
- RNLI. Rip currents. Available at: https://rnli.org/safety/know-the-risks/rip-currents

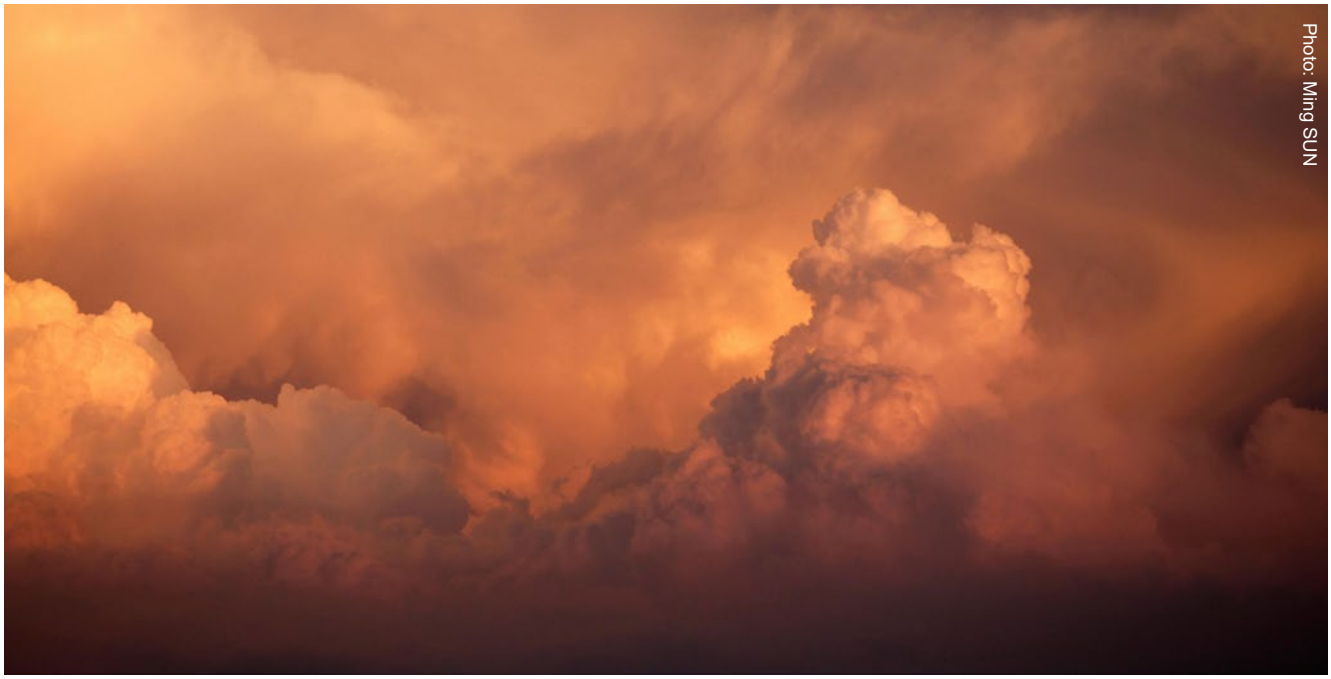


Photo: Ming SUN

5-6 Sandstorms

The escalating frequency and intensity of sandstorms, exacerbated by climate change, present significant challenges to maritime SAR operations. The degradation of land through desertification contributes to the increased prevalence of sandstorms, which can drastically reduce visibility and create hazardous conditions for both boaters and SAR personnel.

Impact mechanisms:

- Increased Incidents: Sandstorms can increase maritime incidents by drastically reducing visibility for navigation, causing communication disruptions, and leading to equipment malfunctions.
- Reduced Visibility: Sandstorms can severely reduce visibility at sea and on inland waters, complicating navigation and making it more difficult for SAR teams to locate individuals in distress.
- Navigation Hazards: Sandstorms can lead to the accumulation of sand and dust on decks and machinery, including the engine air filters, potentially impairing their functionality and creating additional hazards for SAR personnel.
- Health Risks: The fine particles present in sandstorms pose significant health risks to SAR personnel, potentially impairing respiratory function and visibility. Protective gear and equipment designed to filter out particulate matter will be essential for personnel operating in these conditions.
- Strategic Placement of Assets: SAR organisations may need to reassess the deployment of their assets to ensure they are optimally positioned to respond to incidents during sandstorms, taking into account the areas most susceptible to these events.
- Public Education: Increasing public awareness about the dangers of navigating waters prone to sandstorms and providing guidance on precautionary measures can help reduce the incidence of distress calls during these events.
- Enhanced Surveillance and Warning Systems: Investing in advanced forecasting and monitoring systems that can predict the onset of sandstorms with greater accuracy will be crucial for timely SAR operations, allowing also for pre-emptive measures and warning messages.

The impact of climate-induced sandstorms on maritime SAR operations underscores the need for adaptive strategies, enhanced technology, and comprehensive training to ensure the safety and efficiency of SAR efforts in the face of this growing challenge.

Checklist items:

- Develop and enforce health and safety protocols for SAR personnel, including the use of protective gear designed to filter out fine particulate matter during sandstorms.
- Conduct assessments to identify the most vulnerable areas to sandstorms and reposition SAR assets accordingly to ensure rapid response capabilities and protection from sandstorms.

5-7 Low water levels on rivers

In addition to flooding, climate change can lead to more frequent and severe drought conditions, causing rivers to have low water levels. This has several implications for SAR organisations.

Impact mechanisms:

- Increased Incidents: Low water levels can expose hazards that are typically submerged, such as rocks, fallen trees, or other debris, increasing the risk of accidents for boaters. Also, the people swimming or engaging in other types of water recreation on the shore move closer to commercial shipping on the river as the beaches have become shallower, exposing them to hazards presented by large ships.
- Altered Rescue Dynamics: Lower river levels can change the dynamics of rescues. For instance, areas that were previously navigable by boat may no longer be accessible, requiring alternative rescue methods such as using smaller, shallow-draft vessels or even conducting rescues on foot.
- Navigation Challenges: With changing riverbeds and exposed obstructions, navigation can become more challenging, increasing the potential for SAR assets to be damaged during operations.
- Mapping and Intelligence: Updated maps and intelligence on river conditions become more important for planning rescue operations as the terrain changes.

The impact of low river levels due to climate change necessitates a flexible and adaptive approach to SAR operations, with a focus on understanding the changing environment, adjusting tactics and equipment, and ensuring the safety of both rescuers and those they are tasked to help. New technologies such as amphibious vehicles or different kinds of platforms for transportation or work can be introduced to aid rescue, especially in coastal mudflats and wetland areas.

Checklist items:

- Regularly update maps and gather intelligence on current river conditions to plan effective rescue operations in altered terrains.
- Review and adjust SAR operational tactics to accommodate the challenges posed by changing river conditions, ensuring both the effectiveness of rescues and the safety of SAR personnel.

Read more:

- Bierens Joost J.L.M., Webber Jonathon, Quieroga Anna C., Szpilman David, Sempsrott Justin, Barcala-Furelos Roberto and Tipton Mike. Drowning and climate change – a multidisciplinary challenge. Submitted for publication.

Photo: MayaPortail Photography


Photo: George Desipris

5-8 Sea-level rise and flooding

The rise in sea levels is one of the most direct and potentially catastrophic consequences of climate change. It poses a significant threat to low-lying islands and coastal regions. For SAR organisations, this can result in several profound impacts.

Impact mechanisms:

- Evacuation Planning and Execution: SAR organisations may need to develop and implement large-scale evacuation plans for populations at risk due to sea-level rise. This involves pre-planning evacuation routes, identifying safe zones, and coordinating with other agencies to ensure an orderly and efficient evacuation process.
- Rescue from Submerged and Stranded Structures: Inundation can leave people trapped in partially submerged buildings or stranded on what becomes an island. SAR teams must be equipped and trained to perform rescues in these challenging conditions.
- Long-Term Support Operations: After initial evacuations, SAR organisations may be involved in providing long-term support to displaced populations, which can include delivering supplies, providing temporary shelters, and ensuring medical support is available.
- New Maritime Landscapes: As islands and coastal regions become inundated, the maritime landscape changes. SAR organisations must adapt to these changes, which can affect navigation, the location of safe harbours, and the presence of new hazards in the water.
- Navigational Chart Updates: As coastlines change, SAR organisations will need up-to-date navigational charts to safely conduct operations.
- Mental Health Impacts: The psychological stress on SAR personnel involved in long-term support and evacuation of communities can be considerable. Organisations will need to ensure they have support systems in place for their teams.
- Collaboration with Humanitarian Agencies: SAR organisations will likely need to collaborate closely with humanitarian agencies that handle the long-term needs of displaced communities, such as housing, food security, and resettlement.
- Collaboration with Local Authorities: SAR organisations may need to work closely with local authorities to plan and execute mass evacuations and ensure the safety of vulnerable populations, especially during high-risk periods like hurricane season.
- Legal and International Support: There may be legal challenges and a need for international assistance, particularly if the inundation of islands leads to cross-border displacement or statelessness.

As sea levels continue to rise, SAR organisations will be challenged not only by the immediate demands of search and rescue but also by the broader humanitarian needs created by the displacement of communities. This will require strategic planning, increased resources, and international cooperation to manage effectively.

Checklist items:

- Develop and regularly update comprehensive evacuation plans for at-risk coastal and island communities.
- In addition to planning, conduct joint exercises on evacuation plans with local authorities and other relevant organisations.
- Prepare for long-term support operations, including collaboration with humanitarian agencies and local authorities.

5-9 Increased vulnerability of the coastal population

Climate change is expected to disproportionately affect coastal populations due to rising sea levels and increased frequency of extreme weather events. There is also likely to be displacement of the coastal population due to climate change across the world. Globally, an estimated 800 million people in 570 coastal cities are already vulnerable to a sea-level rise of 0.5 metres by 2050 (Economist Impact 2023). For instance, Jakarta, Indonesia, home to some 30 million people, may find 95% of its coastal area entirely submerged, forcing almost the entire population to relocate.

Impact mechanisms:

- Increased Incidents: An increasing number of people visiting or living close to coastlines are not traditionally from such areas due to, for instance, resettlement, meaning they might lack knowledge of local water risks. This can lead to a higher number of water-related incidents, such as drownings or boating accidents, thus increasing the demand for SAR operations.
- Stretched Resources: An increase in the coastal population means more people are potentially at risk during disasters, requiring SAR organisations to expand their capacity and capabilities. This may include more personnel, better equipment, and increased funding.
- Preventive Rescue Operations: There may be a need for more preventive rescue operations, which include patrols and the presence of lifeguards in areas where inexperienced people are at risk.
- Community Engagement and Education: SAR organisations might need to take a proactive role in community engagement and education, offering training and information to new coastal residents on water safety, emergency preparedness, and survival skills.
- Cultural Sensitivity: In dealing with relocated populations, SAR teams may need to be culturally sensitive and understand different languages and customs to communicate effectively during rescue operations. For instance, the RNLI in the United Kingdom has done work with the Black Swimming Association to better understand cultural differences and how to support an inclusive approach to drowning prevention. They have also produced multilingual resources related to water safety.
- Psychological Support: The mental health aspects of rescue operations can become more pronounced, with SAR personnel potentially needing training in psychological first aid to support victims who may be traumatised by losing their homes or being involved in a life-threatening situation.

Photo: Leonardo Rossatti

- Legal and Policy Frameworks: SAR organisations may need to navigate new legal and policy frameworks that come with resettlement programmes, including jurisdictional changes and international assistance guidelines.
- International Assistance and Cooperation: For some SAR organisations, especially in countries with limited resources, there may form an increased reliance on international assistance and cooperation to handle the rising challenges posed by the growing coastal populations.

Overall, SAR organisations will need to be adaptive, flexible, and increasingly integrated with other emergency and humanitarian services to deal with the impacts of climate change on vulnerable coastal populations.

Checklist items:

- Enhance capacity for water-related incident response, including preventive rescue operations such as lifeguard presence, as well as training and resource allocation, to handle an expected increase in drowning and boating accidents.
- Conduct joint exercises with local authorities and other relevant organisations on evacuation and large-scale assistance of coastal populations.
- Prepare a plan for community engagement and educational programmes on water safety and emergency preparedness for new coastal residents.

Read more:

- Bierens Joost J.L.M., Webber Jonathon, Quieroga Anna C., Szpilman David, Sempsrott Justin, Barcala-Furelos Roberto and Tipton Mike. Drowning and climate change – a multidisciplinary challenge. Submitted for publication.
- Economist Impact. 2023. Global Maritime Trends 2050. Available at: https://impact.economist.com/ocean/global-maritime-trends-2050/
- RNLI. Multi-lingual resources. Available at: https://rnli.org/safety/multi-lingual-resources

5-10 Hazardous biota

As the climate changes, warmer sea temperatures and altered ecosystems may lead to an increase in the population and distribution range of marine life that can cause harm to humans, such as jellyfish, stingrays, sea urchins, bluebottles, and other venomous or biting creatures.

Impact mechanisms:

- Increased Medical Emergencies: SAR organisations may see a rise in medical emergencies on beaches and in shallow waters due to stings and bites.
- Training: SAR operational personnel would require training to identify hazardous marine life and provide first aid for stings and bites. This could include training on how to treat jellyfish stings or how to manage allergic reactions until emergency medical services arrive.
- First Aid Supplies: Lifeguard stations and SAR vessels may need to stock additional first aid supplies specific to marine stings and bites, such as antivenoms, pain relievers, and first aid protocols for dealing with marine toxins.
- Personal Protective Equipment: SAR operational personnel may need enhanced PPE to protect themselves when entering the water for rescues or when handling marine creatures during their duties.
- Beach Signage and Alerts: SAR organisations may collaborate with local authorities to ensure that beaches have appropriate signage warning of the presence of hazardous marine life and provide real-time alerts if there is a surge in sightings.
- Public Education: SAR organisations might need to increase public education efforts to inform beachgoers about the potential risks of hazardous marine life and how to avoid harmful encounters.
- Emergency Protocols: SAR groups may need to revise their emergency response protocols to include the potential for multiple simultaneous stings or bites during peak beachgoing times. This should also include establishing protocols for quick evacuation and coordination with medical facilities equipped to treat severe reactions to marine life stings or bites.

Photo: Messala Ciulla

- Incident Reporting and Data Collection: Collecting data on incidents related to marine life injuries could help SAR organisations track patterns and identify high-risk areas.
- Cooperation with Other Organisations: Increases in hazardous marine life may bring a need for further cooperation with other organisations. For instance, in South Africa the NSRI cooperates with Shark Watch, which monitors the movement and behaviour of sharks in order to obtain information on changing migration patterns bringing them to more close contact with humans.

The influx of stinging or biting marine life due to climate change could place additional burdens on SAR organisations, necessitating improvements in medical training, public education, PPE, and operational procedures to ensure the safety and effectiveness of beach and shallow water activities.

Checklist items:

- Provide specialised training to SAR operational personnel on identifying hazardous marine species and administering appropriate first aid for bites and stings.
- Enhance public education efforts regarding the risks associated with hazardous marine life, including prevention tips and what actions to take in case of an encounter.
- Ensure adequate stocking of first aid supplies at lifeguard stations and on rescue vessels, including antivenoms and specific treatments for marine life injuries.
- Coordinate with local authorities for effective beach signage and real-time alert systems to inform beachgoers of potential hazards from marine life.

Read more:

- Climate Council. 2019. Is there a link between climate change and killer jellyfish? Available at: https://www.climatecouncil.org.au/is-there-a-link-between-climate-change-and-killer-jellyfish/
- Learn Joshua Rapp. 2018. Venomous sea creatures on the rise thanks to climate change. National Geographic. Available at: https://www.nationalgeographic.com/environment/article/climate-change-increasing-venomous-creatures-ocean-warming
- Wehner Mike. 2018. Warming oceans are pushing poisonous sea snakes towards the United States. BGR. Available at: https://bgr.com/science/warming-oceans-are-pushing-poisonous-sea-snakes-towards-the-united-states/

5-11 Marine life behaviour

The impact of climate change on marine life behaviour, including migratory patterns and habitat ranges of large marine animals like whales, can have a number of implications for SAR operations.

Photo: RNLI/Gavin Jones

Impact mechanisms:

- Increased Encounters: Shifting water temperatures could lead to marine species migrating to new habitats, raising the potential for human-wildlife interactions at sea. Consequently, SAR organizations might see an increase in requests for assistance with vessels that have encountered or collided with whales or other sizable marine animals. For example, seals may venture from their customary feeding grounds in anticipation of an approaching storm, illustrating the broader ecological impacts that necessitate adaptive SAR responses.
- Rescue Operations for Marine Wildlife: Although traditionally not necessarily part of their operations, SAR organisations might find themselves involved in rescuing marine animals that are stranded or in distress due to changes in sea conditions or being trapped in unusual locations. For instance, in Chile the number of strandings by whales and other cetacean species has increased considerably, and a training system has been proposed for SAR operational personnel to act in these situations.
- Training: SAR personnel may require training on how to handle close encounters with marine life to ensure their safety and that of the animals. This includes understanding animal behaviour, risks, and how to work with wildlife rescue organisations.
- Increased Public Interest: The presence of marine life like whales close to shorelines may draw public interest, leading to more calls for assistance for animal-related incidents or when members of the public put themselves at risk to watch or help the animals.
- Public Education: SAR organisations can play a role in increasing public awareness about the risks associated with changing marine animal behaviours and how to safely observe these creatures.
- Collaboration with Environmental Agencies: SAR operations might need to coordinate closely with marine biologists and environmental agencies when planning and conducting rescues in areas with increased marine animal activity to ensure that the operations are safe for both humans and wildlife.
- Conservation Considerations: SAR organisations will also have to consider the conservation status of marine life during their operations, balancing the urgency of human rescue efforts with the need to protect endangered species.

The changing behaviours of marine life as a result of climate change can significantly affect the operations and priorities of SAR organisations, requiring them to adapt to new challenges and scenarios while performing their critical work. The role of SAR organisations is anticipated to evolve. While SAR teams have responded to incidents like oil spills, the focus has traditionally been on the safety of vessels rather than ecological impact. In future public expectations may encompass a more direct role in environmental and wildlife rescue, alongside human SAR operations. This shift reflects a growing recognition of the interconnectedness of human, animal, and environmental well-being in maritime contexts.

Checklist items:

- Train SAR teams to handle increased encounters with marine life, including safety measures during close encounters, and collaboration with wildlife rescue organisations.
- Establish protocols for rescuing marine wildlife that are stranded or in distress, coordinating with wildlife experts as necessary.
- Engage in public education campaigns about the risks associated with changing marine animal behaviours and guidelines for safe observation.

Read more:

- Moore Kirk. 2022. Study says whales adapting to climate change; so too must mariners and fishermen. National Fisherman. Available at: https://www.nationalfisherman.com/northeast/study-says-whales-adapting-to-climate-change-so-too-must-mariners-and-fishermen
- RNLI. 2023. Fraserburgh RNLI called out in Dolphin Rescue. Available at: https://rnli.org/news-and-media/2023/july/14/fraserburgh-rnli-called-out-in-dolphin-rescue
- Silva Santiago Piedra. 2015. Whales under threat as climate change impacts migration. Phys.org. Available at: https://phys.org/news/2015-12-whales-threat-climate-impacts-migration.html.

5-12 Visibility at sea

The impact of climate change on visibility at sea is a complex issue that can significantly affect the operations of SAR organisations.

Impact mechanisms:

- Increased Incidents: Reduced visibility at sea can increase the risk of collisions between vessels. Reduced visibility can also lead to grounding or navigation errors, especially near coastlines or in treacherous waters with submerged hazards. SAR units may be called upon more frequently to respond to accidents that occur due to poor visibility.
- Complicated Search Efforts: Changes in visibility can make search efforts more difficult and time-consuming.
- Reliance on Instrumentation: With reduced visibility, SAR operational personnel must rely more on instrumentation such as radar, GPS, and sonar. This requires well-maintained equipment and well-trained operational personnel to interpret the data correctly, especially under stress.
- Increased Operational Risk: Operating in low visibility increases the risk to SAR personnel and assets. Navigating through fog, heavy rain, or in areas with sea spray and mist requires additional safety measures and protocols.

As climate change continues to alter weather patterns, SAR organisations must adapt to the increased likelihood of reduced visibility at sea. This includes updating equipment, enhancing training, and revising operational strategies to ensure they can continue to provide effective SAR services under challenging conditions.

Checklist items:

- Ensure adequate training and proficiency of SAR personnel to navigate and conduct search operations effectively in conditions of low visibility, such as fog or heavy rain.
- Ensure that navigational instruments like radar, GPS, and sonar are up-to-date and well-maintained to support operations in reduced visibility.
- Create and regularly update protocols for safe navigation and search efforts in low visibility conditions to minimise risks to SAR personnel and assets.
- Engage in public education campaigns to raise awareness about the increased risks of maritime navigation in reduced visibility, emphasising accident prevention strategies.

5-13 Water characteristics

Climate change is altering the marine environment in ways that directly affect the materials and operational integrity of vessels. For instance, temperature fluctuations and varying salinity can impact potential casualty vessels in various ways, increasing the need for SAR operations.

Impact mechanisms:

- Material Expansion or Contraction: Changes in water temperature can cause the hull and other components of vessels to expand or contract. Metals, composites, and other materials have different coefficients of thermal expansion, and temperature changes can lead to structural stress and potential failure of material bonds or welds.
- Corrosion and Electrolysis: Temperature and salinity directly influence corrosion rates. Warmer waters can accelerate the corrosion of metal components, particularly if coupled with increased salinity. Additionally, changes in pH levels due to ocean acidification can alter the corrosivity of seawater.
- Seawater Intake Systems: Some vessels use seawater intake systems for cooling engines and other onboard equipment. Changes in temperature and salinity can affect the efficiency of these cooling systems and may lead to overheating problems.
- Seal Integrity: Seals and gaskets designed to keep water out of hulls and protect moving parts may degrade more rapidly in changing environmental conditions. Higher temperatures can cause seals to become brittle and fail, while increased salinity can lead to more rapid degradation.

Overall, climate change represents a significant challenge to the structural and operational integrity of vessels, necessitating a proactive approach to maintenance, material selection, and design. Taken together, these factors are likely to lead to increased problems at sea, requiring more SAR resources to respond to them.

Checklist items:

- Engage in boater education campaigns to raise awareness about the importance of adequate maintenance, inspection, monitoring and checks of the seaworthiness of boats.

5-14 Seafoam formation

Climate change is affecting ocean chemistry and biology in ways that can lead to more frequent or intense seafoam formation. Seafoam is created by the agitation of seawater, particularly when it contains higher concentrations of dissolved organic matter, proteins, lipids, and dead phytoplankton.

Impact mechanisms:

- Increased Incidents: If seafoam events become associated with popular beach areas, SAR organisations might see an increase in calls for assistance, as beachgoers can become disoriented or trapped by fast-forming foam.
- Reduced Visibility: Seafoam can significantly reduce visibility for SAR operational personnel, both from boats and from the air. This can complicate search patterns and make it more difficult to locate people in the water or navigate through affected areas, as thick seafoam can obscure obstacles, such as rocks or floating debris, increasing the navigational risks for SAR vessels. In South Africa, the NSRI is starting to deploy infra-red and thermal cameras for seafoam and heavy surf environments.
- Equipment: Seafoam can clog intakes on watercraft, affect the performance of outboard motors, and degrade the effectiveness of safety equipment. Regular checks and maintenance of equipment will become even more critical.
- Training: SAR organisations will need to train their personnel to understand and manage the unique challenges posed by seafoam, including rescue strategies and personal safety.
- Communication Issues: Seafoam could affect communication lines by interfering with radio signals or by making it difficult for SAR personnel to communicate visually with hand signals or flares.
- Health Concerns: Some seafoam can be a sign of algal blooms, which may be toxic. SAR personnel may need protective gear and decontamination procedures if they come into contact with harmful algal blooms.
- Impact on Victims: People awaiting rescue may be at increased risk if surrounded by seafoam, as they may inhale it or find it difficult to stay afloat, increasing the urgency and complexity of rescue efforts.
- Public Education: SAR organisations can contribute to public education efforts about the risks associated with seafoam, encouraging safer behaviours from the public during such events.

With climate change potentially amplifying the frequency and intensity of seafoam occurrences, SAR organisations are encouraged to integrate these considerations into their response strategies for sustained efficacy and safety. The critical lesson from seafoam phenomena is the importance of anticipating the unforeseen. While seafoam serves as a specific instance, it emblematically underscores the necessity for SAR teams to be primed for a range of unexpected challenges, emphasising the broader imperative of readiness for novel situations.

Checklist items:

- Create and practice seafoam-specific rescue strategies that address the unique challenges and safety concerns associated with seafoam-affected areas.
- Deploy infra-red or thermal cameras on popular beaches.
- Engage in public awareness campaigns to educate beachgoers about the risks associated with seafoam and promote safe behaviours.

Read more:

- Berg Ingvar, Kolfschoten Nikki, Elsenga Hylmar, Verweij Bob and Bierens Joost. 2022. Resuscitation of persons who drowned in sea foam. *Resuscitation* 170: 26-27.
- Overview of global sea foam occurrence, rescues and reports. Available at: https://www.surfingmed.com/seafoam/

Photo: Furkan Yavuz

6. Operation Location

6-1 Destabilisation of popular shipping routes

Climate change is leading to more frequent and extreme weather events, which in turn can destabilise popular shipping routes. Some existing hubs of maritime commerce, such as Shanghai, Houston and Lazaro Cardenas face the threat of submersion (Economist Impact. 2023). The routes can be destabilised also for other reasons, including socio-economic instability leading to issues such as piracy.

Impact mechanisms:

- Route Changes: As traditional routes become more hazardous or otherwise unusable, shipping companies may alter their paths to avoid, for instance, extreme weather. This may introduce new risks and SAR organisations may need to adjust their areas of coverage in response.
- Infrastructure Development: SAR operations may need to rely on new ports for support, as the location of rescue changes.
- International Coordination: Destabilised shipping routes may lead to increased international SAR cooperation, as incidents occur across national boundaries or in international waters. This requires standardised protocols and good communication between different national SAR organisations.

Considering these challenges, SAR organisations need to proactively adapt their operational procedures. By anticipating and preparing for the destabilisation of shipping routes due to extreme weather, SAR organisations can continue to provide effective and timely responses to maritime emergencies.

Checklist items:

- Closely monitor shipping in the area, and using all available information, assess and forecast the likely trends in shipping routes.
- Adjust SAR coverage areas and response plans to align with changes in popular shipping routes, accounting for new hazards in less familiar waters.
- Plan and develop SAR infrastructure, including support ports and bases, in strategic locations along newly established shipping routes.
- Enhance coordination and communication with international SAR organisations to ensure effective response across national boundaries and in international waters.

Read more:

- Economist Impact. 2023. Global Maritime Trends 2050. Available at: https://impact.economist.com/ocean/global-maritime-trends-2050/

Photo: Julius Silver

6-2 Destabilisation of popular recreational routes

The changing climate impacts waterways and coasts around the world, which can make traditional routes of recreational navigation unsuitable.

Impact mechanisms:

- Increased Incidents: With the deterioration of traditional knowledge and the unsuitability of old routes, there can be an increase in boating accidents. SAR operations may face more calls for assistance due to groundings, collisions, and other incidents. Also, SAR personnel may no longer rely on indigenous knowledge for planning and executing rescue missions.
- Resource Reallocation: Resources, including personnel and equipment, may need to be reallocated to areas where old routes have become dangerous, or where new routes are being frequently used.
- Navigation Chart Updates: SAR teams often depend on accurate charts for rescue operations. Changes in coastal landscapes and waterways may necessitate frequent updates to nautical charts.
- Technology and Innovation: SAR organisations may need to invest in new technologies such as drones or advanced tracking systems to monitor and manage the changing landscapes and to assist in SAR operations where traditional knowledge is no longer applicable.
- Public Education: SAR organisations may need to increase their efforts in public education, emphasising the risks associated with the changing conditions and the importance of updated navigation knowledge. SAR organisations might need to focus more on incident prevention strategies, working with boating communities to ensure they are aware of new dangers and how to avoid them.
- Community Engagement: Engaging with local communities to build a new body of knowledge about safe navigation in altered waterways will be essential. SAR organisations can play a role in facilitating this knowledge exchange.
- Inter-agency Collaboration: Collaboration between different agencies, such as maritime authorities, coastguards, and environmental agencies, will be crucial for sharing information about changing conditions and ensuring the safety of navigators.

As traditional navigation routes become less reliable due to climate change, SAR organisations will have to adapt operationally and strategically. Any new routes need to be reflected on the charts. SAR organisations will also need to overcome the challenge of losing local expertise and ensuring that their own knowledge and practices are updated to maintain effective SAR capabilities.

Checklist items:

- Closely monitor boating in the area, and using all available information, assess and forecast the likely trends in boating routes and hotspots.
- Adjust the allocation of SAR resources, including personnel and equipment, to areas where traditional routes have become hazardous or new routes are emerging.
- Ensure that navigation charts are frequently updated to reflect changes in coastal landscapes and waterways, aiding in accurate and effective SAR operations.
- Incorporate new technologies like drones and advanced tracking systems to monitor changing landscapes and assist in SAR operations in areas where traditional methods are less effective.
- Amplify efforts in public education, focusing on the risks associated with changing conditions and the importance of relying on updated navigation information.
- Work closely with local communities to develop and share new knowledge about safe navigation practices in altered waterways.

Photo: Szelei Robert


Photo: Roy Kim

6-3 Hydrogen corridors

The formation of hydrogen corridors refers to the development of routes predominantly used for the transportation of hydrogen fuel between production and consumption sites. For example, if Australia, a potential major producer of hydrogen, creates a supply chain to South Africa, a consumer, this would result in a hydrogen corridor between these two countries. These developments may have several implications for SAR organisations.

Impact mechanisms:

- New Traffic Patterns: The establishment of hydrogen corridors means new regular shipping routes for SAR organisations to monitor. These routes may pass through remote or less trafficked areas where SAR infrastructure might be currently limited.
- Specialised Risks: Hydrogen as a cargo presents unique risks. It is highly flammable and, when liquefied, is transported at extremely low temperatures. SAR operations in the event of a hydrogen-related incident would require specialised training and equipment to handle potential fires, explosions, or cryogenic spills.
- Transport Vessel Design: Vessels designed to transport hydrogen might have unique design elements for safety and containment, which could affect SAR operations in the case of an incident. SAR personnel might need to become familiar with these designs to conduct effective rescues. Regular training and joint exercises between SAR units, shipping companies, and port authorities would be critical to prepare for potential emergencies involving hydrogen transport.
- Port Facilities and Operations: Ports at both ends of the hydrogen corridor will need to handle the special requirements of hydrogen loading and unloading, which may also extend to SAR facilities at these ports to support the specialised needs of hydrogen transport.
- Safety and Security Measures: Enhanced safety and security measures may be necessary along hydrogen corridors to prevent sabotage, terrorism, or piracy, all of which could lead to situations requiring SAR interventions.
- International Collaboration: Hydrogen corridors will likely require international collaboration, as they involve the territorial waters and economic zones of different nations. SAR organisations across nations would need to establish clear communication and coordination protocols.

As the hydrogen economy develops, SAR organisations will likely see these and other impacts materialise, requiring proactive planning and adaptation to ensure the safety of hydrogen transport routes. While hydrogen is highlighted here as a prime example, it is important to recognise that climatic changes could significantly influence the shipping dynamics of various other key products as well.

Checklist items:

- Expand SAR monitoring to include new shipping routes used for hydrogen transportation, especially through remote or less frequented ocean areas.
- Provide training to SAR teams for handling incidents involving hydrogen, including risks of fire, explosions, and cryogenic spills, as well as the unique design elements of hydrogen transport vessels.
- Work with ports involved in hydrogen loading and unloading to understand and support the specialised SAR requirements associated with hydrogen transport.

Read more:

- Economist Impact. 2023. Global Maritime Trends 2050. Available at: https://impact.economist.com/ocean/global-maritime-trends-2050/

6-4 Arctic and Antarctic routes and ports

The receding of glaciers and the melting of ice caps due to climate change are opening up the Arctic and the Antarctic for navigation, affecting SAR organisations in several ways.

Impact mechanisms:

- New Traffic Patterns: As the Arctic and the Antarctic ice recede, shipping lanes like the Northern Sea Route and the Northwest Passage are becoming more accessible for longer periods throughout the year. This increased accessibility leads to more maritime traffic through these once-impassable regions. It has been forecast that from 2030 onwards Septembers in the Arctic Ocean are ice-free, and Arctic routes in 2040 are busier than the Suez Canal in 2020 (Economist Impacts 2023).
- Harsh and Unpredictable Conditions: Even as the ice recedes, the Arctic and the Antarctic environment remain harsh and unpredictable. SAR operations in these regions face extreme cold, rapidly changing weather, and seasonal darkness, all of which complicate rescue efforts and can endanger the lives of rescuers and survivors alike.
- Longer Response Times: Given the vastness and remoteness of the Arctic and the Antarctic, SAR response times can be significantly longer than in more temperate regions. This can decrease the chances of survival for those in distress and requires vessels to be better equipped for survival while awaiting rescue.
- Lack of Infrastructure: The Arctic and the Antarctic are remote areas with limited SAR infrastructure. The increase in traffic through these new routes requires the development of additional SAR capabilities, including bases, equipment, and trained personnel, which may be logistically and financially challenging. Establishment of new ports is considered likely in for instance Canada, Greenland, Iceland and Norway (Economist Impacts 2023).
- Operational Personnel Availability and Fatigue: As operations may take place in locations further away from the stations, operational personnel availability and fatigue for longer operations may become an issue.
- Equipment: The development and deployment of specialised equipment designed for cold weather and ice-covered waters are necessary. This includes ice-class SAR vessels, specialised cold-weather gear, and navigation equipment suited for high latitudes.
- Training: SAR personnel will require specialised training to operate effectively in the Arctic and the Antarctic, including cold-weather survival skills, ice navigation, and familiarity with the unique challenges of such operations.
- Increased Research and Patrols: SAR organisations may need to increase their patrols and research efforts in these new waters to better understand the changing conditions and improve safety for all vessels operating in the area.

- Environmental Sensitivity: The Arctic and the Antarctic ecosystems are fragile, and increased shipping traffic heightens the risk of environmental disasters. SAR organisations might need to coordinate closely with environmental agencies to mitigate the impact of incidents such as oil spills or disturbances to wildlife.
- International Collaboration: The Arctic and the Antarctic cover areas that fall under the jurisdiction of various nations, and new shipping routes may cross multiple territories. SAR operations in these waters will require strong international cooperation and agreements to ensure effective response arrangements.
- Indigenous Knowledge: Engaging with indigenous communities who have generations of experience in these environments can provide valuable insights and enhance the effectiveness of SAR operations in the Arctic and the Antarctic.

Overall, the opening of Arctic and Antarctic routes due to climate change represents a significant shift in maritime navigation, with implications for SAR operations that extend to safety, environmental protection, international law, and geopolitics. It will require significant investments in capacity building, infrastructure, and international coordination to ensure that SAR services can be delivered effectively in these new and challenging environments.

Checklist items:

- Modify operational plans and areas of coverage to address maritime traffic through the newly accessible Arctic and Antarctic routes.
- Invest in necessary SAR infrastructure, including bases and equipment, suited to the Arctic and Antarctic environment.
- Provide specialised training and equipment to SAR teams for operations in the extreme cold, variable weather, and seasonal darkness of the Arctic and the Antarctic.
- Create effective response strategies for the extended SAR operation times due to the vastness and remoteness of the Arctic and the Antarctic.
- Enhance cooperation with international SAR organisations to ensure a coordinated response in the multi-jurisdictional waters of the Arctic and the Antarctic.

Read more:

- Economist Impact. 2023. Global Maritime Trends 2050. Available at: https://impact.economist.com/ocean/global-maritime-trends-2050/
- Ford J and Clark D. 2019. Preparing for the impacts of climate change along Canada's Arctic coast: The importance of search and rescue. *Marine Policy* 108: 103662. Available at: https://www.sciencedirect.com/science/article/abs/pii/S0308597X19300260
- Learn Joshua Rapp. 2016. Arctic Search-and-Rescue Missions Double as Climate Warms. *National Geographic* 19 September, 2016. Available at: https://www.nationalgeographic.com/adventure/article/arctic-search-and-rescue-missions-double
- Sydnes Are Kristoffer, Sydnes Maria and Antonsen Yngve. 2017. International Cooperation on Search and Rescue in the Arctic. *Arctic Review on Law and Politics* 8: 109-136. Available at: https://www.jstor.org/stable/48710583

Photo: Thanhhoa Tran

6-5 Water-based recreation locations

The formation of new sites for water-based recreation as a result of climate change can significantly impact SAR organisations in several ways.

Impact mechanisms:

- New Sites of Recreation: As climate change alters landscapes and creates new lakes, rivers, or coastal areas suitable for recreation, SAR organisations might see their areas of responsibility expand. New areas may also arise as old ones become unusable due to changes imposed by climate change. These new areas need to be mapped and the risks associated with them understood.
- Infrastructure Development: New recreational areas might lack the SAR infrastructure (e.g., access points for rescue vehicles, communication networks) necessary for efficient operations, requiring development and investment.
- Resource Allocation: The emergence of new recreation sites may necessitate reallocation of resources or investment in additional equipment and personnel to cover the increased demand for SAR services.
- Training: SAR teams will need to train for rescues in potentially unfamiliar environments that may have unique hazards, such as submerged trees in newly formed lakes or unstable shorelines.
- Public Education: SAR organisations might undertake preventative measures to reduce the number of incidents in new recreational areas. This could include safety education campaigns tailored to the specific risks of the new environment.
- Partnerships with Recreational Entities: Building partnerships with businesses and organisations that facilitate water-based recreation can be a proactive way to enhance safety. SAR organisations may work with these entities to ensure that safety protocols are in place.
- Collaboration with Local Authorities: Establishing relationships with local authorities will be essential to manage the safety of these new recreational sites effectively. SAR organisations may need to work closely with park services, local governments, and environmental agencies.

As climate change continues to reshape our environment, SAR organisations will face evolving challenges that will require flexibility, adaptability, and proactive planning to ensure that they can continue to effectively safeguard the public in new and changing recreational areas.

Checklist items:

- Conduct assessments and mapping of newly formed or expanded recreational areas to understand the associated risks and SAR requirements.
- Invest in developing necessary SAR infrastructure, like access points for rescue vehicles or vessels, in these new recreational areas.
- Engage in public education efforts to inform visitors of the specific risks associated with new recreational sites and promote safe practices.

Read more:

- Bierens Joost J.L.M., Webber Jonathon, Quieroga Anna C., Szpilman David, Sempsrott Justin, Barcala-Furelos Roberto and Tipton Mike. Drowning and climate change – a multidisciplinary challenge. Submitted for publication.
- Day J, Chin N, Sydnor S. et al. 2021. Implications of climate change for tourism and outdoor recreation: an Indiana, USA, case study. Climatic Change 169: 29. https://doi.org/10.1007/s10584-021-03284-w
- Wall G. 1998. Implications of global climate change for tourism and recreation in Wetland areas. Climatic Change 40: 371–389. Available at: https://doi.org/10.1023/A:100549362565

Photo: Carissa Rogers


Photo: Fabien Pasquet

6-6 Fishery locations

Climate change is leading to significant shifts in oceanographic conditions, such as currents, temperature, and acidity, which in turn affect marine ecosystems and fishery locations. Such changes can have substantial impacts on SAR operations.

Impact mechanisms:

- New Sites of Fishing: As fish and fisheries move, SAR organisations may find the focus of their operations shifting to new areas. They might need to redirect resources to cover these zones more intensively. Additionally, fishers tracking the movement of their catch may venture further offshore or into more remote areas, potentially stretching the SAR capabilities in terms of range and response time. For instance, between 2020 and 2030, the four major sea regions of China may lose 15% of their economically important fish species (Economist Impact 2023), forcing the fishing vessels to new areas.
- New Risks and Hazards: Shifting fishery locations might lead to increased maritime traffic in previously quiet areas, raising the likelihood of incidents. Also, the mix of commercial and recreational activities in certain areas can change, potentially leading to an increased demand for SAR services.
- Impact on Small-Scale Fisheries: Small-scale fishers might not have the capacity to move with changing fishery locations. SAR organisations might see an increase in incidents involving these local fishers who take greater risks to maintain their livelihoods.
- Enhanced Communication Systems: SAR organisations may need to enhance their communication systems to stay in contact with fishing vessels that have moved to new fishing grounds, which might be farther away from the coast or in areas with poorer signal coverage.
- International Cooperation: Fishery shifts may cross international boundaries, necessitating greater international SAR cooperation and coordination. Agreements and protocols may need to be updated or established to ensure efficient cross-border SAR operations.

The adaptability of SAR operations to these ecological shifts will be crucial for maintaining safety at sea. Continual assessment of climate impacts on fisheries and the corresponding need for SAR resources will be necessary to ensure that SAR services remain effective and responsive to the changing marine environment.

Checklist items:

- Anticipate and plan SAR operation zones to cover new areas where fisheries have moved, ensuring adequate resource allocation to these regions.
- Enhance communication capabilities to maintain contact with fishing vessels moving to new, potentially remote or poorly covered areas.
- Foster international cooperation and update protocols for cross-border SAR operations to effectively respond to incidents in areas where fishery shifts cross international boundaries.

Read more:

- Economist Impact. 2023. Global Maritime Trends 2050. Available at: https://impact.economist.com/ocean/global-maritime-trends-2050/
- Gilmour Lauren. 2023. Fish relocating to colder waters as a result of global warming – study. The Independent. Available at: https://www.independent.co.uk/climate-change/news/fish-earth-university-of-glasgow-b2348568.html


Photo: Tobias Bjørkli

6-7 Tourism patterns

Climate change is altering global tourism patterns, including shifts in animal migration routes, the emergence of new tourist destinations, and the decline of others. These changes can significantly affect the operations and demands on SAR organisations.

Impact mechanisms:

- Area of Operation: As tourists seek new experiences, such as following changing animal migration patterns or visiting newly accessible areas (like those revealed by receding glaciers), SAR organisations must potentially cover new regions, some of which may be remote or less accessible.
- Resource Reallocation: Existing SAR resources might need to be reallocated or enhanced to address the demand in new hotspots, which could leave traditional areas with reduced SAR coverage. SAR organisations might need to invest in new infrastructure, such as bases or communication networks, in emerging tourist areas.
- Seasonal Shifts: Changed climate conditions can extend or shift the tourism seasons. SAR organisations may face longer periods of high alert and need to maintain readiness for a more extended time.
- Training: SAR personnel might need training for a wider range of environments and scenarios. For example, rescues in cold-water environments may become more common if tourists are attracted to see melting ice features or altered animal migration patterns in polar regions.
- Cultural and Language Training: With shifts in tourism, SAR personnel may increasingly encounter tourists from a broader range of countries, necessitating cultural sensitivity and language skills to effectively manage rescue operations.
- Public Education: There may be a need for increased public education efforts to prevent SAR incidents, particularly in areas where tourists are unfamiliar with the local risks posed by climate change.
- International Collaboration: As tourism patterns shift, international waters may see different traffic patterns, necessitating better international SAR cooperation and potentially new agreements to ensure effective coverage and rapid response.

The readiness of SAR organisations to adapt to these shifting tourism patterns is critical to ensure that the safety of tourists and the effectiveness of rescue operations are maintained.

Checklist items:

- Anticipate and plan SAR coverage areas to include new and emerging tourist destinations, particularly those in remote or less accessible regions.
- Strategically reallocate SAR resources, including personnel, equipment, and infrastructure, to cater to the needs of new tourism hotspots.
- Provide training to SAR teams for a variety of rescue environments, focusing on scenarios more likely to occur in new tourism areas, like cold-water rescues.
- Implement targeted public education campaigns in new tourist areas, focusing on local risks and safety practices.
- Strengthen international SAR cooperation to effectively manage the changing patterns of tourist movement, particularly in international waters.

Read more:

- IMO in the Polar Environment: Search and Rescue. Available at: https://www.youtube.com/watch?v=ouc-BEFsT6U&t=334s
- Sydnes Are Kristoffer, Sydnes Maria and Antonsen Yngve. 2017. International Cooperation on Search and Rescue in the Arctic. *Arctic Review on Law and Politics* 8: 109-136. Available at: https://www.jstor.org/stable/48710583

6-8 Ocean currents and drift patterns

Climate change is having profound effects on ocean currents, which play a critical role in the world's weather and are also a crucial factor in SAR operations. These currents are driven by wind patterns and the differences in water density, which are both affected by global temperature changes. As the climate warms, shifts in these patterns can result in altered ocean currents.

Impact mechanisms:

- Complicated Drift Calculations: SAR operations often involve calculating the drift of people or objects in the water to locate them efficiently. Changes in ocean currents can render existing models and historical data less accurate, complicating these drift calculations.
- Search Area Expansion: If currents shift from their historical patterns, search areas could be larger or differently located than SAR teams expect based on existing knowledge. This can lead to longer search times and more resources being used to cover the new areas.
- Data Analysis Enhancements: To keep software accurate, continuous analysis of environmental data will become increasingly important. There will be a greater need for SAR organisations to work closely with oceanographers and climate scientists to understand the changing patterns and incorporate the latest scientific insights into SAR operations and the drift models.
- Software Development Needs: SAR organisations may need to invest in the development or upgrade of software that can model and predict the new drift patterns more accurately. This may include more sophisticated algorithms and higher-resolution environmental data.
- Training: SAR personnel will require training in understanding and applying new information about ocean currents to their search plans. They'll need to stay abreast of the latest research and incorporate this into their operational procedures.

These impacts necessitate that SAR organisations remain flexible and proactive in adapting to the changing patterns of ocean currents, ensuring that they maintain their effectiveness in life-saving operations under shifting environmental conditions. Technological change may involve development of software and hardware terminals for post-processing, searching and recognising satellite images. In terms of communication, satellite data and voice transmission, such as Starlink, are likely to become more and more efficient.

Checklist items:

- Regularly update and refine drift calculation models to incorporate changes in ocean currents, ensuring that SAR operations are based on accurate and current data. Develop or upgrade SAR software to better model new drift patterns, using sophisticated algorithms and high-resolution environmental data, and train personnel in the effective use of these tools.
- Strengthen collaborations with oceanographers and climate scientists to enhance the analysis of environmental data and integrate the latest scientific insights into SAR operations.

Read more:

- Blakemoore Erin. 2021. World's strongest ocean current is speeding up - and humans are to blame. The Washington Post. Available at: https://www.washingtonpost.com/science/ocean-currents-speeding-humans-warming/2021/12/03/7123d38c-52d4-11ec-8927-c396fa861a71_story.html
- Keating Shane and Roughan Moninya. 2023. Climate change is disrupting ocean currents. We're using satellites and ships to understand how. The Conversation. Available at: https://theconversation.com/climate-change-is-disrupting-ocean-currents-were-using-satellites-and-ships-to-understand-how-214962

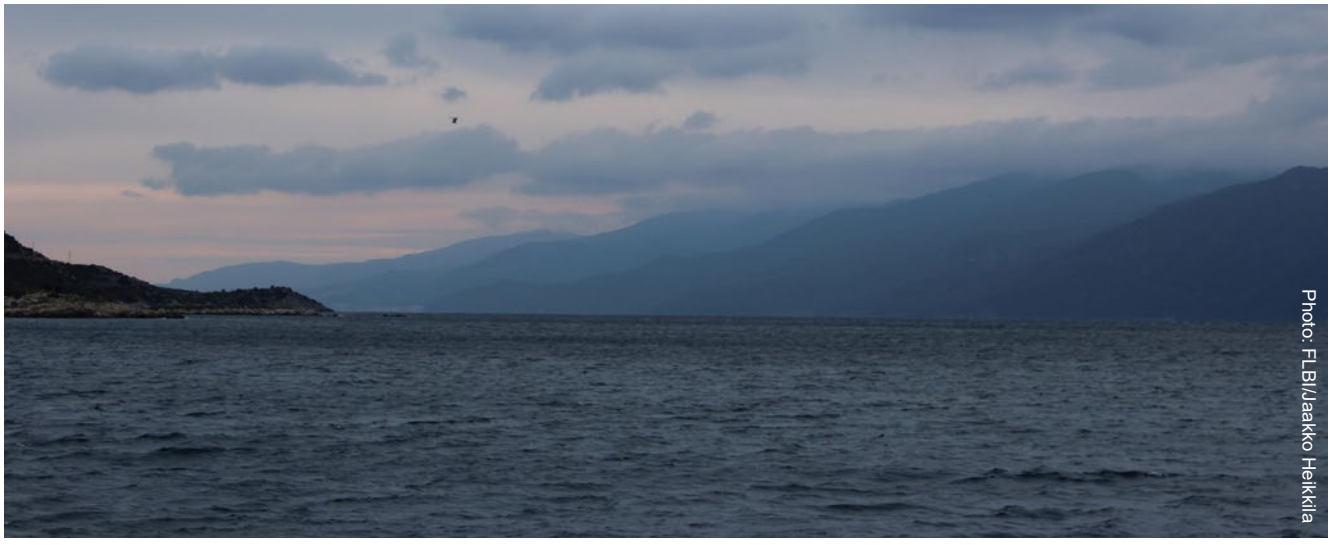


Photo: FLBI/Jaakko Heikkila

7. Operation Targets

7-1 Casualty vessel size

Climate change can affect the size of vessels that find themselves in need of SAR operations.

Impact mechanisms:

- Larger vessels:
  - Economic Factors: As the shipping industry seeks to maximise efficiency, there's a trend toward larger vessels, which can benefit from economies of scale.
  - Rescue Challenges: Larger ships present unique challenges for SAR operations. The increase in size of casualty vessels necessitates SAR organisations to have more robust equipment and strategies to deal with large-scale evacuations or rescue operations, including the resources to stabilise or tow them. The larger the vessel, the more people potentially need rescuing. There is also a greater potential for environmental damage in case of accidents. To address the challenges posed by the increasing size of casualty vessels, the NSRI in South Africa has enhanced its highline rope rescue training. Leveraging the expertise of mountain climbers, they have mastered the art of safely ascending the sides of large ships. Initially, this specialized training was offered primarily at stations where such rescues were most common. However, the growing need for these skills along the eastern coast has led to a broader implementation, underscoring its importance across the region.
  - Port Infrastructure: Changes in the sizes of vessels may also be influenced by the infrastructure of ports, which may be affected by rising sea levels or more severe weather patterns. SAR operations could be complicated by the need to operate in ports that are under-equipped for larger vessels.
- Smaller vessels:
  - Commercial Shipping: Climate change may lead to smaller commercial ships due to various factors. Melting polar ice caps are opening new, shorter maritime routes that favour smaller, more manoeuvrable vessels for safe navigation. Rising sea levels and altered waterway depths can restrict access to ports for larger ships, necessitating smaller ones. More localised food production by necessity may also lead to smaller cargo vessels. Additionally, fluctuations in market demand due to climate change induced supply chain disruptions may make the flexibility of smaller ships more attractive.
  - Environmental considerations: Stricter environmental regulations aimed at reducing carbon emissions could favour smaller, more fuel-efficient vessels. The transition to renewable energy sources might affect fuel availability and costs, further promoting the use of smaller, potentially alternative-energy-powered vessels.
  - Personal and Recreational Craft: With an increase in the frequency and intensity of extreme weather events, smaller personal and recreational vessels might become more susceptible to capsizing or getting into distress. SAR operations may see an increase in calls from such vessels, requiring rapid responses in potentially hazardous conditions.
  - Economic Pressure on Fisheries: Climate change may impact fish stocks, pushing smaller fishing operations into more dangerous waters or to operate in less stable conditions. This could lead to an increase in distress calls from smaller fishing vessels.
- Adapting SAR Assets: SAR organisations may need to ensure that their fleet is versatile enough to respond to incidents involving vessels of varying sizes and types. Handling a small, capsized sailboat requires different tactics and tools than stabilising a large container ship.

Climate change could potentially lead to larger ships due to efficiency needs or smaller vessels because of economic pressures on industries like fishing. Each scenario has distinct implications for SAR organisations, which must adapt their strategies, training, and equipment to ensure effective responses to vessels in distress.

Checklist items:

- Upgrade equipment, training and strategies to handle large-scale evacuations or rescue operations for larger vessels, including resources for stabilisation or towing.
- Ensure readiness for increased SAR operations involving smaller commercial, personal, and recreational vessels, which may require rapid response in challenging conditions.
- Plan and build a versatile SAR fleet and acquire diverse equipment capable of effectively responding to incidents involving a wide range of vessel sizes and types.

Read more:

- Economist Impact. 2023. Global Maritime Trends 2050. Available at: https://impact.economist.com/ocean/global-maritime-trends-2050/

7-2 Electrically powered casualty vessels and craft

The rise of electrically powered vessels due to innovation and a shift towards more sustainable sources of energy has implications for SAR organisations. In addition to traditional boats, we may be seeing more foiling boats, electric kayaks, and motor-powered stand-up paddleboards (SUPs) and surfboards.

Impact mechanisms:

- New Targets of Rescue: While electric boats are not that different from traditional boats in this respect, the enhanced speed and range of foiling boats, electric kayaks, and motor-powered SUPs and surfboards mean that individuals can venture farther from shore and into more hazardous conditions. This can increase the complexity of SAR operations, as rescuers may need to cover larger areas to locate and assist those in distress. These technologies can also attract a broader range of users, including those who may lack experience with traditional watercraft or the understanding of potential risks.
- New Risks and Hazards: Electric vessels introduce different types of risks compared to traditional combustion engine vessels. Battery fires, for instance, can be more intense and require different firefighting techniques and equipment. SAR personnel may need training in electrical safety and specialised firefighting procedures to tackle potential battery malfunctions or electric fires. Additionally, the fact that the technology is still relatively new, and of the kind that cannot be fixed at sea, there is likely to be an increased need for assistance at least in the near to intermediate future.
- Towing and Salvage Operations: Electrically powered vessels may have different weight distributions due to heavy batteries, which could affect towing operations. Additionally, for instance towing a foiling boat can be quite different from traditional tows.
- Recharging Assistance: Many SAR organisations are already equipped with the possibility to provide auxiliary power to recreational or fishing vessels with empty batteries. With the electric vessels becoming more prevalent, it may be possible that SAR vessels need to be equipped with the capability and capacity to recharge high voltage batteries in electrically powered vessels.
- Technical Knowledge: Understanding the operation of electrically powered vessels is crucial for SAR operations, particularly during complex incidents where systems need to be shut down or emergency repairs are required. SAR operational personnel may require additional technical training to safely navigate the intricacies of electric propulsion systems.
- Power Management: During a rescue operation, managing the remaining battery life of an electric vessel could be critical, particularly if the vessel is relying on electric power for essential functions or for manoeuvring in a distress situation.
- Communication and Coordination: SAR operations involving electric vessels may need improved communication and coordination with the vessel's manufacturer or technical experts to understand the specific requirements and potential dangers when providing assistance.
- Environmental Considerations: Electric vessels pose less risk of fuel spills, reducing the environmental impact of maritime incidents. However, battery leaks or ruptures could introduce new types of chemical hazards.
- Charging Infrastructure Issues: Electric vessels depend on charging infrastructure, which is not as widespread as fuel stations. Additionally, batteries can be significantly impacted by cold temperatures, which may reduce their range and efficiency.
- Long-term Drifting: SAR operations might include scenarios where vessels are adrift due to exhausted batteries. If an electric vessel runs out of power, it may drift for longer periods than vessels that might otherwise anchor or operate at reduced power, requiring SAR to account for greater drift distances.

As the maritime industry continues to evolve with electric propulsion technology, SAR organisations will need to update their protocols, equipment, and training to effectively respond to incidents involving these types of vessels. This transition aligns with broader environmental goals but requires operational adjustments to maintain the effectiveness and safety of SAR missions.

Checklist items:

- Provide SAR personnel with training in electrical safety and firefighting techniques specific to battery fires and electric vessel hazards. Provide technical training for SAR operational personnel on the operation and emergency handling of electric propulsion systems.
- Update towing and salvage operations procedures to accommodate the different characteristics of electrically powered vessels.
- Prepare SAR teams to manage and assess the battery life and power systems of electric vessels during rescue operations, particularly for maintaining essential functions. Establish protocols for improved communication and coordination with electric vessel manufacturers or technical experts for guidance during SAR operations.

7-3 Wind farms, tidal power and oil rigs

The proliferation of wind farms, tidal power, and other offshore renewable energy installations due to the global push for sustainable energy sources has direct and indirect effects on SAR organisations. Similarly, a further push for oil and gas explorations, as well as decommissioning of old oil rigs are likely to increase the demand for SAR services. These all increase potential for environmental issues or hazards to navigation, leading to heightened risk of collisions.

Impact mechanisms:

- Navigation Hazards: Wind farms, tidal power installations, and other such structures create additional obstacles at sea, potentially increasing the risk of navigation errors that can lead to accidents and the need for SAR operations. SAR teams need to be familiar with these areas to safely conduct operations around them.
- Increased Area of Operations: As wind farms are located offshore, SAR organisations may have to extend their operational range to cover these new areas, which could mean longer response times and the need for additional or specialised equipment and vessels.
- New Operational Environments: Tidal power installations create new environments where SAR operations might take place. These include underwater turbines, barrages, and other structures that can present unique hazards and require specific SAR approaches.
- Environmental Conditions: Wind farms are usually located in areas with strong winds and currents, which can make SAR operations more hazardous.
- Rescue Operations Complexity: Conducting SAR operations in and around energy structures can be complex due to the presence of numerous structures, such as wind turbines and substations, or strong currents. The physical environment may hinder air rescue operations due to turbulence created by the turbines.
- Training: SAR personnel may require specialised training to deal with incidents unique to wind farms, such as rope rescue, confined space rescue for technicians in turbine nacelles, or dealing with fires in electrical infrastructure, tidal power installations, oil rigs, and other such structures.
- SAR Asset Positioning: The presence of offshore installations may influence the strategic positioning of SAR assets. They may need to be stationed closer to these sites to reduce response times, which could lead to a realignment of existing SAR resources.
- Technological Integration: SAR organisations might need to integrate their communication and tracking systems with those used by offshore installations to improve the coordination of rescue efforts.
- Infrastructure Support: Offshore installations or tidal power installations could potentially offer support to SAR operations, acting as emergency shelters, refuelling or recharging stations for SAR vessels and aircraft, or as platforms for SAR equipment.
- Commercial opportunities: There may also be some commercial opportunities for SAR organisations in providing SAR training to operators of such facilities.

As offshore energy infrastructure becomes more common, SAR organisations must adapt and potentially collaborate more closely with the operators of these installations to ensure that they can continue to provide effective rescue services while ensuring the safety of their operational personnel.

Checklist items:

- Assess the need for new operational procedures or equipment for working around offshore wind farms and other energy installations.
- Train SAR personnel to safely conduct operations and rescues around and in the unique structures presented by offshore wind farms and other energy structures.
- Enhance communication and cooperation with offshore energy installations, leveraging their infrastructure for effective SAR operations.

Read more:

- RNLI. 2023. Harwich RNLI work with Coastguard to assist an injured wind farm worker. Available at: https://rnli.org/news-and-media/2023/august/20/harwich-rnli-work-with-coastguard-to-assist-an-injured-wind-farm-worker
- RNLI. 2023. Midnight call for Bridlington RNLI for a medical evacuation. Available at: https://rnli.org/news-and-media/2023/december/17/midnight-call-for-bridlington-rnli-for-a-medical-evacuation
- Scassola Andrea, Buckland Ian, Lee Joyce, Zhao Feng and Lathigara Anjali. 2023. Global Wind Workforce Outlook 2023-2027.

Photo: Pixabay

7-4 Unmanned casualty vessels

The rise of unmanned casualty vessels, which can include a range of remotely operated vessels (ROVs), autonomous underwater vehicles (AUVs), and unmanned surface vehicles (USVs), is a trend influenced by advancements in technology that can also intersect with the impacts of climate change.

Impact mechanisms:

- Recovery and Salvage Operations: SAR organisations might be tasked with recovery or salvage operations of unmanned vessels, which can be complicated by the absence of crew to provide information about the vessel's status or hazards present.
- Training: SAR personnel may require additional training to deal with incidents involving unmanned vessels. This could include understanding how to take control of an unmanned vessel, how to safely approach and secure it, and how to troubleshoot or deactivate potentially hazardous systems onboard.
- New Search Protocols: With unmanned vessels, there might not be any people in immediate danger when a vessel is adrift or malfunctioning. SAR operations might focus on preventing environmental hazards or navigational risks posed by such vessels.
- Potential for Aid: Unmanned vessels could also be used to aid SAR operations, for instance, by providing a platform for sensors or acting as communication relays.
- Coordination with Controlling Agencies: SAR operations may need to coordinate closely with the agencies or companies that operate unmanned vessels to manage an incident effectively, which could involve complex communication and data-sharing protocols.
- False Alarms: Unmanned vessels may trigger SAR operations due to malfunction or loss of communication, leading to false alarms where SAR resources are deployed without a human life being at risk.
- Cybersecurity Concerns: SAR organisations may also have to contend with cybersecurity concerns, as the control systems of unmanned vessels could be vulnerable to hacking or other malicious activities that could cause incidents at sea.
- International SAR Protocols: The presence of unmanned vessels in international waters may require updates to international SAR protocols, as these vessels can travel across national boundaries without operational personnel and could be subject to different laws and regulations.
- Legal and Liability Issues: There may be complex legal and liability issues involved in SAR operations for unmanned vessels, particularly if they cause damage or require costly recovery efforts.

As climate change may lead to more extreme weather events and rougher sea conditions, SAR organisations will have to consider these factors when planning and executing operations involving unmanned casualty vessels. These operations may differ significantly from traditional SAR missions and will require adjustments in terms of strategy, equipment, and coordination.

Checklist items:

- Establish specific procedures and training for the recovery or salvage of unmanned vessels, addressing the lack of onboard crew information and potential hazards, including approaches to secure and troubleshoot these vessels.
- Develop protocols focusing on environmental and navigational risks posed by unmanned vessels, as opposed to traditional rescue operations where human lives are at immediate risk.
- Set up efficient coordination and communication channels with agencies or companies operating unmanned vessels, ensuring effective incident management and data sharing.
- Prepare for cybersecurity challenges related to unmanned vessel control systems and understand the complex legal and liability issues involved in SAR operations for these vessels.
- Explore opportunities to use unmanned vessels to aid SAR operations, such as sensor platforms or communication relays.

Read more:

- Economist Impact. 2023. Global Maritime Trends 2050. Available at: https://impact.economist.com/ocean/global-maritime-trends-2050/

8. Operation Types

8-1 Swiftwater and flood rescue

Climate change is intensifying the hydrological cycle, leading to more severe and frequent flooding in many regions of the world. This has a direct impact on the operations of SAR organisations as swiftwater and flood rescue operations become more prominent.

Impact mechanisms:

- Urban Environments: Urban flooding presents unique challenges for SAR operations. SAR personnel may need to navigate through submerged streets and buildings, rescue people from vehicles and structures, and deal with hazards such as downed power lines.
- Evacuation and Shelter Operations: In addition to rescue operations, SAR organisations may be called upon to assist with the evacuation of populations from flood-prone areas and manage or support temporary shelters for displaced individuals.
- Equipment: Personal Protective Equipment (PPE) for maritime SAR is largely different from the current PPE for swiftwater rescue, and higher standard equipment may be needed. SAR teams will need specialised equipment such as throw bags, dry suits, swiftwater personal flotation devices (PFDs), helmets with face guards, and rescue craft that are capable of handling fast-moving water and debris.
- Training: SAR personnel must be trained in swiftwater rescue techniques, which are quite different from typical open-water rescue methods. This should include specialised training to recover casualties from flood damaged or threatened buildings and homes in built up areas.
- Use of Technology: The use of technology like drones and live-streaming cameras can help SAR teams in planning and executing swiftwater rescues by providing real-time information on the extent and flow of floodwaters.
- Risk Assessment: SAR teams will need to accurately assess the risks of floodwaters, which can be deceptively powerful and may contain hidden dangers like underwater obstructions, biologically or chemically contaminated water, or unstable surfaces.
- Public Education: With the increasing risk of floods, SAR organisations may also need to invest in community education to prevent flood-related accidents. This includes informing the public about the dangers of floodwaters and how to react in the event of a flood.
- Stress on Volunteer Personnel: Many SAR organisations rely on volunteers who may not be available or adequately trained for the intensity and frequency of operations during prolonged or frequent flooding events. The psychological impact of responding to high-stress flood situations, which may involve a high number of casualties or fatalities, could be significant.
- Recovery Operations: Post-flood recovery can be a lengthy process, with SAR teams involved in locating missing persons and supporting cleanup efforts.
- Multi-Agency Coordination: Floods often cover large areas and can overwhelm local resources. SAR organisations will need to coordinate with other agencies, such as fire departments, emergency medical services, and law enforcement, to mount an effective response.

In summary, as climate change makes swiftwater and flood rescue operations more prominent, SAR organisations must adapt by improving training, equipment, and response strategies to manage the increased risk and ensure the safety of both the public and their personnel.

Checklist items:

- Plan the appropriate procedures and techniques and equip SAR teams with the skills to navigate and conduct rescues in urban flood scenarios, including submerged streets and buildings.
- Assess the need to invest in essential gear like dry suits, swiftwater personal flotation devices, appropriate helmets, and suitable rescue craft for fast-moving and debris-filled waters.
- Plan and conduct public education campaigns about the dangers of floodwaters and appropriate safety measures.
- Develop robust collaboration protocols with other emergency response agencies for effective management of large-scale flood incidents.

Read more:

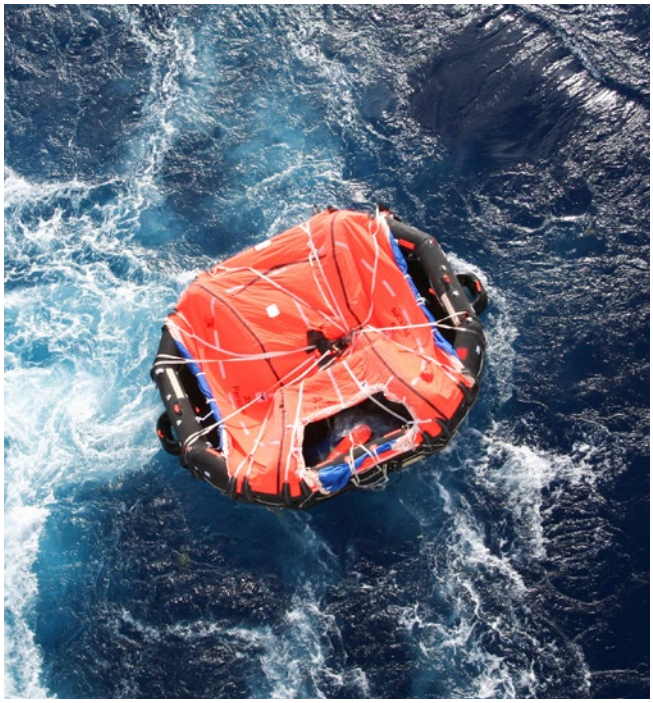
- Chen P, Zhang J and Sun Y. 2018. Research on Emergency Rescue of Urban Flood Disaster Based on Wargame Simulation. J Indian Soc Remote Sens 46: 1677–1687. https://doi.org/10.1007/s12524-018-0823-x
- Keech JJ, Smith SR, Peden AE, Hagger MS and Hamilton K. 2019. The lived experience of rescuing people who have driven into floodwater: Understanding challenges and identifying areas for providing support. Health Promot J Austr 30(2): 252-257. doi: 10.1002/hpja.181. Epub 2018 Jul 25. PMID: 29893063.

8-2 Mass rescue operations

Climate change is expected to exacerbate the frequency and scale of mass migration events, as natural disasters become more common and certain regions become less habitable due to factors like sea-level rise, extreme weather events, desertification, and other climate-related changes. This poses significant challenges to SAR organisations.

Impact mechanisms:

- Enhanced SAR Capabilities: SAR teams will need to have capabilities in land, sea, and air rescue operations to effectively cover the diverse environments where mass migrations may occur.
- Evacuation Planning: SAR organisations may be involved in pre-emptive evacuations of populations from areas at risk of becoming uninhabitable due to climate change, requiring robust planning and execution strategies.
- Long-Duration Operations: Unlike typical rescue operations that may last hours or days, mass migration can result in prolonged operations over weeks or months, requiring SAR operations to plan for long-term deployment of resources and personnel.
- Training: SAR personnel will need training in managing large groups of people, including crowd control, basic first aid en masse, and potentially dealing with language barriers and cultural sensitivities.
- Rescue Under Duress: Mass migrations can occur under politically sensitive or conflict-related scenarios, which may place SAR personnel in dangerous situations that require security measures and conflict-sensitive approaches.



- Public Health Concerns: Mass relocations can lead to public health crises, with the potential spread of diseases in temporary shelters or camps. SAR teams will need to work in conjunction with public health agencies to mitigate and protect themselves from these risks.
- Psychological Impact: The psychological toll on both the migrants and SAR personnel can be considerable. SAR organisations will need to provide support systems for their teams who are exposed to stressful and sometimes tragic situations.
- Legal and Ethical Considerations: There may be complex legal and ethical considerations involved in mass rescue operations, especially in the context of cross-border migrations, that SAR organisations will need to navigate. These may include also PR challenges through response from the public to the situation.
- Logistical Coordination: Mass rescue operations demand high levels of coordination between multiple agencies, local and national governments, humanitarian organisations, and international bodies. Efficient communication systems and protocols will need to be in place to handle complex operations.

Mass migration will probably be the largest and most profound socio-economic impact of climate change that we will observe within the next century. As climate change continues to impact global populations, SAR organisations will have to anticipate, plan for, and adapt to the unique challenges posed by mass rescue operations due to mass relocation and migration. This will necessitate a holistic approach, combining emergency response with long-term strategic planning and international cooperation.

Checklist items:

- Establish comprehensive planning and execution strategies for pre-emptive evacuations of populations from areas at risk due to climate change.
- Plan for prolonged SAR operations over extended periods, ensuring sustainable deployment of resources and personnel.
- Plan and provide specialised training to SAR personnel in managing large groups of people, including crowd control, mass first aid, and communication across language barriers and cultural differences.
- Develop efficient communication systems and coordination protocols for collaboration with various agencies, including local and national governments, humanitarian organisations, and international bodies.

8-3 Coastal wildfires

The increasing incidence of coastal wildfires, exacerbated by climate change, presents a complex challenge for SAR organisations.

Impact mechanisms:

- Urgency of Evacuation: Wildfires can spread rapidly with little warning, especially in coastal areas with dense vegetation and high winds. SAR operations must be swift to evacuate residents and visitors to prevent entrapment by fire.
- Access and Navigation: Coastal terrains can be challenging for evacuation as they may include rugged landscapes, cliffs, and limited access roads, which may be compromised or obstructed by the wildfire, making navigation and access for rescue units difficult.
- Multipronged Rescue Efforts: SAR operations may need to deploy a range of assets, including boats, helicopters, and ground vehicles, to evacuate individuals from different locations along the coast. Wildfires require a considerable amount of resources, and when they occur in coastal areas, SAR operations must be conducted in conjunction with firefighting efforts, requiring careful allocation and prioritisation of resources.
- Smoke and Air Quality: Dense smoke from coastal wildfires can significantly reduce visibility and air quality, which impacts the health of both the victims and the SAR operational personnel. It also complicates aerial and maritime operations.
- Communication Barriers: Power outages and cellular network failures are common during wildfires, leading to communication challenges. SAR teams need reliable communication equipment and contingency plans to coordinate rescue efforts.
- Training: SAR personnel require training specific to wildfire scenarios, including understanding fire behaviour and first aid for burn injuries and smoke inhalation.
- Threat to Wildlife: Coastal ecosystems often have rich biodiversity, and SAR operations might also need to consider the impact on wildlife and potentially assist in animal rescue efforts.
- Coordination with Fire Services: SAR operations must be closely coordinated with fire services to ensure the safety of the rescue teams and the effectiveness of the evacuation process.

For instance, in South Africa wildfires have necessitated the evacuation of entire communities, with the NSRI playing a pivotal role in assisting with the relocation of residents and coordinating these efforts. Unlike conventional SAR missions, these situations demand specialised training and distinct equipment to protect the personnel from bushfires and smoke inhalation, including modifications to personal protective equipment (PPE). As such incidents become more frequent, the NSRI's involvement has grown, demonstrating its critical support in medical aid, transportation, communication, and evacuation planning. Beyond the logistical and technical adjustments, there is a significant welfare component, acknowledging the emotional toll on operational personnel witnessing the impact on their own communities. With climate change amplifying the risk and severity of wildfires, SAR organisations are prompted to refine their approaches, enhance their readiness for rapid response, and develop comprehensive evacuation strategies for more effective responses in coastal wildfire emergencies.

Checklist items:

- Evaluate current evacuation strategies to ensure swift and efficient response capabilities for rapid movement of residents and visitors during coastal wildfires.
- Review the availability and readiness of diverse SAR assets, such as boats, helicopters, and ground vehicles, for simultaneous evacuation operations in various coastal areas. Ensure SAR teams can navigate and access challenging coastal terrains in wildfire scenarios, considering potential obstacles and landscape difficulties.
- Conduct an inventory and assessment of protective gear and tools for SAR personnel to safely navigate through dense smoke and poor air quality, and identify training needs for precautions in these environments.

Read more:

- Rempel Luc. 2023. Sailing into Hubs of Hell: Shuswap marine search and rescue team kept busy with wildfires in 2023. Available at: https://www.castanet.net/news/Salmon-Arm/465545/Shuswap-marine-search-and-rescue-team-kept-busy-with-wildfires-in-2023

Photo: Sippakorn Yamkasikorn

8-4 Environmental cleanup

As climate change intensifies, it triggers a rise in environmental catastrophes, including sewage spills and chemical discharges. Consequently, SAR organisations are finding themselves more frequently called upon to support environmental cleanup efforts, reflecting a broadening scope of their mission to safeguard not only lives but also the environment.

Impact mechanisms:

- Changing Expectations: Environmental cleanup has not historically fallen within the typical purview of SAR operations. Despite SAR units not typically being the primary responders, there is a growing public anticipation for SAR organisations to contribute more significantly to environmental protection efforts. For example, in Sweden, the integration of environmental trailers towable by boats into SAR operations has been positively received, enhancing public perception and support for the Swedish Sea Rescue Society (SSRS). This shift reflects a broader understanding of SAR's potential impact on environmental stewardship and community relations.
- Logistical Support: SAR organisations may find themselves providing logistical support in cleanup operations, such as transporting equipment and personnel to affected areas.
- Environmental Monitoring: Post-cleanup, SAR units might be involved in environmental monitoring to ensure that the affected areas have been properly remediated and to watch for any residual effects of the pollution.
- Equipment: SAR teams may need access to specialised protective gear and equipment, such as hazmat suits, containment booms, skimmers, and other devices used to contain and clean up pollutants.
- Training: SAR personnel may require training in the handling and containment of hazardous materials to ensure that they can safely participate in cleanup operations.
- Increased Health Risks: Environmental cleanup operations often involve working with toxic substances, which can pose significant health risks to SAR personnel.
- Collaboration with Environmental Agencies: SAR organisations might need to collaborate closely with environmental agencies and organisations that specialise in dealing with pollution to effectively coordinate cleanup efforts.

The increased responsibility for environmental cleanup missions signifies an expansion of the traditional role of SAR organisations, which have traditionally focused on saving lives. This shift necessitates new strategies, additional resources, and a more integrated approach to emergency response that includes environmental protection as a key component.

Checklist items:

- Evaluate the current capacity to provide monitoring or logistical support, including transportation of equipment and personnel, for environmental cleanup operations.
- Assess the availability and condition of specialised protective gear and equipment needed for handling hazardous materials, such as hazmat suits, containment booms, and skimmers.
- Determine the need for additional training for SAR personnel in the safe handling and containment of hazardous materials to enhance their safety and effectiveness in cleanup operations.
- Review existing partnerships and identify areas for improved collaboration with environmental agencies and specialised pollution response organisations to coordinate cleanup efforts.

Photo: SRSS

8-5 Night-time operations

Warmer nights, or conversely, nights that offer a cooler respite from hot days, tend to encourage more nocturnal human activities on the water, including fishing, boating, and various other recreational or commercial pursuits. This behavioural trend presents a range of implications for SAR organisations, necessitating adjustments in their operational strategies and readiness to ensure safety during these increased night-time activities.

Impact mechanisms:

- Extended Operating Hours: SAR organisations may need to extend their operating hours or shift their peak readiness periods to accommodate an increase in night-time activities.
- Equipment: SAR vessels and equipment might need adaptations to improve their effectiveness at night, such as higher-grade search and work lights, more advanced radar equipment, and reflective materials on equipment and clothing. There may be a greater need for night vision equipment, such as infrared and thermal imaging devices, to conduct operations in low-light conditions.
- Communication Systems: Robust communication systems become even more critical during night operations, where visual cues are less reliable, and coordination among and within teams is vital.
- Training: Operational personnel will need specialised training to operate effectively at night, which includes navigating, performing rescues, and managing emergencies in the dark.
- Fatigue Management: With potentially increased hours of operation, managing operational personnel fatigue becomes even more important to ensure the safety and effectiveness of SAR personnel.
- Increased Risks and Hazards: Operating at night inherently comes with increased risks, such as reduced visibility for the operational personnel and higher chances of collisions or other accidents. SAR organisations need to ensure that operational personnel safety is paramount, with strict adherence to safety protocols to prevent accidents in the more challenging night-time environment.
- Public Education: SAR organisations may need to engage in public education campaigns about the risks associated with night-time water activities.
- Psychological Challenges: Operating in darkness can bring about additional psychological stressors for the operational personnel, requiring mental health support systems to be in place.

In essence, the impact of climate change on night-time temperatures could require SAR organisations to adapt their operations significantly to maintain safety and effectiveness in responding to incidents that occur under the cover of darkness.

Checklist items:

- Assess the need to adjust operational schedules or procedures to accommodate increased night-time activities.
- Review the current status of operational capabilities, including search and work lights, radar, and night vision technologies to determine if upgrades are necessary for enhanced night operations.
- Establish a system to regularly assess and manage operational personnel fatigue, focusing on maintaining safety and effectiveness during extended or irregular night-time operations.

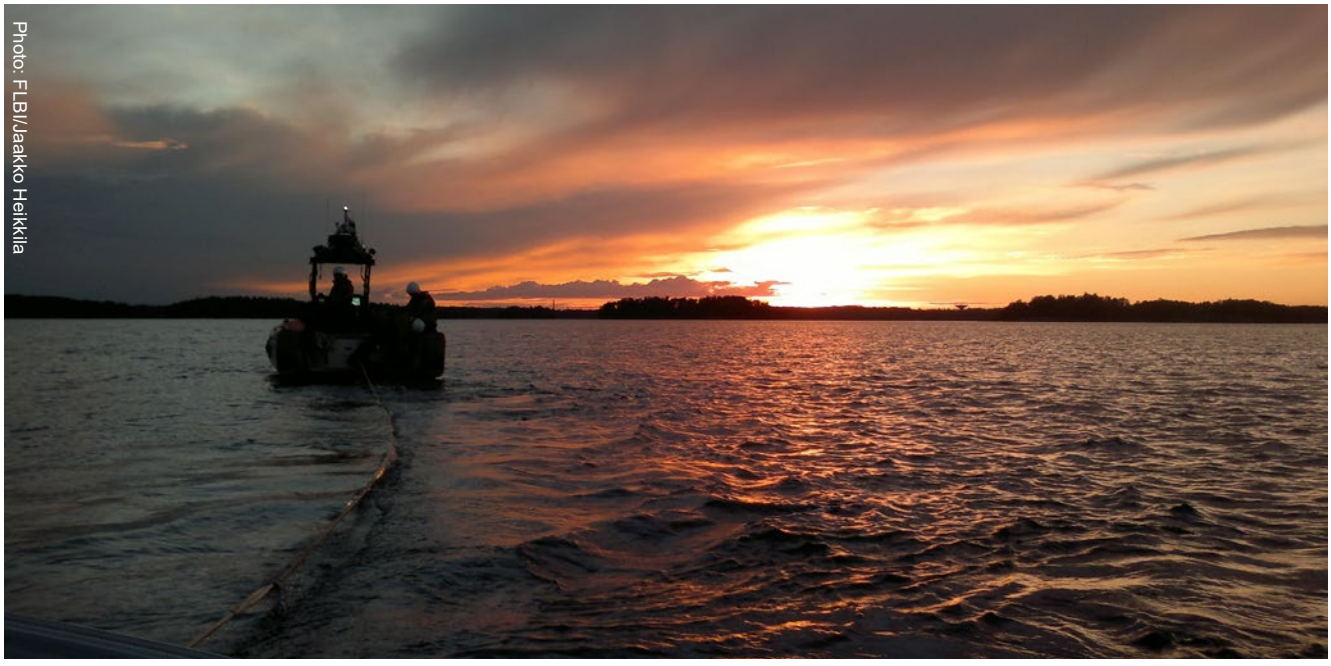


Photo: FLBI/Jaakko Heikkila

8-6 Autonomous rescue vessels

The integration of autonomous rescue vessels, surface, underwater and aerial, into SAR operations represents a significant adaptation to the changing conditions brought by climate change. They also in their part challenge the traditional concept of SAR services always needing vessels with personnel on board for all SAR activities.

Impact mechanisms:

- Quicker Response: Autonomous systems can be on standby and deployed rapidly from an extensive base network, potentially arriving on the scene faster than traditional SAR vessels, especially in conditions that would delay or impede human response. This applies also to cases where the (semi-)autonomous system is operated from a lifeguarded beach. In Sweden, the Swedish Society for Sea Rescue (SSRS) has been pioneering the use of drones over the past decade, marking a significant shift towards more efficient SAR operations. Drones enable rapid initial assessment of incidents, allowing for tailored decisions about the number and type of vessels to deploy, enhancing fuel efficiency by eliminating the default reliance on larger, more fuel-intensive rescue boats. Moreover, drones offer rescuers a preliminary view of the emergency scene, aiding in mental preparation before arrival.
- Extended Reach: Autonomous vessels can operate in hazardous or remote areas where it would be dangerous or impractical to send human operational personnel. This could include regions affected by extreme weather patterns, such as polar regions with unstable ice conditions or areas experiencing severe storms or contaminated environment.
- Safety of Rescuers: By deploying autonomous vessels in initial response efforts, SAR organisations can keep human rescuers out of the most dangerous initial phases of a search operation, reducing risk to life. Some autonomous vessels are designed to perform specific tasks such as underwater searches, which can be extremely challenging and dangerous for human divers, especially in rough or contaminated waters.
- Continuous Operations: Unlike human operational personnel, autonomous vessels are not limited by fatigue, allowing for prolonged search operations, which is crucial in the critical time-sensitive period following an incident.
- Enhanced Data Collection: Autonomous systems can gather comprehensive environmental data, providing SAR teams with better situational awareness, which is particularly valuable in the dynamic and changing conditions.
- Cost-Effectiveness: Over time, autonomous systems may save resources by reducing the need for traditional SAR operations, which require extensive support, including fuel, maintenance, and operational personnel provisions.
- Integration Challenges: SAR organisations will need to develop protocols for integrating autonomous systems into their current operations, including communication and command structures that incorporate these new assets.
- Regulatory Compliance: As autonomous vessels become more common, SAR organisations will need to navigate a complex web of regulatory requirements, which may not yet be fully developed to encompass such technologies.
- Technical Reliability: Ensuring the reliability and maintenance of autonomous systems is critical, as malfunction or failure during a mission could have dire consequences.
- Cybersecurity: With the increase in technology use, SAR operations must also secure their systems against potential cyber threats, which could disrupt autonomous operations.
- Training: Operational personnel will need training to manage and interact with autonomous systems effectively, including understanding their capabilities and limitations. The autonomous systems need also specific personnel to operate them efficiently and safely.
- Search Algorithms: SAR operations will likely employ advanced search algorithms tailored for autonomous systems to maximise search patterns and efficiency.
- Public Perception and Trust: Gaining the trust of the public in the use of unmanned systems for life-saving operations will be essential for the successful integration of these technologies.

The deployment of autonomous vessels offers SAR organisations a means to enhance their capabilities in the face of climate change, leading to more efficient, safer, and potentially more effective SAR operations. Autonomous vessels are currently more suited to search and surveillance tasks, and operations for instance in toxic environments. The actual rescue operations often require a human element, although advancements are being made in this area as well. However, it requires careful planning, investment, and training to integrate these assets successfully into existing frameworks.

Checklist items:

- Review the potential implementation of autonomous surface, underwater and aerial vessels for rapid deployment, for instance in the initial phases of search operations, ensuring faster initial response times in scenarios where human operational personnel deployment is delayed or impeded. Assess the benefits of utilising the non-fatigue advantage of autonomous vessels for prolonged search operations.
- Prepare a feasibility plan for the use of autonomous vessels to extend SAR capabilities, especially in hazardous or remote areas, to enhance response in extreme weather conditions or challenging terrains.
- Establish clear protocols and strategies for integrating autonomous vessels into current SAR operations, focusing on aspects such as communication, command structures, and coordination with manned operations.

Read more:

- Dickie Gloria. 2017. Robots to the Rescue? Drones Could Help With Arctic Search Operations. The New Humanitarian. Available at: https://deeply.thenewhumanitarian.org/arctic/articles/2017/08/10/robots-to-the-rescue-drones-could-help-with-arctic-search-operations
- Economist Impact. 2023. Global Maritime Trends 2050. Available at: https://impact.economist.com/ocean/global-maritime-trends-2050/
- Wikander Markus. 2022. Emission-free sea rescue. SSPA Maritime Center. Available at: https://www.sspa.se/en/news/emission-free-sea-recue
- Yoo Jinho, Goerlandt Floris and Chircop Aldo. 2020. Unmanned Remotely Operated Search and Rescue Ships in the Canadian Arctic: Exploring the Opportunities, Risk Dimensions and Governance Implications. In: A. Chircop et al. (eds.), Governance of Arctic Shipping. Springer Polar Sciences. Available at: https://digitalcommons.schulichlaw.dal.ca/cgi/viewcontent.cgi?article=1610&context=scholarly_works

Photo: Josh Sorenson

9. SAR Stations

9-1 Protection from sea-level rise, floods and currents

Sea-level rise, floods and changing currents pose a substantial threat to SAR organisations. The need to protect rescue stations encompasses several strategic and operational adjustments.

Impact mechanisms:

- Flooding: Rising sea levels and more intense and frequent storm surges can increase the risk of flooding at coastal rescue stations. SAR organisations may need to invest in flood defences, such as sea walls, flood barriers, or elevating buildings above expected water levels.
- Erosion: Enhanced coastal erosion due to changing sea conditions could threaten the structural integrity of rescue stations. Shoreline protection measures, like revetments, groynes, and artificial reefs, might become necessary to safeguard facilities.
- Changing Currents: Altered ocean and river currents can lead to increased sedimentation or scouring around rescue stations, potentially affecting access and operations. Dredging or structural reinforcements may be required to ensure the stations remain functional.
- Docking Facilities: Floating or adjustable docks that can rise and fall with changing water levels ensures that SAR vessels can be safely moored and rapidly deployed even as sea levels change.
- Relocation: In some cases, it might be necessary to relocate SAR stations to higher ground if the risk of inundation is too significant or if mitigation measures are not cost-effective in the long term. For instance, the NSRI in South Africa has assessed that on average existing stations need to be raised at least two metres higher than where they currently are.
- Resilient Design: Future SAR stations will likely need to incorporate resilient design principles that allow them to withstand and quickly recover from flood events. This can include resistance to corrosion and water damage, elevated electrical systems, backup power supplies, and quick-drain facilities. Designing SAR facilities to be adaptable to changing conditions can reduce the need for costly retrofits in the future.
- Natural Defences: Restoration of natural buffers, such as mangrove forests, coral reefs, and marshlands, can reduce wave energy and offer some protection against sea-level rise, floods and storms while also promoting biodiversity.
- Strategic Planning: From an adaptation perspective, a critical challenge lies in the universal impact of sea-level rise on SAR stations. Unlike isolated incidents allowing for sequential station upgrades, sea-level rise presents a concurrent threat to all facilities. Given the logistical and financial constraints associated with simultaneous infrastructure overhauls, strategic foresight becomes imperative. SAR organisations are thus encouraged to embark on comprehensive planning exercise, assessing the long-term sustainability of their stations against sea-level projections. This process should involve detailed flood zone analyses and the development of graduated adaptation or relocation strategies, ensuring continued operational resilience in the face of climate change.
- Insurance and Funding: Obtaining insurance coverage for stations in high-risk areas may become more challenging and expensive. SAR organisations might have to allocate more funding for insurance premiums or self-insure through dedicated funds.
- Emergency Preparedness: SAR organisations will need to develop emergency response plans for their own stations, ensuring that they can secure SAR assets and continue to operate, or have contingencies in place if the station is compromised.
- Environmental Monitoring: Increasing the monitoring of local weather and water conditions can provide early warning of potential threats to SAR stations, allowing for pre-emptive action.
- Collaboration with Local Authorities and Surrounding Landowners: Working with local governments and surrounding landowners on coastal zone management and community-wide flood protection strategies can provide mutual benefits, as SAR stations are often integral to broader public safety networks.

The need to protect SAR stations from the impacts of climate change reflects the broader challenge of adapting critical infrastructure to a changing world. Proactive measures, innovative designs, and a commitment to resilience will be key factors in maintaining SAR capabilities in the face of this global issue.

Checklist items:

- Conduct strategic assessments to evaluate the long-term viability of SAR stations in flood-prone areas, planning for necessary adaptations or potential relocation.
- Review the need for implementing protective measures such as sea walls, flood barriers, or elevating structures to protect SAR stations from flooding and coastal erosion.
- Assess the current state of SAR docking facilities and plan adaptations to accommodate changing water levels, ensuring safe mooring and rapid deployment of vessels.

- Consider designing and retrofitting SAR facilities with resilient features to withstand flood events and rising sea levels, including elevated electrical systems and quick-drain capabilities.
- Develop comprehensive emergency response plans specifically for SAR stations to secure assets and maintain operational capabilities during flooding situations.

Read more:

- BBC. 2022. New RNLI boathouse in Norfolk built 'with climate change in mind'. Available at https://www.bbc.com/news/uk-england-norfolk-62065847
- Sierra Club O'ahu Group. 2023. Civil Beat: Climate Change is Making Hawai'i's Beaches More Dangerous. Available at: https://www.sierracluboahu.org/blog/civil-beat-climate-change-is-making-hawaiis-beaches-more-dangerous

Photo: Miguel Arcanjo Saddi

9-2 Protection from the wind

The intensification of wind patterns and the increase in severe weather events can have significant implications for SAR organisations. Protecting SAR stations from stronger and more frequent wind events requires a multifaceted approach.

Impact mechanisms:

- Structural Reinforcement: SAR stations may need to be retrofitted or initially designed with stronger materials and construction methods to withstand high winds. This can include the use of wind-resistant design standards that can handle the increased load and stress from storm winds.
- Secure Fastenings: Ensuring that roofs, doors, windows, and other structural elements have secure fastenings that can resist being torn off or damaged during windstorms is essential. This can also extend to non-structural elements like signs and external fixtures.
- Roof Design: Flat roofs can be more vulnerable to wind uplift, so peaked or sloped roofs that allow wind to flow over the structure more easily might be more suitable in windy areas. The choice of roofing materials is also crucial.
- Building Orientation: New stations can be oriented to minimise the impact of prevailing winds, based on the local climate data and wind patterns.
- Debris Impact Protection: In areas where high winds can pick up debris, SAR stations should be equipped with impact-resistant windows and shutters to prevent breakage and internal damage.
- Emergency Generators: High winds can disrupt power lines and lead to outages. SAR stations should have emergency generators and redundant power systems to ensure continued operations during and after windstorms. For instance, the NSRI in South Africa has equipped all bases with power generators to maintain essential systems during power outages, and which are sufficient to also launch and recover Class I lifeboats.
- Windbreaks: Planting trees or constructing barriers can act as windbreaks to reduce the wind speed hitting the SAR stations directly. However, care must be taken to ensure that these do not become debris hazards in extreme conditions.
- Landscape Management: Regularly trimming trees and securing loose items around the SAR station can prevent them from becoming wind-borne hazards.
- Equipment: SAR equipment and vehicles need to be housed in structures that can withstand wind events or in secure areas where they are not exposed to potential damage.
- Contingency Planning: SAR organisations should have contingency plans for wind-related events, including protocols for securing the station, backup communication systems, and evacuation routes if the station becomes compromised.
- Community Integration: SAR stations should be integrated into the broader community's wind protection plans, such as wind alert systems and community response strategies, which can offer mutual support.
- Insurance Coverage: Reviewing and updating insurance coverage to include wind damage can provide financial protection and resources for repairs and rebuilding if necessary.

Climate change predictions indicate that weather-related disasters will become more frequent and severe, so SAR organisations will need to prioritise the resilience of their infrastructure to ensure they can withstand the wind and other extreme weather impacts.

Checklist items:

- Assess the need for retrofitting or designing SAR stations with stronger materials and construction methods to withstand high winds, ensuring adherence to wind-resistant design standards.
- Examine and plan for the reinforcement of fastenings on roofs, doors, windows, and other structural elements to enhance their resistance to damage during windstorms.
- Assess the need for implementing debris impact protection measures, such as installing impact-resistant windows and shutters, to safeguard SAR stations against debris carried by high winds.
- Review the necessity and feasibility of installing emergency generators and redundant power systems at SAR stations to ensure continuous operational capabilities during power outages.
- Develop comprehensive emergency response plans specifically for SAR stations to secure assets and maintain operational capabilities during strong wind events.

Read more:

- RNLI. 2023. Sennen Cove RNLI volunteers thank local community following storm damage. Available at: https://rnli.org/news-and-media/2022/february/24/sennen-cove-rnli-volunteers-thank-local-community-following-storm-damage
- Taylor Edward. 2021. Island clears up after Storm Aurore strikes. Jersey Evening Post. October 22, 2021. Available at: https://jerseyeveningpost.com/news/2021/10/22/island-clears-up-after-storm-aurore-strikes/

9-3 Berthing solutions

Climate change can significantly impact marine environments and coastal infrastructure, including the berthing solutions at SAR stations, especially the ones where boats are kept afloat. These impacts may include rising sea levels, increased frequency of severe weather events, and changing coastal dynamics.

Impact mechanisms:

- Rising Sea Levels: As sea levels rise, docks and berths that were once at the optimal height may become submerged or inadequately positioned for the vessels, potentially leading to damage or making berthing difficult. SAR stations may need to adjust the height of docks or invest in floating structures that can adapt to changing water levels.
- Increased Storm Intensity: With more intense and frequent storms, berthing structures may be subjected to stronger wave action, storm surges, and increased likelihood of damage. Berths need to be designed or modified to handle these conditions, possibly including reinforced mooring points and breakwaters.
- Altered Sediment Patterns: Climate change can affect coastal erosion and sediment deposition patterns. This may necessitate dredging operations to maintain water depth at berths or restructuring the berthing area to prevent silting and ensure the vessels can be moored safely without grounding.
- Changing Ice Conditions: In areas prone to ice, changing patterns in freeze-thaw cycles may require a review of berthing solutions to cope with longer seasons of open water or the management of ice build-up around berthing structures.
- Increased Corrosion Rates: Changes in temperature and humidity can accelerate corrosion in metal structures, including berths. SAR organisations may need to use more durable materials or increase maintenance efforts to ensure the integrity of these structures.
- Adaptability and Flexibility: SAR stations may have to invest in adaptable berthing systems that can quickly be modified or moved in response to changing environmental conditions. For example, floating docks can be more easily adjusted than traditional fixed structures.
- Design for Extremes: Berthing solutions must be designed with the understanding that "100-year events" may become much more frequent. This involves using robust design standards that account for extreme water levels and wave forces.
- Location Review: Some SAR stations may find their current locations untenable due to the changing climate and may need to relocate their berthing facilities to more protected or suitable areas.

The review of berthing solutions is a multi-dimensional challenge that requires SAR organisations to engage in proactive planning, invest in resilient infrastructure, and remain adaptable to the evolving impacts of climate change.

Checklist items:

- Evaluate the need for retrofitting or designing new docks and berths to accommodate changing water levels, including the potential use of adaptable floating structures.
- Review the current berthing structures to ensure they employ robust standards and determine the necessity of upgrades to withstand stronger wave action and storm surges, including reinforcing mooring points and installing breakwaters.
- Assess the need for regular dredging to maintain water depth at berths and restructure berthing areas as necessary to prevent silting and ensure safe mooring.
- In ice-prone areas, evaluate current berthing solutions and plan adaptations to cope with variations in freeze-thaw cycles and manage ice build-up.
- Conduct assessments of the long-term viability of current berthing locations considering climate change impacts, and plan for potential relocation to more protected or suitable areas if necessary.

Read more:

- Gonçalves André. 2019. Climate Change Is Causing An Increase In Wave Energy. Youmatter. Available at: https://youmatter.world/en/climate-change-causes-the-increase-of-wave-energy/
- Sierra Joan Pau, Sánchez-Arcilla Agustín, Gironella Xavier, Gracia Vicente, Altomare Corrado, Mösso César, González-Marco Daniel, Gómez Jesús, Barceló Mateo and Barahona Cristina. 2023. Impact of climate change on berthing areas in ports of the Balearic Islands: adaptation measures. *Frontiers in Marine Science* 10. Available at: https://www.frontiersin.org/articles/10.3389/fmars.2023.1124763/full

Photo: RNLI/Graham Holden

9-4 Storing and maintaining special equipment

Climate change is leading to more frequent and severe weather events and disasters, some of which may be unprecedented in certain locations. This shift requires SAR organisations to reassess their equipment needs, storage, and maintenance protocols. Additionally, storage of heat-sensitive rescue equipment may require specific planning and processes.

Impact mechanisms:

- Diversification of Equipment: SAR organisations may need to acquire a broader range of equipment to prepare for new types of disaster events, such as equipment for prolonged power outages, urban search and rescue in flood conditions, or for response to large-scale wildfires.
- Equipment Readiness: There is a need for ensuring that equipment is ready at all times. This can involve regular maintenance checks, ensuring replacements for parts are available, and personnel are trained in the use of this equipment.
- Degradation of Equipment: High temperatures can lead to the degradation of materials. Rubber and plastic components can become brittle, adhesives may fail, electronic components can malfunction, and batteries may degrade more quickly. This can affect a range of equipment from medical supplies to flotation devices and technical gear and require frequent checks to ensure working condition.
- Storage Facilities: Additional equipment will require additional storage space. SAR organisations may need to expand their current storage facilities or find new storage solutions that protect equipment from the elements and potential damage from the very climate events they are meant to respond to.
- Climate-Controlled Storage: Some equipment might be sensitive to temperature and humidity, so climate-controlled storage may be necessary, especially in regions experiencing more extreme temperatures and humidity. Implementing active cooling systems, protective coverings, enhanced insulation, and temperature monitoring systems in storage areas to manage the temperatures and protect the equipment may be needed.
- Inventory Management: With the increase in types and quantities of equipment, effective inventory management becomes critical. This includes tracking the location, condition, and availability of equipment for deployment.
- Prepositioning and Deployment Strategies: With the addition of new equipment, SAR organisations will have to develop or update their deployment strategies to ensure the right equipment is available where and when it is needed most.
- Interagency Cooperation: Some equipment might be too expensive for individual SAR units to procure and maintain. There may be an increased reliance on interagency cooperation, where equipment is shared across agencies and jurisdictions.
- Financial Resources: Funding may be required not only for the purchase of new equipment but also for the construction of new storage facilities and the hiring of additional maintenance staff.

Climate change demands that SAR organisations be more agile and prepared for a wider array of disaster scenarios. Proactively addressing these changes will likely involve a complex balancing act between operational readiness, financial constraints, and safety aspects.

Checklist items:

- Assess the current range of emergency response equipment and consider needs of acquiring a diversified set to address various types of disaster events that may arise.
- Evaluate the need to expand storage capacity and upgrade facilities, including implementing climate-controlled environments where necessary.
- Evaluate the feasibility of stockpiling some elements of critical response equipment away from potential incident sites and stations, should they be compromised in an incident.
- Implement and regularly review a maintenance schedule to ensure all equipment is in a ready-to-deploy condition.
- Review current inventory management systems and consider adopting more effective methods for tracking and deploying various equipment efficiently.
- Explore and develop partnerships with other agencies to facilitate the sharing of specialised equipment and resources, enhancing overall response capabilities.

9-5 Reaching the rescue station

Climate change, with its associated increase in extreme weather events such as flash floods, can significantly affect the ability of SAR operational personnel to reach their rescue stations when needed.

Impact mechanisms:

- Transportation Disruptions: Flash floods can wash out roads or cause damage to transportation infrastructure, making it difficult or impossible for operational personnel to travel to the lifeboat station. SAR organisations may need to plan alternative routes or modes of transportation, such as boats, to ensure that operational personnel can reach the station.
- Increased Response Time: With roadways blocked or dangerous to navigate, response times can be significantly increased, which can be critical in SAR operations where every minute counts.
- Secondary Residences: Operational personnel who live in coastal areas, especially those with second homes that they use during certain times of the year, might find these properties cut off due to rising waters or severe weather events, affecting their ability to respond.
- Local Accommodations: Some SAR organisations might consider setting up local accommodations for their operational personnel near lifeboat stations to ensure they are available when needed, particularly during periods of high risk for extreme weather.
- Remote Access: It may be vital to ensure that operational personnel have remote access to necessary information and communication tools to coordinate their efforts if they cannot physically reach the lifeboat station.
- On-call Systems: Developing on-call systems that allow for a flexible response, with multiple operational personnel available to respond to a call, accounting for the possibility that some may not be able to reach the station. Implementing robust communication plans that allow for the coordination of operational personnel who may be scattered due to flash floods or other events.
- Personal Safety: Ensuring that operational personnel prioritise their own safety and are not taking unnecessary risks trying to reach the station during dangerous conditions.
- Community Assistance: In some cases, SAR organisations may partner with local communities to assist in ensuring that access ways are kept clear and that there are community-based solutions for getting operational personnel to the stations.

As extreme weather events become more common, SAR organisations will need to ensure that operational personnel can always reach their stations, maintain readiness, and fulfil their critical roles in emergency responses.

Checklist items:

- Develop and assess plans for alternative transportation routes and methods, such as boats or all-terrain vehicles, to ensure operational personnel can reach stations despite infrastructure disruptions.
- Consider establishing or enhancing on-call systems that allow for multiple operational personnel to be available for a flexible response.
- Evaluate the feasibility and benefits of setting up local accommodations near rescue stations for operational personnel, ensuring their availability during high-risk weather periods.
- Develop and emphasise protocols that prioritise the personal safety of operational personnel, instructing them to avoid unnecessary risks while trying to reach the station during dangerous conditions.

Photo: FLBI/Jaakko Heikkila

9-6 Local Interaction

Climate change is prompting many organisations, including SAR operations, to reassess their relationships and interactions with local government and emergency services.

Impact mechanisms:

- Joint Planning for Extreme Events: Climate change is expected to increase the frequency and intensity of extreme weather events, such as hurricanes, floods, and wildfires. SAR stations need to assess how climate change alters the risks in their areas of operation. SAR stations will need to work closely with local governments and emergency services to plan and prepare for these events.
- Shared Resources: During large-scale emergencies caused by climate-related disasters, SAR organisations may need to share resources such as boats, equipment, and trained personnel with other agencies. This requires pre-established agreements and understanding of how resources will be allocated and managed, including at the local level and in practice.
- Integrated Communication Systems: To coordinate effectively during a crisis, SAR operations need to be integrated into local government and emergency services communication networks to ensure timely and accurate information sharing.
- Cross-Training: Cross-training between SAR personnel and local emergency services can build capacity and improve the overall response to climate-induced incidents. Understanding each other's protocols and capabilities allows for a more cohesive operation.
- Unified Command Structures: Climate emergencies often require a unified command structure and a chain of command, wherein SAR organisations, local government, and emergency services operate under a single command system to streamline decision-making and response efforts. This also involves agreeing on tasks and responsibilities for each organisation.
- Public Education and Community Engagement: SAR organisations can partner with local governments to educate the public on the increased risks associated with climate change and how to respond during emergencies, which can help reduce the number of incidents and improve community resilience. SAR organisations can act as liaisons between the public and local government to relay concerns, needs, and feedback about disaster preparedness and response.
- Evacuation and Sheltering Operations: As extreme weather events become more common, SAR operations may increasingly support local governments in evacuating residents from danger zones and providing assistance in sheltering operations.
- Climate Change Adaptation Strategies: SAR organisations and local governments should collaborate on developing adaptation strategies to handle the challenges posed by a changing climate.

As the impacts of climate change become increasingly pronounced, the integration of SAR operations with local government and emergency services will become critical for a society's resilience and the protection of life and property. Additionally, as communities are being reshaped, for instance fishing communities switching to leisure industry, the ability to provide the required amount of personnel to the station may be compromised. These changes necessitate not only operational coordination but also strategic and long-term planning.

Checklist items:

- Evaluate current collaboration efforts with local governments and emergency services to plan for and respond to extreme weather events, focusing on risk assessment and coordinated planning.
- Assess the effectiveness of existing agreements and protocols for sharing resources like boats, equipment, and personnel with other agencies, and identify areas for improvement or expansion.
- Examine how SAR operations are integrated into local emergency communication networks and identify ways to enhance coordinated response efforts.
- Consider the development and implementation of cross-training programmes between SAR personnel and local emergency services to improve mutual understanding and effectiveness in responding to climate-induced incidents.
- Assess readiness and protocols for operating within a unified command structure alongside local government and emergency services during climate emergencies, focusing on streamlining decision-making and response actions.

Photo: KNRM

10. SAR Units

10-1 Ecological and economic use of fuel

As climate change leads to alterations in sea ice concentration, storm patterns, and the distribution of marine wildlife, SAR operations may need to cover larger areas or operate in regions that were previously inaccessible. Climate change is also associated with an increase in the frequency and severity of extreme weather events. These issues often require SAR organisations to deploy more resources and consume more fuel. In addition to designing more fuel-efficient or alternative fuel vessels, the ecological and economic use of fuel by SAR units is affected by climate change in several ways.

Impact mechanisms:

- Fuel Efficiency: Changing environmental conditions, such as higher temperatures, can impact the fuel efficiency of SAR vessels and aircraft. For example, higher air temperatures can reduce air density, which affects aircraft performance and can increase fuel consumption. Similarly, higher water temperatures can affect the efficiency of boat engines.
- Optimisation of Operations: SAR units can optimise their operations through better planning and the use of technology. Route optimisation for vessels and aircraft can reduce fuel consumption. The use of data analytics and predictive modelling can help in deploying resources more efficiently, thereby saving fuel.
- Maintenance Practices: Proper maintenance of engines and hulls can significantly improve fuel efficiency. Climate change may necessitate more frequent or specialised maintenance routines, such as hull cleaning to remove more prevalent marine growth, which can reduce drag and improve fuel economy.
- Fuel Storage: Changes in environmental conditions may affect fuel storage infrastructure. For example, higher temperatures can increase the rate of fuel evaporation, leading to the need for improved storage solutions that minimise fuel loss.
- Training: Operational personnel training can also focus on ecological driving techniques, whether for boats, helicopters, or vehicles, to ensure that they are operated in the most fuel-efficient manner possible. Also, several tasks can be trained either in a simulator, using VR training equipment, or in locations that do not require movement over extensive distances.
- Strategic Fuel Reserves: SAR stations or units might need to create strategic fuel reserves, especially in remote areas affected by climate change, to ensure they have adequate supplies for extended or more frequent operations.

The economic implications of increased fuel usage are significant for SAR organisations, particularly as they may face budget constraints. Fuel costs can be a large part of operational expenses, so any increase due to environmental changes can have substantial financial impacts. Overall, climate change challenges SAR organisations to be more ecological and economical in their fuel use, requiring both operational adjustments and strategic long-term planning.

Checklist items:

- Review the current fuel efficiency of SAR vessels and aircraft and plan for upgrades to enhance fuel efficiency, taking into account the impact of changing environmental conditions like higher temperatures on fuel consumption.
- Review mission planning, training and routing strategies to minimise fuel consumption and consider implementing advanced approaches using data analytics and predictive modelling to minimise fuel consumption during SAR operations.
- Plan and provide continuous training for operational personnel in ecological driving techniques for boats, helicopters, and vehicles, ensuring the most fuel-efficient operation possible under varying environmental conditions.

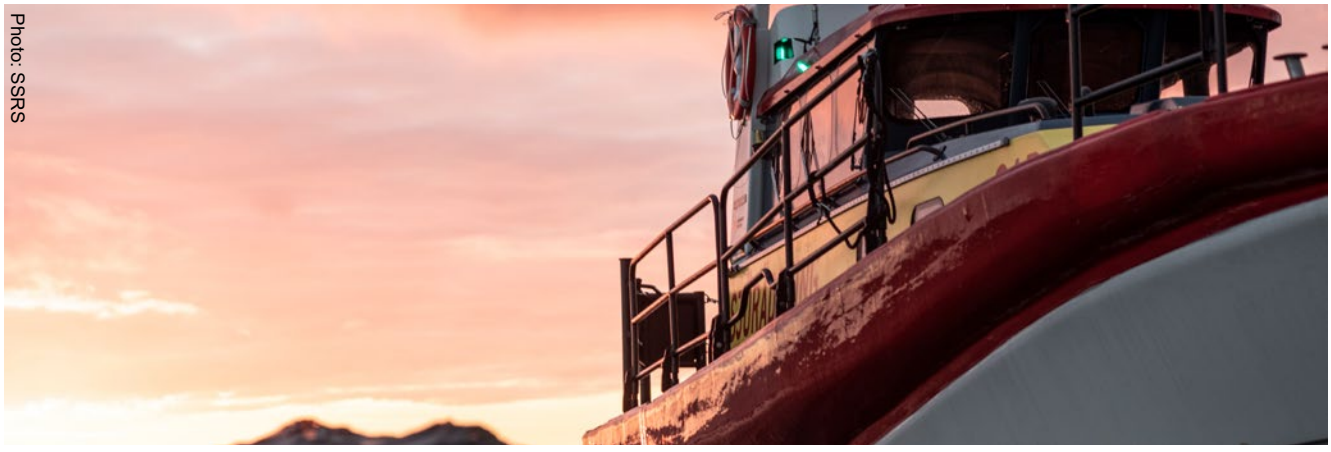


Photo: SSRS


Photo: FLBI/Jaakko Heikkila

10-2 Impact on flight operations

The effects of climate change have a significant impact on flight operations for SAR organisations, as they must navigate an array of environmental changes that can affect both the safety and the efficacy of their missions.

Impact mechanisms:

- Snow and Icing: Climate change can lead to more severe winter storms and icing conditions, which are dangerous for aircraft, as ice build-up can affect aerodynamics and lead to equipment failure. SAR operations in such conditions require specialised de-icing equipment and procedures.
- Temperature Extremes: Increased temperatures can reduce the performance of aircraft by affecting engine efficiency and lift. In colder climates, extreme low temperatures can make mechanical parts brittle and lead to equipment malfunction.
- Wind Patterns and Turbulence: Increasingly volatile and changing wind patterns can lead to unexpected turbulence, which poses risks for SAR aircraft, particularly when flying at low altitudes during search missions or when hovering during rescue operations.
- Rainfall Intensity: More intense and unpredictable rainfall can reduce visibility, increase the risk of flash flooding, and make it more challenging to locate individuals in need of rescue. It can also create hazardous flying conditions and impact the ability of operational personnel to perform rescues.
- Visibility Reduction: Fog, which may become more common in certain areas due to changing climate conditions, significantly reduces visibility, making navigation and location of survivors more difficult. Additionally, wildfires, which are becoming more frequent and severe, can create vast plumes of smoke that can ground SAR aircraft due to poor visibility and the risk of engine ingestion of particulates.
- Changing Coastlines: Changes in sea levels can affect coastal navigation landmarks and infrastructure, altering the reference points SAR pilots use for navigation.
- Increased Demand for Service: With the expected increase in weather-related disasters, SAR flight operations may be in higher demand, increasing the wear on aircraft and the possibility of maintenance issues.

Overall, the impacts of climate change on SAR flight operations are far-reaching, requiring organisations to adapt to new environmental realities through improved technology, training, and strategies to maintain the safety and effectiveness of their life-saving missions.

Checklist items:

- Review the capability of aircraft to perform optimally in both high and low extreme temperature conditions, focusing on modifications and maintenance to address challenges such as reduced engine efficiency and equipment brittleness. Assess the need for developing and implementing specialised de-icing procedures and evaluate the current aircraft de-icing technology to handle severe winter storms and icing conditions.
- Plan and implement advanced training programmes for pilots to navigate increasingly volatile wind patterns and unexpected turbulence, particularly during low-altitude search missions or rescue operations.
- Assess and upgrade SAR aircraft with enhanced navigation and visibility tools to safely operate in conditions of intense rainfall, fog, and smoke from wildfires, ensuring effective location and rescue in reduced visibility.
- Evaluate the current operational capacity and prepare for an anticipated increase in service demand due to weather-related disasters by implementing robust maintenance schedules for aircraft and considering options like fleet expansion or strategic partnerships to manage increased wear and operational frequency.

Read more:

- Puempel Herbert and Williams Paul D. 2016. The impacts of climate change on aviation: scientific challenges and adaptation pathways. ICAO Environmental Report. Available at: https://www.icao.int/environmental-protection/Documents/EnvironmentalReports/2016/ENVReport2016_pg205-207.pdf

10-3 Impact on underwater operations

Climate change can significantly affect underwater operations for SAR organisations in various ways.

- Temperature Extremes: Changes in water temperature can affect the operation of underwater equipment and sensors, as they may be calibrated for a certain temperature range. Higher temperatures can also increase the risk of heat stress for divers or SAR personnel working in water.
- Turbidity: Increased rainfall and stronger storm events can stir up sediments and reduce water clarity, making it difficult for SAR teams to search underwater visually. This can complicate dive operations and necessitate more reliance on sonar and other non-visual search methods.
- Salinity: Changes in salinity, which may result from altered patterns of freshwater inflow due to melting glaciers or changes in precipitation, can impact the buoyancy of objects and organisms in the water, affecting SAR operations and potentially altering the effectiveness of equipment designed for specific salinity levels.
- Acoustic Environment: Changes in salinity and temperature can alter sound propagation, affecting the range and clarity of sonar and other acoustic devices used in underwater search efforts.
- Algal Blooms and Marine Plant Growth: Warmer water temperatures can lead to more frequent and intense algal blooms, which can deplete oxygen levels in the water and release toxins, posing risks to SAR divers. Increased marine plant growth can also obscure visibility and entangle both victims and rescue equipment.
- Migration of Species: Climate change can cause species to migrate to different areas, which could increase the risk of dangerous encounters with wildlife during SAR operations.

The cumulative effect of these environmental changes means that SAR organisations must continuously update their operational protocols, invest in new technologies to deal with less predictable conditions, and ensure that their personnel are trained to deal with the emerging challenges presented by the changing underwater environment.

Checklist items:

- Review and establish regular recalibration procedures for underwater equipment and sensors to ensure optimal functionality in varying water temperatures and varying salinity levels and assess diver safety protocols to address heat stress risks.
- Evaluate the current capabilities in non-visual search technologies like advanced sonar, and plan for investments and training in these areas to enhance effectiveness in conditions of reduced visibility.

Read more:

- Gobler Christopher J. 2020. Climate Change and Harmful Algal Blooms: Insights and perspective. *Harmful Algae* 91: 101731.
- United States Environment Protection Agency. Climate Change and Harmful Algal Blooms. Available at: https://www.epa.gov/nutrientpollution/climate-change-and-harmful-algal-blooms

Photo: FLBI/Jaakko Heikkila

10-4 Disruptions in radio frequencies

Climate change can have various impacts on atmospheric conditions, which may in turn affect the reliability and clarity of radio communications, crucial for SAR units and operations.

Impact mechanisms:

- Atmospheric Disturbances: Climate change is expected to intensify atmospheric disturbances such as storms and lightning, which can cause radio frequency interference and reduce the effectiveness of communication systems.
- Changes in the Ionosphere: The ionosphere, which reflects and refracts radio waves, is affected by solar and geomagnetic activity. Changes in the Earth's climate could affect these upper layers of the atmosphere, altering how radio waves are propagated over long distances. This could lead to issues with high-frequency (HF) radio communications, which are often used by remote SAR operations.
- Temperature Fluctuations: Extreme temperature variations can affect the propagation of radio waves. Higher temperatures can increase the levels of atmospheric noise, especially in the high-frequency bands, and this noise can interfere with signal clarity.
- Altered Propagation Paths: Climate-induced changes in the atmosphere can change the standard propagation paths for radio waves. For instance, if the troposphere becomes more humid or the temperature gradients within it change, this can affect very high frequency (VHF) and ultra-high frequency (UHF) radio wave propagation, leading to decreased range and reliability.

Photo: Albin Biju

- Increased Precipitation: An increase in precipitation levels can lead to greater attenuation and scattering of radio signals.
- Infrastructure Damage: As sea levels rise, low-lying coastal areas where radio infrastructure is installed may be at risk of flooding, which could damage or disrupt equipment necessary for radio communications. More frequent and intense natural disasters like hurricanes and wildfires, which are linked to climate change, can damage the physical infrastructure necessary for radio communications, such as repeater stations and antennae.
- Shift in Operation Areas: As SAR operations may shift to new areas due to changing climate conditions, the existing communication infrastructure may not cover these new areas adequately, necessitating the development and deployment of new communication networks.

Overall, maintaining effective communication is critical for SAR units and operations, and as climate change continues to affect atmospheric conditions, SAR organisations will have to be proactive in updating and adapting their communication strategies to ensure safety and efficiency. It may become necessary to implement redundant systems or alternative communication methods, such as satellite phones or internet-based communications, to ensure reliable connectivity when radio frequencies are disrupted.

Checklist items:

- Evaluate current communication systems for their resilience against atmospheric disturbances, which can interfere with radio frequency signals, and identify necessary upgrades.
- Plan and establish redundant communication systems, such as satellite phones or internet-based communications, to maintain reliable connectivity in scenarios where traditional radio communications are challenged.

Read more:

- Eckert Cambrie. 2023. Rising Global Temperatures Could Affect Military Sensors, Comms Systems (Updated). *National Defense*. Available at: https://www.nationaldefensemagazine.org/articles/2023/8/22/rising-global-temperatures-could-affect-military-sensors-comms-systems
- Science Daily. 2013. Radio waves carry news of climate change: Surprising tool to measure our changing climate. Available at: https://www.sciencedaily.com/releases/2013/07/130730123421.htm

10-5 Changes in visibility

Climate change can impact visibility at sea in various ways, potentially impacting SAR units.

Impact mechanisms:

- Fog and Mist: Increased sea surface temperatures can lead to more evaporation and higher humidity levels, which can contribute to the formation of fog and mist. Dense sea fog severely reduces visibility, complicating navigation and search efforts.
- Precipitation Patterns: Altered precipitation patterns, with some regions experiencing more intense and frequent rain or snowfall, can also impair visibility. SAR operations during heavy precipitation are more challenging and riskier.

Photo: Matt Hardy

- Extreme Weather Events: Intensifying storms associated with climate change can lead to lower visibility due to spray, heavy rain, and cloud cover. The increase in extreme weather events means SAR operational personnel may often have to navigate and conduct searches in suboptimal visual conditions.
- Air Quality and Wildfires: Increased frequency and severity of wildfires can cause smoke to spread over vast areas, even out at sea, thereby reducing visibility. SAR operations may need to be adjusted to account for the possibility of smoke and haze.
- Dust Storms: In arid regions, rising temperatures and changing weather patterns can lead to more dust storms or sandstorms, which can carry fine particles over long distances, including out to sea, thereby reducing visibility.
- Sea Spray and Icing: In colder climates, increased wind speeds and storms can lead to more sea spray, which can freeze on contact with structures and vessels, including SAR equipment, impairing visibility and the functionality of equipment.

With reduced visibility, SAR operations may become more dependent on instruments such as radar, sonar, and GPS to detect and navigate toward individuals in need of rescue. Climate change's impact on visibility at sea presents considerable challenges to SAR operations, necessitating adaptive strategies and investments in technology to maintain and improve SAR capabilities under less favourable conditions.

Checklist items:

- Assess the readiness for upgrading to advanced navigational and detection technologies, including enhanced radar, sonar, and GPS systems, to maintain operational effectiveness in conditions of reduced visibility such as fog, mist, or heavy precipitation.
- Examine current operation and training protocols and develop new ones that are adaptive to varying weather conditions, focusing on navigation and search operations during intense weather events that impair visibility.
- Review the effectiveness of current anti-icing and de-fogging measures and assess the need for enhanced solutions to address visibility issues caused by sea spray and icing in colder climates.

Read more:

- Rempel Luc. 2023. Sailing into Hubs of Hell: Shuswap marine search and rescue team kept busy with wildfires in 2023. Available at: https://www.castanet.net/news/Salmon-Arm/465545/Shuswap-marine-search-and-rescue-team-kept-busy-with-wildfires-in-2023


Photo: Mikhail Nilov

10-6 New routes for rescue

Climate change is affecting the Earth's waterways and oceans in significant ways, which can alter old navigation routes traditionally used by the SAR units and create new hazards for SAR operations.

Impact mechanisms:

- Shifting Sandbanks and Coastlines: Rising sea levels and increased storm intensity can change coastal landscapes, leading to shifting sandbanks, erosion, and the creation of new underwater hazards that are not yet charted. SAR operations need to constantly update their navigational charts and be vigilant for changes in familiar routes.
- Increased Debris: More frequent and intense flooding can sweep trees, structures, and other debris into waterways and out to sea. These objects can pose significant risks to rescue vessels, damaging propellers, hulls, and rudders, and can also complicate the search process.
- Altered Water Levels: Droughts and changes in precipitation patterns can affect river and lake levels, making previously navigable routes too shallow for rescue boats or changing the flow patterns that SAR teams are accustomed to. Similarly, rising sea levels can submerge existing structures that were once above water, such as piers, breakwaters, or buildings, creating new underwater hazards that are not marked on navigational charts.
- Melting Ice: In polar and mountainous regions, the melting of ice can release previously trapped debris into the water. Additionally, weaker ice conditions can lead to unexpected breakups, creating open water where there was previously ice cover, changing the dynamics and risks of SAR operations in these areas.

Adapting to these changing conditions is critical for SAR organisations to ensure the safety of their operational personnel and maintain their effectiveness in rescue operations. SAR teams may need updated navigation systems, robust communication protocols, stronger hulls and more flexible response plans.

Checklist items:

- Regularly review and update navigational charts and other information systems to accurately reflect changes in coastal landscapes, shifting sandbanks, and new underwater hazards resulting from rising sea levels and increased storm intensity.
- Determine the need for equipping SAR vessels with advanced detection systems for identifying and navigating around debris and assess the necessity of reinforcing hulls and propellers for potential impacts.

Photo: Mikhail Nilov

10-7 Maintaining cold chain

Climate change, leading to rising temperatures and more frequent heatwaves, can significantly impact the cold chain management in medical evacuations conducted by SAR organisations.

Impact mechanisms:

- Increased Demand for Cold Chain Resources: SAR operations sometimes involve the transport of temperature-sensitive medical supplies, like certain medications, blood products, and vaccines. Higher ambient temperatures can increase the demand for cold chain resources to ensure these materials remain viable during transport. Patients suffering from heatstroke or other heat-related illnesses may require cooled IV fluids or other interventions that depend on the cold chain.
- Challenges in Temperature Control: Maintaining the efficacy of medical products during evacuations can be challenging as the equipment used for temperature control, like refrigeration units and cool boxes, may be pushed to their limits, especially in extreme heat conditions.
- Adaptation Costs: SAR organisations may need to invest in more robust cooling systems, backup power solutions, and insulated transport containers to ensure the integrity of the cold chain.
- Logistical Complexities: Planning and logistics for SAR operations may become more complex, requiring careful timing and routing of evacuations to minimise exposure to high temperatures, especially in remote areas.

To mitigate these impacts, SAR organisations may need to reassess and possibly upgrade their cold chain capabilities, incorporating more resilient technologies and practices designed to function in higher temperature ranges. This could involve using advanced cooling materials, like phase change materials, that can maintain specific temperature ranges for extended periods or implementing real-time temperature monitoring systems to ensure the integrity of medical supplies throughout the evacuation process.

Checklist items:

- Assess the current strategies, capacity and effectiveness of cold chain resources, including refrigeration units and insulated transport containers, for handling increased demand for temperature-sensitive medical supplies in higher ambient temperatures.
- Determine the necessity for acquiring more robust and reliable temperature control equipment capable of functioning effectively in extreme heat conditions, to reduce the risk of equipment failure and maintain the efficacy of medical products.

Read more:

- Centre for Sustainable Cooling. 2022. Sustainable and Resilient Cold-Chains: The 2050 Imperative. Conference Report. Available at: https://sustainablecooling.org/wp-content/uploads/2023/03/The-Local-to-Global-Summit-Report.pdf
- Mireku Akosua. 2023. Pharma readies for climate disasters amidst supply chain concerns. Available at: https://www.pharmaceutical-technology.com/features/pharma-readies-for-climate-disasters-amidst-supply-chain-concerns/?cf-view

10-8 Biological hazards

Climate change, through its effects on ocean temperatures, can lead to an increase in the blooms of species such as jellyfish or water hyacinth, which thrive in warmer conditions. For instance, in Chile it has been estimated that the number of jellyfish or similar species will increase due to climate change, including the relatively harmful Portuguese Man o'War (*Physalia physalis*). Jellyfish and water hyacinth act here as examples of the diverse impacts that marine life might have on SAR operations.

Impact mechanisms:

- Impeded Access: Water hyacinth is a problematic invasive species in many parts of the world, forming dense mats on the surface of waterways that can block the passage of boats and alter aquatic ecosystems. Similarly, large blooms of jellyfish may physically impede the progress of boats and hinder rescue operations. These not only increase the amount of operations as people get stuck with their boats, but can also make it difficult for SAR vessels to navigate through infested areas, delaying rescue operations.
- Compromised Launch Sites: Infestations of water hyacinth around marinas, docks, and boat ramps can prevent SAR vessels from being launched quickly, which is critical during emergencies.
- Hindered Search Efforts: The dense coverage by invasive plants can conceal submerged objects and make it more challenging to locate individuals who have fallen into the water, as they may be obscured by the vegetation.
- Clogging Intakes: Jellyfish can clog the cooling water intakes of SAR vessels, which are crucial for engine and equipment cooling systems. This can lead to overheating and potential engine failure, especially in smaller rescue vessels that might not have sophisticated filtration systems.
- Safety Hazards for Operational Personnel: Jellyfish stings can be a significant hazard for SAR personnel during operations, especially if operational personnel are required to enter the water to assist with rescues or to conduct repairs and maintenance on the vessel.
- Increased Risk to Victims: Individuals in the water awaiting rescue are at risk of jellyfish stings, which can cause pain, allergic reactions, or even more severe health issues. This adds a layer of complexity to rescue operations, as SAR teams must now also be prepared to provide first aid for stings and possible allergic reactions.
- Maintenance Challenges: Jellyfish can also adhere to and damage the hulls, propellers, and other components of SAR vessels, increasing the need for maintenance and repairs and potentially taking vital equipment out of service for cleaning and restoration.
- Training: SAR organisations might need to invest in training for their operational personnel to handle marine life safely.
- Equipment: SAR organisations may need to provide the operational personnel with protective clothing and equipment to prevent stings and burns. They may also need equipment to clear pathways through plant-infested areas.
- Need for Collaboration: Effective management of water hyacinth may require collaboration with environmental agencies, local communities, and other stakeholders to control and prevent the spread of the plant.

To address these challenges, SAR organisations may have to develop specific strategies and adapt their equipment and operations to ensure they can still respond effectively to emergencies in affected regions. For instance, in the case of the water hyacinth, this could include using airboats that can travel over vegetation mats, investing in mechanical harvesters to clear plants, or establishing alternative launch sites. As for the jellyfish, technology such as specialised nets or water intake filters could be installed on vessels to prevent jellyfish from entering cooling systems or affecting operations.

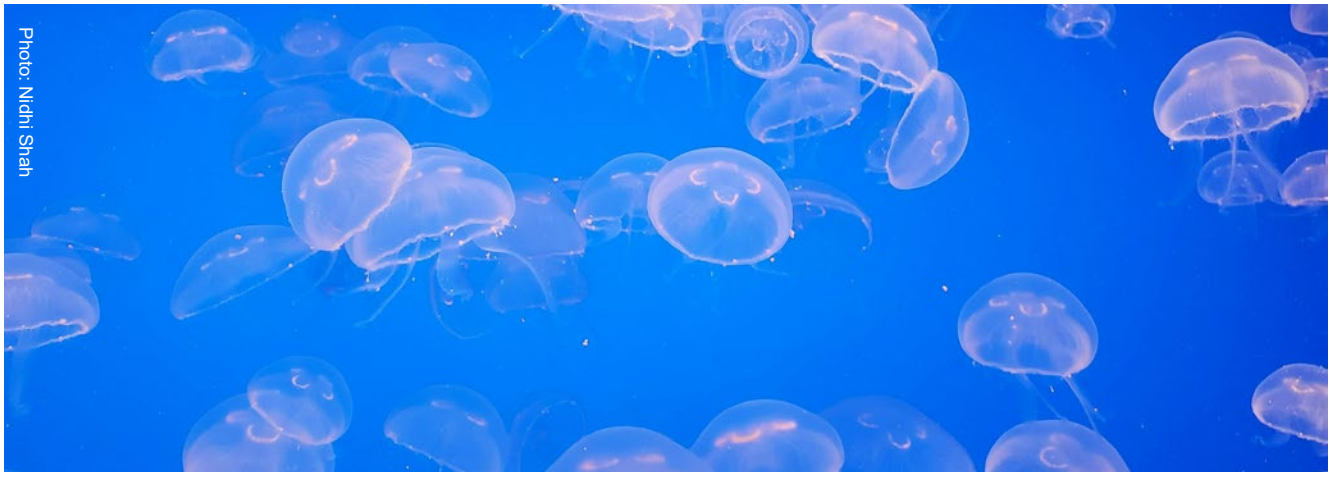


Photo: Nidhi Shah

Checklist items:

- Evaluate the need for upgrading SAR vessels with specialised equipment such as protective netting, advanced water intake filters, and propeller guards to mitigate the impact of biological hazards such as jellyfish blooms and water hyacinth.
- Identify and assess potential alternative launch sites for SAR vessels in regions affected by water hyacinth infestations, ensuring readiness for rapid deployment from these sites.
- Plan and implement comprehensive training for SAR operational personnel focusing on safe handling of biological hazards, including first aid for stings, burns and bites, and specific operational procedures in infested waters.
- Assess the level of collaboration with environmental agencies, local communities, and other stakeholders for the effective control of biological hazards.

Read more:

- Amolo George. 2017. Ugandan Nationals Trapped In Lake Victoria Rescued. Available at: https://www.citizen.digital/news/ugandan-nationals-trapped-in-lake-victoria-rescued-154277
- Omollo Robert. 2018. Fisherman stuck in hyacinth for three days appeals for rescue. Available at: https://www.the-star.co.ke/news/2018-10-24-fisherman-stuck-in-hyacinth-for-three-days-appeals-for-rescue/
- Rigby Mark. 2016. Deadly jellyfish and crocodiles all in a day's work for north Queensland lifeguards. ABC Far North. Available at: https://www.abc.net.au/news/2016-03-02/crocodiles-jellyfish-all-in-a-days-work-for-north-qld-lifeguards/7213458
- Schrader Shea. 2022. Tybee Island lifeguards treat 300 people for jellyfish stings this past weekend. WTOC. Available at: https://www.wtoc.com/2022/08/02/tybee-island-lifeguards-treat-300-people-jellyfish-stings-this-past-weekend/

Photo: Tran Le Tuan

Mitigation of Climate Change by SAR Organisations

Please note that the discussion on mitigation strategies within this report is illustrative rather than comprehensive, offering a selection of potential actions rather than an exhaustive list.

SAR Organisation: Net zero objective

The drive towards a net zero objective for SAR organisations in the context of climate change encompasses a range of initiatives aimed at reducing greenhouse gas emissions across all facets of their operations.

Impact mechanisms:

- Energy Use in Facilities and Operations: SAR organisations are increasingly recognising the importance of assessing and enhancing their energy efficiency. This transformative journey may encompass the adoption of more energy-efficient infrastructure, the integration of renewable energy solutions, and the modernisation of rescue stations and operational centres to minimise energy consumption. A leading example is the RNLI in the United Kingdom, which prioritises renewable energy sources, including solar power and geothermal, air, or water source heat pumps, across its facilities. Notably, they have also installed a wind turbine in Aith, Scotland, underscoring commitment to sustainable operations unless specific constraints dictate otherwise.
- Fleet Transformation: The transition to a net zero fleet would entail investing in alternative energy vessels, such as electric or hybrid rescue boats, and exploring sustainable aviation fuel options for air rescue services. This shift would also require updates to infrastructure, such as charging stations for electric vehicles and other required port infrastructure.
- Operational Adjustments: SAR procedures and protocols may be adjusted to incorporate environmental considerations. This may involve prioritising the use of the most energy-efficient rescue units for operations, such as using drones for initial assessments to reduce the use of fuel-intensive helicopters or boats when possible. It may also be that there is regional variation in the requirements, requiring changes to fleet or exemptions in such cases.
- Investment or Partnerships in Innovation: SAR organisations might need to invest in research and development for new technologies that can help reduce or eliminate emissions. Alternatively, they should establish partnerships with other organisations, universities, or private companies to promote innovation.
- Resource Management: SAR operations would need to adopt sustainable procurement practices, choosing supplies and equipment with lower carbon footprints. This could include everything from biodegradable materials to sustainably sourced food and uniforms.
- Travel and Transportation: Travel methods for personnel would need to be reassessed to reduce carbon emissions. This might involve encouraging the use of public transportation, carpooling, cycling, or telecommuting options where possible to minimise individual car travel.

Photo: Markus Spiske

Photo: Robin Erino

- Compulsory Measures: As regulations tighten, SAR organisations might be legally required to meet certain emission targets. Compliance with these regulations could involve regular reporting on emissions and continuous efforts to reduce carbon footprints in line with national or international standards.
- Voluntary Measures: Beyond compulsory regulations, SAR organisations or stations might adopt voluntary measures such as participating in carbon offset programmes, where emissions that are currently unavoidable are compensated for by funding equivalent carbon dioxide savings elsewhere. Public expectations especially for non-governmental organisations are often higher, and therefore voluntary measures may be necessary to consider.
- Training on Sustainability: Staff and volunteers would need training on sustainability practices and the importance of achieving net zero goals. Creating a culture of environmental responsibility within the organisation is essential for meeting these objectives.
- Monitoring and Reporting: Establishing systems to monitor and report on carbon emissions, energy use and other environmental impacts helps SAR organisations to track their progress towards net zero and identify areas for improvement.
- Partnerships: Collaborating with environmental organisations, government bodies, and the private sector can lead to shared initiatives and funding opportunities to support sustainability goals.

The push towards net zero is both a challenge and an opportunity for SAR organisations to lead by example in mitigating the effects of climate change, while ensuring that their critical life-saving operations continue efficiently and effectively.

Checklist items:

- Conduct an energy audit to identify opportunities for increasing energy efficiency and reducing consumption.
- Consider transitioning the SAR fleet towards low-emission alternatives, such as electric or hybrid rescue boats, and plan for the necessary infrastructure like charging stations.
- Implement sustainable procurement practices, selecting supplies and equipment with lower carbon footprints and managing resources sustainably.
- Evaluate travel and transportation methods for personnel to identify opportunities for reducing carbon emissions and promoting sustainable commuting options.
- Stay informed about and ensure compliance with compulsory emission targets and regulations, including regular emissions reporting and reduction efforts.
- Evaluate engagement in voluntary measures such as carbon offset programmes to compensate for unavoidable emissions.
- Develop training programmes for staff and volunteers on sustainability practices.
- Establish systems for monitoring and reporting carbon emissions and energy use, to track progress towards net zero and identify areas for improvement.
- Build partnerships with environmental organisations, government bodies, and the private sector to support sustainability goals and share best practices and initiatives.

Read more:

- Grenville Colin. Erebus Environment: Working towards Net Zero with Avon Fire & Rescue Service. IEMA. Available at: https://www.iema.net/resources/blog/2020/12/02/erebus-environment-working-towards-net-zero-with-avon-fire-rescue-service

SAR Station: Net zero objective

The global push for net zero emissions is a response to the urgent need to combat climate change, and this agenda impacts all sectors, including SAR stations.

Impact mechanisms:

- Energy Consumption: SAR stations would need to audit their current energy use and transition to renewable energy sources where possible, such as solar panels or wind turbines. This may also include retrofitting facilities to improve energy efficiency, such as using LED lighting, energy-efficient appliances, and better insulation.
- Resource Use: SAR operations may need to review and optimise the use of all resources. This could involve water conservation strategies, sustainable procurement policies for equipment and supplies, and waste reduction initiatives such as recycling programmes. This might also mean using biodegradable lubricants for machinery (check manufacturer's guarantee or insurance criteria first), less environmentally harmful cleaning products (check use in aquatic environment), or uniforms made from sustainable materials.
- Vehicle Emissions: SAR stations often rely on a fleet of vehicles, boats, and sometimes aircraft, all of which contribute to carbon emissions. Transitioning to electric or hybrid vehicles where practical, and optimising routes and missions to reduce fuel consumption, would be part of achieving net zero.

Photo: Chris LeBoutillier

- Sustainable Travel Methods: For staff travel, SAR stations could encourage carpooling, public transportation, biking, or other low-carbon options. They might also consider the carbon footprint of travel when planning training events or meetings, opting for virtual alternatives where appropriate.
- Building Design and Operations: Any new SAR facilities or refurbishments would be designed with sustainability in mind, using materials and designs that minimise energy use and incorporating systems for rainwater harvesting or geothermal heating and cooling. For instance, in the United Kingdom the RNLI Estates Team have produced a Design Guide Handbook for the purpose.
- Training: Education programmes for SAR personnel would be needed to foster an understanding of sustainability practices and the importance of reducing the environmental impact of their operations. However, there might be challenges especially in volunteer organisations, where operational training is typically a priority for the volunteers.
- Monitoring and Reporting: Establishing systems to monitor and report on carbon emissions, water footprint, and other environmental impacts. helps SAR stations to track their progress towards net zero and identify areas for improvement.

By adopting a net zero strategy, SAR stations not only contribute to the global effort to mitigate climate change but may also find that many of these measures can lead to cost savings and operational efficiencies in the long term. Moreover, as public awareness and concern about the environment grow, SAR stations' commitment to sustainability can enhance their reputation and community support.

Checklist items:

- Conduct assessments to understand current energy consumption and explore the potential for transitioning to renewable energy sources. Consider retrofitting existing facilities with energy-efficient technologies.
- Assess the current use of all resources, focusing on implementing water conservation methods, sustainable procurement practices, and waste reduction initiatives, including recycling.
- Review mission planning, training and routing strategies to minimise fuel consumption.
- Develop strategies to encourage sustainable travel methods among personnel, such as carpooling, using public transportation, and adopting virtual alternatives for meetings and training.

Conclusions

The #FutureSAR report outlines the multifaceted impacts of climate change on maritime search and rescue (SAR) operations, marking a crucial step in understanding and preparing for the challenges ahead. The 85 identified impacts, spanning various aspects of SAR organisations, underscore the complexity and breadth of the climate crisis in maritime contexts.

Central to this report is the emphasis on actionable strategies, as reflected in the around 300 checklist items. These serve as vital tools for SAR organisations to assess, prepare, and enhance their readiness in the face of climate-induced changes. It is also foreseeable that in many cases the needed response is not coming from the site affected – the SAR response may come from the less affected neighbouring areas. Therefore, the need for robust international and national planning, trained collaboration, and commitment to common aims and procedures are more critical than ever.

As climate change continues to reshape the maritime environment, SAR organisations must remain agile and forward-thinking. As the case of the sea foam occurrence (5-14) demonstrates, SAR services should expect the unexpected and prepare for unforeseen rescue situations. The journey towards adaptation and resilience is ongoing and demands continuous evaluation, learning, and cooperation across the global SAR community. This report not only provides a foundation for such efforts but also acts as a call to action for all stakeholders involved in maritime safety and environmental stewardship.

In the face of an uncertain future, the #FutureSAR initiative through this report and the associated events plays a pivotal role in equipping SAR organisations with the basic knowledge and tools needed to navigate the challenges ahead, ensuring the safety and protection of lives in maritime environments around the world.

Photo: ArtHouse Studio

Something missing from this report? Please let us know at:
https://www.surveymonkey.com/r/futuresar

References

Agence France-Presse. 2023. Climate Change Leads Reinsurers to Reduce Their Coverage. Available at: https://www.voaafrica.com/a/climate-change-leads-reinsurers-to-reduce-their-coverage/7266472.html

Amolo George. 2017. Ugandan Nationals Trapped In Lake Victoria Rescued. Available at: https://www.citizen.digital/news/ugandan-nationals-trapped-in-lake-victoria-rescued-154277

BBC. 2022. New RNLI boathouse in Norfolk built 'with climate change in mind'. Available at https://www.bbc.com/news/uk-england-norfolk-62065847

Berg Ingvar, Kolfschoten Nikki, Elsenga Hylmar, Verweij Bob and Bierens Joost. 2022. Resuscitation of persons who drowned in sea foam. *Resuscitation* 170: 26-27.

Bierens Joost J.L.M., Webber Jonathon, Quieroga Anna C., Szpilman David, Sempsrott Justin, Barcala-Furelos Roberto and Tipton Mike. Drowning and climate change – a multidisciplinary challenge. Submitted for publication.

Blakemoore Erin. 2021. World's strongest ocean current is speeding up - and humans are to blame. The Washington Post. Available at: https://www.washingtonpost.com/science/ocean-currents-speeding-humans-warming/2021/12/03/7123d38c-52d4-11ec-8927-c396fa861a71_story.html

Canadian Coast Guard. 2023. Government of Canada announces construction of the Canadian Coast Guard's first-ever hybrid vessel in Gaspé. Available at: https://www.newswire.ca/news-releases/government-of-canada-announces-construction-of-the-canadian-coast-guard-s-first-ever-hybrid-vessel-in-gaspe-801803176.html

Carty T and Walsh L. 2022. Footing the bill. Fair finance for loss and damage in an era of escalating climate impacts. Oxfam International. Available at: https://oxfamilibrary.openrepository.com/bitstream/handle/10546/621382/bp-fair-finance-loss-and-damage-070622-en.pdf

Centre for Sustainable Cooling. 2022. Sustainable and Resilient Cold-Chains: The 2050 Imperative. Conference Report. Available at: https://sustainablecooling.org/wp-content/uploads/2023/03/The-Local-to-Global-Summit-Report.pdf

Chen P, Zhang J and Sun Y. 2018. Research on Emergency Rescue of Urban Flood Disaster Based on Wargame Simulation. *J Indian Soc Remote Sens* **46**: 1677–1687. https://doi.org/10.1007/s12524-018-0823-x

Christodoulou Anastasia, Dalaklis Dimitrios, Raneri Peter and Sheehan Rebecca. 2022. An overview of the legal search and rescue framework and related infrastructure along the Arctic Northeast Passage. Marine Policy 138: 104985. Available at: https://www.sciencedirect.com/science/article/abs/pii/S0308597X2200032X

Climate Council. 2019. Is there a link between climate change and killer jellyfish? Available at: https://www.climatecouncil.org.au/is-there-a-link-between-climate-change-and-killer-jellyfish/

Climateguide.fi. Baltic Sea ice conditions will change. Available at: https://www.climateguide.fi/articles/baltic-sea-ice-conditions-will-change

Colin Barras. 2019. The ocean's tallest waves are getting taller. Available at: https://www.science.org/content/article/ocean-s-tallest-waves-are-getting-taller

Cooper Olivia. 2023. Climate change and space debris, a vicious cycle. *Astrobites*. Available at: https://astrobites.org/2023/01/20/climate-change-exacerbates-space-debris/

Day J, Chin N, Sydnor S. *et al.* 2021. Implications of climate change for tourism and outdoor recreation: an Indiana, USA, case study. Climatic Change 169: 29. https://doi.org/10.1007/s10584-021-03284-w

Dickie Gloria. 2017. Robots to the Rescue? Drones Could Help With Arctic Search Operations. The New Humanitarian. Available at: https://deeply.thenewhumanitarian.org/arctic/articles/2017/08/10/robots-to-the-rescue-drones-could-help-with-arctic-search-operations

Eckert Cambrie. 2023. Rising Global Temperatures Could Affect Military Sensors, Comms Systems (Updated). *National Defense*. Available at: https://www.nationaldefensemagazine.org/articles/2023/8/22/rising-global-temperatures-could-affect-military-sensors-comms-systems

Economist Impact. 2023. Global Maritime Trends 2050. Available at: https://impact.economist.com/ocean/global-maritime-trends-2050/

Escobio F , Etiennoul M and Spindola S. 2017. Rescue medical activities in the Mediterranean migrant crisis. *Conflict and Health* 11: 3 DOI 10.1186/s13031-017-0105-1. Available at: https://conflictandhealth.biomedcentral.com/track/pdf/10.1186/s13031-017-0105-1.pdf

Ford J and Clark D. 2019. Preparing for the impacts of climate change along Canada's Arctic coast: The importance of search and rescue. *Marine Policy* 108: 103662. Available at: https://www.sciencedirect.com/science/article/abs/pii/S0308597X19300260

Frank Thomas. 2023. Climate Change Is Destabilizing Insurance Industry. Scientific American. Available at: https://www.scientificamerican.com/article/climate-change-is-destabilizing-insurance-industry/

Gilmour Lauren. 2023. Fish relocating to colder waters as a result of global warming – study. The Independent. Available at: https://www.independent.co.uk/climate-change/news/fish-earth-university-of-glasgow-b2348568.html

Gobler Christopher J. 2020. Climate Change and Harmful Algal Blooms: Insights and perspective. *Harmful Algae* 91: 101731.

Gonçalves André. 2019. Climate Change Is Causing An Increase In Wave Energy. Youmatter. Available at: https://youmatter.world/en/climate-change-causes-the-increase-of-wave-energy/

Grenville Colin. Erebus Environment: Working towards Net Zero with Avon Fire & Rescue Service. IEMA. Available at: https://www.iema.net/resources/blog/2020/12/02/erebus-environment-working-towards-net-zero-with-avon-fire-rescue-service

Hay, C., Morrow, E., Kopp, R. *et al.* Probabilistic reanalysis of twentieth-century sea-level rise. *Nature* **517**, 481–484 (2015). https://doi.org/10.1038/nature14093

IMO in the Polar Environment: Search and Rescue. Available at: https://www.youtube.com/watch?v=ouc-BEFsT6U&t=334s

International Drowning Researcher's Alliance (IDRA). 2022. Impact of Climate Change on Drowning: Setting the research agenda. IDRA – International Drowning Researchers' Alliance. Available at: http://idra.world/event_climate/

International Federation of Red Cross and Red Crescent Societies. 2011. Protect. Promote. Recognize. Volunteering in Emergencies. Geneva. Available at: https://www.ifrc.org/docs/IDRL/Volunteers/Volunteering%20in%20emergency_EN-LR.pdf

Keating Shane and Roughan Moninya. 2023. Climate change is disrupting ocean currents. We're using satellites and ships to understand how. The Conversation. Available at: https://theconversation.com/climate-change-is-disrupting-ocean-currents-were-using-satellites-and-ships-to-understand-how-214962

Keech JJ, Smith SR, Peden AE, Hagger MS and Hamilton K. 2019. The lived experience of rescuing people who have driven into floodwater: Understanding challenges and identifying areas for providing support. Health Promot J Austr 30(2): 252-257. doi: 10.1002/hpja.181. Epub 2018 Jul 25. PMID: 29893063.

Kerry Emanuel. 2005. Increasing destructiveness of tropical cyclones over the past 30 years. Nature Vol436 | 4August2005 | doi:10.1038/nature03906

Lea Robert. 2023. Greenland ice sheets are weaker to climate change than we thought. Space.com. Available at: https://www.space.com/climate-change-greenland-ice-sheet-sea-rise

Learn Joshua Rapp. 2016. Arctic Search-and-Rescue Missions Double as Climate Warms. *National Geographic* 19 September, 2016. Available at: https://www.nationalgeographic.com/adventure/article/arctic-search-and-rescue-missions-double

Learn Joshua Rapp. 2018. Venomous sea creatures on the rise thanks to climate change. National Geographic. Available at: https://www.nationalgeographic.com/environment/article/climate-change-increasing-venomous-creatures-ocean-warming

Marine Business News. 2023. Marine Rescue Brunswick to host flood capability training exercise. Available at: https://www.marinebusinessnews.com.au/2023/10/marine-rescue-brunswick-to-host-flood-capability-training-exercise/

Mireku Akosua. 2023. Pharma readies for climate disasters amidst supply chain concerns. Available at: https://www.pharmaceutical-technology.com/features/pharma-readies-for-climate-disasters-amidst-supply-chain-concerns/?cf-view

Moore Kirk. 2022. Study says whales adapting to climate change; so too must mariners and fishermen. National Fisherman. Available at: https://www.nationalfisherman.com/northeast/study-says-whales-adapting-to-climate-change-so-too-must-mariners-and-fishermen

Morren Mattijn, Dirkzwager Anja J.E., Kessels Frans J.M. and Yzermans C. Joris. 2007. The influence of a disaster on the health of rescue workers: a longitudinal study. *Canadian Medical Association Journal* 176 (9): 1279-1283. Available at: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC1852883/

Ndugga Nambi, Pillai Drishti and Artiga Samantha. 2023. Climate-Related Health Risks Among Workers: Who is at Increased Risk? KFF. Available at: https://www.kff.org/racial-equity-and-health-policy/issue-brief/climate-related-health-risks-among-workers-who-is-at-increased-risk/

New Zealand Search and Rescue. Health, Safety and Wellbeing – Fatigue Management Guidance. Available at: https://nzsar.govt.nz/sar-system-support/health-safety-and-wellbeing/

NSRI. Water Safety Education. Available at: https://www.nsri.org.za/water-safety/water-safety-education/.

Nunatsiaq News. 2022. Canadian Coast Guard finishes Arctic operating season. Available at: https://www.arctictoday.com/canadian-coast-guard-finishes-arctic-operating-season/

Omollo Robert. 2018. Fisherman stuck in hyacinth for three days appeals for rescue. Available at: https://www.the-star.co.ke/news/2018-10-24-fisherman-stuck-in-hyacinth-for-three-days-appeals-for-rescue/

Overview of global sea foam occurrence, rescues and reports. Available at: https://www.surfingmed.com/seafoam/

Puempel Herbert and Williams Paul D. 2016. The impacts of climate change on aviation: scientific challenges and adaptation pathways. ICAO Environmental Report. Available at: https://www.icao.int/environmental-protection/Documents/EnvironmentalReports/2016/ENVReport2016_pg205-207.pdf

Qihua Peng, Shang-Ping Xie , Dongxiao Wang , Rui Xin Huang, Gengxin Chen, Yeqiang Shu, Jia-Rui Shi, and Wei Liu. Surface warming–induced global acceleration of upper ocean currents. Sci. Adv. **8**, eabj8394(2022). DOI: 10.1126/sciadv.abj8394

Reguero, B.G., Losada, I.J. & Méndez, F.J. A recent increase in global wave power as a consequence of oceanic warming. *Nat Commun* **10**, 205 (2019). https://doi.org/10.1038/s41467-018-08066-0

Rempel Luc. 2023. Sailing into Hubs of Hell: Shuswap marine search and rescue team kept busy with wildfires in 2023. Available at: https://www.castanet.net/news/Salmon-Arm/465545/Shuswap-marine-search-and-rescue-team-kept-busy-with-wildfires-in-2023

Rigby Mark. 2016. Deadly jellyfish and crocodiles all in a day's work for north Queensland lifeguards. ABC Far North. Available at: https://www.abc.net.au/news/2016-03-02/crocodiles-jellyfish-all-in-a-days-work-for-north-qld-lifeguards/7213458

RNLI. 2023. Fraserburgh RNLI called out in Dolphin Rescue. Available at: https://rnli.org/news-and-media/2023/july/14/fraserburgh-rnli-called-out-in-dolphin-rescue

RNLI. 2023. Harwich RNLI work with Coastguard to assist an injured wind farm worker. Available at: https://rnli.org/news-and-media/2023/august/20/harwich-rnli-work-with-coastguard-to-assist-an-injured-wind-farm-worker

RNLI. 2023. Midnight call for Bridlington RNLI for a medical evacuation. Available at: https://rnli.org/news-and-media/2023/december/17/midnight-call-for-bridlington-rnli-for-a-medical-evacuation

RNLI. 2023. Sennen Cove RNLI volunteers thank local community following storm damage. Available at: https://rnli.org/news-and-media/2022/february/24/sennen-cove-rnli-volunteers-thank-local-community-following-storm-damage

RNLI. Multi-lingual resources. Available at: https://rnli.org/safety/multi-lingual-resources

RNLI. Rip currents. Available at: https://rnli.org/safety/know-the-risks/rip-currents

RNLI. Safety Resources. Available at: https://rnli.org/safety/

RNLI. Safety Resources. Calling for help: https://rnli.org/safety/how-to-call-for-help-at-sea

RNLI. Safety Resources. Know the risks: https://rnli.org/safety/know-the-risks

RNLI. Safety Resources. Lifejackets: https://rnli.org/safety/lifejackets

Roberts Callum. 2022. Future Ocean. Lecture available at: https://www.youtube.com/watch?v=rHHNPmZlAy4

Scassola Andrea, Buckland Ian, Lee Joyce, Zhao Feng and Lathigara Anjali. 2023. Global Wind Workforce Outlook 2023-2027.

Schrader Shea. 2022. Tybee Island lifeguards treat 300 people for jellyfish stings this past weekend. WTOC. Available at: https://www.wtoc.com/2022/08/02/tybee-island-lifeguards-treat-300-people-jellyfish-stings-this-past-weekend/

Science Daily. 2013. Radio waves carry news of climate change: Surprising tool to measure our changing climate. Available at: https://www.sciencedaily.com/releases/2013/07/130730123421.htm

Sierra Club O'ahu Group. 2023. Civil Beat: Climate Change is Making Hawai'i's Beaches More Dangerous. Available at: https://www.sierracluboahu.org/blog/civil-beat-climate-change-is-making-hawaiis-beaches-more-dangerous

Sierra Joan Pau, Sánchez-Arcilla Agustín, Gironella Xavier, Gracia Vicente, Altomare Corrado, Mösso César, González-Marco Daniel, Gómez Jesús, Barceló Mateo and Barahona Cristina. 2023. Impact of climate change on berthing areas in ports of the Balearic Islands: adaptation measures. *Frontiers in Marine Science* 10. Available at: https://www.frontiersin.org/articles/10.3389/fmars.2023.1124763/full

Silva Santiago Piedra. 2015. Whales under threat as climate change impacts migration. Phys.org. Available at: https://phys.org/news/2015-12-whales-threat-climate-impacts-migration.html.

Smith Timothy William James. 2017. Search and Rescue in the Arctic: Is the U.S. Prepared? Pardee RAND Dissertations. Available at: https://www.rand.org/pubs/rgs_dissertations/RGSD382.html

Sodhi ManMohan S. and Tang Christopher S. 2020. Supply Chain Management for Extreme Conditions: Research Opportunities. Journal of Supply Chain Management 57 (1): 7-16. Available at: https://onlinelibrary.wiley.com/doi/abs/10.1111/jscm.12255

Sydnes Are Kristoffer, Sydnes Maria and Antonsen Yngve. 2017. International Cooperation on Search and Rescue in the Arctic. *Arctic Review on Law and Politics* 8: 109-136. Available at: https://www.jstor.org/stable/48710583

Taylor Edward. 2021. Island clears up after Storm Aurore strikes. Jersey Evening Post. October 22, 2021. Available at: https://jerseyeveningpost.com/news/2021/10/22/island-clears-up-after-storm-aurore-strikes/

Theodosopoulou P, Tsiamis C, Pikoulis A, Pikouli A, Aristomenis E and Pikoulis E. 2021. Rescue medical activities among sea migrants and refugees in the Mediterranean region: lessons to be learned from the 2014-2020 period. Int Marit Health 72(2): 99-109. doi: 10.5603/IMH.2021.0018. PMID: 34212349.

Tipton Michael J., Abelairas-Gómez Cristian, Mayhew Adrian and Milligan Gemma S. 2019. The thermal demands of flood rescue and impacts on task performance. *Ergonomics* 63: 109-118. DOI: 10.1080/00140139.2019.1683617. Available at: https://www.tandfonline.com/doi/abs/10.1080/00140139.2019.1683617

United States Environment Protection Agency. Climate Change and Harmful Algal Blooms. Available at: https://www.epa.gov/nutrientpollution/climate-change-and-harmful-algal-blooms

Wall G. 1998. Implications of global climate change for tourism and recreation in Wetland areas. *Climatic Change* 40: 371–389. Available at: https://doi.org/10.1023/A:100549362565

Wehner Mike. 2018. Warming oceans are pushing poisonous sea snakes towards the United States. BGR. Available at: https://bgr.com/science/warming-oceans-are-pushing-poisonous-sea-snakes-towards-the-united-states/

Wikander Markus. 2022. Emission-free sea rescue. SSPA Maritime Center. Available at: https://www.sspa.se/en/news/emission-free-sea-recue

World Bank. 2015. Emergency Procurement for Recovery and Reconstruction: A toolkit for the delivery of goods, services and construction in situations of urgent need and capacity constraints. Available at: https://pubdocs.worldbank.org/en/315691568908208946/Emergency-Procurement-for-Reconstruction-and-Recovery-Toolkit.pdf

Yoo Jinho, Goerlandt Floris and Chircop Aldo. 2020. Unmanned Remotely Operated Search and Rescue Ships in the Canadian Arctic: Exploring the Opportunities, Risk Dimensions and Governance Implications. In: A. Chircop et al. (eds.), Governance of Arctic Shipping. Springer Polar Sciences. Available at: https://digitalcommons.schulichlaw.dal.ca/cgi/viewcontent.cgi?article=1610&context=scholarly_works

Young Ian R and Ribal Agustinus. (2019). Multiplatform evaluation of global trends in wind speed and wave height. *Science* 364,548-552(2019). DOI: 10.1126/science.aav9527


1924 - 2024
IMRF
centenary

INTERNATIONAL
MARITIME RESCUE
FEDERATION

LR
Foundation

The International Maritime Rescue Federation is a registered company limited by guarantee in the United Kingdom and registered as a charity in England and Wales. Charity Registration Number: 1100883. Company Registration Number: 4852596.

https://www.international-maritime-rescue.org/contact-the-imrf

International Maritime Rescue Federation, PO Box 80585, London, SW19 9RT, UK.