Environmental security in the eastern Indian Ocean, Antarctica and the Southern Ocean

A risk mapping approach

Australian National University
NATIONAL SECURITY COLLEGE

IRIS
INSTITUT DE RELATIONS INTERNATIONALES ET STRATÉGIQUES

Anthony Bergin, David Brewster, François Gemenne and Paul Barnes

May 2019

About the authors

Dr Anthony Bergin was the chief investigator for this study. During the project, he served as a senior research fellow, National Security College, Australian National University (ANU). He is a senior analyst at the Australian Strategic Policy Institute.

Dr David Brewster prepared Section 2 of the report, on the eastern Indian Ocean. He is a senior research fellow at the National Security College, ANU.

Dr François Gemenne is the co-author (with Dr Bergin) of Section 3 of the report, on the Southern Ocean and Antarctica. He is co-director, Observatory on Climate and Defense (*Institut de Relations Internationales et Stratégiques* and the Directorate General for International Relations and Strategy, French Ministry of the Armed Forces). Dr Gemenne is also an FNRS Senior Research Associate and Director, Hugo Observatory, University of Liège.

Dr Paul Barnes was the principal adviser on the risk assessment methodology adopted in the study and prepared the methodology section of the report. He is the director of the Risk and Resilience Program at the Australian Strategic Policy Institute.

Acknowledgements

During the course of this study, we spoke with a very wide range of scientists, military personnel, public officials from environmental and security agencies, senior academics and private-sector executives.

All those who spoke to us and participated in project workshops did so on the condition of anonymity. We wish to thank them for sharing their expertise and insights with us.

We acknowledge the assistance of Dr Ryan Young in organising and supporting the three project workshops that informed the study's risk assessments. Dr Young is the director of the Futures Hub, National Security College, ANU. We thank Professor Rory Medcalf, head of the National Security College, who provided broad oversight for the project.

The Australian research group acknowledge the generous financial support provided for this study by the Australian Department of Foreign Affairs and Trade.

The French research group expresses its gratitude to the French Ministry of the Armed Forces (Directorate General for International Relations and Strategy) for supporting the study.

Disclaimer

The authors are solely responsible for the views expressed in this report, which do not reflect the official policies or positions of the Australian or French governments.

Cover image: Southern Ocean, courtesy Isa Rosso, SOCCOM Project/Flickr.

Environmental security in the eastern Indian Ocean, Antarctica and the Southern Ocean

A risk mapping approach

Anthony Bergin, David Brewster,
François Gemenne and Paul Barnes

May 2019

Contents

Executive summary: risk assessments and recommendations

This report arises from a Track 1.5 Australia–France–India strategic dialogue held in New Delhi in January 2018. It builds on a French proposal introduced at that meeting.

In this study, Australian and French teams did a joint risk-mapping exercise for the area south of latitude 60°S. The Antarctic Treaty establishes that region as Antarctic territory.

Australian researchers performed the risk mapping for the eastern Indian Ocean. French researchers will produce a risk assessment for the western Indian Ocean in 2020.

In the *Vision statement on the Australia–France relationship* published on 2 May 2018, both Australia and France 'welcomed the project to map environmental risks in the south of the Indian Ocean and the Southern Ocean, which will help to understand and anticipate the security consequences of climate phenomena'.

The Indian Ocean region faces a wide range of transnational security challenges, particularly challenges related to environmental stresses and the impacts of climate change.

The geopolitical environment in the Indian Ocean is changing and becoming more contested than it has been for many decades. The future strategic order in the ocean is likely to be more multipolar and unstable than at any time in the modern era.

This is the result of several geopolitical changes that are occurring more or less concurrently, including the relative decline in US military predominance, the rise of India and China as major Indian Ocean powers and the activities of several middle powers.

The consequences of major-power competition and a more militarised strategic environment can easily become intertwined with transnational environmental security issues.

The other geographical focus of this study is Antarctica and the Southern Ocean. That region also faces significant environmental security threats and challenges and is now becoming more geopolitically contested as an array of countries move to assert greater influence.

This report sets out an environmental 'risk map' for Antarctica and the Southern Ocean and the eastern Indian Ocean. It provides a contribution to the national security assessments of Australia and France.

The report provides an enhanced foundation to inform policy decisions about the allocation of national resources, identifies opportunities for cooperation and suggests priorities.

Our overall aim is to identify regional environment issues and threats and align them with options for medium to longer term risk mitigation strategies.

We assess the likelihood and consequences of major potential disruptions, detail cross-cutting sources of disruption and possible triggers for concerted action and consider the implications of emergent issues or threats and escalated responses to them (including likely cascading and compounding impacts if threats are not addressed).

Eastern Indian Ocean

The geopolitical environment in the Indian Ocean, including the eastern Indian Ocean, is changing and becoming more contested than it has been for many decades.

These developments are being paralleled by significant environmental changes that aggravate existing natural hazards in the Indian Ocean.

Climate change and other human interactions with the environment also create an additional series of environmentally related threats.

Environmental and geopolitical threats also have the potential to negatively interact, leading to the further deterioration of the security environment.

Both Australia and France are important maritime powers in the Indian Ocean. As the region becomes more multipolar, they are likely to find themselves playing an increasingly active role in addressing a range of traditional and non-traditional threats.

The risk assessment matrix for the eastern Indian Ocean (below) details identified threats and challenges.

Risk assessment matrix for the Eastern Indian Ocean

Issue/disruption	**A Negligible** (no disruptive effects; 'business as usual')	**B Minor** (regional tensions increase temporarily; situation is manageable within existing processes)	**C Significant** (conflict is temporary and generally constrained by existing arrangements)	**D Major** (significant disruption; limited to areas)	**E Catastrophic** (significant widespread disruptions)
1 Rare (most unlikely but might occur in exceptional circumstances)					
2 Unlikely (unlikely to occur without significant change in current circumstances)		• Impact of seabed mining			• Interdiction of maritime trade by state actors
3 Possible (can occur in most circumstances in the foreseeable future)			• Terrorist attacks on shipping, maritime infrastructure or the marine environment • Disruption of / illicit access to undersea cables		
4 Likely (will occur in current circumstances)			• Shipping accidents • Marine pollution • Piracy • Significant declines in marine-based tourism • Human trafficking / unregulated population movements		• Natural disasters/ extreme weather events
5 Almost certain (already occurs regularly)		• Maritime smuggling of goods		• Declining marine living resources • Growing competition for fish resources	

We make the following recommendations in relation to the eastern Indian Ocean:

1. Australia and France should use their experience in bilateral cooperative fisheries enforcement in the Southern Ocean to promote similar bilateral or regional cooperative arrangements elsewhere in the Indian Ocean, potentially including the eastern Indian Ocean.
2. Australia and France should facilitate greater cooperation among regional coastguard agencies. They should consider joining with like-minded partners to create arrangements for dialogue, cooperation and training among Indian Ocean coastguards. This could include a dedicated facility for the professional development of senior coastguard officials in the region.
3. Australia and France should work together to promote the establishment of integrated national maritime domain awareness systems in the Indian Ocean, including in countries such as Sri Lanka, Bangladesh and the Maldives. Such national systems could then work more effectively with regional maritime domain awareness systems being developed by India and other countries in the Indian Ocean.
4. Australia and France, which have the strongest maritime search and rescue capabilities among Indian Ocean states, should coordinate their capacity-building efforts with other countries that manage search and rescue regions in the Indian Ocean.
5. Australia and France, along with other key countries, such as India, should jointly develop their training and capacity-building efforts in port state control to lift inspection and enforcement rates among Indian Ocean states. This should be coordinated through the Indian Ocean Memorandum of Understanding on Port State Control.
6. There is considerable scope for developing framework disaster management arrangements between Australia and France and other key Indian Ocean states. Those arrangements would create coordination mechanisms for responding to disasters using the experience of ASEAN and the FRANZ arrangements among Australia, France and New Zealand in the South Pacific.
7. Australia should promote cooperation with France in high-level scientific research alliances relevant to the 'blue economy' and climate change, leveraging where appropriate the Intergovernmental Oceanographic Commission Perth Programme Office facility for the Indian Ocean. Several areas of potential cooperation in ocean science are listed in this report.
8. Australia and France should join with other like-minded countries to establish an Indian Ocean Environmental Security Forum. The forum would bring together representatives from military and civilian agencies across the Indian Ocean region to create shared understandings of environmental security threats and help establish habits of dialogue in the field of environmental security. The forum could operate under the auspices of the Indian Ocean Rim Association.
9. Australia and France could consider working together to promote an international agreement to overcome current deficiencies in international law in relation to the protection of the integrity of undersea communications cables.

South of latitude 60°South

In the area south of latitude 60°S, both France and Australia look at Antarctica and the Southern Ocean through a strategic lens, focused on supporting and strengthening the Antarctic Treaty System (ATS).

France and Australia have adjacent territory in Antarctica: France's Adélie Land bisects the Australian Antarctic Territory.

Both nations also possess neighbouring island territories in the sub-Antarctic region; for France, the Kerguelen and Crozet Islands, and for Australia, the Territory of Heard Island and McDonald Islands (HIMI).

Both countries also assert their rights to the maritime zones around their territories, including sections of the Kerguelen Plateau. A delimitation agreement settles the boundary between Kerguelen and HIMI.

The risk assessment matrix for the Southern Ocean and Antarctica (below) details identified threats and challenges.

Risk assessment matrix for the area south of latitude 60°S

Issue/disruption	A Negligible (no disruptive effects; 'business as usual')	B Minor (regional tensions increase temporarily; situation is manageable within existing processes)	C Significant (conflict is temporary and generally constrained by existing arrangements)	D Major (significant disruption; limited to areas)	E Catastrophic (significant widespread disruptions)
1 Rare (most unlikely but might occur in exceptional circumstances)	• Whaling in the Southern Ocean	• Iceberg harvesting			
2 Unlikely (unlikely to occur without significant change in current circumstances)			• Offshore drilling and mining		• Conflict or war due to occupation of Antarctic territory and increasing militarisation
3 Possible (can occur in most circumstances in the foreseeable future)		• Geoengineering in the Southern Ocean • Extreme atmospheric changes (human induced through geoengineering)		• Threats to the Antarctic Treaty System • Displacement of fishing fleets • Krill exploitation	
4 Likely (will occur in current circumstances)		• Changes to Antarctic tourism • Pressures from new treaty members	• Increased danger and frequency of search and rescue operations	• Distant-water fishing fleets	
5 Almost certain (already occurs regularly)			• Ocean acidification	• Climate change impacts on Antarctic infrastructure and accessibility	• Climate change related marine ecosystem change • Illegal, unregulated and unreported fishing

Three broad major needs to mitigate the consequences of these threats and challenges stand out: developing greater trust between states active in the region; enhanced environmental cooperation; and more effective management of environmental and related security concerns.

Risk mitigation in the Antarctic region requires more attention to measures that build confidence among countries active in the region, including greater efforts in such areas as search and rescue (SAR), expanded tourism, fisheries, cooperative scientific efforts and the impacts of climate change on environmental management.

Australia and France both have a strong commitment to scientific research and environmental protection in Antarctica. Both states have maintained a consistent engagement within the ATS.

We make the following recommendations for the area south of latitude 60°S:

10. Australia and France should continue to cooperate in delivering reliable surveillance, compliance and enforcement in the Southern Ocean.
11. They should continue to promote multilateral cooperation on sustainable uses of the Southern Ocean and Antarctica.
12. They should cooperate on SAR planning and work with other countries in the region to foster effective SAR responses.
13. They should facilitate a regular multilateral SAR exercise in the future around the HIMI and Kerguelen Islands area, in the Southern Ocean and on the Antarctic continent.
14. They should jointly examine the management implications of climate change in the Antarctic region, looking at future Antarctic infrastructure, logistics, environmental management, the terrestrial environment, the marine environment and resources.
15. As a trust-building measure for Antarctic countries, Australia and France should lead on identifying guidelines for establishing and reinforcing the resilience of Antarctic infrastructure that take current and predicted climate changes into account.
16. Australia and France should set an example by including more specialists on climate change in delegations to key Antarctic Treaty and Commission for the Conservation of Antarctic Marine Living Resources (CCAMLR) meetings.
17. There should be more active inspections under the Antarctic Treaty, including joint inspections where practical.
18. Australia and France should be working to advance cooperation in East Antarctic science and logistics, including through pooling their resources.
19. They should promote cooperation on environmental and resource protection among Antarctic Treaty parties.
20. They should continue to cooperate on scientific research, such as the recent symposium on the Kerguelen Plateau convened by the Australian Antarctic Division of the Department of the Environment and Energy.
21. They should play an active role in having CCAMLR and Antarctic Treaty Consultative Meetings cooperate with the UN Framework Convention on Climate Change in understanding the impacts of climate change on the objectives of CCAMLR and the Antarctic Treaty.
22. They should consider organising a joint logistics exercise with a focus on environmental management.
23. They should convene events during climate change conferences to highlight the risks and challenges identified in this report. COP 25 in Chile could be a suitable venue.
24. On the basis of this report, Australia and France should identify challenges and issues that warrant further research and cooperation.

1. Background and methodology

1.1 The strategic context

This report arises from the Track 1.5 Australia–France–India strategic dialogue held in New Delhi in January 2018, which involved government and non-government participants. It builds on a French proposal introduced at that meeting and was further refined in close consultation with prospective French and Australian research partners.

The project was originally designed to include Indian research partners. It is hoped that India will be included in any follow-up work arising from this study.

This project is in keeping with the aspirations for enhanced cooperation among the three countries articulated during high-level meetings in 2018, such as the visits to India and to Australia by President Macron.

In the *Vision statement on the Australia–France relationship*, published on 2 May 2018 following President Macron's visit to Australia, point 60 of the statement is to be noted in the context of this study.[1] Both Australia and France 'welcomed the project to map environmental risks in the south of the Indian Ocean and the Southern Ocean, which will help to understand and anticipate the security consequences of climate phenomena'.

In a phase of dynamic change in the Indo-Pacific region, countries such as Australia, France and India are looking for new ways to cooperate on three interlinked goals: their respective national interests; an open, rules-based regional and global order; and the maritime commons.

This was a key area of convergence in the January 2018 strategic dialogue, which stressed the need to build shared information resources on regional challenges, particularly in the Indian Ocean.

Participants noted that there is considerable scope to strengthen bilateral Australia–France, Australia–India and India–France security relations, with a focus on the maritime domain.

Bilateral and trilateral progress will be mutually reinforcing and in the interests of a more resilient and flexible diplomatic architecture in the Indo-Pacific region.

With their substantial capabilities and territorial footprint in the Indian Ocean, all three countries are well placed to share maritime data, beginning with open-source information about transnational security challenges, such as environmental problems, climate change, resource exploitation, transnational crime and civilian maritime traffic.

The Indian Ocean region experiences a wide range of transnational security challenges, particularly related to environmental stresses and the impacts of climate change.

Such challenges affect human security, maritime security, the vulnerability of infrastructure and the stability of the region as a whole. While these issues are often assessed on a national basis, their regional impacts remain poorly understood.

This is one rationale for this study, which brings together research and policy capacities from Australia and France (and, prospectively, India) to produce a shared understanding of environmental security-related risks induced by a range of factors in the Indian Ocean region.

In addition to climate change, this study covers resource exploitation, such as illegal, unregulated and unreported (IUU) fishing; unsustainable fishing practices; trafficking in endangered species; seabed mining; the artificial elevation of seawater iron in attempts to mitigate climate impacts; sea-level rise; natural disasters; an increasing frequency of damaging extreme weather; human factors, such as illegal migration, piracy and seaborne transnational crime; and other economic and security factors, such as the state of critical coastal infrastructure.

Against a backdrop of strategic competition, increasing civilian and naval shipping, growing interest in the 'blue economy', and continued underdevelopment of regional institutions, it is timely to improve the national and regional knowledge base on such challenges and the ways in which they interact. This will inform how Australia, France and India might, in a complementary manner, approach those challenges, which generate new opportunities for cooperation on regional maritime security and new avenues for cooperation and capacity-building between research institutions of the region.

There are also significant broad environmental security challenges in Antarctica and the Southern Ocean. Those regions, and the atmosphere above them, are key components of the global climate system.

This year marks the 70th anniversary of the signing of the Antarctic Treaty in 1959, and the Antarctic region continues to be of immense strategic importance to Australia and France.

The treaty ensures that the area south of latitude 60°S remains unmilitarised, cooperation is ensured, and the focus of activities is on scientific research. It also protects differing positions on sovereignty.

Australia and France were original signatories to the Antarctic Treaty and key proponents of the treaty's Protocol on Environmental Protection and claim adjacent territory in East Antarctica. The Antarctic Treaty System (ATS) has gone on to protect the environment and manage resources.

The Southern Ocean has significant global value, including for carbon sequestration, fisheries and the continued existence of iconic marine wildlife, such as penguins, seals and whales.

The vast, cold continent of Antarctica holds about 90% of the world's ice, or around 60% of the world's fresh water.

The Southern Ocean surrounding Antarctica is a significant driver of the planet's ocean currents and links the Indian, Pacific and Atlantic oceans. It is warming more rapidly than the global ocean average.

The Antarctic Peninsula is showing the most obvious signs of change in the form of increased loss of ice shelves and subsequent greater glacial outflow.

The consequence of losses from the Antarctic and Greenland ice sheets is one of the greatest uncertainties in projections of global sea-level rise. Increased ice loss from Antarctica will accelerate global sea-level rise projections. Recent research suggests that the rate of melting of Antarctic sea ice is much faster than previously thought.

Increased concentrations of carbon dioxide in the atmosphere have led to acidification of the Southern Ocean and have the potential to significantly disrupt marine life, productivity and ecosystems.

In recent times, there has been renewed speculation about the potential for the extraction of mineral resources in Antarctica, even though such activity is banned indefinitely by the Protocol on Environmental Protection.

The ATS covers only the area south of 60°S. China has demonstrated in recent years that it interprets the Commission for the Conservation of Antarctic Marine Living Resources (CCAMLR) as having limited influence in managing the broader CCAMLR area north of that latitude. Beijing increasingly defers to the Convention on Biological Diversity in regard to conservation issues.

Changes to environmental conditions in Antarctica and the Southern Ocean are creating a range of impacts and associated challenges.

They include governance challenges, including to the way the ATS addresses the impacts of a changing environment and how the system interacts with other organisations and instruments, such as the International Seabed Authority.

There are international efforts to better conserve the marine biological diversity of areas beyond national jurisdiction that purport to regulate all or parts of the Southern Ocean and that interact with the ATS, with possible disruptive effects.[2]

At the same time, Antarctica and the Southern Ocean region are becoming more geopolitically contested. There are pressures on existing norms and principles and the shared understanding of rules for resource development, especially fisheries.

China acceded to the ATS in 1983 and became a consultative party in 1985. It became a contracting party to CCAMLR in 2006 and a member of the commission in 2007. It has already bestowed Chinese names on 359 sites in Antarctica. China's Kunlun research station, which opened in the Australian Antarctic Territory in 2009, is located close to the centre of the Antarctic continent (on the highest point of the territory). It is a clear demonstration of China's capabilities and ongoing investments in Antarctica.[3]

There are also more commercial pressures as the Antarctic tourism sector expands. There is interest in developing forms of accommodation, even though permanent tourism infrastructure is not yet permitted.

There is a growing interest, too, in bioprospecting for Antarctic-derived organic material. This form of exploitation of living resources is not specifically regulated.

On intellectual property management, as opposed to environmental management, scientists are given virtually 'free' access to prospect for the purposes of scientific research. Because the species that exist in Antarctica are adapted to extreme conditions (such as cold temperatures, highly seasonal light and isolation), they could contain compounds with valuable commercial or pharmaceutical applications.

Yet the question of who owns the intellectual property arising from such studies is difficult to answer, not least because of the absence of universally recognised sovereignty on the continent.[4]

1.2 Study objectives

This report sets out an environmental 'risk map' for the eastern Indian Ocean, the Southern Ocean and Antarctica. It provides a contribution to the national security assessments of Australia and France. It provides an enhanced foundation to inform policy decisions about the allocation of national resources, identifies opportunities for cooperation and suggests priorities.

This risk mapping will assist in choices about improving cooperation on sustainable development policies by enhancing environmental protection and enforcement measures and by encouraging broader bilateral and also trilateral cooperation (with India) for security outcomes.

Australia, France and India have good reason to deepen their bilateral and trilateral maritime security cooperation: the three countries have a significant territorial presence and modern capabilities, including national datasets.

As first scoped, the project set out a division of responsibilities: the Indian partners would focus on the northern Indian Ocean, France on the west, Australia on the east, and France and Australia jointly on the south.

The Australian team was originally tasked to consider risks in the Indian Ocean area, defined as south of latitude 7°S, east of longitude 81°E and north of latitude 60°S.

The original geographical focus of the Australian team was expanded to cover the entire eastern Indian Ocean from the southern point of India (longitude 78°E) eastwards. This area includes the Bay of Bengal, Andaman Sea and ocean areas south of the Indonesian archipelago.

The area includes threats of significant interest to Australia, including transnational challenges such as people smuggling from countries such as Sri Lanka, Bangladesh and Myanmar; the impacts of climate change in and around the Bay of Bengal and the Indonesian archipelago; the impacts of sea-level rise and fishing; maritime/marine 'dead zones' in the Bay of Bengal; and IUU fishing in and around the Indonesian archipelago.

While we acknowledge that this area may partly overlap areas covered in any future risk-mapping contribution by India, we judged that there would be significant value in addressing these issues from different perspectives.

The Australian and French teams undertook a joint risk-mapping exercise for the area south of latitude 60°S. The Antarctic Treaty establishes that region as Antarctic territory.

The French project partners and team were:

- from government, the Ministry of the Armed Forces (Ministère des Armées), led by Commander Numa Durbec, the Head of the Asia–Pacific Unit, Directorate General for International Relations and Strategy
- from academia, the Institute for International and Strategic Relations, led by Dr François Gemenne, who is also the co-director of the Observatory on Climate and Defence in the Ministry of the Armed Forces.

The French team engaged a range of other French institutions, including:

- Ministry of Europe and Foreign Affairs
- Ministry for Ecological and Inclusive Transition
- French Southern and Antarctic Lands Administration
- French Agency for Development
- Research Institute for Development
- National Museum of Natural History
- French Research Institute for Sea Exploitation
- French Polar Institute 'Paul-Emile Victor'
- National Research Alliance for Environment
- National Centre for Scientific Research.

On the Australian side, the lead institute was the National Security College (NSC) at the Australian National University (ANU).

The NSC has a distinct status as a joint initiative between the Australian Government and the ANU, balancing academic research and independence with a trusted relationship with the national security community.

The NSC chief investigator and project leader was Dr Anthony Bergin, NSC Senior Research Fellow, with significant input on the eastern Indian Ocean component of the study from Senior Research Fellow Dr David Brewster.

Dr Paul Barnes, head of the Risk and Resilience Program at the Australian Strategic Policy Institute, provided significant technical assistance to the study.

The project was supported by the director of NSC's Futures Hub, Dr Ryan Young. The head of the NSC, Professor Rory Medcalf, provided broad oversight.

The NSC project team engaged with a range of Australian institutions, including:

- Department of Foreign Affairs and Trade
- Department of Agriculture and Water Resources
- Department of Defence
- Department of Home Affairs, including the Australian Border Force
- Department of the Prime Minister and Cabinet
- Geoscience Australia
- Australian Fisheries Management Authority
- Australian Antarctic Division of the Department of the Environment and Energy
- Antarctic Climate and Ecosystems Cooperative Research Centre
- Institute for Marine and Antarctic Studies, University of Tasmania
- Integrated Marine Observing System
- Commonwealth Scientific and Industrial Research Organisation
- Australian Maritime Safety Authority
- Indian Ocean Global Ocean Observing System
- University of Western Australia's Oceans Institute
- elements of Australia's offshore oil and gas sector
- Intergovernmental Oceanographic Commission, Perth Regional Programme Office.

The overall aim of this report is to identify regional issues and to map threats, and to align them with options for medium to longer term risk mitigation strategies in the eastern Indian Ocean, the Southern Ocean and Antarctica.

The report sets out the likelihood and consequences of major multi-source disruptions; details on cross-cutting sources of disruption; possible triggers for escalated attention and response; and future implications of emergent issues and threats (including likely cascading and compounding impacts if threats are not addressed).

The report then provides a series of recommendations to mitigate risks, with a focus on potential areas of Australia–France cooperation.

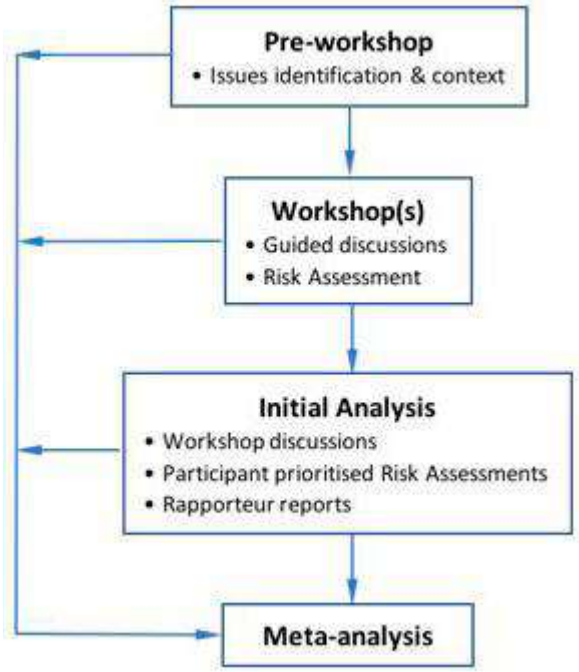
1.3 Methodology

Our goal was to triangulate expert views and opinion into a comprehensive representation of what are deemed matters of concern, why they are important and, ultimately, how to better understand relationships across complex sociological–technical–ecological systems.

A further endpoint was the definition of options for mitigating the effects and likelihood of future crises.

The triangulation of expert views was carried out using the protocol shown in Figure 1.

Figure 1: Data collection protocol



Invited expert informants attended workshops in three different locations: Hobart, Perth and Canberra. The workshops involved representatives from a range of organisations with broad expertise to assess risks to environmental security across the eastern Indian Ocean, Antarctica and the Southern Ocean.

Before the Hobart and Perth workshops, we asked participants to provide advice on issues they deemed significant for detailed discussions in each workshop.

This pre-workshop phase provided a context for identifying possible threats or challenges to security, and wider aspects of environmental security, in the areas south of 60°S and the eastern Indian Ocean.

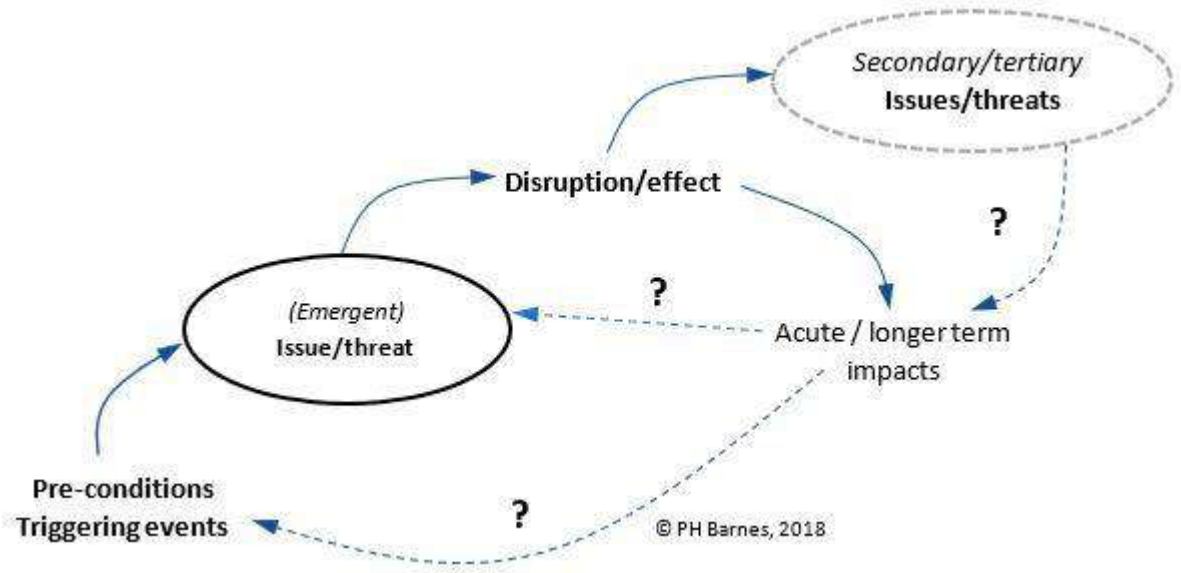
This phase also formed the basis for setting and understanding the wider 'risk' contexts in which political, geostrategic, environmental, economic and security factors influence current and future conditions and issues likely to be present across the regions.

Initial issues and disturbances considered in establishing those contexts were:

- climate change (terrestrial and marine heating effects; extreme weather events)
- environmental engineering, such as iron fertilisation of seawater
- changing geopolitical conditions
- emergence or re-emergence of diseases (animal, plant, human and wider marine ecosystems)
- human migration and refugees (forced and voluntary) in the eastern Indian Ocean
- changing resource economics, including access to minerals and seabed mining
- the effects of IUU fishing
- the security of critical coastal and island-based infrastructure
- the disruption or destruction of marine ecosystems (species loss and food-chain effects).

We asked participants to consider these issues within a broad risk analytic framework (Figure 2) to better consider temporal constraints and the complexity of the social, technical and environmental parameters and causal chains through which primary and secondary impacts could manifest.

Figure 2: Cascading influence framework



Given the complex social, technical and ecological factors active in the Indian Ocean and the Southern Ocean surrounding Antarctica, Figure 2 was central as a focus of experts' deliberations. There are many possibilities for primary and subsequent impacts affecting both an initial disruption and any situational preconditions that may have been present (see box next page).

Interactions between risk elements leading to cascading effects in the future

The ecology of Antarctica and the Southern Ocean is complex. As for most complex adaptive systems, many of the issues identified in this report are themselves disruptions that lead to ongoing cascading primary and secondary effects—many of which can trigger feedback affecting 'upstream' systemic components.

For example, climate change impacts on Antarctic management have cascading effects.

There will be a range of changes in Antarctic climate variables such as air temperature; ocean temperature; snowfall; the extent and duration of sea ice; sea level; ice-shelf status; the ozone hole; permafrost; the frequency and intensity of storms; surface winds; and ocean chemistry. There will also be extreme climatic events, such as unusually high temperatures, high snow accumulation, polar winds, drought or high melt days. While there are unavoidable uncertainties about how these variables may interact with one another, there is little doubt that they will.

Some regions are likely to be more affected than others; for example, low-lying coastal habitats may be lost or significantly damaged by sea-level rise. Operational research protocols that provide for marine or terrestrial activities to be undertaken only outside specific periods of high environmental sensitivity (for example, to avoid wildlife breeding periods) may change due to climate variability.

Climate change will exacerbate the high threat to Antarctic biodiversity associated with the establishment of non-native species.

In addition to increasing pressure on plant and animal habitats, the adverse effects of other climate changes on variables such as snowfall, melt, sea-level rise and freeze–thaw cycles are likely to have significant implications for the maintenance and operation of existing research infrastructure.

For example, there will be high risks to key infrastructure located on permafrost or subject to inundation from sea-level rise or meltwater flooding.

Water storage infrastructure is also likely to be affected by increased melt. Changes in snow accumulation and melt patterns will have implications for the use and maintenance of ice and snow surfaces for inter- and intra-continental fixed-wing air transport.

Decreasing sea ice may improve ship access to coastal locations and reduce icebreaking costs, but a greater number of icebergs may hinder access to shipping routes and anchorages.

In the Indian Ocean, the interaction of risk elements and the problem of cascading effects is further complicated by the growing strategic competition in the region. This can lead to an interaction of environmental and strategic factors.

The problem of Somali-based piracy over the past 15 years is an excellent example of the interrelationship of many security issues. The collapse of law enforcement by the Somali state decades ago, and then the destruction of Somali fishing grounds by illegal fishers (many of them from outside the region), were key reasons why impoverished Somali fishermen banded together and turned to piracy at the beginning of this century.[5]

That, in turn, had a significant and lasting impact on Indian Ocean security. For several reasons, including a lack of regional capabilities, the threat of Somali-based piracy was addressed more as a military threat than as a law enforcement issue.

The threat prompted a major international military response, including the deployment of naval vessels from many countries inside and outside the region.

Many countries continue to maintain a regular naval presence in the western Indian Ocean despite the reduction in piracy over the past several years. This has had an impact on the regional balance of power, including, for example, justifying the establishment of naval support facilities by China in Djibouti.

The piracy threat also spurred the widespread use of military personnel and private security contractors aboard commercial vessels. This has had its own consequences for regional security, including the advent of private floating armouries in the northwest Indian Ocean and a dispute between India and Italy over the deaths of Indian fishermen at the hands of Italian marines.

It is possible that some of these consequences may have been different if Somali piracy had been addressed as primarily a law enforcement, rather than military, issue.

Using the context-setting questions and analytical framework as guides, participants in the first two workshops were asked to:

- identify key current and future issues (environmental pressures and geopolitical drivers) that must be assessed, understood and managed to sustain a common frame for environmental security across the region
- define trigger points or circumstances that can change the criticality of current or future environmental threats and issues (and also what might make things better or worse)
- detail the capabilities and processes needed to sustain management oversight for identified and emergent issues
- identify agencies currently doing research and development in areas relevant to environmental security in the region.

We compiled the responses to the context-setting questions ahead of the first two workshops and used them as core material in workshop discussions.

We asked participants to consider answers to the following trigger questions:

- What changes in conditions (related to the issues or disturbances) are possible and why?
- What is the likelihood of their future occurrence?
- What are the consequences, should they occur?
- What factors could reduce the likelihood of consequent changes?

An important goal of the pre-workshop data collection and the discussion in the workshops was to establish a layered approach to aggregating participants' views of the complex evidence bases that underpin a risk-mapping exercise and ultimately inform the development of risk assessment matrices.

We applied a generic risk assessment matrix (see Table 1) to evaluate the criticality of specific sets of issues or disruptions identified before workshop sessions and then collectively examined during workshops.

Table 1: Generic likelihood and consequence scales

Likelihood	Consequence
• **Almost certain** already occurs regularly • **Likely** will occur in current circumstances • **Possible** can occur in most circumstances in the foreseeable future • **Unlikely** unlikely to occur without significant change in current circumstances • **Rare** most unlikely but might occur in exceptional circumstances	• **Catastrophic** significant widespread disruptions • **Negligible** no disruptive effects and 'business as usual' with economic activity and regional regulations • **Major** significant disruption; limited to areas • **Significant** conflict is temporary and generally constrained by agreements such as the Antarctic Treaty and CCAMLR • **Minor** regional tensions increase temporarily but the situation is manageable within existing processes

The last phase of the work was to analyse the discussions from the workshops though the lenses of geopolitical, environmental and economic consequences and the impact on broad environmental security considerations.

In addition to current developmental contexts, there was an expectation that considerations would include a prospective view out to 10 years from now.

Underpinning the study was also a recognition that there is a more global setting for the analysis in Antarctica, the Southern Ocean and the eastern Indian Ocean: there is an inter-state dimension to all these issues in an international environment of competition and conflict. Several of the identified threats and challenges are essentially forms of inter-state conflict.

This conceptual base is compatible with elements detailed in the international standard on Risk Management (ISO 31010), both in the use of generic risk assessment matrices to map critical issues and in suggested risk mitigation measures.

A level of importance for each issue was derived from an assessment of the likelihood and consequences of its emergence as a disturbance or a geopolitical factor in the broader context of the research.

The following analyses detail identified issues, from those of minor or negligible importance to higher order critical issues of significant importance.

For further context, each issue is presented in sections 2 and 3 of this report with an alpha-numeric reference (likelihood and consequence).

2. The eastern Indian Ocean: the area east of longitude 78°E

This part of the report covers the area of the eastern Indian Ocean from the southern point of India (longitude 78°E) eastwards to the Australian continent and south to the Southern Ocean. This area includes the Bay of Bengal, the Andaman Sea and ocean areas south of the Indonesian archipelago. This area is referred to in this report as the 'eastern Indian Ocean' (Figure 3).

Figure 3: The eastern Indian Ocean

Source: CartoGIS Services, Australian National University.

2.1 The changing strategic environment

The eastern Indian Ocean littoral includes developing states such as India, Sri Lanka, Bangladesh, Myanmar, Indonesia and Timor-Leste; the middle-income states of Thailand and Malaysia; and the economically developed states of Singapore and Australia.

Several of these countries (including Sri Lanka and Indonesia) have experienced civil conflicts in recent years, although civil conflicts are currently active only in India and Myanmar.

This report focuses mainly on environmental and other non-traditional security challenges in the maritime realm and their potential interplay with traditional security challenges.

Section 2.1 provides an overview of the changing strategic environment in the eastern Indian Ocean, including the geopolitical and natural environments. It first provides background on developments in the geopolitical environment in the region, and then focuses on environmental security changes in the maritime environment.

Section 2.2 sets out a risk assessment matrix that presents issues and challenges in the region as a function of probability and consequence.

Section 2.3 provides details on the region's threats and challenges.

Section 2.4 provides recommendations on potential Australia–France cooperation on mitigating the impacts and managing the consequences of the threats and challenges.

2.1.1 Developments in the geopolitical environment

The geopolitical environment in the Indian Ocean, including the eastern Indian Ocean, is changing and becoming more contested than it has been for many decades. As Australia's *2016 Defence White Paper* noted: 'the Indian Ocean region is also likely to become a more significant zone of competition among major powers, with China, India and the United States all increasing their levels of military activity in this region.'[6]

The future strategic order in the Indian Ocean is likely to be more multipolar and unstable than at any previous time in the modern era. This is the result of several geopolitical changes that are occurring more or less concurrently.

The changing role of the United States

The US has been the predominant power in the Indian Ocean for at least 40 years and, even though its relative lead is diminishing, it may remain the leading military power in the region for decades to come.

But there are many uncertainties about the US role in the region. There may be circumstances in which US military predominance in the Indian Ocean will be threatened much faster than many expect.

The US military presence has long been focused principally on ensuring the stability and security of countries in and around the Persian Gulf; the rest of the Indian Ocean region has been given a secondary priority.

However, there have been significant increases in oil and gas production in North America over the past decade and, as a consequence, US energy imports as a proportion of its total needs are falling.

If technological advances in the extraction of gas and oil continue to reduce US dependence on imported energy, the Persian Gulf could easily become much less important to Washington.

In 2011, only 16% of the oil imported by the US came from the Persian Gulf (down from 24.5% in 1990),[7] and that proportion has continued to fall much further. The International Energy Agency has predicted that the US will become a net exporter of natural gas by 2020.[8] The reduction in US dependency on energy imports may be further magnified by the increased use of non-hydrocarbon energy sources in the future.

Despite an apparent recognition in the 2017 US National Security Strategy of a new era of great-power competition, the behaviour of the Trump administration has led to uncertainties about Washington's commitment to security in many parts of the world, including the Middle East.

Reduced US dependence on Persian Gulf energy could fundamentally alter the US commitment to the Indian Ocean. Simply put, Washington will have more strategic options in the Indian Ocean than was previously the case, including the option of not acting in response to maritime security threats.

A reduced US presence in the Gulf could spark a period of intense strategic competition as China, India and other countries move to fill any perceived power vacuum. That would be likely to have a knock-on effect right across the Indian Ocean.

Such a strategic reordering could potentially occur quite quickly—as was the case when Britain precipitously withdrew its military forces from east of Suez in the early 1970s.

The emergence of India as a major regional power

A second major long-term change in the geopolitical environment is the emergence of India as the biggest economic and military power among Indian Ocean states.

It is likely that India's relative power will continue to grow and that it will seek to assume a greater leadership role across the region, beyond its traditional areas of interest in South Asia, including in the eastern Indian Ocean.

India has long aspired to be recognised as the leading Indian Ocean power, with special security responsibilities in the region. However, it is only in recent years that it has been able to extend its strategic reach much beyond South Asia.

Since 1947, India has also shown a strong aversion to the presence of other major powers in the Indian Ocean, although previously it had little power to do anything about it. Those concerns were once directed at the US, but they are now very much directed at China. As a result, strategic competition between India and China is likely to become an increasingly important factor in the dynamics of the region.

China's growing presence in the Indian Ocean

China has several important strategic interests in the Indian Ocean that are likely to drive an ever-greater Chinese military presence.

Beijing's most crucial interest is the protection of its trading routes, over which around 82% of its imported oil needs are transported from the Middle East and Africa. Those sea lanes are highly vulnerable, especially at so-called maritime 'choke-points', such as the Strait of Hormuz and Malacca Strait.

But China also has other important strategic interests in the region, including a growing number of Chinese nationals and investments related to its Belt and Road Initiative (BRI). The imperative to protect people and assets is likely to become an increasingly important driver of China's military presence in the region.

China's economic role in the Indian Ocean region has been growing for some years. This includes investments being made as part of the Maritime Silk Road, which is the maritime leg of the BRI. This involves building a network of ports that will be available to China in many parts of the region, including at Kyaukpyu (Myanmar), Hambantota (Sri Lanka), Gwadar (Pakistan), Djibouti and Bagamayo (Tanzania).

The BRI also involves the development of new overland transport routes and economic corridors between China and the sea, from China's southern Yunnan Province across Myanmar to the new port of Kyaukpyu, and from its western Xinjiang Province across Pakistan to Gwadar.

These overland connections will mean that, for the first time in history, significant numbers of people and volumes of goods will be able to move overland between Chinese territory and the Indian Ocean.

China opened its first overseas military base in Djibouti in 2017 and, given the range of its strategic interests, it is likely to establish further military bases in the region. Its naval presence may grow to a presence of perhaps more than 20 warships, which may also be accompanied by deployments of contingents of Chinese marines and other supporting services.

China is becoming increasingly active in the eastern Indian Ocean. It has conducted annual naval exercises near Australia's Christmas Island since 2014. If the opportunity arises, China may also seek to establish a naval support facility in or around the Bay of Bengal.[9]

The growing role of Indonesia and other middle powers

The growing strategic roles of India and China in the Indian Ocean are being complemented by several middle powers. Australia and France have both long been active in the region. Japan and the UK have also been building their presence (the latter after being mostly absent for some years).

Other middle powers are also becoming more active in the region, including major Indian Ocean states such as Indonesia and even the relatively small state of Sri Lanka.

Indonesia has particular strategic significance. Since independence, it largely turned its back on the Indian Ocean, giving its attention to Southeast Asia and further north. But Indonesia may increasingly come to understand the influence it can wield across the Indian Ocean region, including through its relationships in Southeast Asia and the Islamic world.

Indonesia's announcement of a 'global maritime fulcrum' strategy in 2014 seemed to indicate a greater awareness of its valuable strategic position at the intersection of the Indian and Pacific oceans, although that strategy has been little implemented.

However, Jakarta's period as chair of the Indian Ocean Rim Association (2015–2017), which included that group's first leaders' summit, provided an example of the potential strength of Indonesia's soft power and its ability to facilitate talks among a highly diverse set of regional partners.

Growing strategic competition

Together, these developments mean that the Indian Ocean is becoming a much more multipolar and complex strategic environment than at any time in the modern era.

The dynamics of the rise of several major and middle powers are making the region a much more unstable and competitive environment.

One concern is the Sino-Indian strategic dynamic. Differences in perceptions about their regional roles have the potential to fuel strategic competition between India and China right across the littoral and island states in the Indian Ocean. In some respects, this is increasingly reminiscent of the US–Soviet competition for influence in the Cold War.[10]

Strategic competition between India and China has been an important factor in political instability experienced by Sri Lanka and the Maldives in recent times. Efforts by those countries to use China as an economic and political balance have provoked sharp reactions from India, which may have contributed to the surprise ouster of governments in Sri Lanka (2015) and the Maldives (2018).[11]

Sino-Indian competition also has the potential to fuel instability in countries such as Bangladesh and Myanmar.

China has also become an increasingly important factor in the domestic political affairs of other Southeast Asian states. Corruption and other issues related to BRI projects were material factors in the ouster of Malaysian Prime Minister Najib Razak's government in 2018.

Growing strategic competition in the Indian Ocean has many facets. One has been competition in the development of marine infrastructure. Another has been an increase in the militarisation of the region, including the modernisation and expansion of navies in the region (such as India's and Australia's) and the growing presence of extra-regional navies (such as those of China and Japan).

As is discussed below, the consequences of major-power competition and a more militarised strategic environment can easily become intertwined with transnational issues such as piracy, illegal fishing and natural disasters.

2.1.2 The changing natural environment in the eastern Indian Ocean

Changes in the geopolitical environment in the Indian Ocean are being paralleled by significant changes in the natural environment. This section gives an overview of existing natural hazards in the region and then briefly discusses the potential impact of climate change and other human interactions with the environment.

Section 2.3 of this report discusses how these environmental disruptions might contribute to environmental security threats.

Existing natural hazards

The Indian Ocean region is already an epicentre for a range of natural hazards, including climatological (cyclones and droughts), geological and tectonic (earthquakes and tsunamis) and hydrological hazards (such as floods and tidal surges).

Along with the Pacific, the Indian Ocean experiences the most serious natural hazards in the world, but it is also one of the regions with the least capacity to respond. The people of the eastern Indian Ocean, particularly those who live in Bay of Bengal littoral states, may be one of the most acutely at-risk populations in the Indian Ocean.[12]

The relative impact of many natural hazards, including cyclones, floods and earthquakes, may be magnified by the relatively high population density of parts of the region, including in India, Bangladesh and parts of Indonesia.

It may be further exacerbated by the rapid urbanisation of many parts of the region, leading to the growth of huge, dense, conurbations situated in low-lying areas (such as Jakarta).

Cyclones

Tropical cyclones have historically been a major source of death and destruction across the Indian Ocean. This is particularly the case in the Bay of Bengal, where cyclones have routinely exacted near-apocalyptic death tolls from farming and fishing settlements of the Ganges River delta and Deccan Plateau. Large areas on the Bay of Bengal are flooded by relatively small increases in sea level.

There are two cyclone seasons in the Bay of Bengal, one concentrated in May (pre-monsoon) and the other spanning October–November (post-monsoon). Cyclones making landfall near the time of high tide produce particularly devastating floods.

According to a study by the Intergovernmental Panel on Climate Change (IPCC), although only 15% of tropical cyclones occur in the northern Indian Ocean, the countries of Bangladesh and India alone account for 86% of the deaths.[13]

There are considerable uncertainties about the potential impact of climate change on tropical cyclones. The IPCC states that it has low confidence that any observed long-term increases in tropical cyclones are robust after accounting for past changes in cyclone observing capabilities.

However, while it is likely that the overall global frequency of tropical cyclones will either decrease or remain essentially unchanged, it is more likely than not that the frequency of the most intense storms will increase substantially in some ocean basins.[14]

Earthquakes, volcanic eruptions and tsunamis

The eastern Indian Ocean is also particularly prone to earthquakes, volcanic eruptions and tsunamis. The intersection of the Eurasian, Indian and Australian tectonic plates creates a subduction zone that extends along the coasts of Java and Sumatra and through the Andaman Sea (Figure 3). As a result, the region is particularly prone to earthquakes and tsunamis caused by undersea earthquakes and landslides, as well as volcanic activity.

Figure 4: Tectonic plates in Southeast Asa

Source: A Reid, 'Revisiting Southeast Asian history with geology: some demographic consequences of a dangerous environment', in G Bankoff, J Christensen (eds), *Natural hazards and peoples in the Indian Ocean world: bordering on danger*, Palgrave Macmillan, 2016.

The islands of Java and Sumatra, as well as the Bay of Bengal region, are particularly susceptible to earthquake-generated tsunamis.[15] The earthquake and consequent tsunami that occurred in the Andaman Sea in December 2004 was indicative of the potential for catastrophic events in this region. The undersea earthquake of an estimated magnitude of around 9.0 caused a rise in the seabed of several metres, triggering tsunamis across much of the Indian Ocean.

The greatest damage from the 2004 tsunami was in the eastern Indian Ocean, including Indonesia, Sri Lanka, Thailand and India, but it also had a significant impact as far away as Somalia. The deaths in the eastern Indian Ocean of an estimated 227,000 people, and the displacement of more than 1.7 million people, made it one of the deadliest natural disasters in recorded history.

Despite the magnitude of the 2004 event, the UN International Strategy for Disaster Reduction comments that, while tsunamis are highly destructive, they are also infrequent, and their impact is generally localised along coasts.

Indonesia is also particularly susceptible to volcanic eruptions. However, with some exceptions, their impacts tend to be localised.[16]

Disruptions caused by human interactions with the natural environment

The natural environment in the eastern Indian Ocean is being strongly affected by human interaction, the most significant being climate change. As Robert Glasser, former head of the UN Office of Disaster Risk Reduction, has commented, as a consequence of climate change, we may now be entering the 'Era of Disasters', with profound implications for the way we organise ourselves.[17]

In coming years, climate change is likely to act as an impact multiplier, increasing vulnerabilities caused by natural hazards. It may exacerbate existing threats to human security, including geopolitical, socioeconomic, water, energy, food and health challenges that diminish resilience and increase the likelihood of conflict.

When climate impacts are combined with ethnic or other social grievances, they can contribute to increased migration, internal instability or intra-state insurgencies, often over greater competition for natural resources, and may foster terrorism or cross-border conflict.

Climate-induced resource competition can also increase tensions within and between states, requiring international intervention in the form of stabilisation, peacekeeping or post-conflict operations.[18]

Australia has recognised the potential impact of climate change on the security of the region. The government's *2016 Defence White Paper* described climate change as 'a major challenge for countries in Australia's immediate region' and committed Australia to providing leadership and support in the region.[19]

Australia's *2017 Foreign Policy White Paper* also framed climate change as an issue requiring inter-country cooperation and indicated that responses to this threat 'will be an important influence on international affairs and Australia's economy'. It argued that nations 'need to factor climate change in to long-term planning and investment, including its implications for national and regional security'.[20]

Some potential consequences of climate change in the eastern Indian Ocean include:

- changes in regular monsoon/rainfall patterns
- a rise in sea levels
- declines in fish stocks.

Two of those impacts—rising sea levels and declining fish stocks—are discussed in further detail below.

Rise in sea levels

The rise in sea levels associated with climate change could have a significant impact on several states in or near the eastern Indian Ocean. Sea-level rises would be expected to lead to increases in the frequency and severity of floods, especially when combined with increases in the severity of storms and with ground subsidence (whether due to tectonic reasons or because of the extraction of groundwater).

An increase in sea level can be expected to cause the intrusion of seawater and the salinisation of groundwater, which will challenge freshwater availability and reduce soil fertility.

Sea-level rise is also projected to aggravate storm surges, flooding, erosion and other coastal hazards, resulting in significant losses of coastal ecosystems. The impact of rising sea levels on different states in the eastern Indian Ocean will differ.

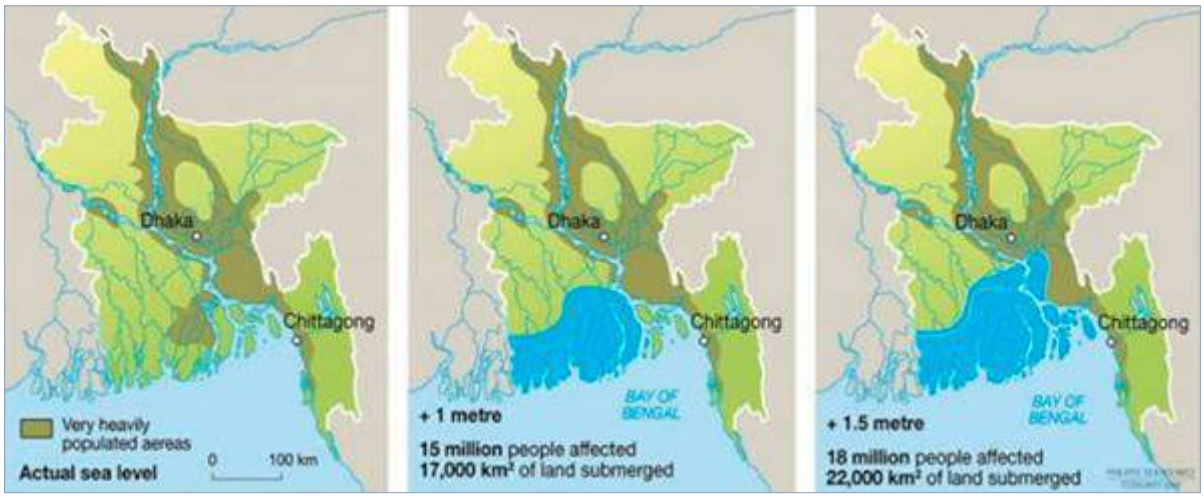
For Indian Ocean island states such as the Maldives, a significant rise in sea level, when combined with the impact of waves, could represent an existential threat. As long ago as 1987, the Maldives President, Maumoon Abdul Gayoom, told the UN General Assembly that a rise of 2 metres above mean sea level would virtually submerge the entire country and that a mere 1-metre rise could also be catastrophic, and possibly fatal to the nation.

In 2008, Maldives President Mohamed Anni Nasheed announced the Safer Islands Plan, which contained provisions for internal resettlement from smaller, less populated islands to larger islands and also mentioned the possibility of relocating the entire Maldives population to another country.

Before potentially rendering the Maldives uninhabitable, any significant rise in sea levels may effectively destroy the Maldives' most profitable industry. Some 99% of tourist accommodation in the Maldives lies within 100 metres of the ocean.[21] Although the Maldives strictly lies outside the boundaries of the area covered in this report, any major impact on that country will also affect other countries in the area.

Sea-level rises could also have a dramatic impact on Bangladesh, particularly when combined with storm surges (Figure 5). A sea-level rise of around 1 metre could leave around 17% of Bangladesh's land area inundated.

Figure 5: Impact of sea-level rise in Bangladesh



Source: Global Military Advisory Council on Climate Change (GMACC), *Climate change and security in South Asia*, GMACCC, Overijse, Belgium, May 2016.

According to the Global Military Advisory Council on Climate Change,[22] a 1-metre rise in sea levels would directly affect around 15 million people in Bangladesh, and a 1.5-metre rise would affect around 18 million people.

In addition to population displacement are impacts from the increased salinity of land, leading to reduced agricultural production.

Sea-level rise may also have a significant impact on parts of Indonesia. Jakarta, in particular, is experiencing fast ground subsidence due to the extraction of groundwater as a result of urbanisation. This may have a major impact on the long-term habitability of that city when combined with rising sea levels.[23]

Declines in fish stocks

There is also the potential for a significant decline in fish stocks in the eastern Indian Ocean. This could be a consequence of several factors, including:

- overfishing by local and extra-regional fishers, acting both legally and illegally
- changes in the marine environment, including changes due to acidification, marine heatwaves, hypoxia marine pollution.

Many states in the eastern Indian Ocean are highly reliant on fishing as a source of income and as a major or primary source of animal protein. According to the Food and Agriculture Organization (FAO), fish contribute 54% of total animal protein consumed in Indonesia, 56% in Bangladesh and 57% in Sri Lanka.[24]

The fishing industry is also a major contributor to employment. In 2014, the Bay of Bengal fishery provided food for approximately 400 million people, while 2.2 million fishers providing livelihoods for 4.5 million people.[25] In Indonesia, the fishing industry employs some 12 million people.[26]

The decline in sustainable fish stocks is therefore a major problem for economic and food security.

Fishers in the eastern Indian Ocean tend to be overwhelmingly artisanal and coastal. In 2012, the region was home to some 45% of the world's fishers, yet brought in only 8% of total world fish production. Most of this catch is harvested close to shore; deepwater catches made up less than 6% of the total catch in Indonesia and 10% in Malaysia in 2012.[27]

The key fisheries, including for neritic and tropical tuna species, in the eastern Indian Ocean are in the Bay of Bengal and in the waters immediately south of the Indonesian archipelago, which are currently dominated by local, often artisanal, fishers, who are to a significant extent unregulated.

The other key area is in the waters to the northwest and southwest of Australia (for southern bluefin tuna), which are currently dominated by extra-regional fishers from countries such as Taiwan, Korea and China.

A major threat to fish stocks comes from overexploitation through legal and IUU fishing by both local and extra-regional fishers. The FAO has estimated that 90% of the commercial fish stocks it tracks worldwide have been overfished or fully fished, and estimates the proportion of illegal catch to reported catch in the Indian Ocean to be among the highest of any region in the world.[28]

The problem of IUU fishing in the Indian Ocean is likely to grow, driven by growing world population, falling fish stocks throughout the world and the relative lack of enforcement arrangements in the region.

Extra-regional states such as Spain, Taiwan, Japan and Uruguay have long been active fishers in the Indian Ocean. They are now being joined and surpassed by China.

In 2013, the decline of fish stocks in Chinese waters, together with China's growing demand for fish protein, led the Chinese Government to build a subsidised fishing industry to operate far from Chinese waters.

With some 2,500 distant-water fishing vessels, China's heavily subsidised fishing industry is the world's largest, and it is pushing into ever more distant waters. The World Bank estimates that China will account for some 37% of the global catch by 2030, many times than any other country.[29]

The Indian Ocean Tuna Commission (IOTC) has regulatory responsibility for the management of tuna and tuna-like species in the Indian Ocean, including the eastern Indian Ocean.

The work of the IOTC has led to an acceptable level of management of the southern bluefin tuna fisheries off Western Australia. The IOTC recognises that the Commission for the Convention for the Conservation of Southern Bluefin Tuna has total jurisdiction over the management of that species. Based on this fact, and given that most of the global southern bluefin tuna catch is taken within the IOTC boundaries, the need has been for greater sharing of information and other compliance measures.

Inter-regional fisheries management organisation cooperation has improved markedly in the past three years, both at formal and at informal levels. This includes the sharing of information on transhipments at sea and in port, pursuing joint projects on surveillance measures such as vessel monitoring systems, and providing information on the implementation of measures to avoid seabird bycatch. This cooperation now needs to be institutionalised in formal arrangements.

However, as noted above, the necritic and other tropical tuna fisheries in the northeast Indian Ocean remain largely unregulated outside of national exclusive economic zones (EEZs) and are in significant danger of a major decline in fish stocks.

Although Indonesia has implemented new rules to increase the proportion of local catch that remains in Indonesia, those rules do not adequately regulate the sustainable management of fish stocks. The nature and defined location of these fisheries suggest that, in the short term at least, they might be most effectively regulated through bilateral or regional agreements among neighbouring countries rather than through more inherently cumbersome multilateral arrangements such as the IOTC.

Another recent study argued that actual fish catches in the eastern Indian Ocean over the past 60 years have been much higher than those reported by the FAO, and that catches are currently declining at a much higher rate than is generally believed.[30]

While the IOTC maintains data on catches and stocks of species such as southern bluefin tuna, data on necritic and tropical tuna species prevalent in the northeast Indian Ocean is sparse, and many species may be being fished beyond maximum sustainable yields.

The risk of significant declines in fish stocks from overfishing may be exacerbated (perhaps in unpredictable ways) by climate change and other changes to the marine environment. This can include changes to oceanic currents, the occurrence of marine heatwaves, ocean acidification, the development of hypoxic areas (where normal oxygen levels are depleted), the introduction of new marine species and marine pollution (including marine debris).

Climate change induced changes in the Indonesian Through Flow, a current that brings relatively warm and fresh water from the Pacific to the Indian Ocean through the eastern Indonesian archipelago, could have a significant impact on the spawning grounds of southern bluefin tuna and other species.

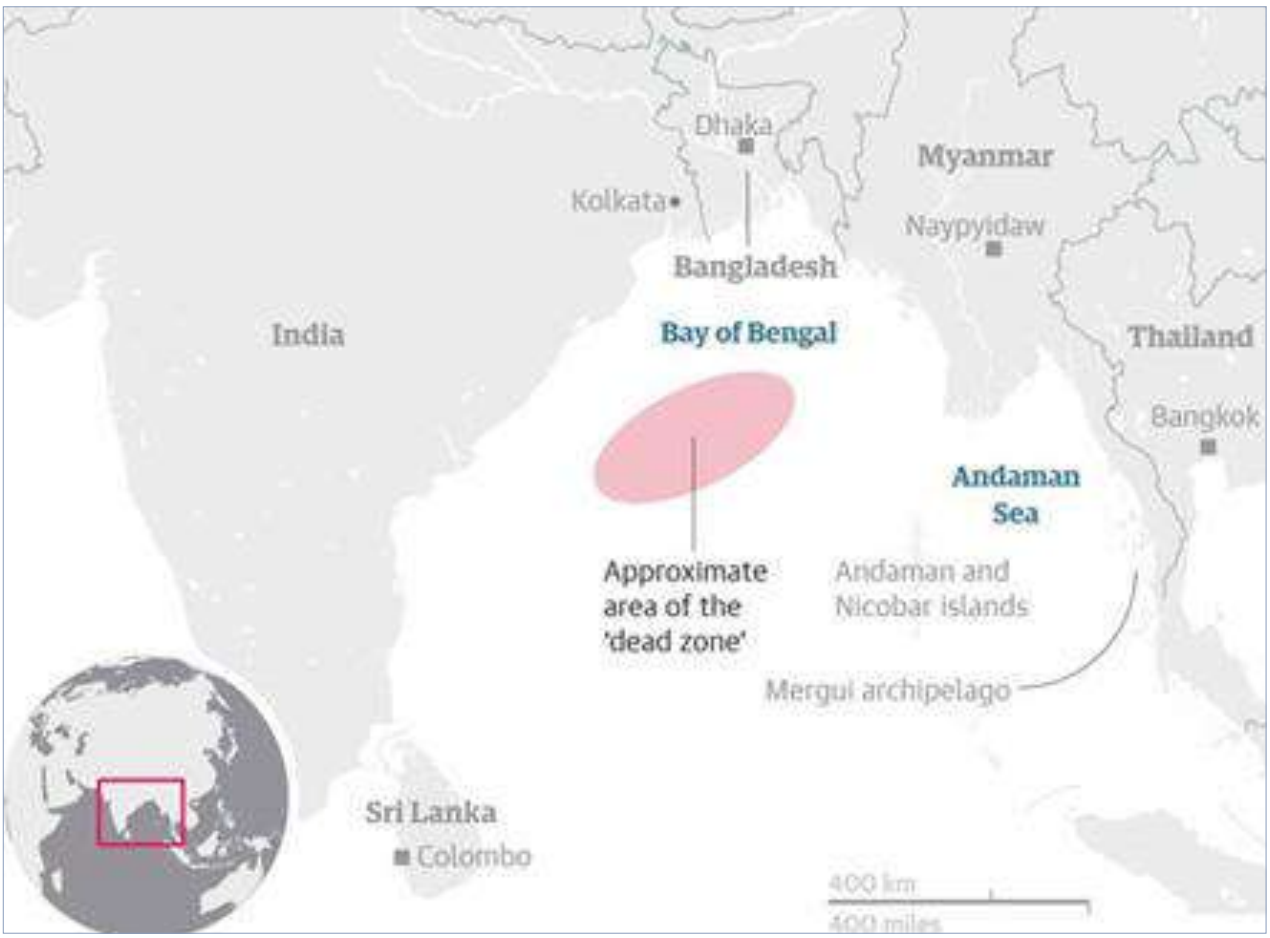
There have also been several instances of marine heatwaves occurring in the Indian Ocean. For example, in 2011, the Leeuwin Current off Western Australia intensified to record strength and increased the water temperature around Ningaloo Reef in northwest Australia by more than 5° Celsius for many days, having disastrous consequences for marine life in the region.

Ocean acidification occurs due to rising levels of carbon dioxide, which can kill coral, shellfish and plankton (with a consequential, mostly negative, impact on the marine food chain).

Another recent occurrence is the development of hypoxic areas in the ocean, where oxygen levels are highly depleted and marine life can no longer be sustained. Two large hypoxic areas (so-called ‘dead zones’) have been identified in the Indian Ocean, including one in the Bay of Bengal that covers 60,000 square kilometres at depths between 100 and 400 metres (Figure 6).

One study found oxygen levels in this zone to be some 10,000 times less than those found in air-saturated surface waters. The size of the Bay of Bengal dead zone is predicted to expand with further global warming.[31]

Figure 6: The Bay of Bengal dead zone



Source: A Ghosh, A Savio Lobo, 'Bay of Bengal: depleted fish stocks and huge dead zone signal tipping point', *The Guardian*, 1 February 2017, online.

Despite significant concerns about the sustainability of fisheries in the eastern Indian Ocean, particularly the necritic fisheries in the northeast, there is currently insufficient data to properly assess the risk exposures. Data is collated by the IOTC and national agencies principally for the purpose of the allocation of quotas rather than for the purpose of environmental security risk assessment.

2.2 Risk assessment matrix

For the purposes of this discussion, threats are individually categorised as 'minor', 'significant', 'major' or 'catastrophic' disruptions.

A level of importance has been ascribed to each threat, derived from an assessment of the likelihood and consequences of its emergence as a disturbance or a geopolitical factor in the broader context.

As set out in the methodology section of the report (Section 1.3), this analysis used input received from the Perth workshop held in November 2018, the Canberra workshop in March 2019, and consultations with various other experts.

Each issue is listed in Table 2 with an alpha-numeric reference (likelihood and consequence) as per Table 1. No negligible disruptions are listed.

Table 2: Risk assessment matrix for the eastern Indian ocean

Issue/disruption	**A Negligible** (no disruptive effects; 'business as usual')	**B Minor** (regional tensions increase temporarily; situation is manageable within existing processes)	**C Significant** (conflict is temporary and generally constrained by existing arrangements)	**D Major** (significant disruption; limited to areas)	**E Catastrophic** (significant widespread disruptions)
1 Rare (most unlikely but might occur in exceptional circumstances)					
2 Unlikely (unlikely to occur without significant change in current circumstances)		• Impact of seabed mining			• Interdiction of maritime trade by state actors
3 Possible (can occur in most circumstances in the foreseeable future)			• Terrorist attacks on shipping, maritime infrastructure or the marine environment • Disruption of / illicit access to undersea cables		
4 Likely (will occur in current circumstances)			• Shipping accidents • Marine pollution • Piracy • Significant declines in marine-based tourism • Human trafficking / unregulated population movements		• Natural disasters / extreme weather events
5 Almost certain (already occurs regularly)		• Maritime smuggling of goods		• Declining marine living resources • Growing competition for fish resources	

2.3 Threats and challenges

This section discusses the assessed importance of issues arising from a particular set of threats and challenges to maritime security in the eastern Indian Ocean:

- seabed mining
- maritime smuggling of goods
- terrorist attacks on shipping, maritime infrastructure or the marine environment
- disruption of or illicit access to undersea cables
- shipping accidents
- marine pollution
- piracy
- significant declines in marine-based tourism
- unregulated population movements
- declining marine living resources
- growing competition for fish resources
- interdiction of maritime trade by state actors
- natural disasters and extreme weather events.

Note that the concurrent occurrence of events (either as a cascading effect or otherwise in combination) is very difficult to predict and may greatly increase the impact of even moderate threats in unpredictable ways. This could be due to the potential magnification of the impact itself or because of the reduced resilience of states to respond to multiple events.

Climate change, in particular, is predicted to lead to an increase in the cascading/compounding of natural hazards (such as cyclones, storm surges, floods and droughts).[32]

Natural hazards can also combine with industrial accidents, producing effects that are magnified far beyond their normal individual impacts. For example, cyclones, storm surges, or both, could trigger accidents in petrochemical plants or nuclear power plants, which are in many cases located in coastal areas. Some recent examples of the cascading and clustering of disruptions in the Indian Ocean and their consequences are discussed below.

The high population density of several countries in the eastern Indian Ocean (for example, India, Bangladesh and Indonesia) and the location of many large and densely populated cities on the coast might be expected to further magnify the impact of such maritime-related disruptions in this region.

Of further interest is the potential interaction between maritime environmental security threats and emerging strategic competition in the Indian Ocean. To what extent might environmental security threats contribute to or exacerbate strategic competition or vice versa? To what extent might environmental security threats provide opportunities for cooperation and confidence building that might mitigate strategic competition? Some examples of potential interactions are discussed below.

Finally, note that threats or disruptions in the maritime domain tend to be inherently much more international in nature than those that occur on land.

Many of the threats discussed below occur outside of national jurisdictions, even if their effects are ultimately felt within national territories. Even where maritime-related threats or disruptions initially occur within national EEZs or national waters, they will be likely to have interrelated impacts elsewhere. For example, overfishing or pollution that occurs within a national EEZ will very likely affect the environment in international waters. This highlights the nature of the ocean domain as an arena of shared rights and responsibilities.

2.3.1 Minor and negligible threats

Seabed mining (2B)

Future competition to exploit seabed resources could be the source of security disruptions. The eastern Indian Ocean, in the waters off the west coast of Australia, is believed to be particularly rich in polymetallic nodules and cobalt-rich crusts.[33]

Both China and India have been active in seabed mining exploration in the Indian Ocean, focusing their efforts on seafloor massive sulphides in the southwest Indian Ocean.

Such activities in international waters are regulated by the International Seabed Authority, which is still in the process of developing a code to protect the marine environment. However, few countries have even begun to develop effective regulatory regimes applicable to territorial waters and EEZs.

There is considerable potential for widespread environmental damage from seabed mining, including on the seabed and in the water column above, which could contribute to disruptions such as the decline of fish stocks.

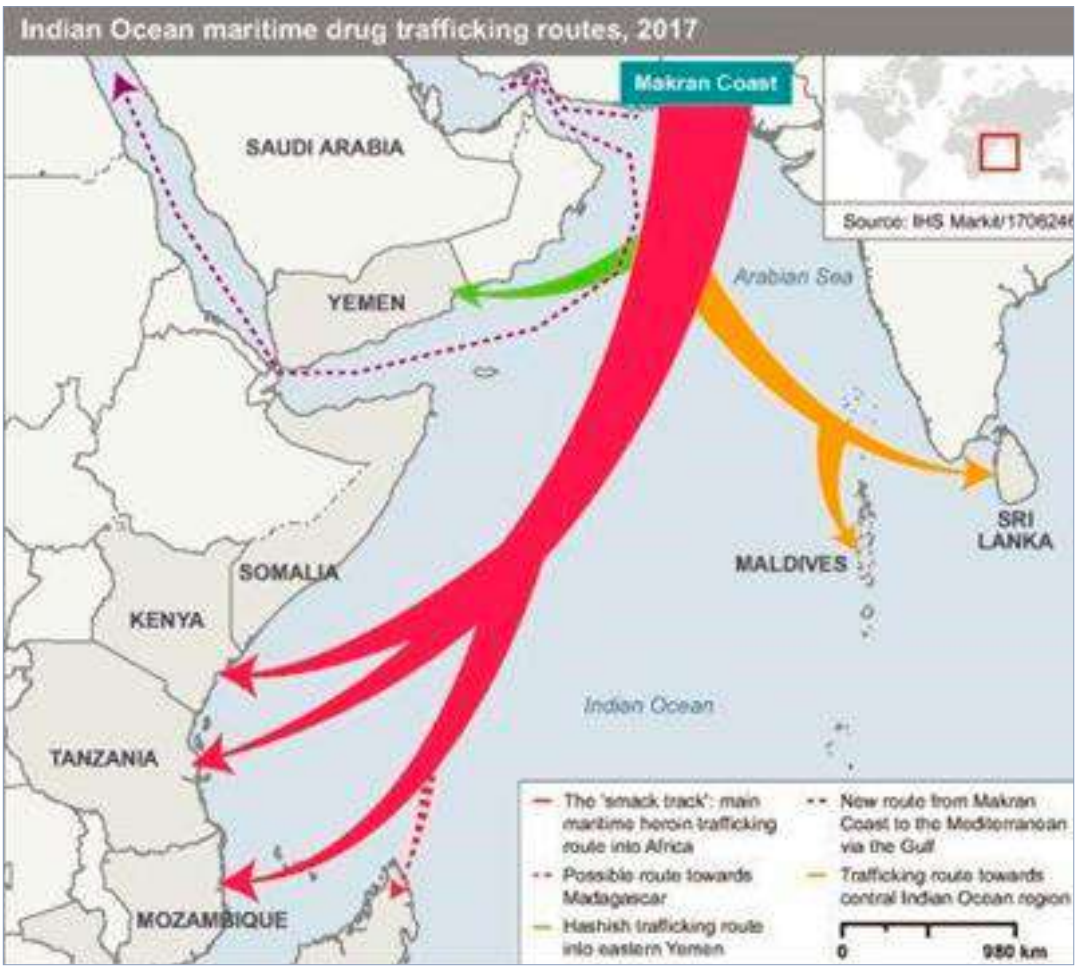
Undersea exploration or exploitation activities in international waters could also become contested either due to the economic value of the resources involved or because of suspicions that undersea mining activities are a cover for security-related activities, such as exploration for use by military submarines, the positioning of undersea surveillance equipment or interference with undersea cables.

Maritime smuggling of goods (5B)

Maritime smuggling of goods (including drugs and weapons) is primarily an ongoing law enforcement issue but can also be an important contributor to broader security threats. Those threats may arise from the activity itself (such as the smuggling of arms to terrorist groups) or from the synergies that can arise between the smuggling activities of criminal and terrorist groups.

The 1993 bombings by violent extremists in Bombay, for example, were implemented by a criminal group importing explosives from Pakistan using a pre-existing maritime smuggling network. Similarly, up until 2009, Tamil insurgents raised money by smuggling illicit drugs to India, using the same network across the Bay of Bengal that had been initially established for smuggling arms into Sri Lanka (Figure 7).[34]

Figure 7: Drug trafficking routes through the western Indian Ocean



Source: IHS Janes.

In recent years, the smuggling of drugs and weapons has become a significant maritime security focus in the western Indian Ocean, to a significant extent because of its association with terrorism.

From around 2012, an increase in opium poppy cultivation in Afghanistan led to a substantial increase in the trafficking of heroin from Afghanistan across the Indian Ocean on what was called the 'smack track' (see Figure 7). This involved transporting drugs by dhow to East and southern Africa, as a route to markets in developed countries.

The Indian Ocean route offers smugglers the ability to move large shipments across sparsely patrolled areas and subject to a relatively limited interdiction regime outside of intelligence-led seizures in ports.[35]

Key hubs in the western Indian Ocean are Mozambique and Tanzania, and there are landing points in Madagascar, Seychelles and possibly Mauritius. This trade is also increasingly expanding towards the central Indian Ocean, as evidenced by an increase in seizures of drugs headed towards Sri Lanka and the Maldives in 2016 and 2017.[36]

These threats have spurred cooperation among several navies, including those of Australia, France and Pakistan, with US support, although powers such as India and China have generally declined to participate in enforcement activities.

But, despite the potential security implications, and the roles played by navies, smuggling normally remains primarily a law enforcement issue.

2.3.2 Major and significant threats

Terrorist attacks on shipping, maritime infrastructure or the marine environment (3C)

Maritime-based terrorism against shipping, maritime infrastructure or the marine environment is a significant threat. There have been numerous such incidents in the western Indian Ocean.

Terrorist attacks on shipping have included attacks on the US naval vessel USS *Cole* in Aden in 2000, the French tanker MV *Limburg* in the Arabian Sea in 2002 and the Japanese tanker MV *M.Star* in the Strait of Hormuz in 2010, and several attacks on merchant vessels and warships off Yemen in 2018.

In 2014, Pakistani terrorists attempted to hijack the Pakistani frigate PNS *Zulfiquar*, reportedly as part of a planned attack on a US naval vessel. Pakistani terrorists also used hijacked fishing boats to infiltrate and attack land-based targets in Mumbai in 2008.

Overall, maritime terrorism has generally been of lesser concern in the eastern Indian Ocean. The Sri Lankan civil war (ending in 2009) involved several maritime incidents, including the sinking of 29 Sri Lankan naval patrol boats and one freighter by Tamil insurgents. Between 1995 and 2001, the insurgents also hijacked several commercial vessels in the vicinity of Sri Lanka.

After 9/11, concerns about the potential for attacks by al-Qaeda on shipping in the Malacca Strait led to the US, India and others to deploy naval vessels to escort shipping through the strait, and no incidents were reported.

In recent times, the threat of maritime terrorism by Philippines-based violent extremists has prompted trilateral coordinated patrols by Philippines, Malaysian and Indonesian authorities in the Sulu Sea.

The Malacca–Singapore Strait remains a high value target; for example, the sinking of a large vessel at the narrowest point of the Singapore Strait (2.7 kilometres) could be highly disruptive to a significant proportion of world trade.

Cruise ships are also potential 'soft' targets. Largely because of fears of pirate attacks,[37] the global cruise industry has remained underdeveloped in the Indian Ocean.

However, there are proposals to develop the cruise industry in both the eastern and western sides of the Indian Ocean, including taking advantage of the growing market of Indian tourists.[38] This could create a new set of maritime targets.

Offshore oil and gas facilities could also be high-value targets. Offshore facilities in the eastern Indian Ocean are currently concentrated off the northwest coast of Australia and off Myanmar, although there is considerable exploration occurring elsewhere in the Bay of Bengal.

Several attacks on offshore facilities in the Persian Gulf during the Iran–Iraq war and following the 2003 Iraq War were reported, but to date there have been no recorded incidents of attacks on facilities in the eastern Indian Ocean.[39]

Large fixed offshore oil and gas installations may present relatively difficult targets for terrorists, although the threat must be viewed as real, as major damage can be inflicted that will have global security and significant environmental and economic consequences.[40]

The significance of this threat may be increased by the deployment of huge floating liquefied natural gas facilities such as the *Prelude,* the largest ship in the world, anchored in the waters off northwest Australia.

Ports are also a potential target for terrorist actions, which could also extend to cyberattacks. This was demonstrated by a 2017 cyberattack by a criminal group against the port of Rotterdam, which had a significant impact on trade transiting that port.[41]

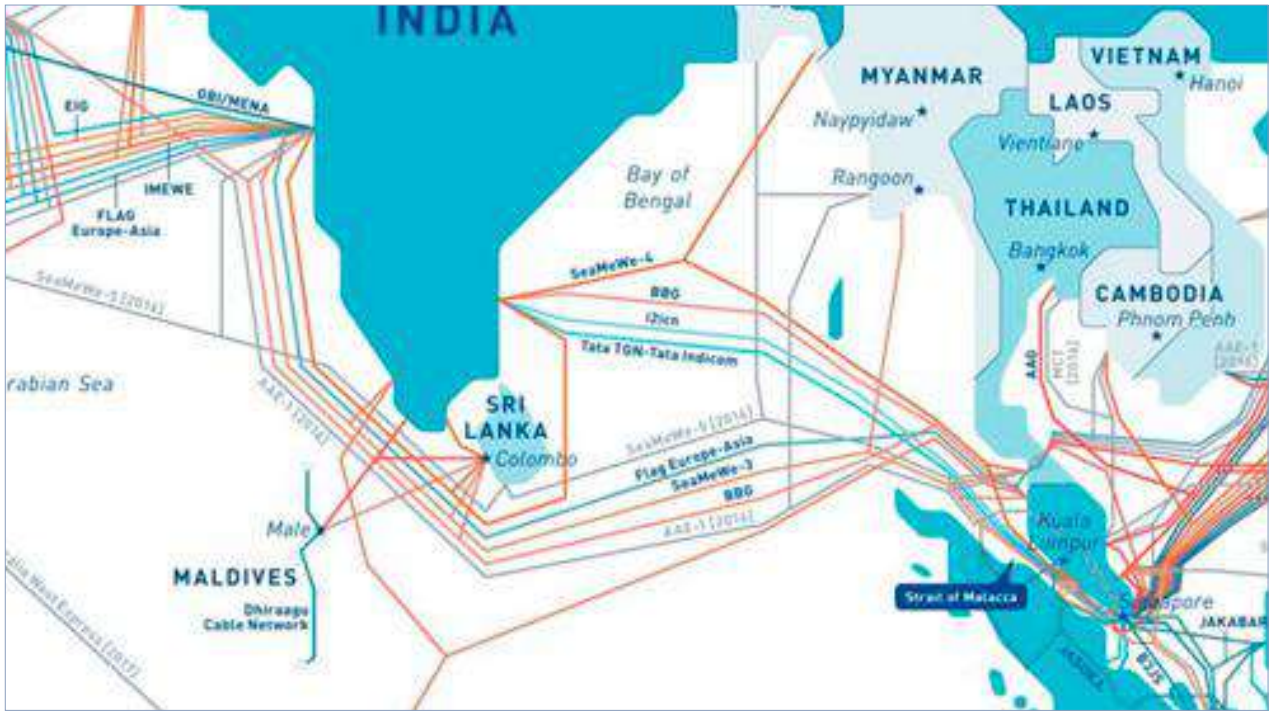
There is also the potential for terrorists to target the marine environment rather than infrastructure. This could include a variety of threats involving organisms (disease, species) or pollution (chemical, radiological) and potentially including attacks involving offshore oil and gas facilities, as noted above. There have not been any recorded instances of such disruptions to date.

Disruption of or illicit access to undersea cables (3C)

Countries around the Indian Ocean also have significant and growing interests in the security of undersea cables that cross the ocean.

Undersea cables carry around 97% of international voice and data communications, including financial transfers and other confidential information (Figure 8). As the former commander of NATO, US Admiral John Stavridis, has commented: 'it is not satellites in the sky, but pipes on the ocean floor that form the backbone of the world's economy. We have allowed this vital infrastructure to grow increasingly vulnerable and this should worry us all.'[42]

Figure 8: Submarine cables in the northeastern Indian Ocean



Source: F D'Sa, 'How undersea fibre-optic cables are repaired', *Deccan Chronicle*, 16 December 2016.

Similarly, as William Evanina, director of the US National Counterintelligence and Security Center, recently commented: 'we are acutely aware of counterintelligence and security threats to undersea cables from a variety of actors. Given that undersea cables carry the bulk of the world's telecommunications data, safeguarding these cables remains a key priority for the US government and its allies.'[43]

Undersea cables are vulnerable to environmental threats such as earthquakes and undersea rock slides, such as in 2006 when an undersea earthquake near Taiwan severed seven key undersea cables connecting much of East Asia.

They are also vulnerable to threats from cutting or disruption (intentional and unintentional), illicit access to data, and their potential use as vectors into domestic communications networks, in each case by state actors or criminal organisations.

The public availability of the location of almost every undersea cable makes them uniquely vulnerable to hostile actors.

Most of the cables connecting Europe, the Middle East and India with East Asia run through the Bay of Bengal, and there is a particular concentration of cables running through the Malacca Strait (see Figure 8). The disruption of several undersea cables, such as those in the strait, could have a major impact on international communications across the Indo-Pacific, potentially with cascading consequences.

The capabilities and capacities needed for successful attacks on undersea cable infrastructure are low. Submarine warfare is the greatest threat, and concerns have also been raised that China's deployment of manned and unmanned deep-sea submersibles to the Indian Ocean, ostensibly for geological surveys, could also provide it with the capability of intercepting undersea communications cables.[44]

However, a successful attack on undersea cables could be mounted with unsophisticated and widely available equipment and vessels.[45] For example, in 2013, Egyptian authorities arrested three scuba divers on charges of attempting to cut one of the main internet cables between Europe and Asia.

Attacks on cables could be an attractive element of hybrid or asymmetric warfare because they offer the scope for plausible deniability and involve limited loss of human life.

In addition, undersea cables are often located far away from land-based or any other means that can detect and monitor the presence of a hostile maritime actor.

Similarly, damage done at these depths is hard to locate and repair. Through the use of unmanned undersea vehicles equipped with high-resolution sonar and explosives, states with access to relatively modest financial resources could acquire the capability to inflict catastrophic damage to communications networks at relatively low cost.

Moreover, international law such as the UN Convention on the Law of the Sea (UNCLOS) is highly deficient when it comes to ensuring the security of undersea cables. UNCLOS does not, for example, give states adequate jurisdiction over offenders, the ability to board suspect vessels or protect cables on land, and is not consistently enacted domestically by all nation-states.

Shipping accidents (4C)

Accidents involving shipping can represent a significant threat. The Indian Ocean is one of the world's busiest oceanic highways**.** A considerable portion of this maritime traffic is clustered in relatively narrow sea lanes across the northern Indian Ocean, particularly in and around so-called 'maritime choke-points' for entry to and exit from to the Indian Ocean.

In the eastern Indian Ocean, the choke-points include the Malacca Strait, the Sunda Strait and the Lombok Strait. In 2017, the Malacca Strait alone saw some 84,000 transits of ships over 300 gross tonnes; oil tankers, including very large crude carriers that can transport up to 318,000 tonnes of oil, account for some 29% of traffic.[46]

A considerable portion of Indian Ocean shipping involves the transport of oil and gas from the Persian Gulf or Africa; indeed, around 80% of the world's seaborne trade in oil is carried over the Indian Ocean.

Australia's North West Shelf is also an important source of gas, most of which is shipped to East Asia through the narrow sea lanes through the Indonesian archipelago.

At the same time, the Indian Ocean is also one of the world's least regulated regions for shipping, meaning that it is frequented by many unsafe ships.

Such vessels can present significant dangers in themselves through running aground or by breaking apart mid-ocean, or through colliding with other vessels. For example, the grounding of the supertanker *Exxon Valdez*

in March 1989 in Alaska's Prince William Sound caused a massive oil spill and subsequent oil slick that spread over 3,000 square miles and onto over 350 miles of beaches in one of the most pristine areas of the US.

The international status of much of the ocean and the highly competitive nature of the international shipping industry significantly complicate efforts to impose minimum safety requirements and environmental standards.

For this reason, port state control measures are an important way of enforcing international standards such as the International Convention for the Prevention of Pollution from Ships (MARPOL) and the International Convention for the Safety of Life at Sea (SOLAS).

MARPOL seeks to prevent or control maritime pollution by oil, noxious substances, sewage, garbage and air pollution. The SOLAS convention, among other things, provides minimum standards for safety.

Through port state control measures, a country can exert its authority to prevent or reduce incidents at sea that may harm the sustainability of marine resources or interfere with the transport routes through the region.

However, port state control works best when it is organised on a regional basis and involves effective enforcement regimes by all members. For one thing, countries with effective enforcement regimes (such as Australia) rely on international information-sharing arrangements such as EQUASIS and the International Maritime Organization's Global Information Shipping Information System (GISIS) to target ships that have been identified by other states to be targeted for further inspections. In addition, substandard ships may also avoid countries such as Australia while still posing a danger to the region.

Although many states in the Indian Ocean are members of the Indian Ocean Memorandum of Understanding on Port State Control (Indian Ocean MOU-PSC), this arrangement is seen as less effective than other regional arrangements applicable in the Atlantic and Pacific oceans.[47]

Some important shipping countries in the Indian Ocean region (such as Pakistan and Madagascar) are not parties to the Indian Ocean MOU-PSC. Other states report minimal inspection activity.

In 2017, the Maldives, Myanmar, Mauritius, Sri Lanka and Tanzania all reported fewer than 10 inspections, in contrast with the 3,128 inspections carried out by Australia.[48] A key reason for this differential is the lack of enforcement capabilities and training in many Indian Ocean states.

Marine pollution (4C)

A potentially significant disruption to the maritime environment could occur as a result of marine pollution. The Indian Ocean is reportedly the second most polluted ocean in the world.[49]

Ocean pollution results from waste from the general population, agricultural activities, shipping and transportation, ocean exploration and other industries.

Pollution of the marine environment in the eastern Indian Ocean is mainly from land-based sources,[50] but also includes ship-sourced pollution, including from substandard shipping practices or shipping accidents.

Marine pollution and oil-related environmental disasters contribute to the destruction of marine habitats, the loss of fish stocks and the bleaching of coral reefs.

Marine debris (persistent solid human-made debris that has adverse impacts on the marine environment and navigation safety) is a threat in the region not only for its adverse impacts on biodiversity, but also for the negative impacts it has on the economies of some coastal and small island states.

Marine pollution may also potentially hinder the flow of shipping if affected nations require ships to avoid such areas.

Coastal states in the region are concerned that major oil spills may affect choke-points, reducing the flow of shipping traffic and resulting in economic losses.

Reducing marine pollution will require integrated management across governments, industries and the community.[51]

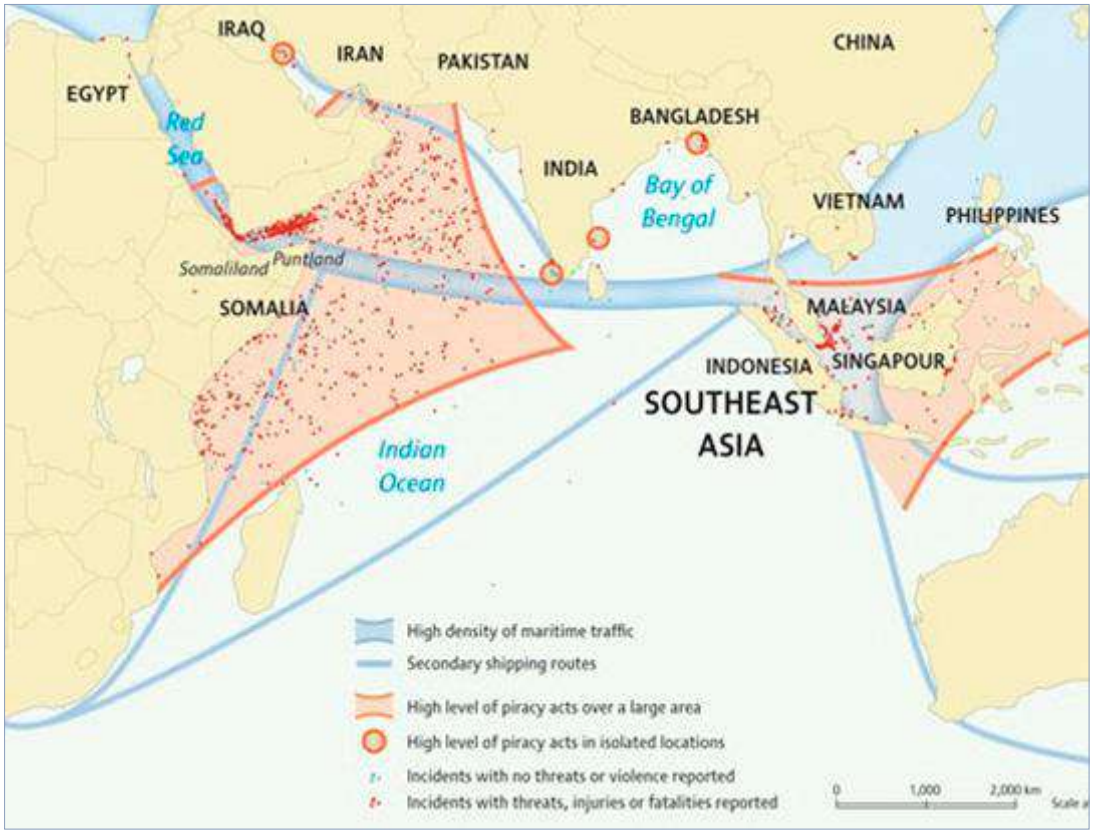
Piracy (4C)

Piracy is usually a maritime law enforcement issue and often can be best managed as such (Figure 9). Nevertheless, the security consequences of piracy have the potential to go well beyond law enforcement and can even have a strategic impact on the region.

The problem of Somali piracy over the past 15 years is an excellent example of the interrelationship of many security issues in the Indian Ocean region (see box in Section 1.3).

The threat prompted a major international military response, including the deployment of naval vessels from Australia, France, India, China, Japan, Russia and the UK.

Figure 9: Acts of piracy and armed robbery at sea, 2006 to 2013



Source: Adapted from UN Institute for Training and Research.

The eastern Indian Ocean also saw an upsurge in piracy around the turn of this century, although there was more emphasis on managing it as a law enforcement rather than a military issue.

In the years after the 1997 Asian economic crisis, the waters of Southeast Asia suffered a significant upsurge in incidents of piracy. This was attributed to several factors, including the economic recession, particularly in Indonesia, inadequacy in policing, and the activities of separatist insurgents in the Indonesian province of Aceh, who were using piracy for fundraising.

There were several different responses to the threat. Indonesia improved its land-based policing efforts in coastal areas. Indonesia, Malaysia and Singapore commenced MALSINDO 'coordinated' naval patrols in the Malacca Strait (although this probably had only very limited effectiveness). Private security contractors were also employed on many ships after the Lloyds insurance association declared the strait as a war-risk zone.

There were also significant improvements in regional maritime domain awareness through the establishment of several multilateral information-sharing or fusion centres, including the Information Sharing Centre of the Regional Cooperation Agreement on Combating Piracy and Armed Robbery Against Ships in Asia (ReCAAP) and the Piracy Reporting Centre of the International Maritime Bureau.

The latter two bodies are focused on *post facto* reporting and analysis of incidents of piracy and armed robbery at sea in and around Southeast Asia.

The number and seriousness of such incidents in an around the Malacca Strait have fallen significantly since 2005, although there has been a slight rise in the number of incidents in recent years.

This overall reduction has largely been attributed to economic recovery in the region, improved (land-based) policing in Indonesia, the 2004 tsunami and the Indonesian Government's settlement with the Aceh separatist movement.

Significant declines in marine-based tourism (4C)

Many of the disruptions to the marine environment discussed above, including climate change, a rise in sea level, marine heating and ocean acidification, could have a significant adverse impact on marine-based tourism, with a consequential impact on human security in several Indian Ocean states.

Tourism forms a key part of several Indian Ocean economies, particularly island states such as Sri Lanka, the Maldives, Seychelles and Mauritius.

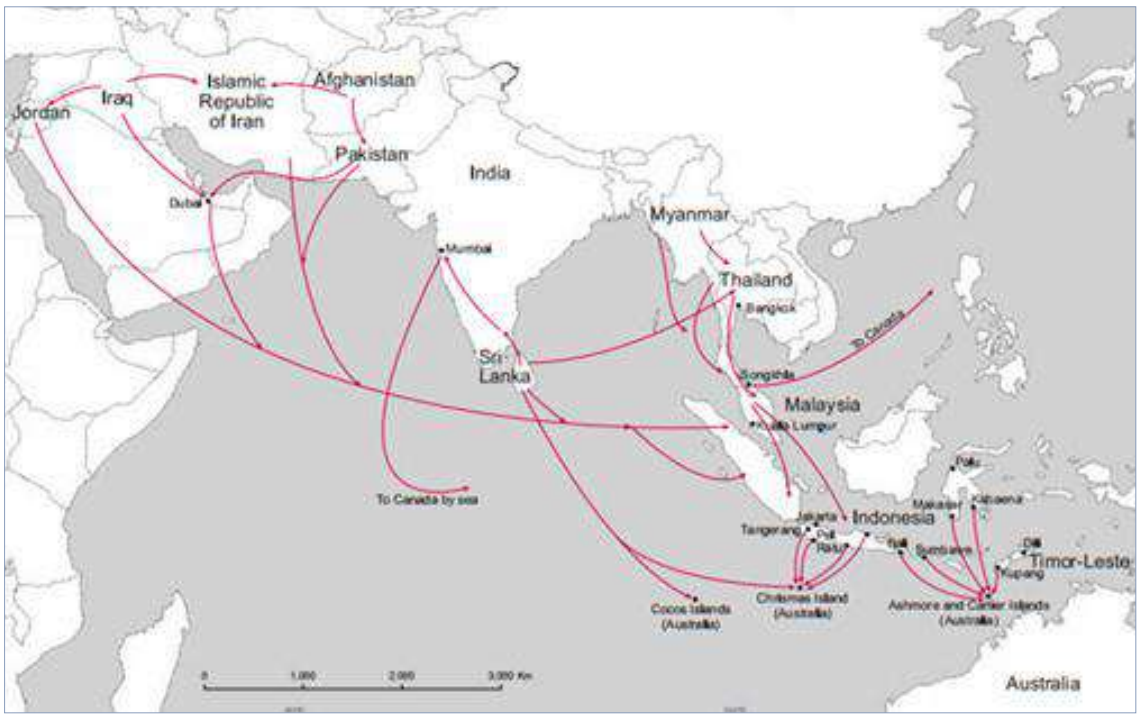
In 2017, the total contribution of the tourism industry was estimated to be 76.6% of GDP in the Maldives, 65.3% in Seychelles, 23.8% in Mauritius and 11.6% in Sri Lanka.[52] With the possible exception of Sri Lanka, all or virtually all of tourism to those countries is marine based.

A substantial deterioration of the marine environment could therefore be expected to have serious economic consequences for those countries, with related consequences for human security.

Unregulated population movements (4C)

Human trafficking and unregulated population movements have been a significant concern to some countries in the eastern Indian Ocean for many years. Those phenomena were associated with civil conflicts in countries such as Sri Lanka, Afghanistan and Iraq, but in the future such movements may be increasingly caused by the consequences of climate change. Figure 10 shows the main routes taken by illegal maritime arrivals across the Indian Ocean up to 2013.

Figure 10: Key routes of illegal maritime arrivals by sea to Australia until 2013



Source: Adapted from UN Office on Drugs and Crime, *Transnational organized crime in East Asia and the Pacific: a threat assessment*, April 2013, 43.

Since the turn of this century, one of Australia's main security focuses in the Indian Ocean has been on unregulated population movements by sea, which has driven considerable investment in Australia's maritime surveillance and enforcement capabilities.

While they have been subject to considerable criticism, the policies instituted by the Australian Government to deter would-be illegal entrants from arriving by boat in Australia largely achieved their objectives, although occasional boat 'turnback' operations continue.[53]

There is every reason to believe that factors pushing migration across the Indian Ocean will continue and quite probably strengthen in the future.

The Global Military Advisory Council on Climate Change identifies displacement as one of the key security threats from climate change in South Asia. According to Bangladesh Government estimates, some 20 million people will be displaced by climate change in that country, while other studies go as high as 30–35 million people.[54]

But the link between climate change and international migration is not clear. According to the IPCC, it is widely established that extreme weather events displace populations in the short term because of their loss of places of residence or economic disruption. However, only a proportion of displacement leads to more permanent migration.[55]

The UN International Strategy for Disaster Reduction states that:

> due to the multidimensional and complex dynamics of migration and displacement, quantitative projections of future trends have low confidence levels, even though there is agreement that climate change will drive future displacement and patterns of movement.[56]

An Australian Senate report commented that the relationship between climate change and migration may be 'non-linear, complex and unpredictable' and 'will not eventuate as straightforward cause and effect.'[57]

Declining marine living resources (5D)

Overfishing (both legal and illegal), together with a variety of environmental factors, is causing a decline in the stocks of fish and other marine living resources.

For countries that are highly reliant on fish as a source of income and protein, the decline in fishing resources could contribute towards economic dislocation, a decline in living standards, violent extremism, political instability and potentially even large-scale population movements out of regions that are highly reliant on coastal and offshore fishing.

A 2013 report by the US National Intelligence Council found that stresses in Indian Ocean fisheries might undermine the internal stability of countries such as Bangladesh, as well as bilateral and regional relations such as those of India–Bangladesh, India–Pakistan and India–Sri Lanka, as fishing becomes an ever more contested activity.[58]

Some disruptions might be mitigated by a significant expansion in aquaculture, but many regions that are currently reliant on wild-caught fishing may not be conducive to the establishment of aquaculture systems.

Growing competition for fish resources (5D)

A closely related, but somewhat different, security threat would arise from growing competition for fishing resources.

The intensification of competition for declining fish resources could create security threats in a variety of ways due to the operation of international fishing management regimes, national agencies and non-state actors.[59]

These can have unexpected consequences. As noted above, the destruction of Somali fishing grounds by illegal fishers around a decade and a half ago was a material reason why impoverished local fishermen turned to piracy.[60]

Competition over access to fisheries will put states under greater pressure to assert claims over and to police their EEZs against other fishers. While EEZ boundaries are now more or less legally settled in the eastern Indian Ocean, the potential for inter-state fishing disputes continues.

This is well demonstrated by the disputes between Indian and Sri Lanka over fishing in the Palk Strait. There a large mechanised Indian fishing fleet depleted fishing resources in Indian territorial waters (including through bottom-trawling) before turning its attention to Sri Lankan waters. The Sri Lanka Navy has taken to firing on vessels that refuse to obey instructions. By one estimate, at least 150 Indian fishers have been killed by the Sri Lanka Navy since 1983.[61]

This dispute has become a major point of contention between the two governments and places significant political constraints on cooperation between them on a range of other issues.

Competition for fish resources may also increasingly involve extra-regional powers such as China, potentially becoming an element in major-power competition in the region. The growth of the Chinese fishing fleet in the Indian Ocean could increasingly become a security issue in several different ways.[62]

Elsewhere, Chinese fishers have used force to prevent interventions by local enforcement agencies. In 2016, a Chinese fishing boat tried to ram an Argentine coastguard vessel as it sought to evade arrest in Argentina's EEZ.

In another instance in 2016, Chinese Coast Guard vessels intervened in or near Indonesian territorial waters in the South China Sea to forcibly free a Chinese fishing vessel that had been detained by Indonesian authorities.

Contests between state agencies over access to fishing resources may increasingly meld into 'grey zone' operations in the maritime domain.[63]

Competition over declining fish stocks could therefore become a factor in growing strategic competition between China and others in the region.

Fishing disputes may also increasingly involve non-state actors. In the western Indian Ocean, there has been a growing use of armed private security contractors on fishing boats.

Fishing enforcement disputes also increasingly involve NGOs such as Sea Shepherd, which has worked with local authorities to catch illegal Chinese fishers in Gabon, Tanzania and Timor-Leste. The presence of such actors in the maritime domain could substantially complicate fishing disputes.

2.3.3 Catastrophic threats

Interdiction of maritime trade by state actors (2E)

An armed conflict between major powers in the Indian Ocean involving, say, the US, China and India could potentially have a catastrophic impact on the region, especially if it involved a substantial interruption of maritime trade (including trade in energy). This may be a disaster for the regional and global economies.

Current strategic competition in the Indian Ocean is to a considerable extent driven by concerns about the security of sea lines of communication. In particular, China is concerned about the interdiction of its energy trade from the Middle East and West Africa, including at the Strait of Hormuz, the Malacca Strait and elsewhere in the Indonesian archipelago.

In theory, in the event of a conflict with China, countries such as the US or India might impose a selective blockade on trade bound for China.

While the impact of a sustained blockade on Indian Ocean maritime trade might be severe for the target country and possibly the world, there seem to be many reasons to believe that the risk is a very low one.

Natural disasters / extreme weather events (4E)

Large-scale natural disasters and extreme weather events are regular occurrences in the eastern Indian Ocean and have the potential to cause massive numbers of deaths, population displacement and material and economic destruction.

The impact of most such events is usually focused on one country or a subregion (such as the Bay of Bengal), although they could potentially affect broad areas of the Indian Ocean, as occurred in the 2004 tsunami.

Natural disasters can also have concurrent or cascading impacts that may be difficult to predict, as was demonstrated by the consequences of the eastern Japan earthquake of 2011, which generated tsunamis and the meltdown of the Fukushima nuclear facility north of Tokyo.

The security impact of natural disasters can also be unpredictable. In the wake of the 2004 tsunami, Tamil separatists in Sri Lanka used the opportunities presented by the chaos and inflow of economic aid to rearm and resume their insurgency.[64]

But the security consequences of the tsunami were very different in Indonesia, which was harder hit. There, the devastation of the Aceh region was a catalyst for the settlement of the long-running separatist insurgency. The destruction of boats used by local pirates in Aceh is also believed to have been a significant factor in the decline in piracy in the Malacca Strait.

The 2004 tsunami also had an unexpected long-term impact on strategic competition in the Indo-Pacific region.

The cooperative efforts of the US, Australian, Japanese and Indian navies in providing relief to countries in the eastern Indian Ocean as part of the ‘Tsunami Core Group’ later evolved into the so-called ‘Quadrilateral’ security grouping among those countries. This group (in its second iteration) is intended to balance China’s regional aspirations.

Perceptions that China responded inadequately to international relief efforts after natural disasters such as the 2004 tsunami (and Typhoon Haiyan in the Philippines in 2013) have led to a greater understanding in Beijing of humanitarian assistance and disaster relief operations as an important form of soft power.

In 2010, the Chinese hospital ship *Daishan Dao* (Peace Ark) deployed on a three-month mission to the Gulf of Aden to provide medical treatment in Djibouti, Tanzania, Kenya, Seychelles and Bangladesh.

In the future, we may, for example, see increased deployments of Chinese helicopter carriers to the Indian Ocean to provide it with further options to respond to future natural disasters.

An increased participation by China in disaster relief efforts in the Indian Ocean may provide opportunities for cooperation and confidence building.

However, outside efforts to provide assistance in natural disasters will not always be welcomed. Some countries may resist external efforts to provide aid, fearing the presence of foreign aid workers or military.

In 2008, the government of Myanmar refused many international offers of assistance following Cyclone Nargis, which caused around 138,000 deaths. The government initially prevented the entry of foreign aid workers. It also refused to allow naval vessels and military aircraft from France and the US to deliver relief supplies, although Indian naval ships and aircraft were permitted entry, reflecting that country's close relationship with Myanmar.[65]

Among other things, this points to the value in using broad coalitions, which may benefit from close or trusted relationships of one of the partners, to deliver assistance.

The level of preparedness for natural hazards can significantly affect the impact of those hazards on human security**.** A case study for a 2012 IPCC special report on extreme events and disasters compared the impact of Cyclone Nargis in Bangladesh in 2007, which caused around 3,400 fatalities, with that of Cyclone Sidr in Myanmar in 2008, which caused 138,000.[66] It concluded that the difference in fatalities was largely a result of the Bangladesh Government's disaster risk reduction efforts, including constructing cyclone shelters, improving forecasting and warning capacities, establishing a coastal volunteer network and the government's coastal reforestation program.

In recent years, there has been increased emphasis on disaster risk reduction, which includes building national resilience.

Australia upholds the principles of the Sendai Framework for Disaster Risk Reduction 2015–2030, and a significant proportion of Australia's overseas aid efforts are directed to the broader issues of disaster risk reduction and building the capacity of the wider international system and countries to respond. This strategic focus recognises the crucial importance of building partner-country resilience to external shocks.

Building national resilience to disasters is likely to be an important agenda item at the Asian Ministerial Conference on Disaster Risk Reduction to be held in Brisbane, Australia, in 2020.

2.4 Mitigating impacts and managing consequences

The Indian Ocean is subject to a very broad range of human and environmental security threats and challenges. They include the impact of strategic competition among major powers, smuggling, piracy, population movements, natural disasters and competition for natural resources.

Often, such threats do not occur in isolation from other security threats. Threats are frequently interrelated, and one event can cascade into a series of other developments. What might initially appear to be a local or isolated development can have much broader strategic impacts across the region.

An important element in managing and mitigating these disparate threats and challenges is to provide cooperative responses wherever possible.

One of the greatest weaknesses in the Indian Ocean region is a general lack (or lack of effectiveness) of existing institutional frameworks, meaning that responses to threats and challenges are often uncoordinated or *ad hoc*.

Accordingly, there are many opportunities for Australia and France (and other key countries, such as India) to cooperate in mitigating the impacts and managing the consequences of the threats discussed in Section 2.3.

This section discusses recommendations for:

- cooperative responses to IUU fishing
- building dialogue among coastguard agencies
- building capabilities in maritime domain awareness
- cooperation in maritime safety capacity building
- providing training in port state control enforcement
- cooperation in disaster risk reduction and relief
- cooperation in marine science and the blue economy
- sponsoring the establishment of an Indian Ocean Environmental Security Forum
- addressing gaps in the international regulatory regime for undersea cables.

2.4.1 Cooperative responses to IUU fishing

Australia and France should use their experience in bilateral cooperative fishing enforcement in the Southern Ocean to promote similar bilateral or regional cooperative arrangements elsewhere in the Indian Ocean, potentially including the eastern Indian Ocean.

Australia and France have relatively advanced cooperative arrangements in connection with marine living resources in relation to research, surveillance and enforcement, including the 2005 Marine Cooperation Agreement and 2011 Cooperative Enforcement Agreement, which have largely focused on regions where the countries' maritime jurisdictions lie close together (such as HIMI and Kerguelen Islands).

This provides opportunities for Australia and France to share their experience elsewhere in the Indian Ocean where cooperative surveillance and enforcement arrangements are an attractive way of overcoming capacity constraints.

2.4.2 Building dialogue among coastguard agencies

Australia and France should facilitate greater cooperation among regional coastguard agencies.

The two countries should consider joining with like-minded partners to create arrangements for dialogue, cooperation and training among Indian Ocean coastguards. This could include a dedicated facility for the professional development of senior coastguard practitioners in the region.

The Indian Ocean Naval Symposium currently provides a forum for regional dialogue among Indian Ocean navies. Although it promotes dialogue on a range of maritime security issues, it is almost inevitably navy focused.

Another forum for coastguard agencies—the Heads of Asian Coast Guard Agencies Meeting—involves coastguards right along the Asian littoral from Japan to Australia to Pakistan.

Although the Indian Ocean Rim Association (IORA) recently established a working group on maritime security and safety that could provide a useful forum for discussion of these issues (although there has been almost no discussion in IORA on maritime safety), there is still no forum specifically devoted to dialogue among Indian Ocean coastguards.

Australia and France should consider joining with partners such as India and Indonesia to create a mechanism for cooperation and coordination among Indian Ocean coastguards.

Fruitful issues for that cooperation include IUU fishing and people smuggling, both of which are of importance to Australia.

Australia should also consider establishing a professional development facility for regional coastguards.[67] France would be a natural partner in such an arrangement.

2.4.3 Building capabilities in maritime domain awareness

Another key area of regional cooperation is in enhancing maritime domain awareness (MDA).

Australia's *2016 Defence White Paper* and *2017 Foreign Policy White Paper* both indicated that regional MDA cooperation should have priority in Australia's regional strategy.[68]

In September 2018, the Australian Government announced that it would sponsor the establishment of a regional MDA system in the South Pacific. This is likely to involve close collaboration between Australian and French authorities in New Caledonia.

Australia and France should work together to promote the establishment of integrated national MDA systems in the Indian Ocean, including in countries such as Sri Lanka, Bangladesh and the Maldives.[69] Those national systems could then work more effectively with regional MDA systems being developed by India and others in the Indian Ocean.

2.4.4 Cooperation in maritime safety capacity building

Australia and France, which have the strongest maritime search and rescue (SAR) capabilities among Indian Ocean states, should coordinate their capacity-building efforts among other countries managing SAR regions in the Indian Ocean.

Australia and France have adjacent SAR regions in the southern part of the ocean and frequently cooperate in SAR operations in southern waters.

Both Australia and France can play important roles in assisting other countries with SARs in the Indian Ocean in conducting operations and in capacity building.

The Australian Maritime Safety Authority has recently completed a highly successful multi-year project, working with counterpart agencies in Mauritius, the Maldives and Sri Lanka to help establish integrated national SAR centres in those countries.

Such efforts can be repeated and expanded across the Indian Ocean, potentially in coordination with relevant French agencies.

2.4.5 Providing training in port state control enforcement

Port state controls can make an important contribution to mitigating environmental degradation and promoting maritime safety and security in the Indian Ocean; 21 Indian Ocean states, including Australia and France, are members of the Indian Ocean MOU-PSC.

However, the effectiveness of this arrangement is currently limited due to the severe capability limitations of many countries.

Although countries such as Australia and France have the ability to enforce port state control measures, an effective regional system requires enforcement across the region.

From 2013 to 2016, Australia funded regional training in port state control measures through the Indian Ocean MOU-PSC. This was a successful and a very economic way of improving port state control in states with limited capabilities.

There are significant opportunities for Australia, France and other partners to cooperate to build capacity in other members of the Indian Ocean MoU-PSC to assist them in lifting inspection rates and making inspections more effective.

2.4.5 Cooperation in disaster risk reduction and relief

Cooperation in disaster relief is one way for strategic partners to work together and provide significant benefit to the region.

As noted above, coordination among the US, Indian, Australian and Japanese navies in providing humanitarian assistance in the region following the 2004 tsunami was an important step in the later formation of the Quadrilateral security grouping.

Australia, France and other key states, such as India, can cooperate in providing assistance and relief to other countries in the region.

Australia frequently works with its partners in Southeast Asia, France often assists island states in the southwest Indian Ocean, and India helps countries such as Bangladesh, Sri Lanka and the Maldives, but disaster relief in the Indian Ocean region is usually provided on a purely bilateral basis and multilateral coordination may only be *ad hoc*.

In the Indian Ocean, there is considerable scope for developing framework arrangements between Australia and France and other key Indian Ocean states, such as India.

Those arrangements could draw on the experience of ASEAN disaster management arrangements, as well as the FRANZ arrangements that have been used successfully in the South Pacific since 1992. Under the latter arrangement, Australia, France and New Zealand exchange information to ensure the best use of their assets and other resources for relief operations after cyclones and other natural disasters. Australia and France currently participate in information sharing as part of the Indian Ocean Tsunami Warning System.

There are also opportunities for Australia and France to share information and experience in implementing regional resilience strategies, including France's experience and lessons learned from participating in the South West Indian Ocean Risk Assessment and Financing Initiative among the islands in the southwest Indian Ocean

2.4.6 Cooperation in marine science and the blue economy

The blue economy is an important tool for regional engagement. Many Indian Ocean states see it as an important element in their future economic development.

The blue economy therefore provides a valuable means for engagement in the maritime realm that can potentially be expanded into other forms of cooperation, including security cooperation.

Australia has significant blue-economy opportunities in the Indian Ocean, including in aquaculture and the provision of blue-economy services, but its greatest strength may in the field of marine science. Perth is currently a centre for marine science and has the potential to become the marine science and education services hub for the entire Indian Ocean region.[70]

The 2018 *Vision statement on the Australia–France relationship* identified the potential for the two countries to work together on science and technology to pursue their shared mission of preserving coral reefs and related ecosystems around the world.[71] However, cooperation in marine science could also be extended to several other areas (see box).

Australia–France ocean science cooperation

Bilateral ocean science cooperation in the eastern Indian Ocean might include:

- working in the international alliance focused on biology and ecosystems (Sustained Indian Ocean Biogeochemistry and Ecosystem Research)
- implementing of the Indian Ocean Observing System for ocean and climate science research and long-term monitoring
- cooperating in the international alliance operating on physical oceanography and related climate science (Indian Ocean Region Panel)
- working together in the 2nd International Indian Ocean Expedition—a framework for scientific collaboration between Australia and France[72]
- strengthening the 2nd International Indian Ocean Expedition in areas such as bathymetric data on mid-ocean ridges and seamounts, which form hotspots of biodiversity that require management and conservation measures to control fishing and the exploitation of mineral resources
- cooperating with France's Indian Ocean territories in the Indian Ocean Tsunami Warning and Mitigation System's Intergovernmental Coordination Group. The secretariat for the group is based in Perth.

This report recommends that Australia promote cooperation with France in high-level scientific research alliances relevant to the blue economy and climate change, leveraging where appropriate the Intergovernmental Oceanographic Commission Perth Programme Office facility for the Indian Ocean.[73]

2.4.7 Establishment of an Indian Ocean Environmental Security Forum

Australia and France should consider joining with India and other like-minded countries to establish an Indian Ocean Environmental Security Forum. Such a forum could potentially be developed through the auspices of IORA, given its focus on blue economy and maritime security. The Indian Ocean Naval Symposium, an inclusive Indian Ocean maritime security group that France is due to chair from 2020, might cooperate with IORA to promote such a forum.

An Indian Ocean Environmental Security Forum could draw from the experience of the Pacific Environmental Security Forum (PESF) which is sponsored by the US Indo-Pacific Command (USINDOPACOM). Through the PESF, USINDOPACOM has sought to increase understanding of environmental stewardship obligations among militaries in the region and develop into a multilateral civil–military organisation focused on mitigating environmental security threats.

The forum includes military and civilian representatives from numerous Indo-Pacific states and works to understand the geostrategic implications of threats to environmental security and develop adaptation and mitigation strategies to counter the effects of climate change. Representatives have shared lessons learned and best practices, deliberated on topics, participated in group activities and exercises, and conducted site visits to environmental security projects.

The PESF has met annually since 2011, involving countries principally in the Asia–Pacific area (reflecting the boundaries of USINDOPACOM's area of responsibility) and also subregional forums. The inclusive list of participants to regional and subregional forums[74] reflects an apparent effort to use the forum to transcend common geopolitical constraints.

Past forums have been hosted by Indonesia, Australia, the Maldives, Thailand, Fiji, the US, Mongolia and New Zealand. The meetings have covered themes such as climate change adaptation, biosecurity, energy security, water security, food security, noise abatement, installation management, environmental security dialogue, cultural heritage, historic preservation, disaster mitigation and air pollution.

The PESF is currently undergoing a transformation from an event-centric initiative to a non-binding multilateral initiative known as the Pacific Environmental Security Partnership, which is intended to be a sustainable structure for cooperative environmental security.

A similar Indian Ocean environmental security forum, possibly under IORA's auspices, focused on environmental threats across the entire Indian Ocean region would provide a forum to create shared understandings of environmental security threats and help establish habits of dialogue in the field of environmental security.

2.4.8 Addressing gaps in the international regulatory regime for undersea cables

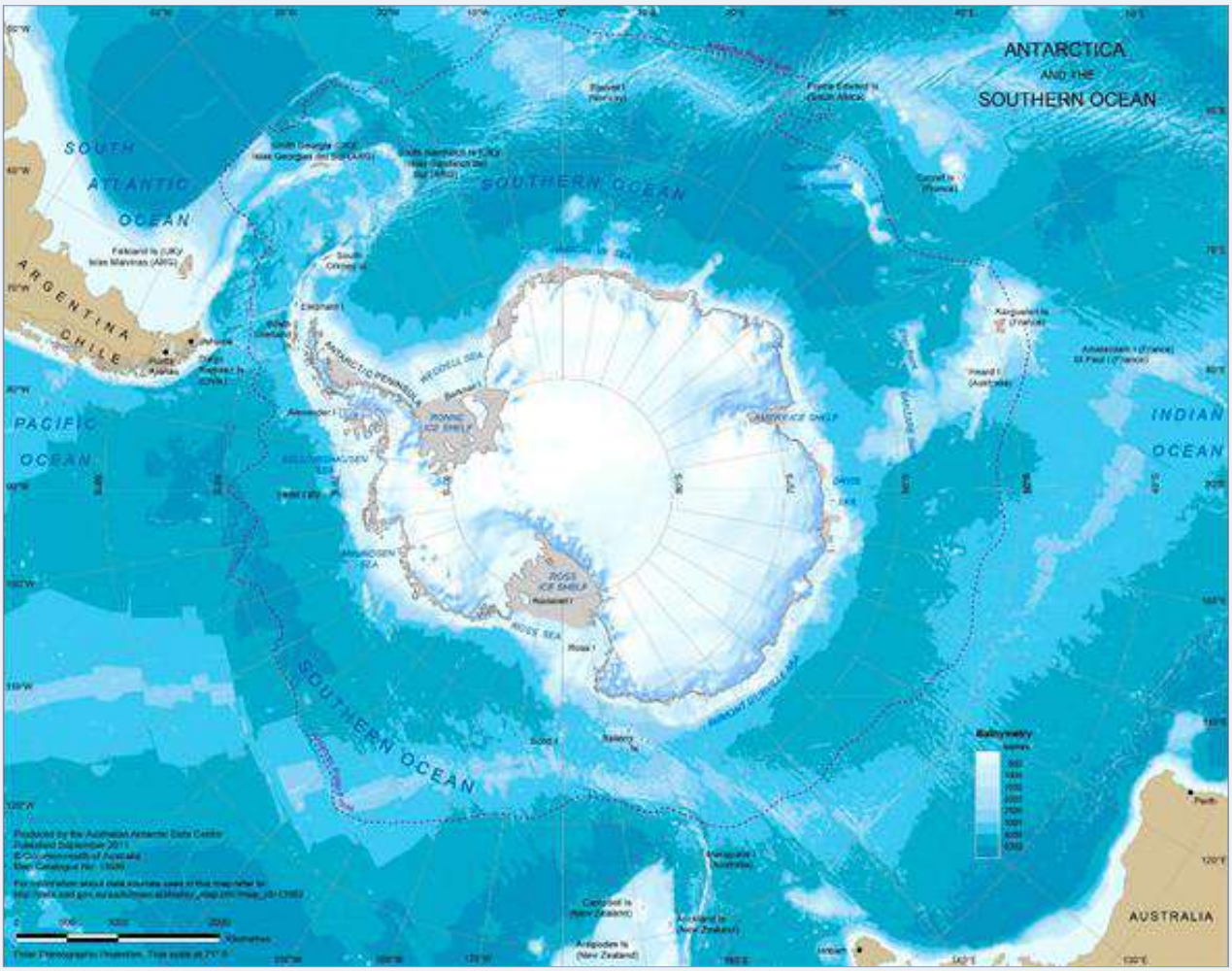
International law, such as UNCLOS, is highly deficient when it comes to ensuring the security of undersea cables in that it does not give states adequate jurisdiction over offenders, the ability to board suspect vessels or the ability to protect cables on land, and is not consistently enacted domestically by all nation-states.

Australia and France could consider exploring international agreements to fill these gaps.

3. Southern Ocean and Antarctica: the area south of latitude 60°S

This section of the report takes as its geographical focus the area south of latitude 60°S (Figure 11), although we discuss the Commission for the Conservation of Antarctic Marine Living Resources (CCAMLR) and note that in some places the CCAMLR area extends further north.[75]

Figure 11: Antarctica and the Southern Ocean



Source: Australian Antarctic Division.

We examine a range of threats and challenges in the Southern Ocean and Antarctica to predict how environmental security in the region might evolve over the next decade.

Under the project proposal, the area considered in this section of the report was a joint Australian and French responsibility.

We note that there are some environmental security threats within the region that are interconnected with the eastern Indian Ocean, including climate change, long-term conservation and the sustainable use of fishery resources.

3.1 The changing strategic environment

Both France and Australia are increasingly considering Antarctica and the Southern Ocean through a strategic lens, closely focused on the integrity of the ATS.

The French Navy has a new polar patrol vessel, *L'Astrolabe*, ensuring the logistic supply by sea of the Dumont d'Urville and Concordia scientific stations, in accordance with the framework defined by the ATS.

L'Astrolabe is the result of a partnership between the French Navy, the French Administration for Sub-Antarctic and Antarctic Territories and the French Polar Institute 'Paul-Emile Victor'.

L'Astrolabe can be deployed to support Australia's research station on Macquarie Island as part of broader logistics-sharing agreements between Australia and France.

Since the first expeditions of Dumont d'Urville in the 1820s, France has consistently maintained a significant interest in Antarctica, not only because of its overseas territories in the region, but also because of Antarctica's great value for scientific research. In recent years, France has appointed an ambassador dedicated to the polar regions.

Australia asserts Australian sovereignty over 42% of the Antarctic continent.

Australia has made greater efforts in recent years to identify and deliver its Antarctic strategic interests in the region with the Australian Antarctic Strategy and 20 Year Action Plan released in April 2016.[76]

Australia is now more focused on matching its Antarctic aspirations with action and carefully directed investment.

Australia has declared a 200-nautical-mile Australian Fishing Zone off the Australian Antarctic Territory, but enforces it only against Australian nationals and Australian vessels.

Australia has SAR responsibilities for a large part of the Southern Ocean, stretching down to the Antarctic continent.

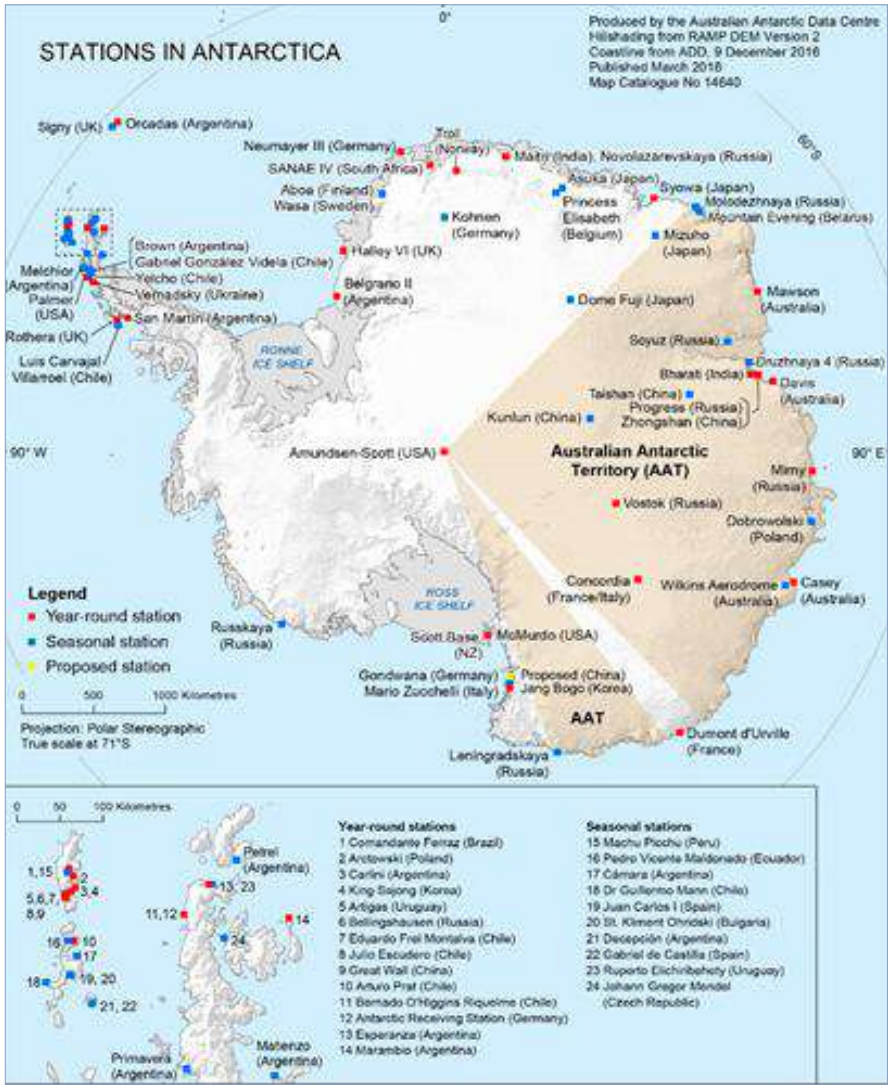
The Antarctic Treaty demilitarises all of the region south of 60°S. Neither Australia nor France needs to maintain or mobilise substantial military assets for potential conflicts in the area, other than in support of civilian activities.

Australia has substantial political, diplomatic, scientific, economic and environmental protection interests in Antarctica and the Southern Ocean.

Canberra's decision to construct a new icebreaker to replace the ageing *Aurora Australis* is a significant investment in Australia's Antarctic future. The new vessel will be ready in 2020.

Australia has three permanent year-round stations (Davis, Casey and Mawson); one large seasonal facility at Wilkins Aerodrome to support intercontinental air transport; three seasonal ski-ways to support intracontinental air transport; and a number of other field camps (Figure 12).

Figure 12: Stations in Antarctica



Source: Australian Antarctic Division.

In recent years, Australia has made new commitments, such as rebuilding the research station on sub-Antarctic Macquarie Island and renewed Antarctic science funding. In February 2019, the government announced $450 million in new capital funding for stations and supporting infrastructure.[77]

Since 2015, Australia has expanded its new heavy-lift air capabilities through military support for its Antarctic operations.

In 2018, Australia announced its intention to build the first paved runway in eastern Antarctica near Davis research station, Australia's southernmost Antarctic research station, subject to environmental approvals.

The total capacity of Australia's research facilities far exceeds that of other nations in East Antarctica. That said, over Antarctica as a whole, Australia's presence is less than that of some other influential nations.

Antarctic science is an integral part of Australia's and France's Antarctic engagement; for example, it reveals much about the weather and climate in Australia's key agricultural regions.

3.1.1 The strategic environment

A range of factors are shaping the strategic environment in Antarctica and the Southern Ocean.[78]

The continued rise of China is now a leading influence on the future environment of the region. China sees near-term economic opportunities in Antarctica, such as fisheries, tourism and bioprospecting. It is pushing for greater status in Antarctica.

In East Antarctica, China has one permanent year-round Antarctic station, Zhong Shan in the Australian Antarctic Territory (AAT). It also has one other year-round station, Great Wall on the Antarctic Peninsula. It has a seasonal field station on the route to Dome A (Taishan) and a seasonal field station (not used every season) at Dome A (Kunlun). Both of them are in the AAT. China is building a fifth station on Inexpressible Island in the Ross Sea region.

China has a new Antarctic icebreaker and is building its first polar cruise ship.

China's National Nuclear Corporation has put out a tender for the nation's first nuclear-powered icebreaker.[79]

There are also trends towards other parties undertaking a larger number of activities in Antarctica. Peru, for example, will increase the number of its expeditions and develop a permanent base there (the current one operates only during the summer). Chile's air force is to run a new base in Antarctica.

After a period of decline, Russia is looking to reinvigorate its Antarctic program and presence. In recent times, the Russian Navy has been back in Antarctica undertaking hydrographic survey work. Russia has been improving its Antarctic research stations and constructing new research vessels for both Arctic and Antarctic operations.

3.1.2 Pressures on the Antarctic Treaty System

The ATS comprises the treaty itself, the Environment Protocol attached to it, two independent conventions (one on sealing and one on the conservation of Antarctic marine living resources), and a corpus of hundreds of legally binding measures and conservation measures from the meetings of parties.

Twenty-nine decision-making states attend Antarctic Treaty Consultative Meetings (ATCMs), and 24 member states and the European Union make decisions in CCAMLR meetings.

The Antarctic Treaty is a successful and effective international instrument, providing a stable framework for collaborative governance. It has provided a means for geopolitical interests to be managed within the framework of international collaboration and commitment to avoiding discord.

However, the growing number of signatories has made the system unwieldy, particularly in view of the tradition of consensus decision-making. In 1980, just 12 countries had 'consultative' status to make the key decisions on treaty matters, but that number has since risen to 29. The number of permanent scientific research stations—a proxy for Antarctic interests and activity—has grown to more than 75.

The expansion of membership of the Antarctic Treaty and CCAMLR has seen some of the norms of the ATS being challenged. That is particularly the case in CCAMLR, where some members have put forward views on fisheries that fundamentally challenge the conservation principle of the organisation. Indeed, the case is worse than this in some respects: consensus decision-making has also been questioned, which goes to the heart of the way decisions are made within the ATS.

Geopolitical interest is growing. Iran,[80] Turkey, Pakistan, the United Arab Emirates and Indonesia are now expressing greater interest in Antarctica. Turkey established a temporary base on the Antarctic Peninsula during the 2018–19 season. Using Ukraine's Antarctic base, Turkey has sent its first expedition to Antarctica.

In CCAMLR, China has pressed for reduced environmental safeguards and taken an unsupportive view of marine protected areas (MPAs).

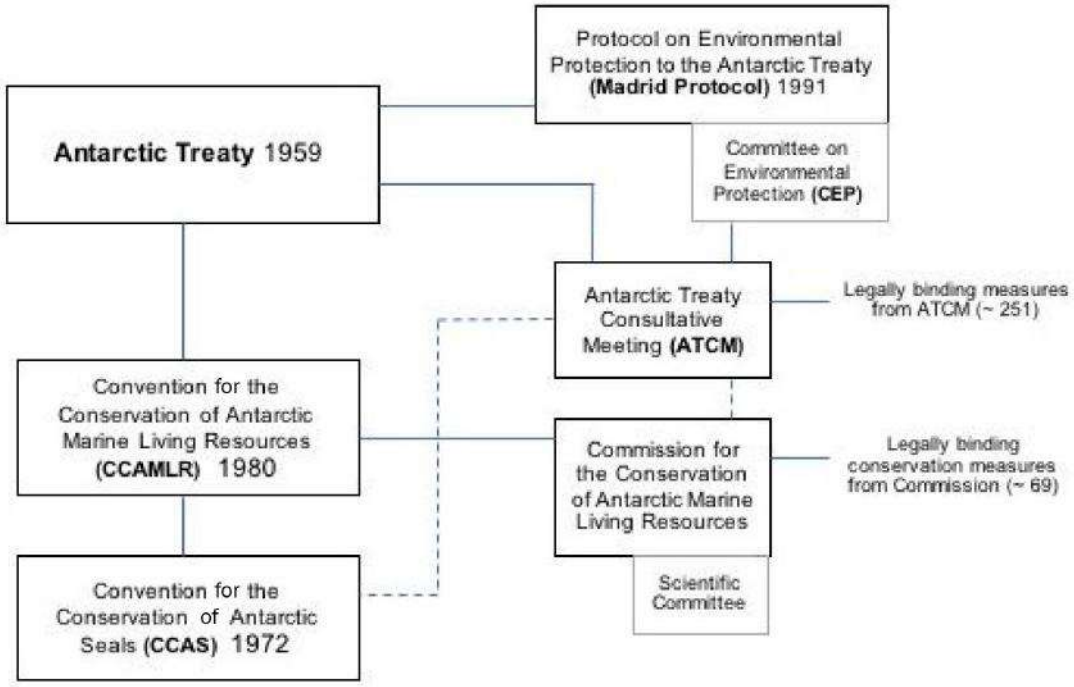
There will be greater pressure on the Antarctic system as parties negotiate responses to the consequences that climate change will bring to the marine environment and the region's living marine resources.

However, the direct and indirect impacts of environmental change are not likely to lead to the collapse of a system that has been resilient over many decades.

The challenge for Australia and France will be to work together within and outside the ATS to do what they can to regulate human behaviour in order to decrease detrimental impacts on ecosystems under stress from changes in natural systems.

The governance arrangements for Antarctica and the Southern Ocean are shown in Figure 13.

Figure 13: The Antarctic Treaty System



As long as the parties accept and maintain commitments to the norms and principles of the ATS, some tensions can be constructive. Australia and France have a major interest in ensuring that those norms and principles are maintained.

Australia is the depositary state for the CCAMLR Convention and host state for its headquarters. The viability of the ATS and CCAMLR depends on a willingness to conduct research in support of those organisations.

Both states have made a major effort to encourage accessions to the Environment Protocol and to ensure that this instrument provides a focus for protecting the continent.

Both countries have provided support to new state entrants to join the ATS, and they should continue that support.

Antarctic parties can expect ongoing and increased scrutiny of their actions by non-government groups. Those groups will push for action on agenda items such as tourism, biological prospecting, hard-surface runways (such as the one proposed by Australia near Davis research station) and especially establishing a representative system of MPAs. NGOs will be very focused on pushing for comprehensive environmental assessments of stations and tourism infrastructure.[81]

A significant threat to the ATS is a 'drift' away from support for the system's underlying norms and principles that encourage cooperation and collaboration among all countries with an interest in the region.

Competition for status on the continent, pressure to gain access to resources or failure to address comprehensive environmental commitments could provide the grounds for the erosion of the current norms of the ATS.

Increased interest in the region

Traditional leaders such as the US, the UK, Australia and New Zealand have had long-term influence in Antarctica, but the continent is now becoming more geopolitically contested as an array of countries move to assert greater influence.[82] China's and Russia's interests have already been noted, but India has also increased its polar presence with the futuristic Bharathi base.

As noted above, Turkey has announced that it will build bases. South Korea opened its second Antarctic research base in 2014. Belarus has built 'Mountain Evening' as a seasonal station, and its long-term intention is to make this year-round. Colombia has said that it plans to join other South American nations with bases in Antarctica.

Nations are also pressing ahead with space research and satellite projects in Antarctica to expand their global navigation abilities as well as to assist scientific research and data upload–download abilities.

Resource interest

As climate change takes its toll on Antarctica, more ground around the margins of the continent will be exposed and subject to examination for resource potential.

Some nations hold out hopes for Antarctica's presumed mineral, oil and gas wealth even though the existence of such resources has not been established. Chinese officials, for example, say China's expansion in Antarctica prioritises scientific research, but they also acknowledge that concerns about 'resource security' influence their moves.[83]

Article 7 of the Environment Protocol establishes an indefinite ban on any activity 'relating to mineral resources, other than scientific research'.

The protocol provides no definition of what is or is not 'scientific research' with respect to minerals, but Australia and France should directly challenge the offending party if there is clear evidence of breaches of any component instruments of the ATS.

The Environment Protocol came into effect in 1998 after France and Australia set about convincing the Antarctic Treaty parties to negotiate a comprehensive environmental regime for the Antarctic—one that would ban mining indefinitely. The ban does not, as some suggest, expire in 2048. That would require the unanimous agreement of all the countries that signed the protocol in 1991 or the complete unravelling of the ATS. The ban, however, applies only to states that are party to the protocol, including all the consultative parties.

The ban on mineral exploitation in the Antarctic is a long-term investment that will require assertive diplomacy to maintain.

If there were to be disputes over Antarctic resource development, the issue would be unlikely to ever get to the UN for settlement. That is because members of the ATS have actively opposed any UN involvement in Antarctic affairs, preferring to work within the ATS.

For example, there are dispute-resolution procedures in the treaty in which the last recourse is stated to be the International Court of Justice (Article XI). In the Environment Protocol, there is an arbitral tribunal to deal with disputes and the International Court of Justice (articles 18–20).

Impacts of climate change

Neither Antarctica nor the Southern Ocean is immune from the global impacts of climate change. Moreover, the region also plays a significant part in driving the global climate system, and a better understanding of it can be used to predict broader climate change impacts.

Antarctic ice sheets are on the move, and the ice cap is not only thinning but also being eroded from below, causing the glaciers to accelerate in their advance to the sea.

Haward and Jabour and the Antarctic Climate and Ecosystems Cooperative Research Centre draw upon a range of scientific research to sum up the main trends very well. Their findings are summarised in a chapter in the *Research handbook on climate change, oceans and coasts*.[84]

Climate models indicate that the Southern Ocean will continue to change in response to increased greenhouse gas emissions, producing further ocean warming and freshening, changes in ocean currents, a greater contribution to sea-level rise through glacial melt, and regional changes in the extent and volume of Antarctic sea ice.

While the warming of the Southern Ocean is expected to be at a slower rate than in the Arctic, it will nevertheless be warming faster than many other places around the globe. It is projected to warm at both surface and depth. Warming will profoundly affect cold-adapted marine species.

Over time, reductions in sea ice will reduce 'natural' barriers to shipping access in high latitudes and open up otherwise difficult areas for marine resources harvesting, while allowing increased access to vessels displaced from the now overfished traditional fisheries.

The Southern Ocean connects the world's other ocean basins and thus plays a major role in global ocean circulation. It accounts for about 40% of the total global ocean take-up of anthropogenic carbon dioxide.

The Southern Ocean has a key role in global ocean circulation through the wind-driven Antarctic Circumpolar Current and the movement of water due to temperature and salinity differences.

At the same time, there has been a decrease in ocean pH, making the Southern Ocean more acidic. This affects organisms with carbonate shells and will reduce their and their predators' viability and ecosystem distribution. Acidification also has a range of other effects on the physiology of many marine animals.

Changing oceanic and atmospheric temperatures, and other conditions such as currents and winds, are likely to affect the seasonal pattern of the freeze–thaw cycle around the Antarctic continent and thus the extent, thickness, timing and duration of sea ice. Those changes are not uniform around the continent. Antarctic-wide, the trend over the satellite area has been an expansion in total sea-ice cover but this masks the distinct differences between different parts of the Southern Ocean. Most of the increase in winter sea ice extent is a result of expansion to the north of the Ross Sea. Importantly, there has been a significant contraction in overall winter sea-ice extent, including the Ross Sea, for the past two years.

Climate models project on average that Antarctic sea ice will reduce by 24% in extent and 34% in volume by the end of this century.

Such a decline will have significant influence on global ocean circulation, and hence climate, as well as ecosystem components that rely on sea ice as a refuge, a habitat, a food source, or any combination of the three.

Climate change exacerbates the high risk to Antarctic biodiversity associated with the establishment of non-native species. There will be a need to continue to develop and implement quarantine measures and better understand related consequences.

Changes in the physical environment of the Southern Ocean constitute changes in habitats, which have implications for diversity and Antarctic marine food webs.

Pelagic species may migrate southward (or deeper) as the ocean warms and the winter sea-ice extent declines. Such range shifts may increase competition for fish resources as vessels move from depleted fishing areas into the Southern Ocean, possibly leading to conflicts between crews. In addition, fishing is a global industry. As fisheries are depleted elsewhere, the fishing fleets will take advantage of the opportunity to exploit improved conditions in the Southern Ocean. This may include fishing by nationals not attached to CCAMLR and thus not bound by CCAMLR conservation measures.

There is also, as noted below, the possibility of conflicts between international organisations, such as the Commission for the Conservation of Southern Bluefin Tuna and CCAMLR, when species migrate south.

Fisheries interests

Fisheries in the region target Antarctic krill, Patagonian and Antarctic toothfish and mackerel icefish.

Antarctic krill is the most likely species to sustain very high catches in the region. Although the fishery is currently operating at a low level (approximately 2% of the total catch limit), it is growing.

This fishery could become one of the top 10 wild-caught fisheries in the world in terms of biomass production.[85]

Catch limits for Antarctic krill are set by CCAMLR, which is responsible for conserving the biota and ecosystems of the Southern Ocean. The limits amount to 8.695 million tonnes, although much lower 'trigger level' limits are in place in most areas and total just over 1 million tonnes for the South Atlantic and southwest Indian Oceans.

The catch limit for krill in the southeast Indian Ocean is very conservatively set at 440,000 tonnes, so the maximum allowable krill catch around the Antarctic is closer to 1.5 million tonnes.

These estimates are considered ecologically sustainable at present, but any future changes in system productivity would require adjustments to the catch limits.

Antarctic krill is a resource that will most likely become the centre of increased exploitation well before any push to overturn the prohibition on mining in Antarctica.

It is extremely expensive to go fishing, so the fishery has always been held in check by economic forces. In January 2019, Norway (already the largest krill-fishing nation) completed the construction of the world's first purpose-built 130-metre krill harvesting vessel.

There are few other fisheries in which the allowable catch is set at such a low proportion of the biomass and in which the actual catch is so much lower than that allowed.

Countries such as China and Russia have opposed the establishment of MPAs, seeing such measures as having long-term blocking impacts on potential access to new fisheries in the Southern Ocean. This is also a reaction to what they see as a push by environmental NGOs for MPAs in all oceans.[86]

China and Russia also view CCAMLR now much more as a fisheries management organisation than as a conservation body.

It should be noted that, while MPAs have dominated discussions in CCAMLR recently, they are really only a side issue: the establishment of MPAs to date has not obviously affected marine conservation or fisheries management. Making sure that the krill fishery is conservatively managed is a far more pressing problem.[87]

Illegal, unreported and unregulated fishing

Projected shifts in global fisheries productivity may be expected to increase the incentive for IUU fishing in Antarctic waters.

Diminishing sea ice will mean that IUU fishing closer to the continent will be less risky. Many nations consider there to be large unexploited populations of Antarctic toothfish. They persist in the exploratory fisheries for that reason.

While IUU fishing, especially that targeting Patagonian toothfish, has declined dramatically in the Antarctic, there is always the potential for new players to enter the scene if the economic conditions are right and the risk of apprehension is low.

IUU fishing for krill is at this stage rather unlikely because it is much more capital intensive than the toothfish fishery and there is not an open market for krill.

CCAMLR is already struggling to deal with issues of transhipment, and that could become a bigger challenge. One of the major issues here is not having control over CCAMLR non-contracting parties' transhipment vessels.

Tourism

Increasing tourism does not in itself place increased pressure on the geopolitical framework of the ATS measures and industry self-regulation. Treaty parties cooperate closely to consider and act on issues associated with tourism.

The expansion of Antarctic tourism can be highlighted on a number of levels: visitor numbers, vessel numbers, visited sites, increased use of tourist flights and diversification of tourist experiences.

Antarctic tourist numbers have grown significantly, along with calls for greater regulation. The impact of climate change may make more areas of Antarctica accessible for tourists. Sub-Antarctic tourism remains at a low level other than at South Georgia.

In 2018, the International Association of Antarctica Tour Operators reported that the number of visitors to the region rose to more than 51,000 last season, an increase of 17% on the previous year. That number is expected to keep growing.[88]

Some 20 new polar expedition vessels are under construction to serve the growing interest, adding to the 33 already used by companies that are members of the association. The fastest growing source of new visitors is China. Chinese operators will in time have their own Antarctic tourism vessels, rather than subchartering ships as they do now.[89]

Search and rescue

There is expected to be a rise in marine traffic in Antarctic waters.[90] Recent figures showed that 45 private yachts visited sensitive Antarctic waters over the 2017 southern summer, up by one-third from the previous year. Larger tourism vessels are going south, including into uncharted seas, increasing the risk of maritime casualties.

Australia's very large area of responsibility makes SAR response hard for Australia. This is compounded by reliance on a single ice-capable vessel. When a tourist ship got stuck in Australia's SAR area in 2014, the ice was too thick for Australia's vessel to rescue it. Australia's new polar vessel, which is expected to arrive in 2020, will improve the capability, although the size of the country's SAR zone will continue to be a major challenge.

Under the SAR convention, if a SAR activity is required in a state's SAR region, that state only needs to 'coordinate' the activity. In Antarctica, any kind of vessel anywhere near a SAR incident is likely to be tasked with assisting.

As Antarctic nations enhance their polar programs, with more personnel and greater coverage of land and marine activities, the risk of SAR incidents will increase, even though the International Maritime Organization's Polar Code is now in force and sets out regulations for polar shipping. The code improves the survivability of incidents but does little to reduce the risk of incidents occurring.

Australia's SAR region is vast. It extends east and west of Australia's landmass and penetrates through the AAT to the South Pole. In the Antarctic region, Australia's SAR area adjoins those of New Zealand and South Africa.

For Australia, close coordination between the Australian Maritime Safety Authority, the Australian Antarctic Division of the Department of the Environment and Energy and the Department of Defence, and the effective exchange of information about the availability of shipping and aircraft assets and suitably trained personnel is critical to effective responses.

Of equal importance will be coordinating with other national Antarctic programs active in Australia's SAR region and the Southern Ocean. The Council of Managers of National Antarctic Programs (COMNAP) keeps a register of national program operator assets available for SAR activities.

The trend towards more non-government operators travelling through the Southern Ocean and to Antarctica will continue. Privately funded voyages, fishing operations, tourist operations and independent travellers are expected to increase over time.

Some fishing vessels undertaking IUU fishing in the Southern Ocean are unstable and poorly crewed. They are old, not suitable for the Southern Ocean (including for ice navigation and superstructure icing) and have a poor safety record.

There is now a move towards industry organisations imposing their own safety restrictions on fishing vessels.

That will have significant environmental and safety considerations and require the revision of arrangements for air traffic management, emergency accommodation, medical facilities and medivac capability.

Military developments

Article 1 of the Antarctic Treaty provides that Antarctica 'shall be used for peaceful purposes only'. It prohibits 'any measures of a military nature, such as the establishment of military bases and fortifications, the carrying out of military manoeuvres, as well as the testing of any type of weapons'. However, it allows the use of military personnel or equipment for scientific research or for any other peaceful purpose.[91]

A number of Antarctic countries, including Australia and France, use military personnel in support roles in Antarctica, but in doing so conform to Article VII of the treaty, which requires a party to the treaty to inform other parties of the details of any military personnel or equipment introduced into Antarctica.

It is difficult to define 'measures of a military nature'. Such measures do not necessarily have to be carried out by military personnel. Scientific research and development for military purposes may be carried out by civilian scientists and private-sector contractors.[92]

Satellite technology is now central to Antarctic operations and research. The inland environment of Antarctica is optically very clear and ideally suited for astronomic and space research. It is also remarkably quiet, with little human radio interference.

With technological developments in information processing, nanotechnologies and astrophysics, research is now possible in Antarctica that was inconceivable in past years. Much of that research also has military applications.

The continent is sometimes seen as having special value for military space capabilities, given that many satellites cross over it. The accuracy of China's Beidou and Russia's GLONASS GPS-like systems, which have few ground stations in the Southern Hemisphere, would improve with the use of ground stations in Antarctica.

But, as Claire Young argues:

> Beidou's accuracy has already been improved by international testing, including from a GPS and Beidou-capable international ground station in Perth. As Beidou installs more ground stations around the world—in Pakistan, Thailand and likely Brazil—the station in the Australian Antarctic Territory is likely to make very little difference. More broadly, Beidou is a legitimate dual-use system under the Antarctic Treaty, just like Norway's Trollsat (part of the EU's Galileo). Beidou's military applications have removed the risk that China ran in relying on GPS in the event of hostilities in the South China Sea. However, that shift occurred when Beidou achieved regional coverage in 2012, before the ground station in the AAT was constructed in 2014. And if major hostilities broke out between the US and China, GPS and Beidou would be attacked in space and cyberspace long before anyone worried about ground stations in Antarctica.[93]

Remote sensing is a legitimate scientific activity enabling long-term monitoring in Antarctica, as it is safer and easier than taking measurements directly.[94] Most remote monitoring systems in Antarctica are developed as international networks. Many countries are investing more in this, but as part of global networks.

China is working within international monitoring frameworks, including on geomagnetics, upper atmospheric research and astronomy, but there is now greater interest in the development of a Chinese networked polar observation system. As one former Australian intelligence analyst has pointed out:

> In its 13th five year plan Part IX, Beijing listed 'the development of real-time online monitoring systems and overseas observation (monitoring) stations for the marine environment' as one of its major aims, not just for the Antarctic but for the ocean as a whole … Australian policymakers need to advise Antarctic scientists on whether the remote observation systems they're using in collaboration with the Chinese are sharing technology we'd rather keep to ourselves.[95]

A key issue here is whether the verification and inspection regime under the Antarctic Treaty is capable of assessing whether research activities are being conducted for non-peaceful purposes.

This is an area where Australia and France could cooperate to get better adherence to the verification and inspection regime and more transparency in reporting than has been the case to date.

Parties are able to inspect any part of a station, its equipment and installations. Once they have undertaken inspections, they submit a paper to the annual Antarctic Treaty Consultative Meeting (ATCM), reporting on the findings of that inspection, including issues regarding access or otherwise to facilities. Inspected parties can, and generally do, then respond to those findings formally at the ATCM.

3.2 Risk assessment matrix

Table 3 is a risk assessment matrix that summarises the likelihood and consequences of the threats and challenges discussed in Section 3.

It is very important to consider the interactions between the risk elements leading to cascading effects in the future.

Issues assessed and placed towards the top left corner of the matrix are either negligible or unlikely and are generally well covered by existing processes of cooperation and dialogue within the ATS.

Those in the bottom right corner are the ones that give most grounds for concern, particularly ones in the 'possible' and 'likely' rows, which have a higher probability of occurring.

Each of the threats and challenges is listed with an alpha-numeric reference (likelihood and consequence) as per the risk assessment matrix in Table 1.

Table 3: Risk assessment matrix for the area south of latitude 60°S

Issue/disruption	A Negligible (no disruptive effects; 'business as usual')	B Minor (regional tensions increase temporarily; situation is manageable within existing processes)	C Significant (conflict is temporary and generally constrained by existing arrangements)	D Major (significant disruption; limited to areas)	E Catastrophic (significant widespread disruptions)
1 Rare (most unlikely but might occur in exceptional circumstances)	• Whaling in the Southern Ocean	• Iceberg harvesting			
2 Unlikely (unlikely to occur without significant change in current circumstances)			• Offshore drilling and mining		• Conflict or war due to occupation of Antarctic territory and increasing militarisation
3 Possible (can occur in most circumstances in the foreseeable future)		• Geoengineering in the Southern Ocean • Extreme atmospheric changes (human induced through geoengineering)		• Threats to the Antarctic Treaty System • Displacement of fishing fleets • Krill exploitation	
4 Likely (will occur in current circumstances)		• Changes to Antarctic tourism • Pressures from new treaty members	• Increased danger and frequency of search and rescue operations	• Distant-water fishing fleets	
5 Almost certain (already occurs regularly)			• Ocean acidification	• Climate change impacts on Antarctic infrastructure and accessibility	• Climate change related marine ecosystem change • Illegal, unregulated and unreported fishing

3.3 Threats and challenges

3.3.1 Minor and negligible threats

Changes to Antarctic tourism (4B)

There will be continued growth in large-scale tourism that creates potential for disturbances to ecosystems. There will need to be strengthened protocols for how people visit Antarctica. Chinese tourism is expected to markedly increase.

China is expected to displace the US as the leading source of visitors to Antarctica (it is currently second).

Tourist operators are increasingly seeking new and unique experiences in the region. For example, there is periodic interest in tourism visits to Heard Island. Another example is increased interest in land-based tourism, such as that provided by companies such as White Desert.[96]

New tourism means greater potential need to deploy SAR capabilities. In the worst case, there would be a repeat of cruise ships getting into accidents in the Antarctic region.

Geoengineering in the Southern Ocean (3B)

Increasing impacts from climate change are already driving broader attention to geoengineering proposals in the region.

Carbon dioxide removal (geoengineering)—the proposal to counteract anthropogenic climate change by large-scale removal of carbon dioxide from the atmosphere—is playing an increasingly prominent role in the modelling that informs international climate change policy.[97]

Even if oceanic geoengineering were to be part of the solution, it would most likely come with unforeseen ecological impacts and consequences across the marine environment.[98]

However, there is currently a lot of research underway on the efficacy and impact of geoengineering projects. Artificial iron fertilisation is at present the only realistic geoengineering proposal for the Southern Ocean, although this research is mostly north of latitude 60°S.

There are many unknowns when it comes to the effects of iron fertilisation, including regional and global ecosystem impacts. Also unknown are the possible impacts on ship operation, including the tracking of subsurface vessels.

Geoengineering in the atmosphere (3B)

There is a potential for extreme changes to the atmosphere in the region, largely resulting from geoengineering activities.

There is increased interest in the feasibility of solar radiation management and ice-sheet stabilisation strategies.

Such ideas have been a 'no-go zone' for scientists and policymakers in the past, but are increasingly being considered in view of mitigation strategies needed to respond to slow action on climate change.

Iceberg harvesting (1B)

South Africa,[99] the United Arab Emirates[100] and Saudi Arabia have been interested in harvesting icebergs as a source of freshwater.

There are challenges in the economic and logistic feasibility of such proposals, but one worry is the introduction of vessels into the region to possibly harvest icebergs (ice is excluded from the ban on mineral resources under the Environment Protocol) by players that are not part of the ATS.

Whaling in the Southern Ocean (1A)

One of the major changes in the Antarctic marine ecosystem over the next two decades will be the recovery of the great whales.[101] This will have huge ecological effects and may encourage some countries to re-examine the prospect of commercial whaling.

There is still some, albeit small, possibility that some traditional whaling states may resume whaling in the Southern Ocean. Apart from the ecosystem impacts on recovering whale populations, this issue raises other concerns, such as impacts on SAR operations (if we were to see dangerous tactics by environmental protest groups).

Pressures from new treaty members (4B)

There is a gradual increase in interest from countries seeking to become involved in the ATS. Iran, for example, has recently expressed interest in becoming a party to the treaty.

This interest originated in Iran's scientific community, the members of which wish to study the region, but Iran would need substantial capacity building to participate effectively. Iran's presence in the ATS could be perceived as problematic for some current treaty parties.

New players could well change the dynamics, particularly if their Antarctic presence qualifies them for consultative party status and a role in consensus decision-making. As an Antarctic Treaty Consultative Party (ATCP) can veto any decision, there would be reluctance to embrace a state that might be disruptive (just as there would be reluctance to allow a state to disrupt the ATS from outside the system).

3.3.2 Major and significant threats

Offshore drilling and mining (2C)

Due to the mining ban in the Environment Protocol, offshore drilling in the Antarctic is at present a non-issue. However, it is a prominent issue in the Arctic. There are potentially resources on the continental shelf in Antarctica, where offshore hydrocarbons have been identified.

The ban does not apply north of 60°S, as those areas are outside the Antarctic Treaty area.[102] The protocol applies south of 60°S (Article V of CCAMLR).

CCAMLR can assert its authority in this regard but only if it believes that seabed mining could affect marine living resources. It will need to at some point. This is critical for the security of Australian and French interests in the region.

There are practical challenges of distance to markets and the need for the price of oil per barrel to be extremely high to make offshore drilling economically feasible.

A warming climate might be expected to expose mineral resources currently buried by ice, although this would only be an issue for high-value materials (such as rare earths) not readily obtainable elsewhere. Technological advances in coming years will ease the task of mining in such a frigid environment (as has taken place in the equally frigid Arctic).

If someone does discover something of value in an accessible area, a way will be found to extract it if is economically and politically viable to do so. Ultimately, resources of sufficient strategic or economic value will be exploited in a resource-hungry world.

In any event, the existing mining ban applies to all the parties to the Environment Protocol, and there are stringent provisions for reviewing the ban if there is less than consensus on lifting it.

Threats to the Antarctic Treaty System (3D)

As indicated above, the competence of CCAMLR is being tested. China prefers a limited role for CCAMLR in conservation, even in managing fisheries.

Other countries have varied views on CCAMLR's competence depending on the issues. The addition of new members from among developing countries may revive the push for the ATS to adopt UN approaches towards benefit sharing.

Such a complex issue is at the heart of difficulties in managing exploratory fisheries and determining how 'allocation' may be pursued in the future. Who has the right to how much catch? How will fishers be controlled when IUU fishing will become increasingly easier after climate change impacts?

The ability of countries to respond to impacts in the environment posed by activities in the Southern Ocean is served by the continuing robustness of the ATS, but other organisations could become involved in the Southern Ocean due to shifts in species distributions induced by climate change.

There are other non-climate change related factors that may affect the ATS, such as current negotiations for a binding implementing instrument on the conservation and sustainable use of marine biological diversity of areas beyond national jurisdiction (BBNJ).[103]

While we cannot predict the outcome of negotiations that are currently underway, the BBNJ instrument has the potential to destabilise the ATS due to differing opinions among countries about the instrument's area of application.

Some countries have argued that the BBNJ instrument should apply to all areas beyond national jurisdiction, without recognising existing legal and institutional frameworks.

Australia and France argue that the Southern Ocean and Antarctic region are already served by the ATS, which manages biodiversity issues through CCAMLR and the Environment Protocol. Marine living resources are covered by CCAMLR conservation measures.

From this perspective, the BBNJ instrument is to fill gaps where they exist, but not in the Southern Ocean.

Attention must continue to be given to ensuring the continuing stability and robustness of the ATS and its existing architecture and norms of operation. If there are increased threats to the stability of the ATS, there will be more conventional inter-state competition.

Increased danger and frequency of search and rescue operations (4C)

There are environmental and broader implications of increased emergencies and incidents in the Southern Ocean and Antarctica due to increased human traffic.

The International Code for Ships Operating in Polar Waters does not apply to many vessels now attempting to access Antarctica. The Polar Code does not apply to yachts, fishing vessels and vessels on government service. Protest vessels are only subject to the code if they are SOLAS-rated.

Other drivers affecting SAR operations include weather conditions on a local scale increasing the frequency of and danger involved in delivering SAR services. All vessels operating in the Southern Ocean are at risk from weather conditions, ice and emergencies such as fire. The risks are not specific to non-Polar Code vessels.

Changes in Antarctic tourism will have impacts as the ageing cruise ship fleet is retired and if new Polar Code vessels are introduced.[104] The introduction of new players into the region, including universities hiring their own research vessels, wealthy individuals chartering vessels and an observed rise in the adventure tourism market more generally, will add pressure.

There are real and tangible signs of increased marine traffic in the region, and the greater the intensity of marine traffic, the greater the likelihood of incidents.

Ocean acidification (5C)

The Southern Ocean is one of the world's largest carbon dioxide sinks and one of the areas most vulnerable to ocean acidification.[105]

Increased carbon dioxide in the atmosphere has led to changes in the acidity of the Southern Ocean and has the potential to degrade the ocean's marine life and ecosystems.

The range of possible disruptions caused by ocean acidification include impacts on phytoplankton species.

Changes to the pH of the Southern Ocean could prevent krill finishing their life cycles, threatening the krill fishery and causing declines in the abundance of predators. That said, the latest research suggests that some life stages may be vulnerable but that krill are more resilient than first thought.[106]

Displacement of fishing fleets, leading to overfishing (3D)

The management of surplus fishing-fleet capacity is a global problem. In the future, the Southern Ocean may be affected by the displacement of fishing fleets in other parts of the Indian Ocean, despite CCAMLR rules designed to ensure that it does not occur (exploratory fishing has to be approved). Such displacement may pose real challenges to existing mechanisms for fisheries management in the Southern Ocean, as occurred in the 1990s and 2000s with the Spanish fleet.

This will also have implications for bycatch management, including for mitigating the bycatch of seabirds.

Two recently established regional fisheries management organisations (RFMOs)—the Southern Indian Ocean Fisheries Agreement and the South Pacific Regional Fisheries Management Organisation—are creating some monitoring, control and surveillance issues for new Patagonian toothfish harvesting in their areas of application. In part, this is because some fish stocks outside the CCAMLR area straddle CCAMLR and other RFMOs' areas.

CCAMLR is now looking at how to take into account fisheries management actions taken outside CCAMLR's convention area. The key issue is that there are no effective management measures outside that area. These are essentially unregulated or underregulated fisheries.

There will be a need, for example, for CCAMLR to examine how it could work with other RFMOs to effectively manage toothfish, even though it would seem that there is little scope for any expansion in toothfish harvests. (There are no known valuable fish resources elsewhere in the Southern Ocean.)

The primary goals should be to ensure that Antarctic marine living resources are not depleted and that the objective of CCAMLR is not compromised by the fishing of straddling stocks outside the CCAMLR area.

There is also the broader issue of how CCAMLR will address climate change induced migration shifts of fish species such as southern bluefin tuna (SBT) southward, where they are expected to be exploited in the CCAMLR area.

These shifting migrations will have implications for national interests and for relations among RFMOs, such as between CCAMLR and the Commission for the Conservation of Southern Bluefin Tuna (CCSBT), between which there is a memorandum of understanding.

One encouraging development here is that, from January 2019, China has agreed that it will not retain any SBT in any area and will not fish in certain areas.[107] This implies that China will eventually join the CCSBT. It is illegal under the tuna RFMO laws to catch SBT without a quota. This is a problem for China now because it is a member of all the other tuna RFMOs, which cover many SBT fishing areas.

Krill exploitation (3D)

Krill is an underexploited resource in East Antarctica. The krill fishery could contribute to food security, both directly as a food source and indirectly as feed for the aquaculture industry.

Trawl vessels currently catch krill for three purposes: for pharmaceuticals, for food markets and for aquaculture feed (this low-value product dominates the catch).

The fishery has reached approximately half of the allowable catch (620,000 tonnes a year) in the South Atlantic, but there are considerable political, operational and physical barriers to the fishery in that region getting much larger.

Off the Antarctic Peninsula, there remain local hotspots where the catch reaches its limit (the subdivided trigger level) each year. The industry now has voluntary closures to accommodate additional pressure from other activities in the area, such as tourism (the closures, which are meant to avoid tourists seeing vessels fishing, are a UK initiative).

This may well push fishers to move to East Antarctica, notwithstanding the increased cost of fishing operations there.

China has already begun investigating fishing grounds in the southern Indian Ocean, but there are operational impediments (such as distances to ports) to the establishment of a major fishery in that region.

But a threat here is that management measures for fisheries aimed at achieving conservation outcomes may become stalled and that therefore the conservation remit might not be achieved. This is happening right now in terms of local area restrictions on the krill fishery.

Harnessing the scientific requirements for good conservation and sustainable fisheries in the Southern Ocean will remain a real challenge.[108]

Distant-water fishing fleets (4D)

The fishing fleets of Taiwan, South Korea, Spain and China have continuously expanded their distance to fishing grounds. These are globally operating distant-water fleets and flag states, accounting for nearly 20% of the global industrial catch over the past decade.

Distant-water fishing has been made viable by the growing number of refrigerated transhipment and resupply vessels that allow individual fishing vessels to remain at sea for extended periods.

Of particular interest to those studying distant-water fishing is China's fleet, which is expanding and is heavily subsidised by the state.[109]

China's long-term plans for the krill fishery are unclear. It is the only state fishing for krill in East Antarctica and the only one to do so since the collapse of the Soviet Union.

Chinese fishing behaviour could be seen to be more directed at 'staking a claim' in the fishery so that China's fishing interests will be considered in future decision-making within CCAMLR.

We note that the krill catch limits are enshrined in CCAMLR conservation measures and can be overturned only through a consensus decision. At this point, such a decision seems unlikely, unless someone wants to work outside the system, so the krill fishery will remain relatively small.

China's negotiating strategy within CCAMLR is often to protect its own fishing (and other) interests, and it is willing to block consensus if it feels that those interests are threatened.

When compared to CCAMLR's other members, China tends to play by its own rules (although in some ways it is gravitating towards behaviours typical of Russia), forgoing the behavioural norms of 'give and take' style negotiations that characterise cooperation among other members within CCAMLR.

3.3.3 Catastrophic threats

Illegal, unreported and unregulated fishing (5E)

Despite recent successful activities in combating IUU fishing in the Southern Ocean,[110] it remains a serious concern and could increasingly be affected by climate change due to range-shifting of species, causing ripple effects on the management of marine resources in the southern Indian and Southern oceans.

Climate change related shifts in migrations by fish such as tuna may move new species into the Southern Ocean.

If that were to eventuate, the Indian Ocean Tuna Commission, the CCSBT and CCAMLR would need to cooperate. (Some memorandums of understanding already exist in cases where fish stocks occur under the jurisdiction of multiple RFMOs.)

There will be challenges in how RFMOs will manage shifting fish stocks, especially given the value of both demersal and pelagic fish species in the Southern Ocean.

There will also be the challenge of ensuring the recording of catches for scientific purposes. Accurate reporting of catches across wide areas is important for managing populations and setting catch limits. However, the recording of catches through the catch documentation schemes of different organisations could become complicated and open loopholes or opportunities for abuse.

IUU fishing will be a significant challenge, as it is difficult to see arrangements being put in place to account for increased distant-water access to valuable fishing grounds.

Climate change related marine ecosystem effects, including sea-level rise (5E)

There are many potential indicators for climate change impacts on the Southern Ocean and Antarctica, such as changes to the acidity and temperature of waters in the region and to the ranges of different species' migrations. Both the West and East Antarctic ice sheets are collapsing or in retreat. Climate change increases the likelihood of non-native species displacing native species as well as the establishment of new diseases.

The complexity of these changes is likely to produce unknown and unanticipated consequences into the future, including catastrophic ice-shelf collapse and sea-level rise. Disruptions would have further feedback effects, such as on marine ecosystems.

Antarctic Treaty countries such as France and Australia cannot do much about mitigating climate effects in Antarctica, as the area is fundamentally a prime impact zone for climate change.

However, while CCAMLR and the ATCM cannot, on their own, implement mitigation measures, Australia and France can provide leadership in having CCAMLR and the ATCM engage with the UN Framework Convention on Climate Change (UNFCCC) on the prognoses for the impacts of climate change on the CCAMLR and Antarctic Treaty objectives.

Action in the appropriate international forums, such as the UNFCCC, to mitigate climate change would also have benefits for the Antarctic region.

Other than that, CCAMLR and the ATCM can only take adaptation actions (which are currently poorly specified and acted upon).

Climate-change impacts on Antarctic infrastructure and accessibility (5D)

As set out above, there is a high likelihood of substantial ecosystem-scale changes in both the terrestrial and maritime domains.

Issues resulting from factors such as changing precipitation and a changed sea-ice regime will have their own flow-on implications for Antarctic infrastructure, access and transport. Responses to risks to infrastructure may place additional pressure on plant and animal habitat.[111]

Those impacts might not alter the geopolitical or strategic setting within Antarctica, but they will require Antarctic countries to better understand not just regional climate-change effects and localised implications for the protection of existing infrastructure that might be threatened by inundation from sea-level rise or meltwater flooding or by physical isolation due to snow and ice melting.

The impacts of climate change on Antarctic infrastructure will divert funds away from scientific research and into stabilising infrastructure and assets, reducing our ability to gauge the impact of climate change through scientific measurement.

Conflict or war due to occupation of Antarctic territory and increasing militarisation (2E)

Over the next decade, there is not a high risk that Southern Ocean or Antarctica will generate the kind of tension that would require substantial military responses.

The Antarctic Treaty mandates the use of Antarctica for peaceful purposes, but the region may see conflict if resources become scarcer elsewhere and states turn their attention to the Antarctic.

One possible scenario would be occupation by another power of Heard Island, the undisputed sovereign territory of Australia. HIMI is not routinely occupied by Australia; nor is it frequently visited.

Outside of war, there is also the issue of whether the region will see an increasing range of military activities.

Antarctica is sometimes seen as having special value for military space capabilities, given that many satellites cross over it and Antarctic-based ground stations can serve dual-use purposes.

Remote sensing is, however, a legitimate scientific activity in Antarctica. It will be hard to prove that states are using Antarctic bases for military research or using Antarctic ground stations to control offensive weapon systems.

But it's likely that there will be increasing difficulties in distinguishing between legitimate and prohibited activities under the ATS, and this could be exploited by states seeking to carry out a range of military-related activities.[112]

3.4 Mitigating impacts and managing consequences

The concluding part of this section of the report addresses the last question in the risk assessment process: Are there any factors that mitigate the likelihood of the disturbances and challenges set out above? It also explores what France and Australia might do, together or independently, to further their interests.

Three broad major needs stand out:

- greater trust between states active in the region
- enhanced environmental cooperation
- more effective management of environmental security concerns.

3.4.1 Trust

Responding to many of the threats and challenges outlined in this report comes back to the basic question of trust that states involved in the Antarctic and Southern Ocean region will do what is right by way of broad environmental management. Apart from Australia and France, countries such as the UK, the US, Norway, Russia, Brazil and Japan are also very important in developing consensus.

There is no doubt that seeking greater cooperation on a range of issues discussed here, such as SAR, fisheries management, scientific research and marine environmental protection, should in theory help build trust. But even that cooperation cannot proceed without trust among the leading players in the region.

Strategic distrust in the Antarctic and Southern Ocean region is evident in tensions caused by speculation about China's long-term Antarctic goals. China sees such concerns as simply attempts to constrain its Antarctic ambitions.

There is also some nervousness among some of the older Antarctic players about how committed some of the newer ATS entrants are to the norms and values of the system and whether newer entrants see it as in their longer term interest to challenge the older players' influence in Antarctic and Southern Ocean affairs, especially that of the US, France and Australia.

At the same time, we should recognise that global pressures and relationships may play out in the Antarctic arena.

For example, the Ross Sea MPA was not a product of conservation agreements: it was a strategic outcome between the US, Russia and China at a higher level. Russia and China were able to achieve Antarctic outcomes (including eliminating restrictions on their interests in the Ross Sea and in adjacent areas) as a result of US interest to establishing an MPA to satisfy domestic pressures.

More broadly at the operational level, high levels of trust among the countries active in the Antarctic region to advance the cooperation necessary to deal with some more likely risks and challenges, such as SAR, IUU fishing and increased tourism, are yet to emerge.

Even if it proves hard to build high-level trust, operational trust can be developed to allow the cooperation necessary for the management of Antarctica and the Southern Ocean and activities within them. France and Australia can lead here.

Cooperative activities on a range of issues, such as examining impacts of climate change on the region, should be seen as helping build trust levels overall.

Australia and France should continue to cooperate in patrols and surveillance in the Southern Ocean, where there are existing arrangements.

The Australia–France Maritime Cooperation Treaty on Surveillance in the Southern Ocean entered into force on 1 February 2005.[113] It was aimed at combating IUU fishing around the HIMI and the adjacent French territory of Kerguelen Islands.

An agreement between the two countries that creates a framework to enhance cooperative surveillance of fishing vessels and encourages scientific research on marine living resources in the 'area of cooperation' in the Southern Ocean came into force in 2011.[114]

SAR planning offers an opportunity for Australia and France to work with China, India, Korea, Japan, South Africa and New Zealand to foster good relations and sound SAR practices, as well as to build operational trust.[115]

SAR and other international efforts are particularly demanding tasks for Australia and France in the Southern Ocean in view of the distances involved, sea conditions and limited permanent human presence.

Australia and France should facilitate a regular multilateral SAR exercise in the future[116] around the HIMI – Kerguelen Islands area and the Antarctic continent as well, given that Terre Adélie is sandwiched between sectors of the two countries. The exercise would be practically focused and designed to strengthen interoperability and cooperative responses. This would help to build patterns of cooperative interaction between Antarctic countries and help to generate strategic and operational trust.

Australia and France should come together to examine the management implications of climate change in the Antarctic region, looking at future Antarctic infrastructure, logistics and environmental management in both the terrestrial and the marine environments.

They should also look at options for effective adaptation to climate impacts, as well as methods for securing the long-term resilience of Antarctic and Southern Ocean ecosystems.

This work would examine the regions, habitats and species most vulnerable to climate change. It would examine existing protected and managed areas to identify vulnerable environmental features.

It might examine the temporal aspects of environmental management, since many operational procedures provide for activities to be undertaken outside periods of high environmental sensitivity and the timing and duration of those sensitive periods may change.

It might examine the effects of climate change on the current logistic support network to see what modifications may be needed to mitigate such impacts as snow accumulation and melt patterns for intra- and intercontinental fixed-wing air transport and surface transport. Changes in sea ice may affect ships' access to coastal locations.

As a trust-building measure for Antarctic countries, Australia and France should lead on identifying guidelines for establishing and reinforcing the resilience of Antarctic infrastructure that take current and predicted climate changes into account.

France and Australia should exchange information that they collect that might be useful in operations, such as when sea ice is no longer safe for over-ice travel.

The two countries should encourage trust by continuing to engage to develop common approaches to the common challenges that are posed by climate change in the Antarctic region. They should set an example by including more climate scientists in delegations to key Antarctic Treaty and CCAMLR meetings.

Australia and France should be more active in inspections under the Antarctic Treaty. This will assist in transparent and full reporting under Article VII—the requirement to disclose the use of military personnel and equipment. Both countries should more regularly exercise the treaty's right of inspection.[117]

3.4.2 Cooperation

The Antarctic region needs a more cooperative mindset. The absence of such cooperation in the longer term increases the likelihood that Southern Ocean fisheries will be overfished, territorial disputes will arise, key protected habitats in Antarctica will be destroyed, and Antarctic countries will lack the scientific knowledge needed to manage and develop their Antarctic interests.

There is also the potential for seabed mining that may not be manageable north of latitude 60°S, which will need to come under the CCAMLR umbrella.

Key environmental, safety and resource management issues are likely to be politicised and caught up in geopolitical contests in the terrestrial and maritime domains in the region.

Without cooperation, the Antarctic region will not be able to deal effectively with many of the threats and challenges set out in this report. All stakeholders in Antarctic Treaty environmental security should play a part in these cooperative initiatives.

Australia and France already work closely together[118] and should continue to advance cooperation through pooling resources for eastern Antarctic science and logistics. Both are pivotal players in Antarctic science. Joint Australia–France projects are being designed for ice-core experiments in the vicinity of the Concordia station. Joint projects are also underway using advanced genetic methods for fish stock assessment and for an inventory of marine biodiversity, especially using environmental DNA.

Australia will soon get a new icebreaker, which will help it to support resupply to the French base at Dumont D'urville and other stations. And France, as noted above, has recently acquired its own new Antarctic vessel, which contributes support for Australia's Macquarie Island and the eastern sector of the AAT.

Successive Australian and French governments have promoted cooperation on environmental and resource protection among Antarctic Treaty parties.

Both states have championed the Environment Protocol's ban on mining in Antarctica and the goal of CCAMLR to conserve Antarctica's marine living resources and protect the Antarctic ecosystem.

Both are aware of and focused on the renewed interest of a range of powers in this area and the way in which other nations are investing substantially in Antarctic and Southern Ocean science, logistics and infrastructure.

Both states are increasingly aware of the possible consequences of a modification of the Antarctic and Southern Ocean ecosystems due to climate change and increased human activities. This includes fisheries and the wish of some states to consider resource exploitation, even including harvesting icebergs, and expanded tourism.

Australia and France should convene events during climate change conferences to highlight the risks and challenges identified in this report. COP 25 in Chile could provide an adequate venue for this.

Both countries are committed to ensuring that the peace and security that the Antarctic Treaty provides are maintained for the future.

Cooperation on the range of these issues might be dealt with separately from some of the harder issues that relate, for example, to goals of resource exploitation by some players.

This kind of cooperation will not achieve the desired result of better regional environmental security management if it is used as part of a strategy by some Antarctic and Southern Ocean states to advance strategic competition in the region. That would only add to distrust at all levels in Antarctica and the Southern Ocean.

3.4.3 Managing environmental security

The management of the Antarctic and Southern Ocean to date has been based on a reasonably robust legal and political framework that bridges strategic and cultural divides and broadly reflects the common interests of all stakeholders.

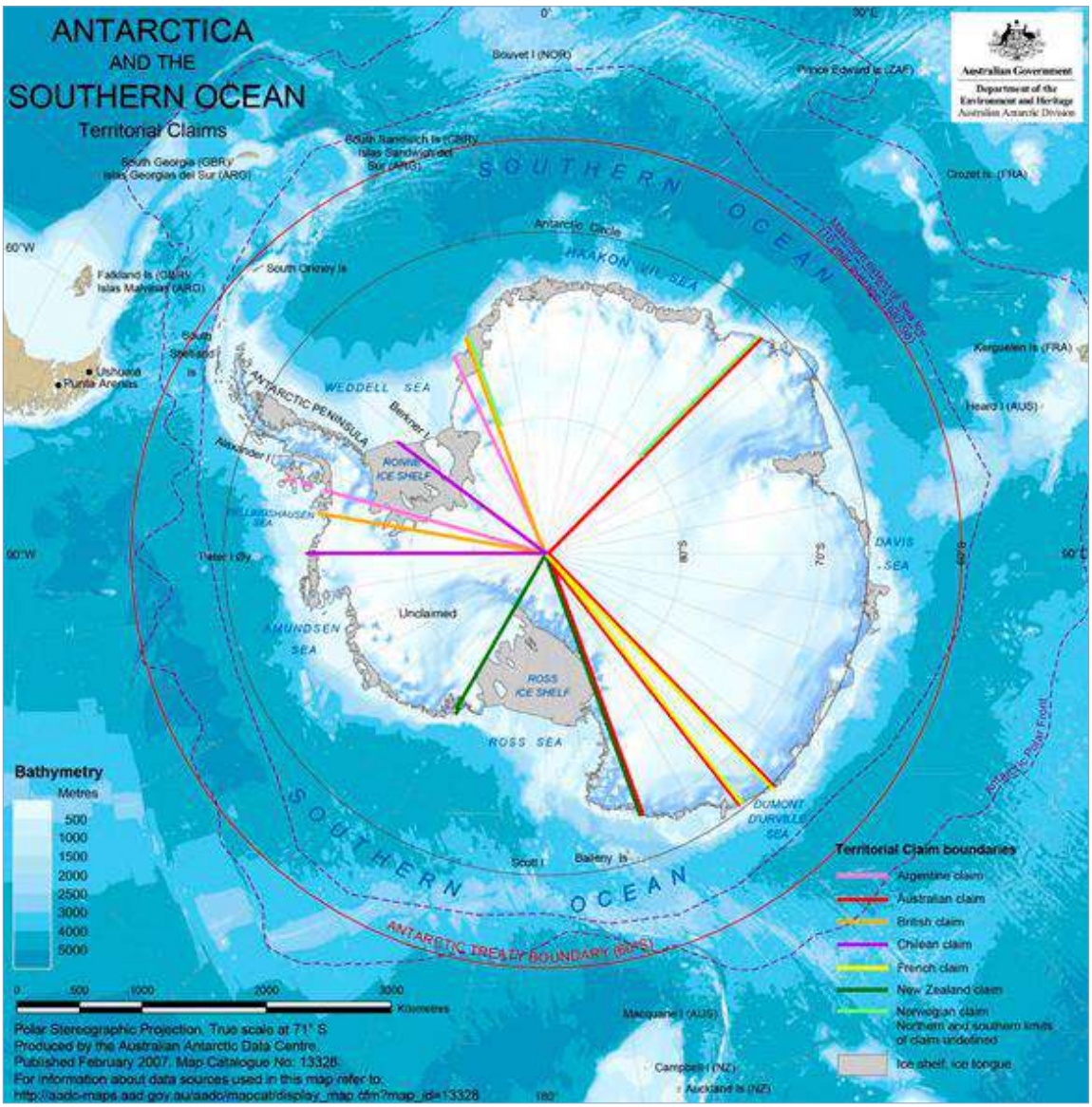
However, in the light of emerging threats and challenges there is now a need to build greater levels of trust and cooperation. Both Australia and France see a strong and effective ATS as being in their national interests.

The mitigation of disturbances requires increased efforts to leverage the environmental and political architecture that is in place in the Antarctic and Southern Ocean region.

Current forums have all been established under the ATS, but there are now greater pressures on the norms and principles of that system.

Australia and France work very well together in Antarctica. Both nations are claimant states (Figure 14) and adjacent coastal states and take a similar approach to the norms and principles of the ATS.[119]

Figure 14: Territorial claims in Antarctica



Source: Australian Antarctic Division.

France and Australia are pushing for MPAs off East Antarctica. France has provided logistic support to Australian scientists to do inland ice-drilling work from Australia's Casey station. Australia and France have cooperated on scientific research (especially fisheries science), such as a 2017 symposium on the Kerguelen Plateau convened by the Australian Antarctic Division. At the symposium, there was a real effort to include not only scientists but also policymakers and industry representatives.

It would help to manage environmental security among the key players in the region if Australia and France were to focus on areas such as SAR and environmental protection.

Both countries could work to provide the necessary policy direction and the higher level political framework to support increased broad environmental cooperation. Australia and France should consider organising a multilateral logistics exercise with a focus on environmental management.

They should work to bring China into a more cooperative environment. This will not be effective without successfully engaging others that have close relationships with China.[120]

Risk mitigation requires more attention to measures that build confidence among countries active in the region, including greater efforts on functional issues such as SAR, expanded tourism, fisheries, cooperative scientific efforts and the impacts of climate change on environmental management.

One important issue is benign neglect—the temptation to believe that all the problems of Antarctica and the Southern Ocean have been solved.

France and Australia should continue to be active in driving the agenda in ATCMs and CCAMLR and can increase their cooperation to build greater levels of trust among all the key players in the region.

However, a global perspective on Antarctica and the Southern Ocean is needed to deliver strategic outcomes in the future. States participating in the ATS are operating under global conditions of uncertainty: the international political environment is increasingly marked by changes that are nonlinear and sometimes abrupt. That puts a premium on establishing systems that can adapt to changing circumstances on an ongoing basis in an area of the world that is of critical importance to understanding the wider global environmental system.

4. Concluding remarks

This report has attempted to take a longer term view of the future of environmental security in the eastern Indian Ocean, Antarctica and the Southern Ocean.

We suggest that bilateral France–Australia cooperation can be further developed to assist in risk mitigation to better manage activities in the geographical areas discussed in this report.

There are grounds for optimism here. Environmental interests have, for example, played a major role in driving France's cooperation with Australia in Antarctica and the Southern Ocean.

Both states have cooperated to take action on IUU fishing that has enabled the protection of the Kerguelen Plateau—an important environmental zone.

In their role as claimant states, France and Australia have undertaken close scientific collaboration that has contributed to knowledge on environmental issues, such as climate change.

They have demonstrated a strong interest in the environmental management of fisheries resources in the Southern Ocean and concluded two bilateral agreements on that issue.

Australia–France environmental cooperation in the Southern Ocean and Antarctica is likely to deepen, especially in the area of climate science.

Both states can be expected to increase their level of information sharing and also share capabilities to advance bilateral and broader multilateral environmental cooperation in the region.

Despite the distances between Australian and French territories in the Indian Ocean, there are also substantial opportunities for bilateral cooperation in the eastern part of the ocean, reflecting their past experience in cooperation, their capabilities and their shared perspectives on many issues.

Australia and France have successful experience in bilateral cooperative fishing enforcement in the Southern Ocean that could be used to promote similar bilateral or regional cooperative arrangements elsewhere in the Indian Ocean.

The capabilities and experience of the two countries in maritime security could also be leveraged to facilitate greater cooperation among regional coastguard agencies in the Indian Ocean, to enhance national maritime domain awareness systems and to build SAR capability among other countries in the region. Australia and France, along with other key countries, such as India, should also jointly develop their training and capacity-building efforts in port state control to lift inspection and enforcement rates among Indian Ocean states.

There is also considerable scope for developing framework disaster management arrangements between Australia and France and other key Indian Ocean states, including by using the experience of the FRANZ arrangements among Australia, France and New Zealand in the South Pacific.

There are many opportunities for bilateral cooperation in high-level scientific research alliances relevant to the blue economy and climate change. Several areas of potential cooperation in ocean science are listed in this report.

This report also recommends that Australia and France join with other like-minded countries to establish an Indian Ocean Environmental Security Forum, possibly under IORA's auspices, which would bring together representatives from military and civilian agencies across the Indian Ocean region. This would help create shared understandings of environmental security threats and help establish habits of dialogue on environmental security in a way that transcends geopolitical tensions and competition.

The protection of the eastern Indian Ocean, Antarctic and Southern Ocean ecosystems will require actions well in advance of when changes to those ecosystems may be detected. Both Australia and France will need to work with a range of like-minded states with which they share common interests to address current challenges in managing the environmental system and the strategic risks that poor environmental management in the eastern Indian Ocean and the area south of latitude 60°S will bring.

On the basis of this report, Australia and France should also identify challenges and issues that warrant further research and cooperation.

Notes

1 Department of Foreign Affairs and Trade (DFAT), *Vision statement on the Australia–France relationship*, Australian Government, Canberra, 2 May 2018, online.

2 It should be noted, however, that the impact of discussions on biological diversity of areas beyond national jurisdiction (BBNJ) is currently unknown. The BBNJ framework is currently being negotiated. For a summary of the latest round in March–April 2019, see *Earth Negotiations Bulletin*, 8 April 2019, 25(195), online. Australia is advocating to protect the Antarctic Treaty System in its entirety through this process.

3 Anne-Marie Brady, *China's expanding interest in Antarctica: implications for Australia*, Australian Strategic Policy Institute (ASPI), Canberra, August 2017, online.

4 D Leary, 'Marine genetic resources in areas beyond national jurisdiction: do we need to regulate them in a new agreement?', *Maritime Safety and Security Law Journal*, 2018–19, issue 5; J Jabour, 'The potential to regulate bioprospecting for marine genetic resources: two case studies', in *Handbook of maritime regulation and enforcement*, Routledge, 2015; R Warner, 'Protecting the diversity of the depths: environmental regulation of bioprospecting and marine scientific research beyond national jurisdiction', in Aldo Chircop, Moria McConnell, Scott Coffen-Smout (eds), *Ocean yearbook 22*, Martinus Nijhoff Publishers, Boston, 2008.

5 M Sow, *Piracy and illegal fishing in Somalia*, Brookings Institution, Washington DC, 12 April 2017; C Schofield, 'Plundered waters: Somalia's maritime resource insecurity', in T Doyle, M Risely (eds), *Crucible for survival: environmental security and justice in the Indian Ocean region*, Rutgers University Press, 2008.

6 Department of Defence (DoD), *2016 Defence White Paper*, Australian Government, Canberra, 2016, paragraphs 292–293, online.

7 'The weekly focus: a market and economic update', *Standard Life*, 8 October 2012.

8 International Energy Agency, *Energy policies of IEA countries: the United States*, review, OECD, Paris, 2014.

9 D Brewster, 'The red flag follows trade: China's future as an Indian Ocean power', in Ashley J Tellis, Alison Szalwinski, Michael Wills (eds), *Strategic Asia 2019: mapping China's expanding strategic ambitions*, National Bureau of Asian Research, Washinton DC, 2019.

10 M McDevitt, *Great power competition in the Indian Ocean: the past as prologue?*, Center for Naval Analyses, March 2018.

11 D Brewster, *Between giants: the Sino-Indian Cold War in the Indian Ocean,* Institute Français des Relations Internationales, 2018.

12 G Bankoff, J Christenson, *Natural hazards and peoples in the Indian Ocean world: bordering on danger*, Palgrave, 2016.

13 Intergovernmental Panel on Climate Change (IPCC), *Managing the risks of extreme events and disasters to advance climate change adaptation*, IPCC, Geneva, 2012, Chapter 9.

14 IPCC, *Managing the risks of extreme events and disasters to advance climate change adaptation,* Chapter 9.

15 J Roach, 'Bay of Bengal faces major tsunami threat, study says', *National Geographic News*, 5 September 2007.

16 UN Office on Disaster Risk Reduction (UNISDR), *Global assessment report on disaster risk reduction, 2015*, online.

17 Robert Glasser, *Preparing for the Era of Disasters*, ASPI, Canberra, March 2019, online.

18 Foreign Affairs, Defence and Trade References Committee, *Implications of climate change for Australia's national security,* Australian Senate, May 2018.

19 DoD, *2016 Defence White Paper.*

20 Australian Government, *2017 Foreign Policy White Paper*, November 2017, online.

21 S Chaturvedi, V Sakhuja, *Climate change and the Bay of Bengal: evolving geographies of fear and hope*, ISEAS – Yusof Ishak Institute, Singapore, 2015, 156.

22 Global Military Advisory Council on Climate Change (GMACCC), *Climate change & security in South Asia*, GMACCC paper no. 2, May 2016.

23 A Arshad, W Soeriaatmadja, 'Battling rising sea, sinking land', *The Straits Times,* 4 November 2018.

24 Food and Agriculture Organization of the United Nations (FAO), *State of world fisheries and aquaculture 2014*, FAO, Rome, 2014.

25 R Hermes, C O'Brien, 'Fish and fisheries of the Bay of Bengal large marine ecosystem', 3rd Global LME Conference, Swakopmund, Namibia, 2014.

26 The Nature Conservancy, *Indonesia fisheries*, online.

27 D Michel, R Sticklor, *Indian Ocean rising: maritime security and policy challenges*, Stimson Center, 2012.

28 David J Agnew , John Pearce, Ganapathiraju Pramod, Tom Peatman, Reg Watson, John R Beddington, Tony J Pitcher, 'Estimating the worldwide extent of illegal fishing', *PLoS ONE*, 2009, 4(2).
29 World Bank, *Fish to 2030: prospects for fisheries and aquaculture*, 2013.
30 D Pauly, D Zeller, 'Catch reconstructions reveal that global marine fisheries catches are higher than reported and declining', *Nature Communications,* 2016, issue 7.
31 *A new dead zone in the Indian Ocean*, Max Planck Gesellschaft, 7 December 2016.
32 Glasser, *Preparing for the Era of Disasters*.
33 J Aldred, 'The future of deep seabed mining', *Chinadialogue ocean*, 25 February 2019, online.
34 G Peiris, 'Hanging on to tiger's tail: LTTE and narcotics', *The Island,* 16 June 2015.
35 R McLaughlin, 'Towards a more effective counter-drugs regime in the Indian Ocean', *Journal of the Indian Ocean Region*, 2016, 12(1).
36 J Wright, 'Drug trafficking routes proliferate through Indian Ocean,' *Janes Intelligence Review,* 2017.
37 J Pearlman, 'Cruise passengers ordered to switch off lights and music at night to "be prepared for pirate attack"', *The Telegraph,* 8 August 2017.
38 'India keen to jump on-board cruise boom', *Travel Weekly Asia,* 1 October 2018.
39 L Cordner, *Offshore oil and gas safety and security in the Asia Pacific: the need for regional approaches to managing risks*, RSIS monograph no. 26, 2013; L Cordner, 'Indian Ocean maritime security: risk-based international policy development', doctoral dissertation, University of Wollongong, 2015.
40 S Bajpai, JP Gupta, 'Securing oil and gas infrastructure', *Journal of Petroleum Science and Engineering*, 2007, 55:174–186.
41 'Rotterdam port arms itself against a new cyber attack', Klevenberg Shipping Centre, 2017, online.
42 R Sunak, 'Undersea cables: indispensible, insecure', *Policy Exchange*, 2017.
43 J Page, K O'Keeffe, R Taylor, 'America's undersea battle with China for control of the global internet grid', *Wall Street Journal,* 12 March 2019.
44 V Sakhuja, 'China in the Indian Ocean: deep sea forays', *IPCS*, article 4284, 3 February 2014.
45 Sunak, 'Undersea cables: indispensible, insecure'.
46 'Malacca Straits VLCC traffic doubles in a decade as shipping traffic hits all-time high in 2017', *Seatrade Maritime News,* 19 February 2018.
47 Sam Bateman, Submission 10, Australian Senate, *The Indian Ocean region and Australia's foreign, trade and defence policy,* 14 June 2013.
48 Indian Ocean Memorandum of Understanding on Port State Control, *2017 annual report,* online.
49 'Indian Ocean second-most polluted in the world,' *Northglen News,* 2 June 2016.
50 Britta Denise Hardesty, TJ Lawson, Tonya van der Velde, Matt Lansdell, Chris Wilcox, 'Estimating quantities and sources of marine debris on a continental scale', *Frontiers in Ecology & Evolution*, 2016, vol. 15; Jenna R Jambeck, Roland Geyer, Chris Wilcox, Theodore R Siegler, Miriam Perryman, Anthony Andrady, Ramani Narayan, Kara Lavender Law, 'Plastic waste inputs from land into the ocean', *Science,* 13 February 2015, 3.
51 See, generally, B Mapstone (ed.), *Oceans: science and solutions for Australia,* Commonwealth Scientific and Industrial Research Organisation, 2017; for the area of the Indian Ocean off northwest Australia, see S Wilson, 'The north-western margin of Australia', in C Sheppard (ed.), *World seas: an environmental evaluation, volume II: The Indian Ocean to the Pacific*, Academic Press, 2018, 303–331.
52 World Travel and Tourism Council, *Travel & tourism: economic impact*, 2018.
53 J Philips, *Boat arrivals and boat 'turnbacks' in Australia since 1976: a quick guide to the statistics*, Parliamentary Library Research Paper Series, Australian Parliament, 2016–17, updated 17 January 2017. Between January 2015 and June 2017, some 17 boats carrying 320 people were removed from Australian waters.
54 GMACCC, *Climate change and security in South Asia*.
55 IPCC, *AR5 Climate change 2014: impacts, adaptation, and vulnerab*ility, Chapter 12, 'Human security'.
56 UNISDR, *Global assessment report on disaster risk reduction 2015*, 107.
57 Foreign Affairs, Defence and Trade References Committee, *Implications of climate change for Australia's national security,* Australian Senate, May 2018.
58 Office of the Director of National Intelligence, *The future of Indian Ocean and South China sea fisheries: implications for the United States*, National Intelligence Council, report NICR 2013–38, 30 July 2013.
59 D Rumley, 'A policy framework for fisheries conflicts in the Indian Ocean', in D Rumley, S Chaturvedi, V Sakhuja (eds), *Fisheries exploitation in the Indian Ocean: threats and opportunities,* Cambridge University Press, 2009.
60 M Sow, *Piracy and illegal fishing in Somalia*, Brookings Institution, Washington DC, 12 April 2017.
61 N Deshpande, 'Fishing in the troubled waters: fishermen issue in India–Sri Lanka relations' *India Quarterly,* 2018, issue 74.
62 D Brewster, 'Chinese fishing fleet a security issue for Australia,' *Lowy Interpreter,* 17 November 2018.
63 J Goldrick, *Grey zone operations and the maritime domain*, ASPI, Canberra, 30 October 2018, online.
64 S Chaturvedi, 'The post-tsunami Indian Ocean region', in T Doyle, M Risely (eds), *Crucible for survival: environmental security and justice in the Indian Ocean region*, Rutgers University Press, 2008.
65 N Samaranayake, C Lea, D Gorenburg, *Improving US–India HA/DR coordination in the Indian Ocean*, Center for Naval Analyses, July 2014.
66 IPCC, *Managing the risks of extreme events and disasters to advance climate change adaptation*, Chapter 9.

67 J Coyne, 'Coastguard academy would boost maritime security for Australia and the region', *The Strategist,* 14 December 2018.

68 DoD, *2016 Defence White Paper*; Australian Government, *2017 Foreign Policy White Paper.*

69 D Brewster, 'Give light, and the darkness will disappear: Australia's quest for maritime domain awareness in the Indian Ocean', *Journal of the Indian Ocean Region*, 2018.

70 D Brewster, *Australia's second sea: facing our multipolar future in the Indian Ocean,* ASPI, Canberra, 2019, online.

71 DFAT, *Vision statement on the Australia–France relationship*.

72 2nd International Indian Ocean Expedition, online.

73 The Intergovernmental Oceanographic Commission's Perth office is being reconstituted under a treaty being developed by the Australian Government and UNESCO. This would create the only UNESCO intergovernmental commission node in the Southern Hemisphere. It would provide the framework for an important marine and related climate hub looking out into the Indian Ocean from Perth.

74 Including Australia, Bangladesh, Cambodia, China, the Cook Islands, Fiji, France, Indonesia, Japan, Kiribati, Laos, Malaysia, the Maldives, the Marshall Islands, Mongolia, Nauru, Nepal, New Zealand, Palau, Papua New Guinea, the Philippines, Samoa, Solomon Islands, South Korea, Sri Lanka, Thailand, Timor-Leste, Tonga, Tuvalu, the US, Vanuatu and Vietnam.

75 The CCAMLR convention area extends beyond the geographical area encompassed within the Antarctic Treaty (south of 60°S) and approximately follows the Antarctic Convergence (also known as the Polar Front).

76 'Australian Antarctic Strategy and 20 Year Action Plan', *Australian Antarctic Magazine*, 2016, issue 30, online.

77 Australian Antarctic Division, 'New funding for upgrades of Antarctic research centre', Department of the Environment and Energy, Australian Government, 25 February 2019, online.

78 K Dodds, A Hemmings, P Roberts (eds), *Handbook on the politics of Antarctica*, Edward Elgar, 2017; A Hemmings, D Rothwell, K Scott eds, *Antarctic security in the twenty-first century: legal and policy perspectives*, Routledge, 2012.

79 It has been suggested by some analysts that China may be positioning itself to make a territorial claim in the future. But there is nothing that China does in Antarctica that could be used to support such an act, and the Antarctic Treaty specifically prohibits such action. The Antarctic Treaty came into force for China on 8 June 1983. At that point, and from then on, the treaty's Article IV, which relates to sovereignty in Antarctica, applies to all activities by China in the treaty area. Specifically, it states that 'no acts or activities taking place while the present Treaty is in force shall constitute the basis for asserting … a claim to territorial sovereignty in Antarctica or create any rights of sovereignty in Antarctica'.

80 Z Madani, J Jabour, 'Developing an Iranian Antarctic science roadmap: a legal and policy outlook', *Yearbook of polar law*, Brill, 2018, 10.

81 The environmental impact system is one in which the ultimate responsibility rests with the state proposing the activity. See ST Brooks, J Jabour, AJ Sharman, DM Bergstrom, 'An analysis of environmental incidents for a national Antarctic program', *Journal of Environmental Management,* April 2018; I Hodgson-Johnston, A Jackson, J Jabour, A Press, 'Cleaning up after human activity in Antarctica: legal obligations and remediation realities', *Restoration Ecology*, 16 May 2016, 25; H Cohen, 'Public participation in Antarctica: the role of non-governmental and intergovernmental organizations', in P Berkman, MA Lang, DWH Walton, O Young (eds), *Science diplomacy: Antarctica, science, and the governance of international spaces*, Smithsonian Institution, Washington DC, 2011.

82 See K Dodds, 'Five inconvenient truths about the Antarctic', *OUP Blog*, 2013, online; A Hemmings, 'Antarctic politics in a transforming global geopolitics', in K Dodds, A Hemmings, P Roberts (eds), *Handbook on the politics of Antarctica*, Edward Elgar, 2017; L Hook, B Mander, 'The fight to own Antarctica', *Financial Times*, 24 May 2018; K Dodds, 'In 30 years the Antarctic Treaty becomes modifiable, and the fate of a continent could hang in the balance', *The Conversation*, 12 July 2018, online.

83 Anne-Marie Brady, *China as a polar great power*, Cambridge, 2017.

84 J Jabour, M Haward, 'The Southern Ocean and changing environmental conditions: Antarctic Treaty System', in J McDonald, J McGee, R Barnes (eds), *Research handbook on climate change, oceans and coasts*, Edward Elgar, 2019, in press; AJ Constable, J Melbourne-Thomas, R Trebilco, AJ Press, M Haward, *Position analysis: Managing change in Southern Ocean ecosystems*, Antarctic Climate and Ecosystems Cooperative Research Centre (ACE CRC), Hobart, Australia, 2017, online; see also M Haward, 'Climate change and the Southern Ocean: the regime complex for regional governance', in P Harris (ed), *Climate change and ocean governance: politics and policy for threatened seas*, Cambridge University Press 2019; T Naish, 'What does the United Nations Paris Climate Change Agreement mean for Antarctica ?', *New Zealand Antarctic Journal*, December 2017; R Davis,'The durability of the Antarctic model and Southern Ocean governance', in T Stephen, D VanderZwaag (eds), *Polar oceans governance in an era of environmental change*, Edward Elgar, 2014.

85 J Melbourne-Thomas, SP Corney, R Trebilco, KM Meiners, RP Stevens, S Kawaguchi, MD Sumner, AJ Constable, 'Under ice habitats for Antarctic krill larvae: could less mean more under climate warming?', *Geophysical Research Letters*, 2016, vol. 43; S Nicol, *The curious life of krill*, Island Press, 2016; B Meyer, 'Less Antarctic sea ice may not mean fewer krill', *Nature Ecology and Evolution*, November 2017; S Kawaguchi, A Ishida, R King, B Raymond, N Waller, A Constable, S Nicol, M Wakita, A Ishimatsu, 'Risk maps for Antarctic krill under projected Southern Ocean acidification' *Nature Climate Change*, July 2013; AK Constable, J Melbourne-Thomas, SP Corney, KR Arrigo, C Barbraud, DK Barnes et al, 'Change in Southern Ocean ecosystems: how changes in physical habitats directly affect marine biota' *Global Change Biology*, 2016, vol. 20; S Nicol, J Foster, 'The fishery for Antarctic krill: its current status and management regime', *Biology and ecology of Antarctic krill,* Springer, 2016; D Miller, 'CCAMLR conservation measures: how the chairman's statement works', *Yearbook of polar law*, 2015, V11; R Hofman, 'Stopping overexploitation of living resources on the high seas', *Marine Policy*, May 2019, vol. 103.

86 J Nilsson, EA Fulton, M Haward, CR Johnson, 'Consensus management in Antarctica's high seas: past success and current challenges', *Marine Policy*, 2016, vol. 73; N Liu, C Brooks, 'China's changing position towards marine protected areas in the Southern Ocean: implications for future Antarctic governance', *Marine Policy*, August 2018, vol. 94; J Jabour, D Smith, 'The Ross Sea region marine protected area: can it be successfully managed?', *Ocean Yearbook*, 2018, vol. 32.

87 See, generally, M Haward, 'Marine resources management, security and the Antarctic Treaty System: an ongoing agenda?', in A Hemmings, D Rothwell, K Scott (eds), *Antarctic security in the twenty-first century: legal and policy perspectives*, Routledge, 2012.

88 International Association of Antarctica Tour Operators, *Overview for 2017–2018 season and preliminary estimates for 2018–19*, online; ST Brooks, J Jabour, DM Bergstrom, 'What is "footprint" in Antarctica: proposing a set of definitions', *Antarctic Science*, 2018, vol. 30; T Tin et al., 'Setting the scene: human activities, environmental impacts and governance arrangements in Antarctica', in T Tin, M Lamers, D Liggett, P Maher (eds), *The future of Antarctica: human impacts, strategic planning and values for conservation*, Springer, 2014.

89 'Antarctic trips attract China's social elites', *Global Times*, 17 February 2019.

90 J Jabour, 'Case study Antarctica: up against the ice barrier Antarctic tourism operators prepare for the Polar Shipping Code', in *Global climate change and coastal tourism: recognising problems, managing solutions, future expectations,* CABI, Oxfordshire, UK, 2017; J Jabour, 'Southern Ocean search and rescue: platforms and procedures', in K Dodds, A Hemmings, P Roberts (eds), *Handbook on the politics of Antarctica*, Edward Elgar, UK, 2017; A Bergin, D Grant, 'Search and rescue; a growing responsibility', *The Strategist*, 24 June 2014, online.

91 J Jabour, 'Why has there been a long peace in Antarctica?', *Yearbook of polar law*, 2015.

92 S Bateman, 'Is Antarctica demilitarised?', *The Strategist*, 23 April 2013, online.

93 C Young, 'What's China up to in Antarctica?', *The Strategist*, 20 September 2018, online

94 This is being pursued also through the Southern Ocean Observing System, online.

95 Young, 'What's China up to in Antarctica?'.

96 White Desert Antarctica, online.

97 J McGee, K Brent, W Burns, 'Geoengineering the oceans: an emerging frontier in international climate change governance,' *Australian Journal of Maritime and Ocean Affairs*, 2018, 10:67–80; O Corry, 'The international politics of geoengineering: the feasibility of plan B for tackling climate change', *Security Dialogue*, 2017, vol. 48; E Chalecki, L Ferrari, 'A new security framework for geoengineering', *Strategic Studies Quarterly*, 2018, vol. 12; *Position analysis: ocean fertilisation,* ACE CRC, Hobart, Australia, 2016, online.

98 Professor Tom Trull's writings (online) summarise this. See P Boyd, 'Developing a test-bed for robust research governance of geoengineering: the contribution of ocean iron biochemistry', *Philosophical Transactions*, August 2016.

99 'Could a 100-million-ton iceberg alleviate S Africa's water woes?', *CBS News*, 5 July 2018, online.

100 The United Arab Emirates proposal was north of 60°S. The Emiratis believed they could get icebergs from the sub-Antarctic. 'UAE to tow icebergs from Antarctica for new project', *Khaleej Times*, 1 July 2018, online.

101 AM Magera, JE Mills Flemming, K Kaschner, LB Christensen, HK Lotze, 'Recovery trends in marine mammal populations', *PLoS ONE*, 30 October 2013, 8; J Roman, JA Estes, L Morissette, C Smith, D Costa et al.,'Whales as marine ecosystem engineers', *Frontiers in Ecology and the Environment*, 3 July 2014, 12.

102 The protocol also applies to 'dependent and associated ecosystems', and those are also north of 60°S.

103 R Tiller, E De Santo, E Mendenhall, E Nyman, 'The once and future treaty: towards a new regime for biodiversity in areas beyond national jurisdiction', *Marine Policy*, January 2019, vol. 99.

104 Ship insurers and classification societies will make efforts to ensure they are compliant.

105 E Harrould-Kolieb, O Hoegh-Guldberg, 'A governing framework for international ocean acidification policy', *Marine Policy*, 2019, vol. 102; M Roleda, C Hurd, 'Seaweed responses to ocean acidification', in C Wiencke, K Bischof (eds), *Seaweed ecology*, Springer, 2012; *Southern Ocean Acidification Report Card*, ACE CRC, Hobart, Australia, 2010, online.

106 'Business as usual for Antarctic krill despite ocean acidification', news release, Institute for Marine and Antarctic Studies, University of Tasmania, 14 November 2018, online.

107 Commission for the Conservation of Southern Bluefin Tuna, 'New tuna management legislation, including SBT, for China', circular #2019/004.

108 See AJ Constable, J Melbourne-Thomas, R Trebilco, AJ Press, M Haward, *Position analysis: Managing change in Southern Ocean ecosystems*, ACE CRC, Hobart, Tasmania, 2017, online. Dr Andrew Constable and his colleagues at ACE CRC have been developing a marine ecosystem assessment of the Southern Ocean with four elements: assessments of status and trends; process studies to fill important gaps on ecosystem function; long-term sustained observations of key species; and ecosystem models that have high skill in examining the likelihood of different futures as a result of different scenarios. These pillars provide engagement with most of the marine biological community internationally, including those involved in fisheries science in the key countries involved in these discussions in CCAMLR. Australian Antarctic Division, 'Marine Ecosystem Assessment for the Southern Ocean: framework and outcomes of the MEASO 2018 conference', Department of the Environment and Energy, Australian Government, 24 May 2018, online.

109 T Hancock, 'China seeks bigger catch from far-sea fishing fleet', *Financial Times*, 20 February 2018; A Darby, 'China moves in for the krill', *Sydney Morning Herald*, 5 April 2015, online.

110 IUU fishing in CCAMLR was extremely problematic in the 1990s. IUU toothfish catches were estimated to have been over six times the catch reported by authorised vessels. CCAMLR Secretariat, *Illegal, unreported and unregulated (IUU) fishing*, 6 December 2018, online.

111 'Management implications of climate change in the Antarctic region: an initial Australian assessment', paper to ATCM meeting, Uruguay, 3–14 May 2010. There is also the issue of natural disasters and weather events; for example, there was evidence of ice shelves being affected in Antarctica following the events in Japan in 2011. There has been some investigation of the possibility of an earthquake-tsunami from Chile generating an impact at Macquarie Island. While natural disasters could affect accessibility to Antarctica (having occupational health and safety implications), the chance of this is very low.

112 New Zealand Government, *Strategic Defence Policy Statement 2018*, June 2018, 22, online.

113 DFAT, *Treaty between the Government of Australia and the Government of the French Republic on cooperation in the maritime areas adjacent to the French Southern and Antarctic Territories (TAAF), Heard Island and the McDonald Islands*, Canberra, 24 November 2003, online.

114 DFAT, *Agreement on Cooperative Enforcement of Fisheries Laws between the Government of Australia and the Government of the French Republic in the Maritime Areas Adjacent to the French Southern and Antarctic Territories, Heard Island and the McDonald Islands*, Paris, 8 January 2007, online.

115 The Council of Managers of National Antarctic Programs (COMNAP) plays a key role in sharing practices and skills.

116 Some of this is happening at a more multilateral level, including through the Committee for Environmental Protection (online) under the Environment Protocol and COMNAP.

117 Australia will be conducting inspections at a range of stations in the 2019–20 season. P Riordan, 'Antarctic chief says China concerns unfounded', *The Australian*, 9 April 2019. For a list of recent inspections, see *Inspections database*, Secretariat of the Antarctic Treaty, online.

118 C Sulikowski, 'France and the Antarctic Treaty System', doctoral thesis, University of Tasmania, April 2013, online.

119 Sulikowski, 'France and the Antarctic Treaty System'; M Haward, 'The originals: the role and influence of the original signatories to the Antarctic Treaty', in K Dodds, A Hemmings, P Roberts (eds), *Handbook on the politics of Antarctica*, Edward Elgar, 2017.

120 Australia has met with Chinese officials under the Joint Committee on Antarctic and Southern Ocean Collaboration, established under the China–Australia Memorandum of Understanding on Cooperation in the Field of Antarctic and Southern Ocean Affairs. The Tasmanian Government and the State Oceanic Administration of China have a memorandum of understanding providing support for Chinese logistics. China has committed to regular use of Hobart's port for Antarctic resupply by its icebreakers. Australia has transported Chinese expeditioners on its intercontinental flights from Hobart to Antarctica. China has provided support to the Australian Antarctic Program through its intra-continental aircraft for science surveys in Antarctica. Australia and China are increasing collaboration in scientific research.

Acronyms and abbreviations

AAT	Australian Antarctic Territory
ANU	Australian National University
ASEAN	Association of Southeast Asian Nations
ATCM	Antarctic Treaty Consultative Meeting
ATCP	Antarctic Treaty Consultative Party
ATS	Antarctic Treaty System
BBNJ	biological diversity of areas beyond national jurisdiction
BRI	Belt and Road Initiative
CCAMLR	Commission for the Conservation of Antarctic Marine Living Resources
CCSBT	Commission for the Conservation of Southern Bluefin Tuna
COMNAP	Council of Managers of National Antarctic Programs
EEZ	exclusive economic zone
FAO	Food and Agriculture Organization of the United Nations
GDP	gross domestic product
HIMI	Heard Island and McDonald Islands
Indian Ocean MOU-PSC	Indian Ocean Memorandum of Understanding on Port State Control
IORA	Indian Ocean Rim Association
IOTC	Indian Ocean Tuna Commission
IPCC	Intergovernmental Panel on Climate Change
IUU fishing	illegal, unregulated and unreported fishing
MARPOL	International Convention for the Prevention of Pollution from Ships
MDA	maritime domain awareness
MPA	marine protected area
NATO	North Atlantic Treaty Organization
NGO	non-government organisation
NSC	National Security College
PESF	Pacific Environmental Security Forum
RFMO	regional fisheries management organisation
SAR	search and rescue
SBT	southern bluefin tuna
SOLAS	International Convention for the Safety of Life at Sea

UK	United Kingdom
UN	United Nations
UNCLOS	UN Convention on the Law of the Sea
UNFCCC	UN Framework Convention on Climate Change
US	United States
USINDOPACOM	US Indo-Pacific Command

Environmental security in the eastern Indian Ocean, Antarctica and the Southern Ocean

A risk mapping approach

Australian National University
NATIONAL SECURITY COLLEGE

IRIS
INSTITUT DE RELATIONS INTERNATIONALES ET STRATÉGIQUES