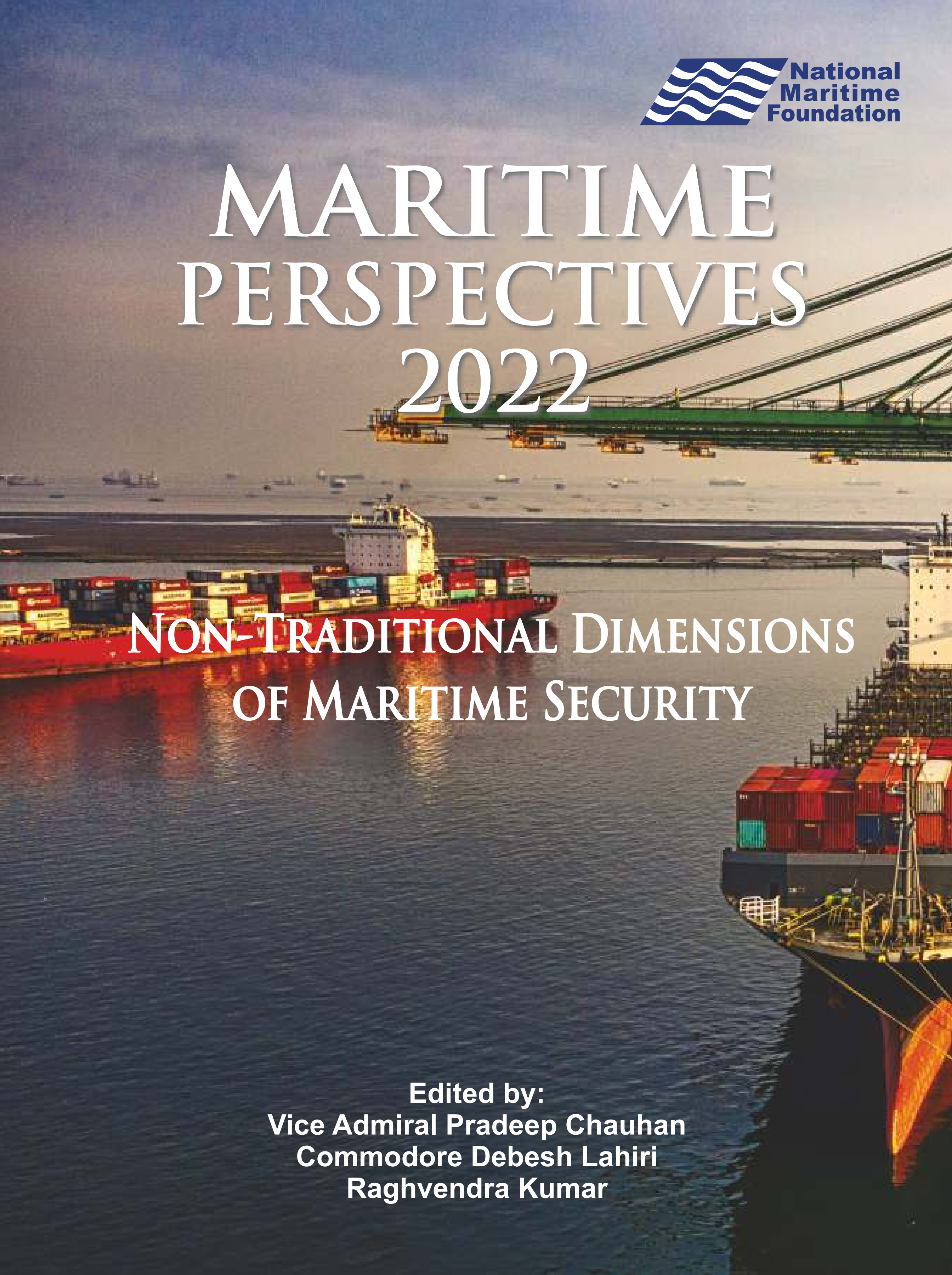


National Maritime Foundation

MARITIME PERSPECTIVES 2022

Non-Traditional Dimensions of Maritime Security

Edited by:
Vice Admiral Pradeep Chauhan
Commodore Debesh Lahiri
Raghvendra Kumar

MARITIME PERSPECTIVES 2022

Non-Traditional Dimensions of Maritime Security

Edited by

Vice Admiral Pradeep Chauhan
Commodore Debesh Lahiri
Raghvendra Kumar

National Maritime Foundation

MARITIME PERSPECTIVES 2022:
NON-TRADITIONAL DIMENSIONS OF MARITIME SECURITY

Editors: Vice Admiral Pradeep Chauhan, Commodore Debesh Lahiri and Raghvendra Kumar

First Published in 2022

Cover Picture Credit: *Tom Fisk, Drone Shot of a Docked Cargo Ship at a Port, Pexels,* 11 September 2020, https://www.pexels.com/photo/drone-shot-of-a-docked-cargo-ship-at-a-port-3856440/

ISBN: 978-81-959079-1-5 (Paperback)
ISBN: 978-81-959791-0-3 (eBook)

Rs. 600.00

Maritime Perspectives, published since 2014, is an annual publication of the National Maritime Foundation (NMF), which compiles thematically-arranged research articles that have been published on the NMF website on issues related to holistic maritime security. As a consequence of COVID-induced disruptions, Maritime Perspectives 2022, the sixth edition of the series, compiles articles covering the period 01 February 2019 to 31 Oct 2022 in six thematically-focused volumes. Articles published by the NMF Research Faculty elsewhere are reproduced with permission of the original publisher.

The editors would like to acknowledge the contribution of former Executive Directors of the NMF, Captain GS Khurana (03 June 2014 - 03 June 2019) and Captain Sarabjeet Singh Parmar (04 June 2019 – 30 Jan 2022).

The editors would also like to acknowledge the contributions of the following:

Overall Coordination	:	Captain Himadri Das, Dr Oliver Nelson Gonsalves, and Ms Krithi Ganesh
Volume Coordination	:	Mr Raghvendra Kumar
Compilation	:	Mr Dhananjay Shinde, Mr Manav Saini, and Mr Mohammad Umar Shakil
Cover Design	:	Ms Krithi Ganesh
Administrative Support	:	Commander Saurav Mohanty, Mr Kamal Meena, and LLOG (MAT) Bhupinder Kumar

Published by:
NATIONAL MARITIME FOUNDATION
Varuna Complex, Airport Road,
NH-8, New Delhi-110 010

Printed by:
Alpha Graphics
6A/1, Ganga Chambers, W.E.A.,
Karol Bagh, New Delhi-110005

Foreword

The increasing salience of the Indo-Pacific in the global security discourse continues to drive India's acceptance of a wider role of being ***a*** net-provider of security and ***the*** 'preferred security partner' and 'first responder' in the region. This is entirely in conformity with the country's maritime policy, which is encapsulated in the acronym 'SAGAR' (Security and Growth for All in the Region). Traditionally, security had been thought of only in terms of the defence of territory within a State system whose defining characteristic was an incessant competition for military superiority with other nation-states, all lying, without superior or governing authority, within a classic state of anarchy. Today, however, the Government of India, in common with most governments of the world, recognises that security is a concept that encompasses far more than military security alone holistic approach and acknowledges that there are several dimensions of security — for instance, a societal dimension, a political dimension, an economic one, an environmental one, etc. — apart from the military one. The military dimension might well be the most important, but it is, nevertheless, only one amongst many. Likewise, the maritime component of security is much more than merely a navy-coast guard amalgam. In India, maritime security has been defined at the apex level of the Indian government as "Freedom from threats arising 'in'- or 'from'- or 'through' the sea". These threats may be traditional ones (such as geopolitical constriction or State-on-State conflict), or non-traditional ones incorporating a wide range of maritime crime, or natural threats (such as cyclones, seaquakes, *tsunami*s, etc.), or even combinations of some or all of these (e.g., climate-change, pollution of the ocean, challenges of the Area Beyond National Jurisdiction [ABNJ] or those involving Biodiversity Beyond National Jurisdiction [BBNJ]). Consequently, maritime security in an era of extensive interconnectivity (if not globalisation) is far more dynamic and complicated than it was in times past and requires a holistic approach if it is to be attained at all.

It is, therefore, fitting that this particular volume of *Maritime Perspectives* should present *holistic* maritime security perspectives and focus upon some facets of the wide range of non-traditional security-challenges that confront us in the maritime common — ranging from terrorism and piracy to the illegal ingress, across maritime borders and boundaries, of drugs, illegal arms, and human beings, as also illegal, unreported, and unregulated (IUU) fishing. The geopolitical tensions that are roiling distant waters such as those of the Arctic and Antarctica, too, demand our attention as their impacts transcend geographies and certainly impinge upon Indo-Pacific, distant though the latter might be from the polar regions of the planet. To enable us to rise to these diverse challenges, a growing, interlocking set of regional, intergovernmental constructs relevant to *holistic* maritime security is being established in both, the eastern (Pacific) and the western (Indian Ocean) segments of the Indo-Pacific.

Insofar as India is concerned, its aspiration to emerge as a US$ 5 trillion economy by 2025 demands an outward leaning outlook, in which the oceans are viewed not only as a medium of connectivity but also as a primary source of economic resources that need to be harvested in a sustainable manner that is as respectful of nature as it is of human need.

It is against this backdrop that the perspectives contained within this volume are offered to the expert and lay reader alike. It is my belief that these perspectives will trigger fresh responses at the individual and collective levels to the challenges to which each of us must rise.

Jai Hind! Sam no Varunah!

Vice Admiral Pradeep Chauhan
AVSM and Bar, VSM, IN (Retd.)
Director-General
National Maritime Foundation

Contents

Naval Security

Impact of COVID-19 and Other Viral Outbreaks On-Board Ships

Vice Admiral Pradeep Chauhan and Commander Saurav Mohanty

On 12 March 2020, the World Health Organisation (WHO) declared that the ongoing COVID-19 outbreak was a pandemic.[1] Two significant concerns were — and remain — first, the speed and scale of transmission, and second, the evidence-based belief that some countries were not handling the threat with the desired level of political commitment.[2]

With reports having emerged of a few members of the crew of more than one US warship being infected with COVID-19, the question of the degree to which warships and merchantmen are vulnerable to this viral disease has become a pressing one. This article addresses this question.

COVID-19 cases On-Board Warships

Conventional wisdom appears to be that warships are especially vulnerable to the spread of viral infection, due to the density of manpower on board, and the constricted workspaces that are characteristic of such ships. On 13 March 2020, a sailor on board the US Navy's Amphibious Assault Ship, the USS *Boxer* (LHD 4), was declared 'Presumptive Positive' for COVID-19, making this the first case of a sailor on a warship being infected by Severe Acute Respiratory Syndrome Coronavirus-2 (SARS-CoV-2), as the virus is formally known.[3] The *Boxer*, a *Wasp* Class warship of the US Navy, which was, at the time, berthed at the Naval Base in San Diego, California, has an estimated complement in excess of 1,200 personnel.[4] As per more recent updates, on 24 March 2020, eight sailors aboard the aircraft carrier USS *Theodore Roosevelt*, too, have tested positive for COVID-19, making this the first COVID-19 case aboard a warship on active deployment. Those infected are being airlifted, while those suspected, have been quarantined.[5] The *Theodore Roosevelt is* the centrepiece of one of the US Navy's Carrier Strike Groups (CSG). This particular CSG comprises the aircraft carrier itself, along with the USS *Bunker Hill* (a Ticonderoga Class guided-missile cruiser with a crew strength of 330 (30 officers and 300 sailors), and three *Arleigh Burke* Class guided-missile destroyers: the USS *Russell*, the USS *Kidd* and the USS *Rafael Peralta*, each of which have a crew-complement of about 325 (25 officers and 300 sailors). Thus, the number of naval personnel in the CSG as a whole would be in the region of 2,500 individuals. During its ongoing deployment, the CSG made a port-call at Da Nang, Vietnam. It is not yet confirmed whether or not the infected members of the crew came in contact with other crew members of the CSG while in port. That answer, important as it is, is perhaps less relevant than the answer to the question of how warships, including those of the Indian Navy, deal with viral infections such as this one. It is also important to compare this infection rate of the CSG with the cruise-ship *Diamond Princess*, which was quarantined in Yokohama after an outbreak of COVID-19 amongst its 3,711 passengers and crew. More about this later in this chapter. At this juncture, it would suffice to remember that unlike merchantships (including cruise-liners), which perform a single port-to-port logistic function, warships are required to discharge multiple roles that include, *inter alia*, warfighting, constabulary functions, disaster response, diplomacy, search-and-rescue, to name just a few. A warship is required to respond to multiple challenges and threats in a single mission or sortie, often simultaneously. It is packed with many different types of equipment, including, in many cases, fixed-wing and rotary-wing aircraft, each manned by a number of experts. Hence, warships have severe space constraints, making it difficult for people onboard to maintain the requisite social distance.

Moreover, warships, unlike their merchant marine counterparts, are designed to operate in environments contaminated by nuclear and / or biological and / or chemical agents. In the instant case, of course, focus needs to be retained on biological safeguards. In general, the several vertical segments (decks) and horizontal segments ('compartments' or 'spaces') of a warship are capable of being sequentially isolated from one another through a system of watertight and / or gastight 'walls' (bulkheads and the ship's side), doors and hatches. A group of such watertight compartments and / or decks that can be completely isolated from the external environment is known as a citadel and warships, depending upon their size and complexity, may have one or more citadels. Entrance-into and exit-from the citadel are controlled by specifically designed airlocks. Thus, an individual seeking ingress into a given citadel, who may have been contaminated by the contaminants prevalent in the environment that is external to the citadel, will first enter an airlock, undergo a repetitive cycle of 'monitoring' and 'cleansing' until he or she is declared free of contamination and only then will ingress into the citadel be permitted. This is done by adopting Standard Operating Procedures (SOPs) for a lockdown, which, in naval terminology, is known as imposing / adopting a Gastight Condition. There are grades of severity of such a lockdown and these translate to different gastight conditions. In the Indian Navy, these are usually two, Condition ALPHA and Condition BRAVO, the former promulgating a more severe lockdown than the latter. Two questions now arise. First, what if the contaminant has already entered the citadel before the lockdown could be imposed / adopted? Second, does the warship have the necessary monitoring and cleansing capacity and capability for the biological agent in question?

The relevance of the first question stems from the fact that an infection from the SARS-CoV-2 may not manifest itself in any discernible symptoms for quite a few days and, hence, the carrier of COVID-19 and potential victims who may contract the disease from the former might both already be within the citadel. The second question could well be related to the first since if the citadel has already been breached, the monitoring and cleansing cycles are rendered ineffective. It would, however, be premature and imprudent to dismiss the importance of the questions, because it is certainly not necessary that the transmitter of the disease is already inside the citadel, and, if he / she is not, then the monitor-cleanse-monitor procedures within the airlocks become very important.

Will the outbreak of the COVID-19 disease within an Indian warship that is at sea and on a mission-based deployment render the warship incapable of discharging its primary mission? The answer is probably a 'No', because although it is very difficult to quarantine more than a very small number of afflicted individuals on board a ship by socially distancing them, all major Indian Naval warships (certainly frigate-sized and larger ones) carry highly-trained medical personnel on board and are equipped with medical facilities of varying complexity. Large ships such as aircraft carriers and fleet-replenishment ships have fairly extensive facilities available in dedicated onboard hospitals, while smaller warships will certainly have a sickbay capable of handling battle-casualties. Moreover, all Indian warships have elaborately-detailed SOPs for rapid and significant expansion of their medical facilities by 'requisitioning' pre-designated mess-decks (living spaces).

In the above context, it is pertinent to recall a 2017 case of an outbreak of H1N1 aboard an Indian Naval warship. Over a three-week period in June of 2017, 21 patients sought treatment at the sickbay of a single warship of the Indian Navy. Of these 21, swab-tests of 14 turned out to be positive for Influenza A (H1N1). Effective Standard Operating Procedures relating to preventive and containment measures were instituted on a war footing and the outbreak was controlled within 14 days. The majority of the cases responded well to treatment and attained disease-free status without developing any complications.[6] The subsequent report unsurprisingly highlighted the fact that controlling the spread of the H1N1 influenza outbreak in the confined environment of a warship was challenging, but it also reinforced the fact that the Indian Navy was well equipped and adequately well-trained to be able to rapidly implement effective preventive measures.

Merchant Shipping

Taking cognisance of the threat posed by the pandemic to the shipping industry, the International Maritime Organisation (IMO), which is a specialised agency of the United Nations that is responsible for shipping, is making concerted efforts to ensure uninterrupted shipping operations. The IMO Secretary-General, Mr Kitack Lim, has stated that, *"In these difficult times, the ability for shipping services and seafarers to deliver vital goods, including medical supplies and foodstuffs, will be central to responding-to and eventually overcoming this pandemic."*[7] In compliance with WHO recommendations, the IMO has promulgated guidelines on the precautions to be taken to minimise the risk to seafarers, passengers, and others aboard ships, from COVID-19. For example, IMO Circular Letter Number 4204 / Add 3 dated 02 March 2020 on, Operational Considerations for Managing COVID-19 Cases / Outbreaks on board Ships, provides guidelines to all authorities involved in the public-health response to COVID-19, and these are being implemented on board merchant ships.

A case in point is the COVID-19 outbreak that occurred on the Cruise Ship *Diamond Princess*. The ship was quarantined in Yokohama, on 05 February 2020, for nearly a month, with about 3,700 passengers and crew on board. As per updates, around 700 people have been infected, with the death toll reaching eight.[8] At least 25 other cruise liners have confirmed COVID-19 cases, including 78 cases on the *Grand Princess*, which was quarantined off the coast of California.[9] After the consequent issue of travel advisories and warnings against cruise-ship travel, many cruise-ship companies have suspended operations. Paradoxically, however, these vessels, especially the *Diamond Princess* have provided healthcare researchers and professionals with a rare opportunity to understand features of the new coronavirus that are hard to investigate in the wider population, where only some people — typically those with severe symptoms — are tested and monitored.[10] Japanese officials performed more than 3,000 tests on the *Diamond Princess*, starting with older passengers and those with symptoms. Some passengers were tested more than once, offering insight into the virus's spread over time. Testing almost all of the passengers and crew helped researchers to understand a key blind spot in many infectious-disease outbreaks — how many people are actually infected, including those who have mild symptoms or none at all. These cases often go undetected in the general population. A major finding of experts who have analysed the *Diamond Princess* data, concerns the effectiveness of the stringent quarantine measures that were introduced, in reducing the virus's spread. On 05 February 2020, the day the quarantine was introduced, one person could go on to infect more than seven others, largely because people were living in close quarters and touching surfaces contaminated with the virus. However, once the crew and passengers had been quarantined in their rooms, the average number of others to whom one infected person passed the virus dropped below one, thereby providing robust evidence that 'quarantine' is, indeed, effective.[11]

Other than cruise-liners, merchant ships generally have very small numbers of onboard staff (crew). The large size of merchant ships *per se* means that there is far more space available per human being on-board, than there is aboard a warship. At first glance, therefore, merchant ships might be expected to be better placed to handle an onboard outbreak of COVID-19. On the other hand, the crew of a merchantman (other than a cruise-liner) will seldom, if ever, include a fully-trained and experienced medical officer along with the requisite support-staff. The ship's Chief Officer is expected to handle medical emergencies on-board, but has only a very basic level of medical competence and experience.

Involvement of the Indian Armed Forces in Evacuation and setting up Quarantine Facilities as an Internal-Security Response

With the global number of COVID-19 cases approaching 650,000, most countries have scaled up their efforts and even pressed their armed / defence forces into action. For their part, the Indian Defence Forces have been proactive in rendering assistance to the National and State authorities in the fight against COVID-19. For instance, the Indian Air Force has evacuated Indians and foreign citizens from countries such as China and Iran. One batch of these evacuees was quarantined in naval facilities at Mumbai, while a second batch (including 234 Indians was brought to Jaisalmer and quarantined at the Indian Army Wellness Centre.[12] Likewise, army field-hospitals are being constructed using equipment used in combat zones. The Vice Chief of the Naval Staff recently provided an excellent overview of the commendable performance of the Indian Navy in combating the COVID-19 disease. Speaking in a television interview[13] on the NewsX TV News Channel, the Vice Chief mentioned that, amongst other steps, the Indian Navy had set-up quarantine facilities and isolation wards, for use by uniformed personnel and their families as well as by civilians in its hospital-establishments in all three naval commands — not just in the cities where the command-headquarters are located, but in outlying units, too. The countrywide shortfall of surgical-masks is being ameliorated by mass-production of high-quality masks by the several tailoring units under the Naval Wives Welfare Units, and a naval aircraft was used just a couple of days ago to rush 60,000 face-masks from Delhi to Goa for use by civilian healthcare workers.[14] Likewise, naval aircraft are being used to airlift doctors to Pune, to receive training at Pune's virology centre. India's ability to respond to the global pandemic hinges on the efficiency and well-being of its armed forces.

Naval Preparedness for Biological Warfare

There has been some speculation on social media that the SARS-CoV-2 virus is a manmade product of biological research, even if it was not intended to be an actual weapon for biological-warfare.[15] This, however, has been debunked by more reliable research-findings such as those of the Scripps Research Institute.[16] This notwithstanding, the fact that the virus has struck naval personnel aboard warships that are on active deployment serves to re-focus attention on the defensive measures that warships can and do adopt against biological-warfare threats. Although the exact contours of the Indian Navy's capabilities in this regard are largely classified, substantial general information is, indeed, available in the public domain. For instance, the report of the committee formed in 2004 by the Naval Studies Board of the USA's National Research Council, which was mandated by the US Chief of Naval Operations (CNO) to examine the defensive capabilities of naval forces against chemical and biological warfare threats offers invaluable research-insights.[17]

As far back as 2001, it was already widely acknowledged that biological weapons are potentially comparable to nuclear weapons in the scale of damage they might do.[18] And yet, there appears to be some reluctance in acknowledging that defensive measures in warships against biological agents is not a contemporary priority, but one that can be tackled in slow time. This reluctance might possibly have to do with the fact that India is a ratifying party to the Biological and Toxin Weapons Convention (BTWC), which came into force on 26 March 1975, and that as many as 183 States — including China and Pakistan — have ratified or acceded to the treaty.[19] The COVID-19 incidents aboard US Navy warships could, therefore, be considered to be a timely and useful wake-up call. This notwithstanding, a number of countries do have ostensibly 'defensive' research as an ongoing activity. Moreover, the relative ease of acquiring a biological weapons capability as opposed to a nuclear-weapons one even by malevolent non-State actors is something that cannot be forgotten.

Although the claim that the SARS-CoV-2 virus may be a biological weapon is entirely unsubstantiated, the almost total unpreparedness of India's mercantile marine to withstand any form of Chemical, Biological, Radiological and Nuclear (CBRN) attack — including by malevolent non-State actors is something that needs to be addressed at a policy level. On the one hand, Indian defence laboratories of the Defence Research and Development Organisation (DRDO), such as the Defence Research and Development Establishment (DRDE) and the Defence Bio-Engineering and Electro Medical Laboratory (DEBEL), working in tandem with a few Indian private-sector industries such as Larsen & Toubro, have developed equipment for the detection of microorganisms and hazardous chemicals, also for protection and decontamination against these hazards.[20] Much of this equipment is capable of being installed aboard warships as well as merchantmen. It is pertinent to mention that the Indian Navy, inaugurated a Nuclear, Biological and Chemical Training Facility (NBCTF), named *Abhedya*, which is a Sanskrit word meaning 'Impenetrable', at its premier engineering-training establishment, INS *Shivaji*, in Lonavala, in March of 2019.[21] Given that there are several privately-owned training centres of the merchant marine in the immediate proximity of INS *Shivaji* (e.g., the Tolani Maritime Institute, the Samundra Institute of Maritime Studies, etc.) and some more in the neighbouring city of Pune, perhaps the Navy could contribute towards enhancing the preparedness of at least some segments of India's mercantile marine. For its part, the mercantile marine needs to get over its present Ostrich syndrome and be more proactive about its own preparedness.

Recommendations for Indian Naval Authorities and Organisations under the Ministry of Shipping

- Given the possibility of the number of COVID-19 cases detected on-board ships increasing, it is imperative that all stakeholders involved in shipping operations implement — in letter and spirit — the guidelines being periodically issued by the IMO, WHO and International Maritime Health Associations.

- Formulate (where necessary) and revisit (where extant) SOPs for the management of viral outbreaks. These SOPs must be comprehensive, and, *inter alia*, include aspects such as the earmarking of isolation wards, cabins, etc., and the clinical management of affected and suspected cases, including their food, laundry, medical needs, utensils, waste-management, cleaning, disinfection, etc.

- Undertake / revitalise the training of onboard crew for the setting-up of isolation wards, handling of patients, paramedical duties, etc. Authorise and earmark additional crew for maintaining health, hygiene, sanitation and disease-control measures.

- Recheck the inventory and holdings of onboard Personal Protective Equipment, medical equipment, testing kits, etc.

- Implement pre-boarding screening and briefings to all passengers and crew and formulate comprehensive questionnaires (incorporating travel-history, health-history, of the individual, as also his / her relatives, etc.).

- Make shore-based and onboard arrangements to ensure that if one or more passengers or crew of a ship should present symptoms suspected to be those of COVID-19, even after a certificate of 'free pratique' has been received[22], the port health authorities are notified and provided with all essential information for contact-tracing.

- Formulate / revisit and implement SOPs for the disembarkation and transfer of suspected cases to an onshore health facility at the earliest for further assessment and laboratory testing. The SOPs must emphasise the need for proactive actions by both, the onboard staff and the health authorities ashore, and the need to minimise the exposure of other persons and environmental contamination.

- Work assiduously toward enhancing the availability of testing kits.

- Formulate / revisit SOPs for basic training and knowledge on swab collection, and the expeditious despatch of environmental samples (such as surface swabs from cabins where suspected / presumed / positive COVID-19 cases have occurred, frequently touched surfaces in public areas, food-preparation areas [including pantries], and air from relevant cabins) to a laboratory for testing can be helpful in this regard.

- Insofar as enhancing naval preparedness in particular (and the preparedness of shipping in general) for biological attack is concerned, the Navy's senior leadership must:

- Recognise that threats posed by chemical and biological weapons are similar but not identical.

- Commit to strengthening and integrating chemical and biological defence at levels (not seagoing ones alone).

- Invest in training at all levels, not merely at basic ones.

- Commission operational net-assessment studies and the formulation of a layered defence that exploits the synergies among individual components and levels of the Navy.

- Formally task naval-intelligence echelons to obtain, upgrade and regularly update intelligence on the capacities and capabilities for biological warfare amongst adversarial State and non-State entities.

- Provide requisite manpower and associated resources to enable a successful tasking of the Directorate of Strategy, Concepts and Transformation, in conjunction with the National Maritime Foundation, for the collection, compilation, collation, and retrieval (information-management) of publicly available literature on the defensive-preparedness of other navies against biological warfare threats.

- Wargame a number of scenarios that would enable a truthful evaluation of the current levels of defensive-preparedness of the Indian Navy against biological threats, deeply and intensively involving not just operational staff but also the Director General Medical Services (Navy) and his / her subordinate medical echelons at Command-, Fleet-, Dockyard-, hospital-, and, ship-levels.

- Proliferate available theoretical knowledge and practical onboard experience to the merchant marine, through a top-down approach, involving the Ministry of Defence and the Ministry of Shipping, as also a simultaneous approach pursued at the functional-level by proactively engaging naval and merchant marine training colleges / institutions.

Conclusion

Seagoing ships need to be prepared for a viral outbreak such as COVID-19. Adequate knowledge, training, equipment and comprehensive SOPs are the keys to combating COVID-19. It must be recognised that a deployed warship may not be able to disembark infected and / or suspected cases. At the same time, the naval and national leadership must be cognisant of the challenges a warship would encounter in enforcing a quarantine on-board. It must also be recognised that the preventive and curative measures, procedures and practices adopted against COVID-19 will almost certainly stand the navy and the nation in good stead in the years ahead, and efforts in these areas must, therefore, be maximised. Best practices must be shared in terms of both, disseminating one's own experiences and imbibing those of others. The availability of medical advice / support through tele / video conferencing / satellite communication must be maximised, along with a significant intensification of ship-wide paramedical training to all onboard crew members on aspects such as the setting-up and maintenance of an isolation ward, CBRN measures, swab-testing, etc. Finally, the Navy's senior leadership must proactively drive the navy's initiatives and seek the guidance of the IMO and the WHO wherever practicable.

ENDNOTES

1. *"The amount of a particular disease that is usually present in a community is referred to as the baseline or 'endemic' level of the disease. This level is not necessarily the desired level, which may in fact be zero, but rather is the observed level. An 'Epidemic' refers to an increase, often sudden, in the number of cases of a disease above what is normally expected in that population in that area. 'Pandemic' refers to an epidemic that has spread over several countries or continents, usually affecting a large number of people"*. Principles of Epidemiology in Public Health Practice, Third Edition, Updated November 2011; Lesson One, Section One. https://www.cdc.gov/csels/dsepd/ss1978/lesson1/section11.html.

2. WHO Director-General's opening remarks at the Mission Briefing on COVID 19. 12 March 2020.https://www.who.int/dg/speeches/detail/who-director-general-s-opening-remarks-at-the-mission-briefing-on-covid-19—12-march-2020.

3. World Health Organization (WHO). "Naming the Coronavirus Disease (COVID-19) and the Virus that causes it". https://www.who.int/emergencies/diseases/novel-coronavirus-

2019/technical-guidance/naming-the-coronavirus-disease-(covid-2019)-and-the-virus-that-causes-it.

4. Military.com.2020. "Navy has 1stCoronavirus case on a ship days after family event onboard". 15 March 2020. https://www.military.com/daily-news/2020/03/15/navy-has-1st-coronavirus-case-ship-days-after-family-event-onboard.html.

5. News.usni.org. 2020. "8 Sailors on USS Theodore Roosevelt have COVID-19; Port Calls cancelled as Navy investigates outbreak", 24 March 2020. https://news.usni.org/2020/03/24/3-sailors-on-uss-theodore-roosevelt-have-covid-19-port-calls-canceled-as-navy-investigates-outbreak.

6. Arun Gupta, Sougat Ray, Rahul Tyagi & Avishek Kumar. "Control of H1N1 Influenza Outbreak: A Study Conducted in a Naval Warship". Journal of Marine Medical Society, 2017. 19. 142. 10.4103/jmms.jmms_70_17.

7. Iims.org.uk. 2020. "IMO Secretary-General asks for pragmatic approach in response to COVD-19". 23 March 2020. https://www.iims.org.uk/imo-secretary-general-asks-for-pragmatic-approach-in-response-to-covid-19/.

8. Ship-technology.com.2020. "COVID-19: Diamond Princess Cruise Ship reports eighth death". 23 March 2020. https://www.ship-technology.com/news/covid-19-diamond-princess-cruise-ship-eighth-death/.

9. Smriti Mallapaty. "What the cruise-ship outbreaks reveal about COVID-19", "Nature" Journal, 26 March 2020 https://www.nature.com/articles/d41586-020-00885-w.

10. Ibid.

11. Ibid.

12. Business-standard.com.2020. "234 Indians evacuated from Iran, quarantined at Army Camp in Jaisalmer. 15 March 2020.https://www.business-standard.com/article/pti-stories/over-230-indians-evacuated-from-iran-quarantined-at-army-wellness-centre-in-jaisalmer-120031500142_1.html.

13. YouTube (NEWSX Channel), 27 March 2020. https://www.youtube.com/watch?v=S9cHtdwfBuA.

14. The Economic Times, 27 March 2020. "COVID-19: Indian Navy mobilises IL38 aircraft to transport 60,000 face masks from Delhi to Goa". https://economictimes.indiatimes.com/news/defence/covid-19-indian-navy-mobilises-il38-aircraft-to-transport-60000-face-masks-from-delhi-to-goa/articleshow/74850995.cms.

15. Dr Rashid Buttar. "The Virus Is Not a Naturally-Occurring Phenomenon" https://www.youtube.com/watch?v=-T9vlpC0bRo.

16. Scripps Research Institute, 17 March 2020. "The COVID-19 Coronavirus Epidemic has a Natural Origin, Scientists Say". https://www.scripps.edu/news-and-events/press-room/2020/20200317-andersen-covid-19-coronavirus.html.

17. "Naval Forces' Defense Capabilities Against Chemical and Biological Warfare Threats (2004)", The National Academies Press; 500 Fifth Street, N.W. Washington, DC 20001. https://www.nap.edu/download/11034.

18. Ibid, p. 18.

19. Wikipedia. "List of parties to the Biological Weapons Convention" https://en.wikipedia.org/wiki/List_of_parties_to_the_Biological_Weapons_Convention.

20. Defence Research Development Establishment (DRDE) – Achievements, 27 March 2019. https://www.drdo.gov.in/defence-research-development-establishment-drde-achievements.

21. Economictimes.indiatimes.com. 2019. "Indian Navy nuclear, biological, chemical training facility launched ". 26 March 2019.

22. A 'Certificate of Free Pratique' is a certificate from the port-health-authorities that the ship is without infectious disease or plague on board and is therefore permitted to enter port and to allow people to board and disembark.

About the Author

Vice Admiral Pradeep Chauhan, AVSM & Bar, VSM, IN (Retd.) is the Director-General of the National Maritime Foundation. He may be contacted at directorgeneral.nmfindia@gmail.com

Commander Saurav Mohanty is a Research Fellow and Deputy Director at the National Maritime Foundation. The contents of the article are the personnel views of the author and do not represent the official policy of the Indian Navy or the Government of India. He may be contacted at nmf.deputydirector@gmail.com

Note

This article was first published on the Website of the National Maritime Foundation on 30 March 2020

Enhancing Maritime Domain Awareness in the Indo-Pacific and the Eastern Mediterranean Regions: Indian and Israeli Perspectives

Captain (Dr) Nitin Agarwala, Dr Ram Erez, and Suriya Narayanan

Nations around the world have been and continue to be both ravaged and protected by the oceans and seas from traditional (military) and non-traditional (non-military) threats.[1] Hence, the securing of the seas is essentiality and not a mutually exclusive condition for securing the interests of most nations. Though the theoretical perspective on security can be bifurcated, based on the approaches to address traditional and non-traditional threats, *maritime security* is considered to have been culled out as a relationship between the traditional (already established) and non-traditional concepts such as marine safety, blue economy, and resilience. This thus prominently requires a focus on non-traditional threats such as piracy and maritime terrorism, arms trafficking, drug smuggling, Irregular Human Migration (IHM), Illegal, Unreported, and Unregulated (IUU) fishing, marine pollution, and natural disasters, to name a few as seen in Figure 1.

This threat scenario essentially requires that countries susceptible to such threats need to be situationally aware of the maritime domain that is likely to initiate such a threat upon them. Since these threats are essentially transnational in their attributes, they require multinational response strategies. This, in return, requires comprehensive maritime cooperation among the stakeholders so as to be able to be prepared to face these threats and challenges. A broad working of and the elements of a successful MDA are seen in Figure 2.

Such cooperation is possible only if there is an effective information-sharing arrangement between the countries of the Indo-Pacific Region and the Eastern

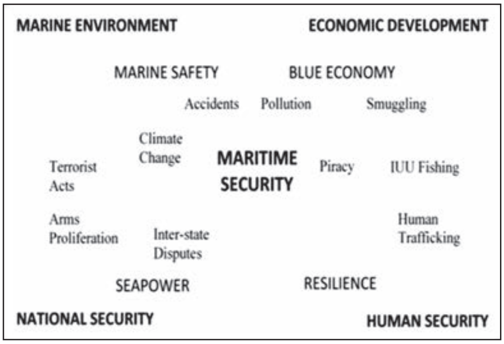


Figure 1: Maritime Security Matrix

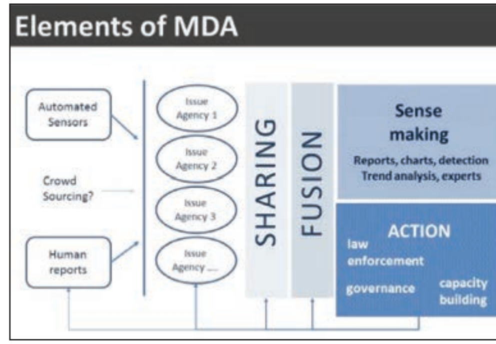


Figure 2: Elements of MDA

Mediterranean region. It is essential to emphasise that maritime security is 'not' limited to military security alone but can be defined as freedom from threats arising from 'above' or from 'under' the sea. These threats could arise from natural causes, man-made causes, or from the interplay of one with the other, as is in the case of global warming and environmental degradation.[2]

Maritime Domain Awareness – Definition and Historical Background

Maritime Domain Awareness (MDA), as a phrase, was first used in the early years of the twenty-first century as a part of the new maritime thinking in the US when security became an area of prime concern.[3] The inception of the term 'MDA' can be traced back to the attacks on the World Trade Centre on 09 September 2001.[4] The traumatic events of this attack on the American territory drove the Bush administration to address the threats from the maritime domain since its concern was, among other things, that the next terror attack could be perpetuated from the maritime domain. The maritime domain was identified as exposed and vulnerable, with limited control and a broad freedom to operate for hostile elements.[5] In defining the maritime domain as 'important' and 'vulnerable', the need for defining operational tools that would enable the country to be aware of and vigilant towards any relevant event to its national security evolved. Hence, the concept of *Maritime Domain Awareness* (MDA) was considered essential. More specifically, the US has defined MDA as "…the effective understanding of anything associated with the global Maritime

Domain that could impact the security, safety, economy, or environment of the United States."[6] This definition called for the ability "to facilitate timely, accurate decision making that enables actions to neutralise threats…"[7]

Subsequently, the Maritime Transportation Security Act of 2002[8], the National Security Presidential Directive-41, and the Homeland Security Presidential Directive-13 (NSPD-41 / HSPD-13) of 2005[9] led to the first National Plan for Maritime Domain Awareness in 2005. Six overall goals for the achievement of security in the maritime domain were defined:[10]

- Preventing terrorist attacks or criminal acts or hostile acts in, or the unlawful exploitation of, the Maritime Domain, and reducing the vulnerability of the Maritime Domain to such acts and exploitation;
- Enhancing US national security and homeland security by protecting US population centres, critical infrastructure, borders, harbours, ports, and coastal approaches in the Maritime Domain;
- Expediting recovery and response from attacks within the Maritime Domain;
- Maximising awareness of security issues in the Maritime Domain in order to support US forces and improve US Government actions in response to identified threats;
- Enhancing international relationships and promoting the integration of US allies and international and private sector partners into an improved global maritime security framework to advance common security interests in the Maritime Domain; and
- Ensuring seamless, coordinated implementation of authorities and responsibilities relating to the security of the Maritime Domain by and among Federal departments and agencies.

This concept of MDA was adopted by the international community and was subsequently embedded in the international discourse within a few years. Most significantly, the International Maritime Organisation (IMO) acknowledged the phrase in 2010 by making amendments to the International Aeronautical and Maritime Search and Rescue (IAMSAR) manual[11] by defining MDA as *the effective understanding of any activity associated with the maritime environment that could impact upon the security, safety, economy or environment*.[12]

Security needs, notwithstanding, limiting MDA to only the security construct may not be appropriate. With reducing resources on land compounded by an ever-increasing population that is forcing humanity to move into the oceans for fulfilling their needs, and nations focusing on 'Blue Economy', the need to know and understand the oceans to achieve sustainable exploitation becomes imperative. Such an understanding is possible only by achieving mapping of the ocean surface and the ocean floor, hence MDA, so as to undertake activities that range from trade, fishing, exploration and exploitation of offshore gas, offshore wind farms, exploration activities for deep seabed mining, marine scientific research, offshore solar farms, submarine cable laying, and many more activities both benign and offensive.[13]

As more nations delve into the oceans, they realise the gravitas to make well-informed maritime engagements in order to protect their maritime interests. However, as explained by Jonathan Colby, maritime engagements are possible only after intelligence gathering and awareness.[14] It is with this understanding that countries have been collaborating with each other to gather and share intelligence and awareness of their maritime region, primarily from a security point of view. The tripartite maritime security arrangement between India, Sri Lanka and the Maldives, signed in 2013, is one such example, and can be considered as a quintessential framework for MDA within the Indo-Pacific Region.[15] This arrangement has been established for the purpose of joint cooperation in EEZ surveillance, Maritime Search and Rescue (SAR)[16], anti-piracy efforts, and sharing of white shipping information since the maritime challenges experienced by these countries are similar, if not identical.

Since the expanse of the seas is large and dynamic, over which information gathering cannot be achieved alone by the efforts of a single actor, a cooperative mechanism provides a better, more accurate, and more expansive MDA. This monograph volume offers a unique look at the issue of Maritime Domain Awareness from two very different perspectives: Indian and Israeli. Despite the profound differences in size, scope, and complexities of the two nations, the two perspectives emphasise the common denominator in dealing with the Maritime Domain Awareness issue from a security perspective – its centrality to coastline countries as well as the main questions that must be dealt with regarding the path to be taken to execute a meaningful Maritime Domain Awareness policy. With this understanding, the monograph aims to explicate the interlinking of existing systems and the potential interoperability opportunities in the MDA infrastructure prevalent in the Indo-Pacific and Eastern Mediterranean Regions from a security perspective. In doing so, it will bring out how such existing systems and their interoperability is providing the necessary inputs for a better decision making. The monograph has so far given a brief overview of the concept of Maritime Domain Awareness. It now moves to reviewing the major trends and developments in the regional maritime domain of the Indo-Pacific and the Eastern Mediterranean Region and the status of the efforts of India and Israel in this field. This will be followed by a discussion of the unanswered questions that plague the availability of a complete MDA picture, followed by some thoughts on the road ahead for each of the two countries with specific reference to possible India-Israel collaboration.

Getting an MDA picture

MDA consists of two key components: information and intelligence. It is all about collating information along with actionable intelligence in the form of a comprehensive common operating picture (COP) to create a substantive, layered presentation of the maritime environment that can help increase the range of options available and hence a more informed decision-making. Numerous governmental and military organisations already possess a COP of some sort or another; however, no one source captures all of the maritime information needed. Once a consolidated COP is available, priorities of resource allocation can be decided in a much more informed manner. From a security point of view, those most critical would be addressed first.

In order to generate this actionable intelligence, it is imperative that the tools so used must be both timeless and scenario-independent. The functional capabilities of the tools used must include *focused sensing and data acquisition* (provide information on the area of interest), *dynamic, interoperable connectivity* (must be dynamic to address changing threats and scenarios), *responsive information management* (information available on demand, de facto provided or pushed when essential), *information assurance* (to ensure that the information has not been tampered with by a third party), *consistent representation* (providing same accurate and timely information to all users making decision making simpler), *distributed collaboration* (to provide transparent interactions between users), and *dynamic decision support* (provide status of both friendly and enemy sensors, systems, platforms, and weapons in real-time).[17] Accordingly, these seven functional imperatives are considered essential to achieve this dominance.

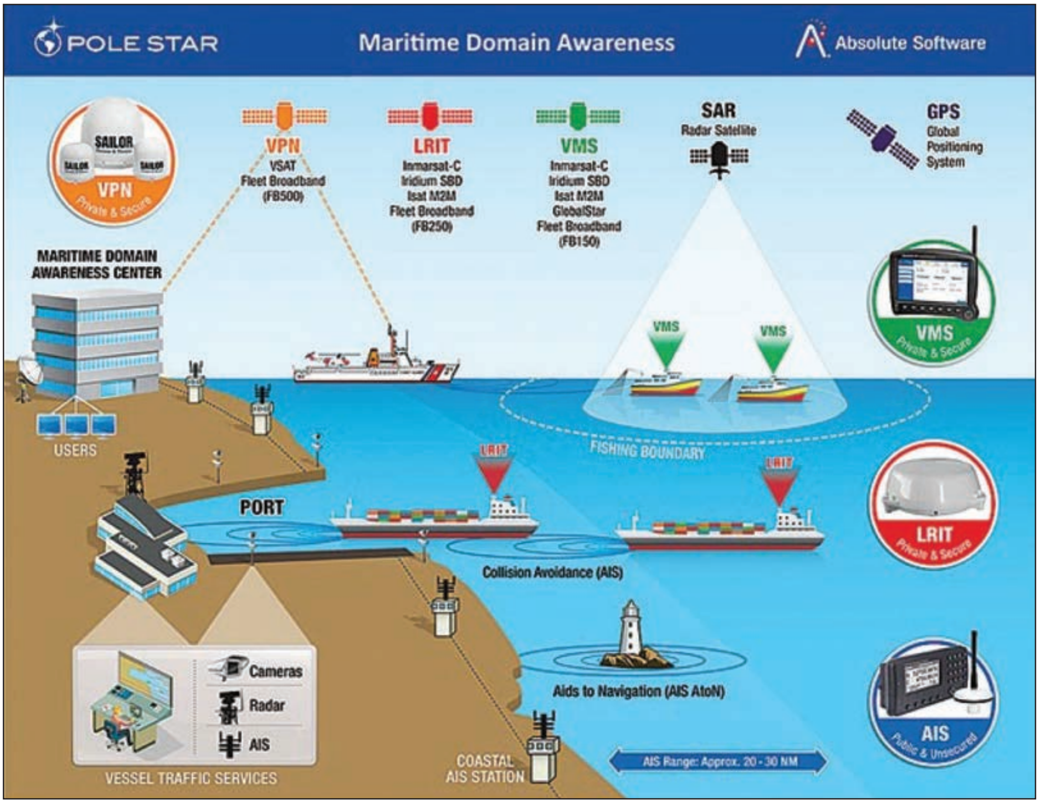


Figure 3: Technologies used to gather an MDA
Source: Douglas (2013)[18]

Sensing the environment to gain situational awareness involves gathering data about the physical world through the electromagnetic, acoustic, seismic, optic, and other measurement means. This can be accomplished with platform-borne sensors or with off-board assets from unattended sensors, unmanned systems, satellites, and intelligence sources through focused sensing. Focused sensing implies concentration on things of interest and on the area of interest while avoiding the gathering of an overwhelming amount of data. Such focused sensing eventually requires technology with data-sensing capabilities.

In order to achieve the desired COP, both existing capabilities and new technologies are used. For example, the 'Automatic Identification System' (AIS), which is analogous to Identification Friend or Foe (IFF) transponders fitted aboard commercial airliners, carried by large commercial vessels for collision avoidance and harbour traffic control.[19] Sensing systems such as long-range, over-the-horizon radars; high-altitude, long-dwell unmanned aerial vehicles (UAV); lighter-than-air craft; oceanic surveillance buoys; and acoustic systems are also used for this purpose in the open ocean environment[20] as seen in Figure 3. Technologies such as space-based (satellite) AIS allow to fuse AIS data with optical and radar imagery and other data sources. Such fused data, along with information from other sensors and open-source intelligence, helps track compliant ships and "dark" ships.[21]

Defining the Regions

In order to ensure clarity and consistency, it is considered essential that the 'Indo-Pacific' and the 'Eastern Mediterranean' as regions are defined before we delve into the issue related to the Maritime Domain Awareness for these areas. In doing so, we will try and explain the linkages between these two areas and how they can be considered as one region.

The Indo-Pacific Region

The definition of the Indo-Pacific as a region has been an area of discussion for many years now, with various economic blocks / authorities referring to different regions that make up this region. While the US refers to the region as the Indo-

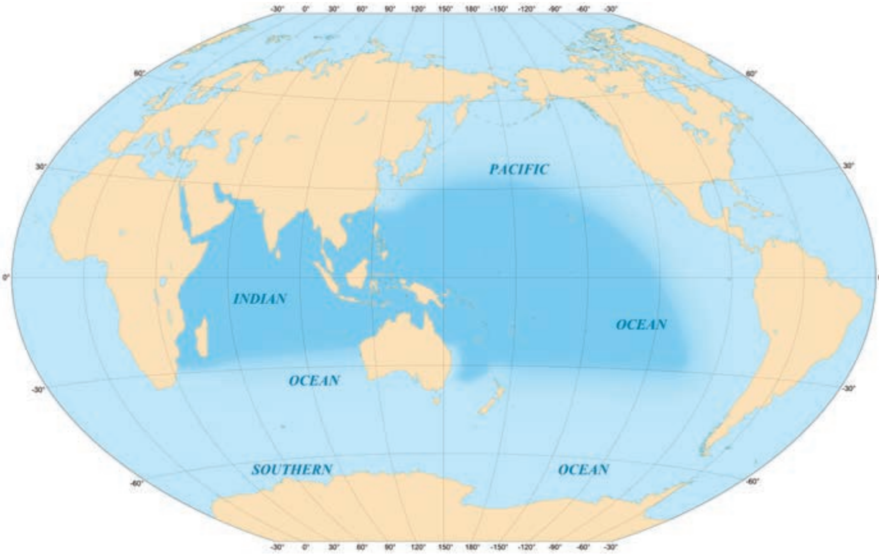


Figure 4: The Indo-Pacific Region
Source: wikimedia.org

Pacific, China prefers to call it the Asia-Pacific. The generally accepted Indo-Pacific Region is a stretch of oceanic space that links the Indian and Pacific Oceans, which encompasses the Arabian Sea, the Bay of Bengal, the Strait of Malacca, the South China Sea, the Philippine Sea, and the Western Pacific as seen in Figure 4. This region is the epicenter of the global economy in terms of availability of natural resources, trade flow and transportation of energy over the Western and the Eastern SLOCS to the West, East Asia, and South Asia. It is home to nearly 60 per cent of the world's population[22] and nations in this region experience more natural disasters than any other region. Between 2014 and 2017, nations were affected by 55 earthquakes, 217 storms and cyclones, and 236 cases of severe flooding, impacting 650 million people and causing the deaths of 33,000 people.[23] In the words of Admiral D.K. Joshi, this region signifies the fusion of two geopolitically sensitive and economically vibrant regions, the shores of which are washed by the Indian and the Pacific Oceans.[24]

The term was first used by Gurpreet Khurana[25] in 2007 where he defined the Indo-Pacific to refer to the maritime space stretching from the littorals of East Africa and West Asia, across the Indian Ocean and Western Pacific Ocean, to the littorals of East Asia. The Indian apex political leadership[26] began using the term in 2010 while the strategic analysts and leadership of Australia, Japan and the US used it only in 2011, with the first documented articulation by Australia in the 2013.[27] The term Indo-Pacific acquired prominence in 2010 because of India's growing economic and security engagement with Southeast Asia, west and east of the Malacca Strait, India's deepening security arrangements with other democracies like Australia, Japan and the US and the growing Chinese maritime appearance in the Eastern Indian Ocean, the South China Sea and the Western Pacific. Off late, Prime Minister Narendra Modi during his speech at the 2018 Shangri La Dialogue (Singapore) outlined India's vision for the Indo-Pacific, and defined the Indo-Pacific Region as that extending from the shores of Africa to that of the Americas.[28]

The region involves the intersecting interests of at least four major powers — China, India, Japan, and the United States — as well as significant middle players such as Australia, South Korea, and the Southeast Asian countries. While the US seeks to maintain a status quo in the world order and international system, China is trying to assert recognition as a major power and strives to carve out its own sphere of influence. Russia, Japan, South Korea, India and the ASEAN countries are all playing an important role in balancing power in this region.

The Eastern Mediterranean Region

The Eastern Mediterranean region includes the littoral waters of Greece, Turkey, Cyprus, Syria, Lebanon, Israel, Gaza, Egypt, and Libya, as well as the international waters between these countries. For a long time, this region has been significant strategically and economically. Accordingly, foreign powers have gone to a great effort in controlling it. Strategically situated on the route from the East to Europe (through the Suez Canal), all relevant actors try to hold stakes in the region. It is a highly contested region with regional rivalries (e.g. Greece and Turkey; Israel-Lebanon) and the great powers trying to offset the balance of power in their favour. In this context, the US holds the 6th Fleet in the region, Russia is investing in its naval base in Syria, and China is promoting its BRI with maritime-related infrastructure projects in nearly all the countries of this region. Accordingly, both the European powers as well as Israel hold vital interests in the maritime domain of this region. Following the gas finds in the region, the importance of this region has grown, as will be elaborated

Figure 5: The Eastern Mediterranean Region
Source: https://israelbehindthenews.com/israels-challenges-eastern-mediterranean/11934/

in the discussions to follow. Understandingly, intertwined with the strategic and the economic importance lies the political significance of the region [29] and hence the need to form a clear maritime domain picture.

Their Linkages

Broadly speaking, all oceans are connected to each other in some form or the other. However, for these two maritime regions, under discussion, the common denominator is Israel. Israel as a State has a major stake in the East Mediterranean as the water of the East Mediterranean washes the shores of Israel. Similarly, Israel finds itself connected to the Indo-Pacific region through the Red Sea where it has its maritime port of Eilat. This essentially means that though Israel may consider Eastern Mediterranean to be the area where it needs to concentrate on its MDA, it cannot afford to overlook activities occurring in the Indo-Pacific region as they too have an indirect bearing, if not direct, on Israel through the Port of Eilat.

MDA in these Two Regions

As discussed, since these two maritime regions have their own concerns, over the time, they have developed their own mechanisms of MDA. To understand the existing mechanisms, it is considered essential that we look at the existing MDA structures in these two areas separately.

MDA in the Indo-Pacific Region

Like any other maritime space, the Indo-Pacific region too faces numerous maritime security-related issues that involve identifying and countering behaviour ranging from the trafficking of people, drugs, small arms, and other illicit goods; illegal, unreported, and unregulated fishing; safety of ferries and inter-island shipping; protecting marine ecosystems and resources that are vital to food security, human health, and economic well-being; and other environmental crimes. This essentially means that it is crucial to share information on marine incidents, oil spill responses, management and conservation of fisheries resources, marine pollution, and coastal management. This nature of information sharing, fusion, and joint analysis allows countries to react faster to incidents and set regional priorities.

Unfortunately, many coastal states of this region have low capacities to achieve MDA. They often have few law enforcement vessels capable of patrolling their exclusive economic zones (EEZs) and lack effective navies, coast guards, or air force resources capable of ensuring maritime rule of law. Since the area of concern comprises of 38 countries that share 44 per cent of world surface area and 65 per cent of the world population, and account for 62 per cent of the world GDP and 46 per cent of the world's merchandise trade, many extra-regional powers have spent their resources and manpower to develop and operationalize various maritime domain information collection and dissemination setups to strengthen maritime cooperation with countries of this region. These setups include:

- Maritime Security Centre – Horn of Africa (MSCHOA)
- Indian Ocean Regional Information Sharing platform (IORIS)
- MASE (Maritime security programme) for the ESA-IO region
- Information Fusion Centre – Singapore
- Information Fusion Centre – Indian Ocean Region (IFC-IOR)
- Agencies addressing piracy

Maritime Security Centre – Horn of Africa (MSCHOA)

MSCHOA, run by the EU Naval Force (EUNAVFOR), helps protect merchant shipping in the region by providing information that assists in preventing pirate attacks and disrupting the activities of pirate groups.[30] MSCHOA aims to provide service to mariners in the Gulf of Aden, the Somali Basin, and off the Horn of Africa. This service involves protection to shipping from the threat of pirate attacks by guiding them away from the piracy hot spots and providing anti-piracy charts and an anti-piracy briefing package for masters. To provide this service, MSCHOA needs vessels to register to know what vessels are operating in the piracy hot spots. The services provided include:

- The *piracy chart*, which is a map of the Red Sea, Gulf of Aden and the Arabian Sea and shows the Gulf of Aden's internationally recommended transit corridor (IRTC), with advice for vessels on how they should safely join it, an overview of Best Management Practices (BMPs) and what to do in case pirates are spotted. The advice on the chart is listed under headings, including 'Identified suspect vessels in vicinity', 'Attack in progress', 'Pirates on board' and 'Vessel hijacked'.

- The *masters' briefing package*, which is given to vessels with a speed of less than 15 knots and a freeboard of less than seven metres, which are perceived to be more vulnerable, consists of a checklist booklet; a DVD on BMPs and a folder entitled "How to survive a piracy attack".

Indian Ocean Regional Information Sharing platform (IORIS)

Initiated by the EU CRIMARIO project, IORIS is a new secure information-sharing and incident-management tool. It was launched on 4 September 2018 to enable member nations to create a collaborative working environment to improve the understanding of the maritime domain and coordinate operations when incidents occur at sea. It uses the cooperative approach developed by the EU to address piracy and the new maritime security challenges faced by the Indian Ocean littoral states, such as drugs and arms trafficking, illegal fishing, environmental damages, etc. Future developmental phases of IORIS will be supported by the EU CRIMARIO project, which includes running costs (hosting, maintenance, and support) until March 2020.[31]

MASE (Maritime security programme) for the ESA-IO region

Initiated by MASE (Maritime security programme, EU-funded), and implemented by IOC (Indian Ocean Commission), two regional centres have been set up to promote maritime situational awareness of the coastal countries of ESA-IO (Eastern and Southern Africa and the Indian Ocean). These are:

- *RMIFC (Regional Maritime Information Fusion Centre) based in Madagascar*: The RMIFC was initiated by the Malagasy authorities in 2013 in collaboration with MASE and was confirmed by the Djibouti Declaration on Maritime Security and Safety on 15 May 2016. However, the five states of ESA-IO (Djibouti, Madagascar, Mauritius, Union of Comoros, and Seychelles) signed the Regional Agreement for the setting up of RMIFC only on 29 April 2018 when it became operational. Several steps have been taken by RMIFC since this start. These include staff training, expansion of information exchange network, setting up of the communication tools (Website, Twitter and Facebook) and the production of basic deliverables (daily brief, ESA-IO Ports Maritime Traffic Status, Press summary, Recognized Maritime Picture, weekly, monthly and annual report on Maritime Security and Safety in the ESA-IO Region).[32]
- *RCOC (Regional Centre for Operational Coordination) based in Seychelles*: The RCOC is a regional centre for operational coordination alongside the

RMIFC. The RCOC organizes the operational response to maritime crimes in the western Indian Ocean along with its nine members: Comoros, Djibouti, France / Réunion, Kenya, Madagascar, Mauritius, Seychelles, Somalia, and Tanzania.[33]

- ***The NISCC (National Information Sharing and Coordination Centre)***, is a national entity, based at Seychelles with a mission to co-coordinate and manage the ever-increasing level of activities within the maritime sector, coordinating oil spills and responses to coastal maritime crime. The NISCC will act as the first point of contact and as the centre of maritime security operations for key national stakeholders.[34]

Information Fusion Centre – Singapore

The Information Fusion Centre (IFC) was established on 27 April 2009 in Singapore. It is a 24/7 Regional Maritime Security (MARSEC) information-sharing centre. It aims to facilitate information-sharing and collaboration between partners to ensure safety and security at sea. Through an integrated team of International Liaison Officers and the Republic of Singapore Navy (RSN) personnel, the IFC delivers information to regional partners to cue timely operational responses by regional and international navies, coast guards and other maritime agencies to deal with the full range of MARSEC threats and incidents. This includes piracy, sea robbery, maritime terrorism, contraband smuggling, illegal fishing and irregular human migration.

As on 6 May 2019, 155 International Liaison Officers (ILOs) from 24 countries have been deployed to the IFC, and 19 ILOs from 18 countries currently serve alongside 12 RSN personnel. The IFC has 97 linkages from 41 countries and is one of the four Technical Leading Navies of the Trans-Regional Maritime Network, which brings together the IFC's Open and Analysed Shipping Information System to enhance global maritime information-sharing and cooperation.[35]

Information Fusion Centre – Indian Ocean Region (IFC-IOR)

In order to provide a greater reach to the COP generated by the IMAC with stakeholders of various nations of the region, the IFC-IOR has been established at the IMAC. The IFC-IOR is to be a single point centre linking the coastal radar chains as and when installed in other countries and the existing white shipping information exchange (with 36 countries[36] at the time of writing the article) with various countries of the region to generate a seamless real-time picture. Such countries can position International liaison officers (ILOs) at this centre. The IFC-IOR is to be a separate platform and it is expected that all members of the Indian Ocean Naval Symposium (IONS) will be part of it.

Other agencies addressing piracy in the region

Some successful regional constructs to address piracy that provide an effective platform for joint counter-piracy exercises are:

- ReCAAP[37] has fostered mutual trust and promotes information sharing between 20 countries in the Asia-Pacific, Europe, and North America.
- The Djibouti Code of Conduct[38] that was adopted on 29 January 2009 by various African states.
- EUCAP Nestor launched by the EU was adopted in July 2012 for civilian maritime capacity building in Djibouti, Seychelles, Somalia, and Tanzania.
- The Yaoundé Code of Conduct that was adopted by West and Central Africa on 25 June 2013.
- Based on the successful Malacca Strait Patrols (MSP), the Sulu Sea Patrol Initiative (SSPI) was established on 14 July 2016.[39]
- The Shared Awareness and Deconfliction (SHADE) umbrella has been effective in curbing piracy in the Gulf of Aden.

MDA in the Eastern Mediterranean

Maritime security has become an area of growing interest in the Eastern Mediterranean with the recent gas finds; disagreements over maritime boundaries; large-scale violence; political instability; mass migration via sea routes; and environmental hazards. These are compounded by the lack of shared values, culture and norms; protracted conflicts in the region, such as those among Turks, Greeks and Cypriots, and between Israelis and Palestinians; and the absence of effective sovereignty in parts of the region such as Libya, Syria, the Gaza Strip and parts of the Sinai Peninsula. These all have necessitated a need for a greater Maritime Domain Awareness in this region.

Today, the region has Egypt, Turkey, and Iran as existing regional naval powers, and Russia and the United States as extra-regional naval powers with Israel increasing its maritime focus to evolve as another maritime power in this region.

The War in Syria as well as the instability in Syria, Iraq and Libya bears maritime implications. The war in Syria has brought about the Russian maritime presence, and the resulting instability has brought a flux of refugees that try to reach European shores for asylum. The diminishing interest of the US in the region is offering opportunity to Russia as well as China to increase their presence in the region. [40] This is permitting Russia to increase its maritime presence in the Mediterranean by positioning vessels in various countries of the region, including increased number of military vessels that are entering the ports of Spain, Greece and Malta, as well as a docking agreement with Cyprus signed in 2015.[41]

MDA in India and Israel

Since India and Israel are two independent countries, they have their own maritime security challenges. Even though they are geographically separated and their challenges are unique, the broad issues related to maritime security remain the same and hence there exist many commonalities wherein the two countries can work together. In order to understand these similarities, it is essential that the security MDA being practised by the two countries is discussed before the collaborative mechanism can be discussed.

India

MDA

As discussed, MDA is an all-encompassing term. It involves being aware of the location and intentions of both friends and foes, in the dimension and area of interest of a highly dynamic and evolving maritime environment. Such an MDA enables an early identification of potential threats, a more informed decision-making and suitable allocation of resources. Due to a dynamic maritime environment, MDA is never absolute. It requires a continuous effort to acquire and to analyse information. The feed for this effort is provided from Intelligence, Surveillance, Reconnaissance (ISR) and information sharing. The MDA picture is known to change with advances in technology of platforms, sensors and weapons, increased density in the maritime environment, trade flow patterns and interactions between nations and regions.

Like any other maritime nation, an MDA picture is essential for a country like India. However, even though the data was being collected by various agencies, not a single consolidated MDA picture was being developed for security assessment. The attacks on Mumbai from sea on the 26 November 2008 exposed three critical gaps in Indian maritime security namely: porous water-front of the Indian coastline, lack of inter-agency coordination and poor surveillance of the maritime domain hence an urgent need of a consolidated MDA picture.[42] In August 2009, as a result of these attacks, the National Committee on Strengthening Maritime and Coastal Security against threats from the sea (NCSMCS) was constituted with the cabinet secretary as its Chairman. However, with 15 or more agencies involved, ranging from the Indian Navy, the Indian Coast Guard, customs, intelligence agencies and port authorities to the home and shipping ministries, state governments and fisheries departments, the task was daunting and the NCSMCS alone was found to be ineffective. In order to remove the large number of variables and be able to achieve a *"common operational picture" of activities at sea through an institutionalised mechanism for collecting, fusing and analysing information from technical and other sources like coastal surveillance network radars, space-based automatic identification systems, vessel traffic management systems, fishing vessel registration and fishermen biometric identity databases*,[43] the Modi government in 2014 established the National Maritime Domain Awareness (NMDA) grid by instituting a number of organisational, operational and technological changes.

Since identification systems have been a critical common requirement for Maritime Security,[44] India decided to set up such identification systems along the coastlines for better surveillance under the NMDA project. This project aims to detect and tackle threats emanating from the sea in real-time and to generate a holistic picture based on the information received from various simultaneous and dedicated layers. These layers include: the Vessel Traffic Management System (VTMS) and Vessel and Air Traffic Management System (VATMS); the National AIS (NAIS) Network; the Merchant Shipping Information System (MSIS); the Coastal Surveillance Network (CSN); and the National Command Control Communication and Intelligence Network (NC3IN). Of these, the NC3IN system, presently with the Indian Navy and the Indian Coast Guard, will be progressively extended to other stakeholders such as the fishing and merchant vessels for improving the overall MDA and will help in the coordination between the maritime agencies, coastal states and union territories by linking them. To appreciate the working of this layered information system, let us look at each of these resources independently.

- *Vessel Traffic Management System (VTMS)* is present with the commercial ports for monitoring the maritime traffic in the port. The surveillance information from the port radars, Automatic Identification System (AIS), Direction Finding (DF) system, CCTV, VHF communications and other systems provide the feed to the VTMS and a local maritime picture of the ports to NC3IN.

- *Vessel and Air Traffic Management System (VATMS) – West*: Present with the Offshore Development Area (ODA) on the Western Coast of India since 2007. It is a sophisticated surveillance system that assists in Search and Rescue (SAR) operations[45] and tracks any drifting or intruding vessel in all weather conditions. It can facilitate voice communication with vessels in its range and collect and share metrological formation in its surveillance zone. The VATMS provides round the clock monitoring of the waters of the Arabian Sea with real-time data.[46] The feed from this system to the NC3IN provides a maritime picture of the Offshore Development Areas.

- *National Automatic Identification System Network (NAIS)*: The Directorate General of Lighthouses and Lightships (DGLL) has developed and installed in August 2012 a NAIS network in coordination with the Indian Navy and the Indian Coast Guard. Seventy Four shore stations on existing lighthouses along the Indian coast, six regional control centres, two coastal control centres and one national data centre at Mumbai have been set to help Marine Navigation and tracking of SOLAS compliant vessels and those carrying transponders as per DG Shipping Notices so as to have an overall image of AIS complying vessels along the Indian coastline. The new proprietary system developed for smaller (sub-20 m), non-AIS vessels would be compatible with this network. The feed is provided to Naval Headquarters, Coast Guard Headquarters and the NC3IN.[47]

- ***Coastal Surveillance Network (CSN)***: CSN that was mooted almost two decades ago found approval only after the 26/11 attacks. The Indian Coast Guard, as part of the CCS directive of 2009 developed the Coastal Surveillance Network (CSN) all along the coast on the mainland and along the Lakshadweep group of islands and along the Andaman and Nicobar Group of Islands. The project consisting of a chain of static sensors having radars, Automatic Identification System (AIS), day / night cameras and Met sensors has two phases. Of this, thirty six radar stations on the mainland, six in Lakshadweep and Minicoy and four in Andaman and Nicobar have been operationalized. The second phase, approved by the Defence Acquisition Council (DAC) in 2017, will involve setting up thirty eight more radar stations with static radars and electro-optic sensors, four mobile surveillance stations and integration of VTMS sites in the Gulf of Kutch and Khambhat.[48] The feed from this is shared with the NC3IN.

- ***Merchant Shipping Information System (MSIS)***: The MSIS is a MDA system that provides the maritime traffic movement and is developed to correlate, fuse and disseminate the data obtained from the National AIS (NAIS) Network and other sources of Automatic Identification System (AIS), including open-source information on 'white shipping'. The resultant feed is made available on the nodal Information Management and Analysis Centre (IMAC).

- ***National Command Control Communication and Intelligence Network (NC3IN)***: The Indian Navy has established the NC3IN as the backbone of the 'National Maritime Domain Awareness' (NMDA) Project[49] by linking 51 stations, including 20 of the Navy and 31 of the Coast Guard and the

Joint Operation Centres (JOCs), with a nodal Information Management and Analysis Centre (IMAC). The network rides on dedicated terrestrial data circuits, as well as, satellite communication, which helps the stations in remote locations to be networked and can track 30,000 to 40,000 merchant ships transiting through the Indian Ocean. Other than the above mentioned sources, real-time information is fed from Long-Range Identification and Tracking (LRIT), space based AIS and other open sources to develop a correlated picture of maritime traffic.

- *Information Management and Analysis Centre (IMAC)*: The IMAC is the nodal centre of the National Command Control Communications and Intelligence Network (NC3I Network), and is a joint initiative of the Indian Navy and the Indian Coast Guard with Bharat Electronics Ltd as the service provider that functions under the National Security Adviser (NSA) to improve coastal surveillance. At the IMAC, all the information being received from the various sources (stations, centres, etc.) on NC3IN is connected through a high-speed computer network through the Coastal Surveillance and Decision Support (CSDS) software. The data from various sensors and databases is aggregated, correlated and then disseminated to various stations for enhanced awareness. The software on which the coastal surveillance will be carried out incorporates hi-tech features like data fusion, correlation and decision support features thus facilitating better decision making.[50] The information so collated is analysed and disseminated in the form of a Common Operational Picture (COP) so that the decision makers at all levels are able to anticipate potential threats and respond appropriately.

Shortfalls

It is not that the system in use by India is fool-proof and covers the entire gambit of the maritime domain to provide a perfect COP. There are some major shortfalls in the existing system of which some of them are:

- *VATMS-East*: The East coast of India does not have a VATMS. This thus does not provide a picture of the ODA of the East coast, thereby hampering a

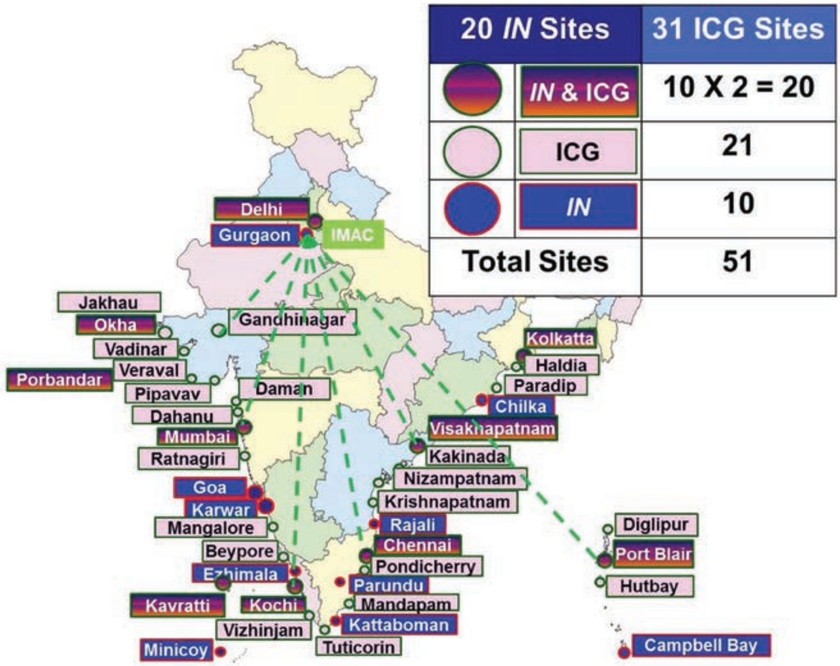


Figure 6: Stations linked onto the National Command Control Communication and Intelligence Network (NC3IN) and IMAC
(*Source*: Modified from Chawla (2016)[51]

complete MDA for this region. Since the existing oil and gas installations on the Eastern coast of India are few in numbers that spread across Pondicherry offshore, KG offshore and Mahanadi basin, no major installations of ONGC are in operation on the East coast and the existing installations are the CRP (Control and Riser Platform) of Reliance, a cluster of unmanned platforms of Cairn Energy at Rawa field and Floating Point Units (FPU) and tankers of Hardy Oil at Cauvery basin, there is no lead partner for installation of the VATMS. However, since some more structures are planned in the future[52] the VATMS-East becomes critical.

- *Integration of feed*: While the feed to the current NMDA setup has been integrated with CSN (ICG), NAIS (DGLL), LRIT (DG Shipping), VATMS(W) (ONGC), and space-based AIS (ISRO), that with others such as fishing vessel bio-ID database (MoA), Fishing Vessel Registration Database

(MoA), Fishing Vessel Tracking System (MHA), Port Community System (MoS), MSIS (IN), MAC / SMAC database of IB, VATMS (E) (ONGC), VTMS of Major Ports (MoS), ship security alert system (DG Shipping), VTMS of Gulf of Kutch (DGLL) and VTMS of Gulf of Khambhat (GMB) still needs to be achieved.[53]

India's efforts towards MDA in the IOR

The emerging MDA structures that exist in the Indo-Pacific Region need to be strengthened and the agreements or initiatives need to be operationalized to its full potential for effective surveillance. Enhancing the MDA will ensure maritime security and good order in the region. This can be pursued through a mutually inclusive approach, addressed at the conceptual level (say SAGAR), the political level (say IORA and EAS) and the operational level (say IONS and WPNS). Such interventions can be made effective through the mechanisms of policy, monitoring and coordination within the MDA framework.

In order to cement a stronger understanding and cooperation amongst friendly nations in the region, India has been engaging with its littoral neighbours. India's Maritime Security Strategy of 2015 recognises MDA as a critical requirement for maritime security and an essential tool to deter adversaries, maintain a strategic advantage and engage with her neighbours. In order to ensure that open-source information of maritime shipping movement is available to India, it has signed technical agreements with countries in the region for exchange of white shipping information. This would enhance the MDA in the Indian Ocean Region. As discussed, prior to the inauguration of the IFC-IOR, there were only two IFCs covering the Indo-Pacific Region.

Realising that the IFC of Singapore covers regions towards the Eastern seaboard of India, and the RMIFC covers the south-western region of the Indian Ocean, there is a void on the Western seaboard of India in terms of an MDA picture for the Indo-Pacific Region. Accordingly, India commissioned the IFC-IOR at the state-of-the-art Information Management and Analysis Centre (IMAC).

The nature of the maritime domain and the sheer magnitude of maritime traffic in the region, make it difficult for countries to address MDA, unilaterally. Hence, collaborative efforts between like-minded maritime nations are essential. In line with this thinking, India proactively engages with countries of the region to enhance maritime cooperation. To further this, the Republic of India pursues activities such as:

- ***White shipping information exchange***: In order to effectively fill gaps in attaining the domain picture India has signed white shipping agreements with 36 countries of the region. The data received as a part of such an information exchange is collated and analysed at the Integrated Headquarters Ministry of Defence (Navy) and IMAC

- ***Coastal Surveillance Radar Systems***: Towards capacity building and promoting maritime security in the Region, Coastal Surveillance Radar systems (including Automatic Identification System AIS Chains) are being installed in neighbouring countries. India has already installed coastal surveillance radar system (CSRS) networks across Seychelles, Mauritius and Sri Lanka. As of January 2019, India is in advanced discussions with Myanmar to install these radars there. India has also offered these radars to Bangladesh, Indonesia, Thailand and Maldives.[54]

- ***Trans-Regional Maritime Network (T-RMN)***: The T-RMN facilitates information exchange on the movement of commercial traffic on the high seas with the information being made available primarily through the AIS. This network boosts maritime security of the country and helps improve the MDA of the region. The T-RMN is an initiative led by Italy and India has signed the agreement on 11 December 2018.[55]

On the home front for a better and an organised MDA, India has

- Prepared its National Maritime Policy in 2018 which is currently under discussion before it can be promulgated.

- India conducted a one of its own kind maritime domain awareness exercise named SEA VIGIL on 22-23 January 2019 that involved maritime stakeholders at the Centre and all the 13 Coastal States and Union Territories.[56]

Areas of concern

While the need of the hour is to ensure a comprehensive MDA, there are some areas of concern that make this task challenging. These include:

- *Technical hurdles*: The effectiveness of an MDA is governed by the efficiency of the practitioners to create a common operational picture. The creation of such a picture is complicated due to poor interoperability between the source of information and challenges of data integrity with lack of standardisation between systems being the main reason for this drawback. Given the fact that the IMO standardises only AIS and Long-Range Identification and Tracking (LRIT) systems, other networks and data exchange systems are not always interoperable. This leads to technical hurdles when non-standard equipment is used to facilitate date exchange.
- *Law and MDA*: A number of legal issues plague the smooth preparation of MDA. These are:
  - ➢ Lack of a clearly defined legal mechanism to prosecute maritime criminals.
  - ➢ Lack of legal mechanisms to handle data misinterpretation and misclassification or loss.
  - ➢ Lack of provision to demand data from vessels transiting off their own maritime zones under the UNCLOS due to the absence of any further international cooperative mechanisms being established.[57] As an example of the latter, in 2004, Australia declared its intention to create a 1,000 nautical mile (nm) "Maritime Information Zone" within which it proposed that any passing vessel would be "required to provide details of cargo, destination, crew, port of call and likely arrival time at port."[58]
- *Military data*. When States gather intelligence, the effort involves the collection of information, including that about the maritime areas of another State that at times may enable a nation to make decisions about their own national defence [59] due to which at times such collaborative arrangements are not seen with trust.

- *White shipping data*: The white shipping data as collected may become a critical question for assessing its legality. Though UNCLOS makes reference to MSR and survey activities but provides no comprehensive definition of white shipping data which creates an ambiguity.
- *Integrity of AIS*: The AIS is vulnerable to 'data manipulation'.[60] In the last two years, there has been a 30 per cent increase in the number of ships reporting false identities. Nearly 40 per cent of the ships do not report their next port of call to prevent the commodity operators and to preclude speculation.[61] There is a growing tendency among merchant ships to shut down AIS, and 'go dark'. This can mislead the security forces who have to respond in time of need.

Israel

MDA

The centrality of the maritime domain for Israel, notwithstanding, the Israeli national policy has been characterized — from the period of illegal immigration before the establishment of the State of Israel to the recent times — by a *lack of awareness*, resulting in the lack of a National Maritime Domain Policy.[62]

During the past two decades, the stark contrast between the crucial importance of the marine domain to the State of Israel and the lack of an overall National Maritime Domain Policy has become more acute. However, a number of baby steps have brought about changes and developments in the Israeli Maritime Domain Awareness.

The sea and its routes have been central for Israel from the days of the Mandate[63], when the sea was the main channel for Clandestine immigration. Furthermore, the Arab pressure and the fear of an embargo were among the main motives for the creation of an independent merchant fleet under an Israeli flag, including passenger ships, which reached its peak in the 1970s. Since then and as part of the globalisation process, Israel has come to depend on international shipping for its trade that has led to a decline in its local shipping.[64]

Israel's maritime domain however has changed dramatically in the recent decades, due to both, the changes in its characteristics and the change in its national awareness. The characteristics of Israel's maritime domain reflects to a large extent the characteristics of the maritime domains of the other Eastern Mediterranean countries, namely the tension between the desire to economically develop the maritime domain and the strains of this development on the environment and the ecology that are liable to transform the domain into a *marine desert* due to pollution, warming of the sea, excess salinity, change in the acidity of the sea, the destruction of fisheries and overfishing.

In the Israeli case, the issue is particularly acute in view of the importance of the maritime domain from a security viewpoint. The Israeli Navy has—within its limited resources—developed an ability to maintain 'situational awareness' in the maritime domain. However, from a national perspective, there is still no full solution to the issue as the State of Israel does not have a national policy for the maritime domain, nor a grand maritime strategy.[65] The perspective has been littoral at best, and so have been the legal jurisdiction and the planning tools.[66] However, starting 2012 and subsequently picking up momentum in 2014, the Planning Authority (today a part of the Ministry of Finance) initiated a national process with the support of the EU to formulate Israel's policy for the maritime domain. As part of the process, a draft policy paper was published in October 2017[67] for public review. Public seminars were held to present the program and to get the public involved[68] to refine the policy. This done, it was finally submitted for approval in 2018 where it remains to date.

The need for a Maritime Domain Awareness is also important in other areas other than defence. Though this monograph focuses primarily on the defence aspect, other areas where it has great potential are in dealing with environmental issues, including monitoring of the seas, marine pollution such as oil spillage[69], bio-diversities, fish stocks, and underwater mining, to name a few.

Major Trends and Developments in Israel's Regional Maritime Domain

Israel's regional maritime domain has become increasingly dynamic, complex and at times volatile – mainly in the realms of national security and economics. These developments as discussed herein carry major political implications and calls for action.

- ***Destabilising effect of the Shiites on the maritime domain:*** The most important development for Israel in recent times is the destabilising effect of the Shiites on the maritime domain. The attack by Yemeni Houthi rebels on two Saudi crude carriers in July 2018 and the series of attacks on tankers which are attributed to Iran, as well as GPS jamming in the Straits of Hormuz and the seizure of two British ships[70] are some examples of this destabilising effect. The hostile Iranian activities in the Strait of Hormuz and the assaults of the Houthis in the Strait of Bab-el-Mandeb in the Red Sea both marked the importance of the maritime region and emphasised the world's vulnerability to the event in these areas.[71] Both straits are vital trade routes for energy and for world trade. The very threat to freedom of navigation through these routes affects the global economy – the oil prices, maritime transport prices and insurance costs – as well as political stability and the chances of a violent clash.

It is with this thinking in mind that the Israel's Prime Minister, Netanyahu, declared in August 2018, following the threats to close the Bab-el-Mandeb Strait, that "If Iran tries to block Bab-el-Mandeb Strait, I am convinced that it will find itself facing an international coalition determined to prevent it. This coalition will also include the State of Israel."[72] A year later, Israel's Foreign Minister was quoted saying that Israel is taking part in the international coalition in the Persian Gulf.[73] Currently, the US is trying to form an international maritime coalition, including Gulf Arab nations and Israel, aimed to secure vital trade routes from additional Iranian attacks on tankers in the Persian Gulf waters. Accordingly, the US held in Bahrain a conference of Maritime and Aviation Security Working Group including Gulf States and Israeli official representatives in October 2019 putting "aviation and maritime security as the top of the policy agenda in the region."[74] From an Israeli perspective, the willingness of Gulf States to publically meet Israeli officials is yet another step towards a coalition against the Iranian threat, including its threat to the maritime domain.[75]

Furthermore, Iran is active in trying to establish a maritime position in Syria. This Iranian move interconnects with its larger scheme to build a strategic land path from Iran to the Mediterranean. However, both Israel and the US regard this step as undesirable, while Russia is putting pressure on Syria to prevent this from happening.[76] Iran, in the meantime, keeps pressuring the Assad regime to let it lease a part of the Port of Latakia despite Russian objections.[77] If Iran succeeds, it is expected to expose substantial consequences for Israel's maritime domain awareness and increase the potential for a direct confrontation between Israel and Iran in the maritime domain as well. Although the Iranian Navy is aging and its power projection in the Mediterranean is limited in scope, even such limited potential presence bears consequences for Israel, considering the proximity between the Syrian territorial waters and the Israeli border and the potential use of fast boat attacks and standoff capabilities.[78]

These and others of a similar nature necessitate the requirement for a near-real-time multi-sensor intelligence, data fusion, and the need to share information so as to act in a timely fashion. Israel has a relative advantage in intelligence gathering, and data fusion and hence can become a meaningful partner in a possible international coalition.

- ***Growing tension between the US and China***: Another major development in Israel's maritime domain derives from the growing tension between the US and China. China, on the one hand, continues to promote its Belt and Road Initiative (BRI) in the region with significant success, while the US, on the other hand, applies pressure on the host nations of the BRI, including Israel, to rethink their position, thereby creating a major political tension.

China's growing activism in the Mediterranean and the Red Sea is part of its maritime strategic plan that compliments the BRI. This includes growing investments in transportation infrastructure, naval presence, and naval exercises.[79] In this perspective, China has become increasingly active since 2008 in the anti-piracy campaign off the Horn of Africa.[80] This continuous effort serves China in turning its traditional coastal Navy into a Blue-water navy with global capabilities, enhanced power projection capabilities, and acquired operational experience in far seas missions.[81] In order to indicate its presence and stakes in this region, China conducted its first maritime exercise in the Eastern Mediterranean in May 2015, together with Russia.[82]

In addition, the other significant development in this region is the completion of the construction of China's first overseas military base in Djibouti in 2017.[83] This base is located just over 10 km away from the US sole military base in the whole of Africa. China calls it a logistics support base, which supports its anti-piracy effort, its ability to protect Chinese assets in the region, and it enables China to evacuate its citizens when needed.[84] But more significantly, this base is a strategic post, central to securing vital Chinese trade routes as well as supporting its potential power projection in the region.

With China's involvement in this region, Israel is forced to take into consideration the Chinese impact on its maritime domain awareness, among other things. Moreover, pressure from the Trump Administration on Israel regarding the planned operation of the newly built port in Haifa by the Chinese has put Israel in a spot with regard to its maritime domain policy.[85]

- ***Progress in the energy field***: The third development concerns the dramatic and vast progress in the energy field, mainly due to the discoveries and developments of new gas fields in the region. This includes the new cooperation in the eastern Mediterranean between Cyprus, Greece, Israel, Italy, Jordan, and the Palestinian National Authority with the support of the US and the EU called the 'East Mediterranean Gas Forum' in January 2019 and the progress of the Israeli new gas fields, especially with regard to the fields deep in the Israeli EEZ.

The forum aims to ensure gas resources in the East Mediterranean that can be developed economically with countries "fostering regional energy cooperation". This development was augmented by agreements between Israel and Egypt in February 2019 to commence export of gas from Israel to Egypt, and between Cyprus and Egypt to pipe gas from Cyprus' Aphrodite field to Egypt.[86]

The new cooperation in the Eastern Mediterranean between Israel, Greece and the Republic of Cyprus since 2012, focuses on energy, defence, commerce and tourism. At the backdrop of the contested relations with Turkey and the support of the US and the EU, the tripartite cooperation is gaining momentum.[87] Energy and defence issues drive the three to further explore new projects that expose maritime aspects. To provide a couple of examples:

- The concept of transporting gas from Israel and Cyprus EEZ in the Eastern Mediterranean basin to Europe through Cyprus, Greece and onward to Italy which is called the Eastern Mediterranean Gas Pipeline (East-Med), bears dramatic consequences for the energy market in the region as well as for maritime domain awareness. Constructing, operating and securing such a gigantic project will demand an increase in the maritime operational capabilities of Israel as well as demand for further interstate cooperation on issues of surveillance, data integration and intervention. So far, the EU has given a green signal to a feasibility study. However, it is yet to be decided if the parties will go on with the project. Furthermore, Israel and Cyprus share holdings to a vast gas reserve, which spreads to the EEZ of both countries and has yet to be agreed upon regarding its co-development. In the meantime, Turkey is drilling for gas in waters that are internationally recognized as part of Cyprus EEZ. In this case as well, any progress will accent the need for and the importance of joint maritime awareness activities between Israel, Cyprus, Greece and Italy.
- As part of the newly formed political alliance, it was published that Greece and Israel are jointly building a 'Long Horizon' radar, which will be stationed in eastern Crete and will enable monitoring the Eastern Mediterranean.[88]

Current status of MDA

For Israel, like any other maritime nation, the traditional maritime domain awareness (situational awareness), is maintained by the Navy by adjusting and rising to new challenges. In doing so, the Israeli Navy is building a new generation of corvettes (SAAR-6) with extended operational capabilities, as part of the Navy's mission to protect the EEZ. This necessity to protect the EEZ forced the Israeli Navy to triple the range of coverage and to significantly widen its situational awareness.

In the realm of international cooperation that aims to promote maritime awareness, Israel participates in several EU-led programs, two of which are the Border Security Project as part of the Southern Neighbourhood cooperation and the Project for Technical Assistance.

- ***EU4Border Security project*** **–** Israel was invited to join the Border Security Project together with Algeria, Egypt, Jordan, Lebanon, Libya, Morocco and Tunisia, as part of the EU Southern Neighbourhood (SN) program. The project aims at building trust, understanding, structured partnerships, and exchange of experiences / practices between Southern Neighbourhood countries and the European Border and Coast Guard Agency (Frontex).[89] In addition it aims to promote integrated border management, training, risk analysis, situation monitoring and information management.[90] In the maritime domain, the Agency takes special interest in maritime domain awareness, as part of its mission in migration enforcement, smugglers apprehension, as well as search and rescue operations.
- ***Project for Technical Assistance*** **–** Israel was also invited to participate in the EU effort to promote maritime domain awareness through the Technical Assistance Project.[91] In this regard, the European Maritime Safety Agency (EMSA) brings together EU members and regional non-EU members, with the aim of enhancing national capabilities to monitor vessel traffic and encourage data exchange, namely to improve national maritime domain awareness through regional cooperation and promote maritime pollution preparedness and response capabilities, based on the established maritime domain awareness. Of special interest in the context of maritime awareness are the CleanSeaNet – EMSA's Satellite Based Oil Spill and Vessel Detection Service[92] that Israel joined in 2014, as well as activities promoting Vessel Traffic Monitoring and Information Systems, which include, among other things, Vessel Traffic Service (VTS) training and AIS sharing through Integrated Maritime Services (IMS).[93]
- ***National maritime policy*** **–** As on date Israel lacks a national maritime strategy policy. A policy paper was drafted in 2018 and awaits its approval. The policy paper draft offered, for the first time, an integrative approach that includes a maritime strategy for Israel, suggestions for required legislation, a framework for the management, the preservation and planning of all utilities in the maritime domain that would relate to all of the relevant issues, including but not limited to security considerations. Lamentably, there has been no major progress so far.

Unanswered Questions

Subsequent to the review of Israel's current status of the maritime domain awareness issue, some questions need to be addressed.

- Is the expansion of the maritime domain awareness concept beneficial? One may recall that the origin of the concept is primarily 'operational' and was mainly focused on 'military affairs'. As discussed earlier, expanding the concept of maritime domain awareness beyond military affairs has benefits however, it raises risk of over-expansion, namely, the risk of all-inclusiveness. This would make the concept lose its meaning and its conceptual rigour.

Having considered the pros and cons of the issue, the bottom line is pro-expansion. However, one should outline the borders of the concept to prevent over-expansion. The need for expansion rests on the notion that some non-military aspects are at least as important to maritime security as military ones. Notwithstanding, the discussion should be limited to the impact of military and non-military implications on the possibility of use of force.

- The need to articulate how or what is threatening, and whom or what is being threatened and how so. This question encourages non-unitarian answers to questions that not so long ago were considered straightforward. In that sense, it takes the route of 'problematizing' the issue of maritime domain awareness.
- Is there one agency responsible for maritime domain awareness in a nation? In most countries, it is not so. In the meantime, different agencies master different aspects of the issue, may it be the Navy, the Coast Guard, the Port Authority, the Customs, the Police, and the Ministry of Environmental Protection. Furthermore, in some aspects, the issue is being privatised. For example, the Energean Oil and Gas Company that developed the new Karish and Tanin gas fields (90 km west to Haifa) invested in independent situation awareness capabilities, in addition to the Navy's capabilities. In that context, as of January 2019, Elbit Security Systems has won the tender to secure the field. Among other things, Elbit will be providing Energean with a wide range of sensors, electro-optics, sonar, radar and advanced control centre

to be used.[94] The question that needs an answer is – should we privatise Maritime Domain Awareness?

- How far should any country go in setting the vision of maritime domain awareness? For both India and Israel this question is premature, since both of them are still struggling to set the basic ground of the issue. However, setting a long term vision for maritime domain awareness can serve as a compass for future endeavours. In that sense, the question relates also to the length and depth of future international and regional cooperation that countries should be willing to take. Israel, like other countries in the region, is very keen in keeping its independence and holds a profound belief that it must always be able to protect itself by itself. In that regard, going beyond regular military to military, or government to government dialogue is hard to expect. India, on the other hand, believes in Security and Growth for all in the Region (SAGAR) and hence feels that all boats need to rise together as in a tide for growth of the region and hence wishes to cooperate and engage with all in the Indo-Pacific region to ensure free, safe and open seas.

Way Ahead

The need for Maritime Domain Awareness cannot be but emphasised as a necessity for every maritime nation, irrespective of where they may be. However, in the same breath one would like to say that the growing challenges in the maritime domain and the zeal for humanity to go deeper into the ocean depth are increasing the challenges to achieve this maritime domain awareness. Though not conclusive and exhaustive, there are some actions that can be recommended for both India and Israel at the national and at the collaborative front.

India

Some possible way-ahead at the *international / regional level* are:

- Regional information needs to be supported by continuous training and capacity building endeavours. Such endeavours should not be viewed as short-term goals but as part of long-term efforts that contribute to progressive steps that are necessary for the region.

- Investment in regional structures cannot be ignored by the international community. Greater investment in analytical and relevant technologies is required. Given the overall resource constraints, further attention needs to be given in orchestrating the initiatives and programmes in order to develop a coherent structure that aids all users of the regional waters.
- These realities signal the need to ensure that actions taken as a part of a comprehensive approach in addressing sea-based threats ought to balance sovereignty and national interests on the one hand, and duties and responsibilities on the other. Regardless of how interests are balanced and what compromises are reached, a common and non-negotiable principle among all stakeholders must be that there should not exist a lack of awareness. In this regard:
- Regional nations and stakeholders should regularly update agreements between national maritime security agencies and other respective functionaries.
- The Indo-Pacific needs to put in place regional logistical burden-sharing arrangements and mechanisms to allocate resources and facilities of member states to reduce the burden on coastal States responsible for large scale MDA operations.
- Logical burden sharing arrangements aid in connecting the various information systems to build comprehensive maritime domain awareness and promote effective maritime governance by addressing current gaps and overlaps. This could be taken up by regional nations, in collaboration with other interest groups and stakeholders under the extant regional arrangements.

Some possible way-ahead at the *national level* are:

- IFC-IOR being young can focus on communication methods (Website, Twitter and Facebook), production of basic deliverables (daily brief, IOR ports Maritime Traffic Status, Press summary, Recognized Maritime Picture, weekly, monthly and annual report on Maritime Safety and Security of the region of concern) like other IFCs to develop faith amongst stakeholders and indicate its relevance for more nations to join.

- Though small fishing boats complicate MDA, they also act as 'eyes and ears' of the security agencies. There is a need to ensure compulsory identity cards for fishermen, registration and tracking for their boats is undertaken. Furthermore, training capsules need to be conducted for them to ensure that they are wary of the looming security threats from the ocean. In return, they need to be supported with a robust MDA for ensuring a sustainable Blue Economy.

Israel

Since the State of Israel is still taking its preliminary steps in the area of Maritime Domain Awareness, further progress should be pursued in three different levels: national level, regional level and international level. At the end of this section a reference will be made as to possible future India-Israel collaboration.

At the ***national level***, Israel must implement an institutionalised national framework to deal with regional maritime awareness. Such a process attracts inherent bureaucratic and organisational antagonism. Hence it is expected to be tedious, arduous and long. However, at the end, if the process will succeed and forge an integrative body that is responsible for defining the goals, policies and means to implement them, including information integration, coordination and synchronisation among stakeholders, as well as formulating workable and implementation-oriented work plans, then the effort would be worthwhile.

At the ***regional level***, Israel should promote regional maritime awareness cooperation, with an emphasis on promoting cooperation with regional players – in the Mediterranean and the Red Sea. In the Mediterranean, promoting cooperation with Egypt, Greece and Cyprus appears to be a top priority. Further promotion and institutionalisation of maritime awareness plans with EU naval forces operating in the region is expected to be beneficial for both sides. In the Red Sea, Israel should promote coordination and cooperation with Egypt as well as with European and American naval forces, and possibly with moderate Arab forces in the region.

At the ***international level***, Israel should pro-actively participate in international maritime awareness initiatives where it can offer its advantages, mainly in technological solutions – products and services. In return, Israel can benefit by adopting best practices from countries that are more advanced in implementing the concept of maritime domain awareness.

Collaborative

As discussed earlier, generating an effective MDA is not possible by the efforts of a single player alone. It requires collaboration. In this regard, it is opined that India and Israel can cooperate in various areas of technology and interoperability to support each other in creating an MDA, especially for security purposes. The Indian Navy has dealt with the concept for several years now and has come out with substantial results. On the Israeli side, the concept of MDA is still under review with little conceptual traction, at this stage. However, on the practical level, Israel develops and implements concrete and operational measures regarding its maritime domain awareness. Therefore, Indian-Israeli possible future cooperation can include:

- Navy-to-Navy learning process, in which the Israeli Navy can learn and adopt relevant Indian concepts and practices in the field of maritime domain awareness.
- The Red Sea is a common focal point for both India and Israel. Hence the Red sea presents a possible common focal point of interest and possible cooperation. This can include sharing of information and joint naval exercises.
- Israel being a leading actor in the domain of cyber security can provide for the enhancement of the security of data for the MDA network at IMAC.
- The existing technical bilateral agreements between India and Israel with regard to sharing of white shipping information allows for rapid integration of the two nations. Though there is already a technical agreement to share white shipping data between the two countries, the next logical step would be to position an ILO at IFC-IOR.

Takeaway

The key takeaway from this monograph for the two countries may be summarised as under:

- Although Israel lags behind on the institutional and organisational level of implementing maritime domain awareness structure, it is rather advanced in developing technological tools to tackle the issue. Therefore, it is recommended that Israel should:

- Implement an institutionalised national framework to deal with regional maritime awareness.

- Promote cooperation with regional and international players in the Mediterranean and the Red Sea, with India being a pertinent partner for the task.

- Pro-actively participate in international maritime awareness initiatives.

- Learn and adopt relevant practices from the Indian Navy.

As seen in the discussions, India has over the years put its mechanisms for MDA in the field of maritime security in place. However, it realises that it cannot achieve a complete MDA without collaborative arrangements in place. There it is recommended that India should:

- Support continuous training and capacity building endeavours as long-term efforts to contribute to progressive security and growth for the region.

- Orchestrate initiatives and collaborations with Israel to develop a coherent structure that aids all users of the regional waters.

- Update agreements at regional level between national maritime security agencies and other respective functionaries.

- Put in place regional logistical burden-sharing arrangements and mechanisms to reduce burden on coastal States for MDA operations.

- Support and recognise the contribution of small fishing boats as 'eyes and ears' of the security agencies with identity cards, boat registration and installation of tracking devices.

Conclusion

The need to understand and know the oceans is increasing as the international community has commenced its movement into the oceans for fulfilling its needs. With oceans being an important medium for maritime trade, the need to create awareness about the ocean becomes even more important. Nations and organisations have been trying to understand and map the ocean individually. However, with time they have realised that cooperative mechanisms provide better and more accurate results. The Indo-Pacific Region is not different in this regard. It also requires collaborative and cooperative mechanisms to harness a reliable Maritime Domain Awareness (MDA). From the security point of view, MDA in its entirety should feed into effective awareness that would result in better law enforcement and in furthering the national interests of the countries while maintaining peace, security and good order at sea.

The concept of maritime domain awareness is valuable, since it offers a tool of strategic assessment as well as situational assessment. In developing this MDA architecture, the Regions need to take an incremental approach that pursues realistic goals and ensures ownership and sustainability. Such architecture needs to focus on measures that benefit the larger Blue Economy and regional ocean governance, along with its primal area of concern, 'security'. There is hence a need to advance coordination of regional and / or sub-regional capacity-building exercises and training related to maritime security information sharing.

ENDNOTES

1. Christian Bueger, What is Maritime Security? 53 Marine Policy, 159 (2015); Dirk C. Sonnenberg, Maritime Law Enforcement: A Critical Capability for the Navy? 1–3 (Mar. 2012) (unpublished MA thesis, Naval Postgraduate School), http://calhoun.nps.edu/handle/10945/6873.

2. Pradeep Chauhan, Maritime cooperation and confidence-building, in Southeast Asia and the Rise of Chinese and Indian Naval Power: Between rising naval powers, Ed. Sam Bateman, Joshua Ho, 197 (2014).

3. Joseph L. Nimmich and Dana A. Goward, Maritime Domain Awareness: The Key to Maritime Security, https://digital-commons.usnwc.edu/cgi/viewcontent.cgi?referer=https://www.google.com/&httpsredir=1&article=1160&context=ils.

4. Steven C. Boraz, Maritime Domain Awareness; Myths and Realities, https://www.hsdl.org/?abstract&did=699259.

5. In December 2004, President Bush issued a Presidential Directive on the subject in which he broadly defined the maritime domain as follows: "all areas and things of, on, under, relating to, adjacent to, or bordering on a sea, ocean, or other navigable waterway, including all maritime-related activities, infrastructure, people, cargo, and vessels and other conveyances. Due to its complex nature and immense size, the Maritime Domain is particularly susceptible to exploitation and disruption by individuals, organizations, and States. The Maritime Domain facilitates a unique freedom of movement and flow of goods while allowing people, cargo, and conveyances to transit with anonymity not generally available by movement over land or by air." National Security Presidential Directive NSPD-41, 21 December, 2004. https://www.hsdl.org/?abstract&did=776173.

6. National Security Presidential Directive NSPD-41, 21 December, 2004. https://www.hsdl.org/?abstract&did=776173.

7. DHS (2005), US National Plan to Achieve Maritime Domain Awareness. https://www.dhs.gov/sites/default/files/publications/HSPD_MDAPlan_0.pdf.

8. DHS (2005), US National Plan to Achieve Maritime Domain Awareness. https://www.dhs.gov/sites/default/files/publications/HSPD_MDAPlan_0.pdf.

9. National Strategy for Maritime Security: National Plan to Achieve Maritime Domain Awareness, Homeland Security Presidential Directive, Government of United States of America (2005), https://www.dhs.gov/sites/default/files/publications/HSPD_MDAPlan_0.pdf.

10. National Security Presidential Directive NSPD-41, 21 December, 2004. https://www.hsdl.org/?abstract&did=776173.

11. Amendments To The International Aeronautical And Maritime Search And Rescue (IAMSAR) Manual, International Maritime Organisation (2010) http://www.imo.org/blast/blastDataHelper.asp?data_id=29093&filename=1367.pdf.

12. It is however essential to clarify that the amendment is primarily harmonization of SAR as a result of ICAO-IMO joint working group recommendation. They have made a mention 'SURPICs can be used to identify and locate potential vessels as well as improve maritime domain awareness (MDA)', where SURPICs are that of system as per SAR Convention and not that of MDA. They have only allowed, if required that can be used to improve the MDA and not vice versa.International Maritime Organization, MSC.1/Circ. 1415, Amendments to the International Aeronautical and Maritime Search and Rescue (IAMSAR) Manual 11 (25 May, 2012), http://www.mardep.gov.hk/en/msnote/pdf/msin1242anx1.pdf.

13. Such as warfare, dumping, detonation, Underwater explosion etc.

14. Jonathan E. Colby, The Developing International Law on Gathering and Sharing Security Intelligence, Yale Studies In World Public Order 49, 53 (1974) (quoted in Natalie Klein, Maritime Security and the Law of the Sea 211 (2012)).

15. India, Sri Lanka, Maldives sign maritime pact, The BRICS Post, 9 July 2013, http://www.thebricspost.com/india-sri-lanka-maldives-sign-maritime-pact/#.XQNIqi2B1QI.

16. MEA, 09 July 2013, Outcome Document of the Second NSA-Level Meeting on Trilateral Cooperation on Maritime Security between India, the Maldives and Sri Lanka, Retrieved from https://www.mea.gov.in/bilateral-documents.htm?dtl/21922/Outcome+Document+of+the+Second+NSALevel+Meeting+on+Trilateral+Cooperation+on+Maritime+Security+between+India+the+Maldives+and+Sri+Lanka.

17. George Galdorisi, June 2006, "Maritime Domain Awareness: The Key to Maritime Security Operational Challenges and Technical Solutions", https://apps.dtic.mil/dtic/tr/fulltext/u2/a463128.pdf.

18. Jeff Douglas, CTO 11 September 2013, Positioning and Telemetry for Efficiency and Safety, https://www.slideshare.net/JeffDouglas2/solas-high-value-telemetry.

19. Resolution A.1106 (29), Revised Guidelines for the onboard operational use of shipborne automatic identification systems (AIS), International Maritime Organisation, 2015.

20. Global security, Maritime Domain Awareness, https://www.globalsecurity.org/intell/systems/mda.htm.

21. Vessels that choose to not broadcast their AIS signal or that broadcast a spoof AIS signal.

22. Population trends, UNFPA Asia and Pacific, https://asiapacific.unfpa.org/en/node/15207.

23. Johnny Wood, 06 December 2018, Why Asia-Pacific is especially prone to natural disasters, World Economic Forum, https://www.weforum.org/agenda/2018/12/why-asia-pacific-is-especially-prone-to-natural-disasters/.

24. In his keynote address, of the Annual Maritime Power Conference 2013, at the Institute for Defence Studies and Analyses (IDSA), under the aegis of the National Maritime Foundation, Available at http://www.spsnavalforces.com/story/?id=258.

25. Khurana, Gurpreet S. , (2007) 'Security of Sea Lines: Prospects for India-Japan Cooperation', Strategic Analysis, Volume 31, No. 1, p.139 – 153.

26. David Scott (2012) "India and the Allure of the 'Indo-Pacific'", International Studies, 49 (3&4), p.1-24, Sage Publications, London.

27. Defending Australia and its National Interests, Defence White Paper 2013, Department of Defence, Australian Government, 13 May.

28. PIB, 01 June 2018, Text of Prime Minister's Keynote Address at Shangri La Dialogue, http://pib.nic.in/newsite/PrintRelease.aspx?relid=179711.

29. Eran Lerman, "New Realities in the Eastern Mediterranean," the Jerusalem Institute for Strategy and Security, 19.12.2018, https://jiss.org.il/en/lerman-new-realities-in-the-eastern-mediterranean/.

30. Gard New 198, July 2010, "Why registration with MSCHOA is vital in the war on piracy", http://www.gard.no/web/updates/content/3486550/why-registration-with-mschoa-is-vital-in-the-war-on-piracy.

31. https://www.crimario.eu/en/2018/07/11/ioris-indian-ocean-regional-information-sharing-platform-is-operational/.

32. RMIFC website, http://crfimmadagascar.org/en/historique/; See also, https://africacenter.org/programs/enhancing-maritime-security-in-africa/.

33. Press release, 27 October 2017, "A stronger maritime cooperation in Madagascar and Comoros", https://www.crimario.eu/wp-content/uploads/2017/11/20171025-CRIMARIO-formation-MDP-9-Madagascar-communique%CC%81-final-EN.pdf.

34. CRIMARIO Watch, 16 July 2017, Seychelles opens two maritime information sharing centres, https://www.crimario.eu/en/2017/07/16/seychelles-opens-two-maritime-information-sharing-centres/.

35. MINDEF Singapore, 14 May 2019, Fact Sheet on Information Fusion Centre (IFC) and Launch of IFC's Real-Time Information-Sharing System (IRIS), https://www.mindef.gov.sg/web/portal/mindef/news-and-events/latest-releases/article-detail/2019/May/14may19_fs.

36. PTI, 11 December 2018, India signs ascension pact to the 30-member Trans Regional Maritime Network, The Economic Times, https://economictimes.indiatimes.com/news/defence/india-signs-ascension-pact-to-the-30-member-trans-regional-maritime-network/articleshow/67037915.cms?from=mdr.

37. The Regional Cooperation Agreement on Combating Piracy and Armed Robbery against ships in Asia, officially launched on 29 November 2006 in Singapore, is a multilateral agreement between 20 nations (14 Asian countries, 4 European countries, Australia, the USA).

38. Signed by Djibouti, Ethiopia, Kenya, Madagascar, Maldives, Seychelles, Somalia, the United Republic of Tanzania and Yemen.

39. Prashanth Parameswaran, 29 October 2015, What Does Malaysia's New Defense Budget for 2016 Mean?, The Diplomat, Available at https://thediplomat.com/2015/10/what-does-malaysias-new-defense-budget-for-2016-mean/.

40. Shaul Chorev & Douglas J Feith et. al. (2019). The Eastern Mediterranean in the New Era of Major-Power Competition: Prospects for U.S.-Israeli Cooperation. University of Haifa-Hudson Institute Consortium on the Eastern Mediterranean, p. 9. http://hms.haifa.ac.il/images/publications/HUDSON/EasternMed_in_New_Era.pdf.

41. Aviad Rubin, Ehud Eiran, Regional maritime security in the eastern Mediterranean: expectations and reality, International Affairs, Volume 95, Issue 5, September 2019, Pages 979–997, https://doi.org/10.1093/ia/iiz146.

42. Vijay Sakuja, 01 December ember 2014, IPCS, India and Maritime Security: Do More, Retrieved from http://www.ipcs.org/comm_select.php?articleNo=4764.

43. Rajat Pandit, 10 June 2014, "Apex maritime authority for coastal security", Indian Express, http://timesofindia.indiatimes.com/articleshow/36316877.cms?utm_source=contentofinterest&utm_medium=text&utm_campaign=cppst.

44. IMSS, Ministry of Defence, India, 2015, ISBN: 978-93-81722-22-0 https://www.indiannavy.nic.in/sites/default/files/Indian_Maritime_Security_Strategy_Document_25Jan16.pdf.

45. Navi-Harbour VTMS, TRANSAS, Retrieved from https://www.transas.com/products/vtms/vessel-traffic-management-system/VTS.

46. PTI, 13 September 2007, "ONGC installs offshore surveillance system", Economic Times, https://economictimes.indiatimes.com/ongc-installs-offshore-surveillance-system/articleshow/2366591.cms?from=mdr.

47. DGLL, NAIS, http://www.dgll.nic.in/Content/73_1_NAIS.aspx.

48. TNN, 24 September 2018, "Phase-II of Coastal Surveillance Network to be completed on time: Nirmala Sitaraman", Times of India, http://timesofindia.indiatimes.com/articleshow/65938754.cms?utm_source=contentofinterest&utm_medium=text&utm_campaign=cppst.

49. https://www.slideshare.net/cppr123/coastal-security.

50. Press Information Bureau, 23 November 2013, "Coastal Security Network Must Ensure Zero Tolerance to Error: Parrikar", http://pib.nic.in/newsite/PrintRelease.aspx?relid=111697.

51. VAdm AK Chawla, IN perspective: Coastal Surveillance and Response, presentation in Session on Coastal Surveillance and Response Systems and Platforms, 'Make in India' Paradigm: Roadmap for a Future Ready Naval Force, April 18-19, 2016,FICCI, New Delhi http://ficci.in/events/22716/ISP/1-VAdm-AK-Chawla.pdf.

52. Infraline energy, 18 May 2011, Oil and Gas, http://www.infraline.com/Details/vatms-project-for-east-coast-128592.htm.

53. VAdm AK Chawla, IN perspective: Coastal Surveillance and Response, presentation in Session on Coastal Surveillance and Response Systems and Platforms, 'Make in India' Paradigm: Roadmap for a Future Ready Naval Force, April 18-19, 2016,FICCI, New Delhi http://ficci.in/events/22716/ISP/1-VAdm-AK-Chawla.pdf.

54. Bagchi, Indrani, 23 January 2019, India to renew coastal radar offer during Maldives defence minister's visit, Retrieved 28 January 2019 – via The Economic Times, https://economictimes.indiatimes.com/articleshow/67652263.cms.

55. PTI, 11 December 2018, India signs ascension pact to the 30-member Trans Regional Maritime Network, The Economic Times, https://economictimes.indiatimes.com/news/defence/india-signs-ascension-pact-to-the-30-member-trans-regional-maritime-network/articleshow/67037915.cms?from=mdr.

56. PIB, 23 January 2019, Two-day coastal defence exercise "Sea Vigil" concludes, https://pib.gov.in/Pressreleaseshare.aspx?PRID=1561201.

57. See Douglas Guilfoyle, Maritime Security, in Law of the Sea: UNCLOS as a living treaty, 329 (Jill Barrett & Richard Barnes eds., 2016).

58. Catherine McGrath, Government Boosts Maritime Security, ABC (15 December, 2004), www.abc.net.au/pm/content/2004/s1266082.htm.

59. Natalie Klein, Maritime Security and the Law of the Sea, Oxford University Press, 2011.

60. Tom Simonite, 18 October, 2013, Ship Tracking Hack Makes Tankers Vanish from View, MIT Technology Review, https://www.technologyreview.com/s/520421/ship-tracking-hack-makes-tankers-vanish-from-view/.

61. Kyle Wilhoit and Marco Balduzzi (Senior Threat Researcher), 15 October, 2013, Vulnerabilities Discovered in Global Vessel Tracking Systems, Trend MICRO, https://blog.trendmicro.com/trendlabs-security-intelligence/vulnerabilities-discovered-in-global-vessel-tracking-systems/.

62. The gap between the importance of the maritime domain and the lack of a maritime policy raises a fundamental question that is beyond the scope of this chapter, namely: Why didn't Israel develop Maritime Domain Awareness and a national maritime policy?

63. The strife-torn three decades of British rule over Palestine is known as the Mandate.

64. In this context, it is worth mentioning the emergence of the container as the main means of maritime trade, which is based on transshipment ports and feeder routes which have taken the punch out of the Arab embargo on ships visiting Israeli ports and has reduced the need to rely on ships under an Israeli flag, along with the globalization of many systems in the national markets and the collapse of the Communist (and pro-Arab) bloc.

65. Oded Gur-Lavi, 2017, A Grand Maritime Strategy for Israel, The Maritime Strategic Evaluation for Israel, the Haifa Center for Maritime Policy and Strategy https://poli.hevra.haifa.ac.il/~hms/images/publications/Report_2016/4.pdf; See also the Technion, 2015, The Israel Marine Plan, http://msp-israel.net.technion.ac.il/files/2015/11/Israel-Marine-Plan-.pdf.

66. The proposed Maritime Zones legislation has been on the table of the Knesset since July 2014. It is meant to define the rights and juristiction of the State of Israel in the coastal waters, the internal waters, the contiguous waters and the Exclusive Economic Zone. As of the time of writing, the proposed law had passed First Reading and was awaiting approval in Second and Third Reading. http://fs.knesset.gov.il//20/law/20_ls1_392707.pdf.

67. The Planning Authority, 2017, Policy paper for Israel's Maritime Domain – Stage II of the Maritime Domain Policy Repot – First Draft for Comments, http://www.iplan.gov.il/Documents/Report_4.pdf Hebrew.

68. As part of the public process, the Haifa Research Center for Maritime Policy and Strategy prepared a response to the draft report and submitted it the Planning Authority. Hebrew, http://hms.haifa.ac.il/index.php/he/component/content/article/14-publications-heb/98-2018-10-18-11-45-53?Itemid=108.

69. National Monitoring Program in the Mediterranean, Ministry of Environment, Israel, Retrieved from http://www.sviva.gov.il/subjectsEnv/SeaAndShore/MonitoringandResearch/Pages/NationalPlanMed.aspx.

70. Iran jams GPS on ships in Strait of Hormuz, 09 August, 2019. https://www.gpsworld.com/iran-jams-gps-on-ships-in-strait-of-hormuz/; Iran stokes Gulf tensions by seizing two British-linked oil tankers. https://www.theguardian.com/world/2019/jul/19/british-tanker-iran-capture-fears-stena-impero-uk-ship-latest.

71. In previous years, the issue of piracy was central to the red sea area. However, since the active presence of foreign navies in the region, the number of incidents off the shores of Somalia has dropped dramatically, and became basically a non-issue.

72. Israeli Navy, 01.08.2018.

73. https://www.maariv.co.il/news/politics/Article-712414 09/08/2019 (Hebrew).

74. Opening remarks by Bahraini Foreign Minister Sheikh Khalid bin Ahmed al-Khalifa quoted in Senior Israeli official attends Bahrain security meeting focusing on Iran, Reuters, 21 October, 2019, https://www.reuters.com/article/us-mideast-iran-tankers/senior-israeli-official-attends-bahrain-security-meeting-focusing-on-iran-idUSKBN1X019T.

75. This was not the first time such a gathering took place publicly. In February 2019 the US held a Middle East Conference in Warsaw, U.S. meeting on Middle East brings together Israel, Gulf Arab states, Reuters, 13 February, 2019, https://www.reuters.com/article/us-mideast-crisis-summit/u-s-meeting-on-middle-east-brings-together-israel-gulf-arab-states-idUSKCN1Q22E2.

76. https://www.haaretz.co.il/news/world/middle-east/.premium-1.7340082?utm_source=App_Share&utm_medium=Whatsapp&utm_campaign=Share 07.06.19 (Hebrew).

77. 08 April, 2019, Iran To Lease Part Of Latakia Port – Reports, The Jerusalem Post, https://www.jpost.com/Middle-East/Iran-to-lease-part-of-Latakia-port-reports-586033.

78. Haaretz, 21 July, 2019, As Gulf Tensions Grow, Israel Prepares to Fend Off Maritime Threats, https://www.haaretz.com/israel-news/.premium-as-gulf-tensions-grow-israel-prepares-to-fend-off-maritime-threats-1.7544557.

79. Alice Ekman, February 2018, China in the Mediterranean: An Emerging Presence, IFRI Papers, https://www.ifri.org/sites/default/files/atoms/files/ekman_china_mediterranean_2018_v2.pdf.

80. During 2008–18, the Chinese Navy deployed 26,000 personnel to the region. See: Neil Melvin, The Foreign Military Presence In The Horn of Africa Region, SIPRI Background Paper, April 2019, p. 3. https://www.sipri.org/sites/default/files/2019-05/sipribp1904_2.pdf.

81. Jerome Henry, China's Military Deployments in the Gulf of Aden: Anti-Piracy and Beyond, IFRI Policy Paper no. 89, 21 November, 2016, p. 24 https://www.ifri.org/sites/default/files/atoms/files/chinas_military_deployments_in_the_gulf_of_aden_anti-piracy_and_beyond_0.pdf.

82. China has evacuated some 800 citizens from Yeman to Djibouti in April 2015. SIPRI Background Paper (2018), p. 18.

83. 01 August, 2017, China formally opens first overseas military base in Djibouti. https://www.reuters.com/article/us-china-djibouti-idUSKBN1AH3E3.

84. e.g. China has evacuated some 800 citizens from Yeman to Djibouti in April 2015. SIPRI Background Paper (2018), p. 3.

85. Bolton Relays Concerns to Netanyahu Over Chinese Investment in Israel, U.S. Official Says, Haaretz, 10 January, 2019. https://www.haaretz.com/israel-news/netanyahu-and-bolton-concerned-over-chinese-telecom-companies-u-s-official-says-1.6827512; See also, Douglas J. Feith, China's Maritime Strategic Challenge, 18 October, 2019. https://www.hudson.org/research/15404-china-s-maritime-strategic-challenge.

86. The meeting was also attended by US energy secretary Rick Perry and the EU's director-general for energy, Dominique Ristori, East Mediterranean states look to accelerate regional gas cooperation, 27 July 2019. https://www.hellenicshippingnews.com/east-mediterranean-states-look-to-accelerate-regional-gas-cooperation/.

87. Gallia Lindenstrauss and Polykarpos Gavrielides, A Decade of Close Greece-Israel Relations: An Assessment, Strategic Assessment, Volume 22, No. 1, April 2019 (Hebrew), https://www.inss.org.il/he/wp-content/uploads/sites/2/2019/04/%D7%92%D7%9C%D7%99%D7%94-%D7%95%D7%A4%D7%95%D7%9C%D7%99%D7%A7%D7%A8%D7%A4%D7%95%D7%A1.pdf.

88. 04 March.2019, https://www.kathimerini.gr/1012813/article/epikairothta/politikh/ellhnoisrahlino-rantar-kataskeyazetai-sthn-krhth (Greek. Google translated).

89. Frontex homepage https://frontex.europa.eu/about-frontex/foreword/.

90. The EU Neighbours portal, EU4Border Security project. https://www.euneighbours.eu/en/south/stay-informed/projects/eu4border-security-project.

91. Additional participant countries include Algeria, Egypt, Jordan, Lebanon, Morocco and Tunisia.

92. The service uses 12 optical satellites and 8 SAR. Celebrating the CleanSeaNet Service. A

ten year anniversary publication, 2017, http://emsa.europa.eu/component/flexicontent/download/4980/3150/23.html.

93. SAFEMED IV PROJECT http://www.emsa.europa.eu/safemed-iv-project.html.

94. https://www.globes.co.il/news/article.aspx?did=1001267965 07/01/2019 (Hebrew).

About the Authors

Captain (Dr) Nitin Agarwalaa was a Research Fellow at the National Maritime Foundation, India

Dr Ram Erezb, is a Research Fellow, Maritime Policy and Strategy Research Centre, Haifa University, Israel

Suriya Narayanan was a Research Associate at the National Maritime Foundation, India

Note

This article was first published on the Website of the National Maritime Foundation on 2 August 2021

Naval Air Stations as Catalysts for State Economies

Rear Admiral Sudarshan Shrikhande (Retd.)

In recent days, some newspapers in Goa have reported on issues of No Objection Certificates (NOC) that the Indian Navy provides for certain buildings, development and infrastructure at a specified radius around the Naval Air Station (NAS), Dabolim. As is widely known, NAS (Dabolim) is also the international airport at Goa. All airports in the world have restrictions related to height and purpose for construction around them. There are landing and take-off 'funnels' aligned for the runway (or runways) and height-restrictions for construction, radiating outwards, which are not radially uniform. Besides these, there could be restrictions that relate to the likelihood of increased bird-hits that are caused due to garbage-accumulation, processing and disposal; chimneys and factories that could cause air-flow disruptions, visibility issues, etc. In generic terms, the greater the distance from an airport, the fewer are the restrictions on height and purpose. For very important infrastructure projects, some relaxations are afforded, by the military agreeing to some additional difficulties in landing and take-off paths and circuit-patterns. An example of such relaxations may be seen in the case of NAS (Kochi), where specific and critical port-infrastructure on Willingdon Island needed to be enabled. Nonetheless, there is occasional criticism, sometimes direct and at other times implied, in some sections of print and electronic media, that the Navy is either being obstructionist or is not sufficiently aware of the imperatives of economic-development. This commentary seeks to put the issues into perspective. This is not to deny that there could be an instance or two of malfeasance on the part of one or more individuals in the processing-chain wherein an NOC is given for something that the Navy should have rightly objected-to. Equally, there could be malfeasance or simply 'cussedness' in withholding a NOC even when there was no real justification for doing so. However, these are individual cases where the Navy's own internal mechanisms take corrective and, if required, punitive action. This article is about the larger, positive contributions and catalysing role that naval air-stations have played, and continue to play, in state and national development.

Trade and Flag

The symbiotic relationship between trade, flag and navies, is now increasingly appreciated in India's policy-making levels as well as finding better understanding within Indian society as a whole. Along with a few other agencies and individuals, institutions such as the National Maritime Foundation (NMF) have contributed very significantly to advocating the inextricable linkages between maritime strength, the 'blue' economy, and, indeed, sea power itself, with the country's prosperity and security. As a consequence, there is lesser 'sea-blindness' all around. As the world hurtles through the Twenty-first Century, the seas and oceans are going to be more critical to India's prosperity, and security than at any time in the past. However, this article is not about the sea but about the skies, especially those above the interface between the land and the sea. There is a lesser appreciation of the catalysing role played by the Indian Navy and the MoD in regional economic-development through the establishment of Naval Air Stations (NAS) decades ago in Goa, Kochi, Port Blair and Visakhapatnam. There are others in more remote areas and their 'start-up' impact on further development is a story that can be recounted after a few years. Indeed, there may well be a need to enhance the 'air-mindedness' of the nation as a whole. While the National Maritime Day has been observed since 1964, there is, as yet, no National Aviation Day, although suggestions for its observance have been made from time to time.

Goa and *Hansa*: Touchdown to Prosperity

Let us consider the state of Goa to illustrate the story. The basic airstrip used by the Portuguese was taken over by the Indian Navy immediately after Liberation in 1961. This became NAS (Dabolim) and, shortly afterwards, INS *Hansa*, when the latter was relocated from its first home at Sulur (near Coimbatore) in what was then Madras

State, to Goa. It is interesting to note that as they grow in size and capability, several Naval Air Stations are formally commissioned as "Ships" and are named after birds. Indicative examples would include *Garuda, Rajali, Shikra, Utkrosh, Dega, Baaz, and Parundu*. To return to the story of the NAS Dabolim, the MOD provided budgetary-support to the Indian Navy to lengthen the runway and for other related facilities for the NAS, so as to better support air operations by the Navy. Simultaneously, *Hansa* was opened for civilian flights. In the initial years, there were hardly any civilian flights. Air travel was expensive, tourism virtually nil, and economic development had yet to gather steam. However, it was that lone runway that triggered — more than anything else — tourism and consequent economic development in Goa. Compared to the connectivity that we take for granted today, given the broad-gauge railway lines, dozens of daily flights, and the several bridges built or on the anvil, Goa was quite poorly served by transportation infrastructure right up to the early 1990s. However, the great beauty of this verdant, coastal state and its charming and friendly people, inexorably made Goa into an attractive holiday-destination. In much of this, the Navy's air station played a pivotal role by enabling millions of visitors to fly in and out. Today, Goa has the sixth-busiest airport in all of India! Two points need to be noted. First, if the Indian Navy had not made significant and continuing investments of men and money into military-aviation infrastructure, civilian air operations would have increased very slowly — if at all they were slated for expansion in the first place. Military-aviation infrastructure involves airfield emergency services, high-load runways and taxiways; air-traffic control; navigation aids; radar surveillance; perimeter security — and these are only the more important ones. After all, it is only in recent years that civilian airports have received impetus through both 'push' and 'pull' factors. Secondly, one of the very important roles of a Navy is to keep communications open through knowledge-of trade-routes, shipping, commerce, and whatever it takes to protect sea lines of communications in times of conflict or risk. Therefore, the Navy readily appreciated the need for air-communications as a marker of development and prosperity, especially for coastal regions of a nation. It bears mention here that in most nations, coastal regions are gateways, not only to the hinterland, but for economic activity in general and, as such, they exert a significant and entirely impact on overall prosperity. What sea-ports did in past centuries, airports have been doing in the past few decades.

Pan-India Contribution of Military-Aviation to "Incredible and Resurgent India"

Whether they are citizens, policy-shapers or policy-makers, readers once again ought to answer for themselves a 'what if?' question: How much slower would economic development have been in Goa or in the Kochi region, in Andhra or in the remote Andamans, if there had been either zero or reduced naval initiatives leading to these Naval Air Stations? It was not only the Indian Navy, the Indian Air Force as well, whose expanding network of air-bases was similarly a key trigger for the opening-up of the North-East, Punjab, Rajasthan, Jammu and Kashmir, and even of cities like Hyderabad and Pune. With new, well-appointed and efficient airports in Cochin / Kochi or Hyderabad (Shamshabad), one needs to pause and acknowledge what NAS Kochi or the IAF Station at Begumpet have contributed in terms of economic opening-up and consequent prosperity. It ought to come as no surprise that in the havoc and human tragedy that followed in the wake of the recent devastating floods in Kerala, it was NAS Kochi which handled relief and passenger flights when CIAL, Nedumbassery, was inundated for several days.

Civil-Military Cooperation at its Daily, Quiet and Barely Noticed Best!

The fact that military and civilian aviation have coexisted over decades is, in and of itself, a fine example of strategic-, operational- and tactical-level cooperation. This cooperation evolves from policies, strategic-planning, operational coordination of routes, flying areas, broad schedules and air-space management. At the level of air stations and their associated civilian air-enclaves, 'tactics' connote daily-schedules, air-traffic control, safety-services and drills, tarmac-coordination, and other minutiae. Despite occasional hiccups, this multi-level, multi-pronged relationship between various ministries, authorities and organisations has worked well.

Some Areas of Concern

Of course, there are aspects that we need to be concerned about. Growing prosperity and increasing air-traffic has created issues of 'crowding' in the air as well as on the ground. Willy-nilly, military flying comes under pressure, not only in terms of restricted timings, but also in terms of airspace. Combat flying, quite obviously requires readiness for training at all times, in bad weather, in different types of terrain, and sometimes, in large numbers, where coordination between different air-stations is necessary for massed-impact on the enemy. Often, there is a need to simulate 'enemy' forces, too, which, in many ways, doubles the problems. Civil aviation has its own, generally-regular rhythm, but the tempo increases every year! Consequently, military flying is constantly under urging and pressure to 'adjust' to these realities. *De facto*, this means that time-slots as well as air-spaces shrink. The situation in India requires understanding and addressing, but the issues are by no means unique. Due to a posting as Defence Adviser in the Indian Embassy in Australia, the author is aware that in that vast island-continent, with a national population only slightly more than that of Greater Mumbai, the Royal Australian Air Force (RAAF) maintains air-stations that are also used for civil-aviation. Amazingly, some of these are under pressures similar to those that we experience, and the airlines and departments that speak for them sometimes seem to have greater lobbying power than those that speak for the RAAF. Given these contradictions, how is military flying to be done so that the pilots and ground-crew keep themselves trained for combat? This is not a question that can be or should be brushed aside.

Some Other Positives

And yet, there are several positives from this 'dual-use' approach to aviation. Speaking for the Navy, quite a few 'civilian' airports set-up in recent times, or being planned, have some areas and facilities set aside for naval-aviation enclaves. Such facilities enable flexibility in peace-time operations for disaster-relief and logistics, and, during war-time, for operational purposes. One hopes that one day we may fly more indigenously-produced helicopters and passenger / transport aircraft with versions for civil as well as military aviation. These could benefit from common or overlapping MRO (Maintenance / Repair / Overhaul) facilities that could be set-up near such airports.

Conclusion

The millions of passengers who touch-down and / or take-off from Goa may hardly be aware of the complex arrangements for flying, services, security, infrastructure upgrades and maintenance, payments, etc. Their ability to "sit back and enjoy" their flights require continuous attention, arrangements, monitoring and execution by unnamed-individuals, whether in uniform or in civilian attire, and that too, in a number of diverse places, ranging from ministries and headquarters, right down to control-towers and tarmacs. They all contribute to 'Happy Landings'. Perhaps that needs to be kept more firmly in mind.

About the Author

Rear Admiral Sudarshan Shrikhande (Retd.) is a former Rear Admiral of the Indian Navy. The views expressed are his own and do not reflect the official policy or position of the NMF, the Indian Navy, or the Government of India. He can be reached at syshrikhande@rediffmail.com

Note

This article was first published on the Website of the National Maritime Foundation on 13 February 2019

Energy-Security, and Security-of-Energy

Adoption by India of Hydrogen: An Ocean Renewable Energy Approach

Dr Sameer Guduru and Vice Admiral Pradeep Chauhan

The need for India to secure its future energy security by effecting a transition away from fossil fuels amidst the changing geopolitical environment, coupled with the concern about climate change, act as a compelling driver of India's shift to renewable resources of energy. The dynamics of India's primary-energy basket and the geopolitical vulnerabilities arising from India's need to import a substantial proportion of these, particularly crude oil, from West Asia and climate consideration, when taken in aggregate, not only support ocean-based renewable energy as an economically viable and ecologically sustainable option but to specifically adopt hydrogen-fuel derived from the oceans as India's best option. The current projections by the government are excessively optimistic, and that additional sources of energy (apart from solar and wind) would be required if India was to meet its targets for electricity-generation capacity, while simultaneously meeting the commitments it had made at the Paris COP, in 2015.

The country's transport sector, whose demand for energy by way of petroleum-products drives much of India's oil-based dependence upon imports, hence makes a significant contribution to the country's geopolitical vulnerability. In an effort to mitigate this dependence (quite apart from the environmental aspects), India's ongoing drive to switch to Electrically-driven Vehicles (EVs) is a case in point. Since a critical ingredient for the cathodes of batteries used by all electrically-driven vehicles (EVs) is cobalt, the need for cobalt makes new but equally critical geographic areas the focus of the geostrategies that drive India's geoeconomics and hence shape its geopolitics.

Therefore, in order to set the stage for the recommended thrust towards harnessing Ocean Renewable Energy Resources (ORER) in general, and hydrogen-fuel from the sea, in particular, the adoption of hydrogen derived from ORER and the adoption of this hydrogen-fuel, instead of fossil-fuels, for India's energy needs specifically for the maritime-transport and port sectors is a viable option worth the effort to be examined. The strength of this sector is that far from being mere theoretical speculation, this 'hybrid-solution' is a rapidly maturing option for the maritime sector as a whole. Since the maritime sector must necessarily incorporate naval facets as well as those related to mercantile shipping. Therefore, this paper has presented arguments that address the issue of hydrogen-fuel being used to power warships — both, surface combatants and subsurface ones, and, the appropriateness of this option when contextualised to India. As such, it offers policy-makers within the Government of India a viable and clean-energy alternative that could terminate India's current geopolitical vulnerability arising from the largescale import-dependence from foreign sources of fossil-fuels.

India's Primary Energy Basket and Fossil Fuel Imports from West Asia

Large countries, particularly those with rapidly growing economies, find it difficult to delink energy from their economic growth.[1] The rapid pace of economic growth in large, middle-income, emerging economies, in particular, implies a larger demand for energy resources and related consumption.[2] Hence, energy security for an emerging economy is of strategic importance.[3] This is true for a number of large, rapidly-growing contemporary economies such as those of China and India.[4] Figure 1 depicts India's basket of sources of primary energy in 2019-20,[5] and shows that the largest share in India's primary-energy basket is coal, followed by crude-oil.

Coal

Although India is the second-largest producer of coal, it is also the second-largest importer of coal on the planet.[6] There are two basic reasons for this import: The first is that as the Indian economy grows, coal demand is continuously outstripping indigenous supply. According to the Annual Report (2019-20), *"Demand for coal for 2019-20 was estimated at 1000 million tonnes against which, actual supply of coal in*

India's Primary Energy Basket
(in Kilotonnes of Oil Equivalent [Ktoel])

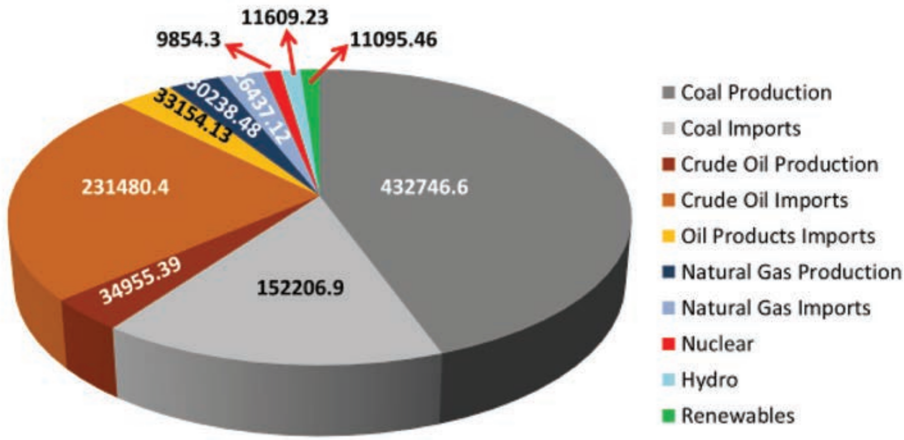


Figure 1: India's Primary-Energy Basket (As on March 31, 2020)
Source: Department of Commerce, Ministry of Commerce & Industry, Government of India

2019-20 up to December, 2019 (provisional) was 695.49 Mt".[7] The second is the poor quality of Indian coal — both, 'coking coal' (used for metallurgical purposes), and, 'non-coking coal' (such as 'thermal coal' a.k.a. 'steaming coal', which is so named because it is used to generate steam, mainly for the production of electricity and, to a somewhat lesser extent, cement). The quality of coking coal is dependent upon the ash content of the coal. The higher the ash content, the poorer is the quality. Indian coal has generally high ash content that exceeds 40 per cent.[8] The gradation of non-coking coal is based on Gross Calorific Value (GCV). High amounts of moisture and ash-content lower the GCV. The lower the GCV, the poorer the coal. Fifteen countries account for 99.6 per cent of the imports of coal by India: Australia, Indonesia, South Africa, the USA, Canada, Russia, Mozambique, Singapore, the UAE, Switzerland, New Zealand, China, Latvia, the Netherlands, and the UK.[9] It is important to note that barring China, none of these import-sources are located in areas of acute geopolitical turbulence, particularly such turbulence as might deteriorate into armed conflict. This is why India's vulnerability and geopolitical sensitivity in the case of coal imports are so very much lesser than those attending the import of crude-oil, where the geopolitical situation is more fragile by several orders

India's Oil Imports *(in billions USD)*

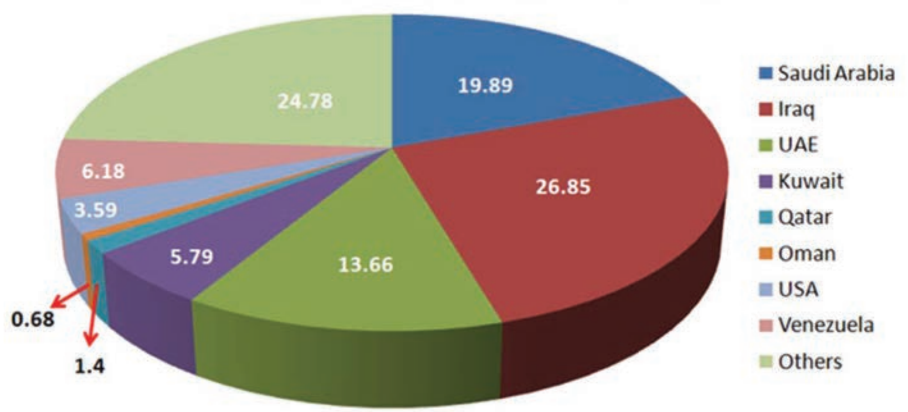


Figure 2: India's Sources of Import of Crude Oil (As on March 31, 2020)
Source: Department of Commerce Ministry of Commerce & Industry, Government of India

of magnitude.

Crude Oil

Insofar as crude-oil is concerned, India's import dependence is even higher than that in the case of coal. India is the third largest importer of crude oil in the world, next only to China and the United States,[10] and has an especially heavy dependence on imports from West Asia (a.k.a. the 'Middle East').[11] As depicted in Figure 2, two-thirds of India's crude oil imports are sourced from countries in West Asia with Iraq contributing the highest, followed by Saudi Arabia, United Arab Emirates, Qatar etc.[12]

Natural Gas

Natural gas is another fossil-fuel resource that is extremely important for India's energy security. Natural gas is used both as feedstock[13] (i.e., for the production of ammonia, which is then converted into urea) and as a source of energy for the generation of electricity. It is especially vital for India's fertiliser sector, within which it is used as feedstock. As of 2016, 43 per cent of natural gas in India was used as

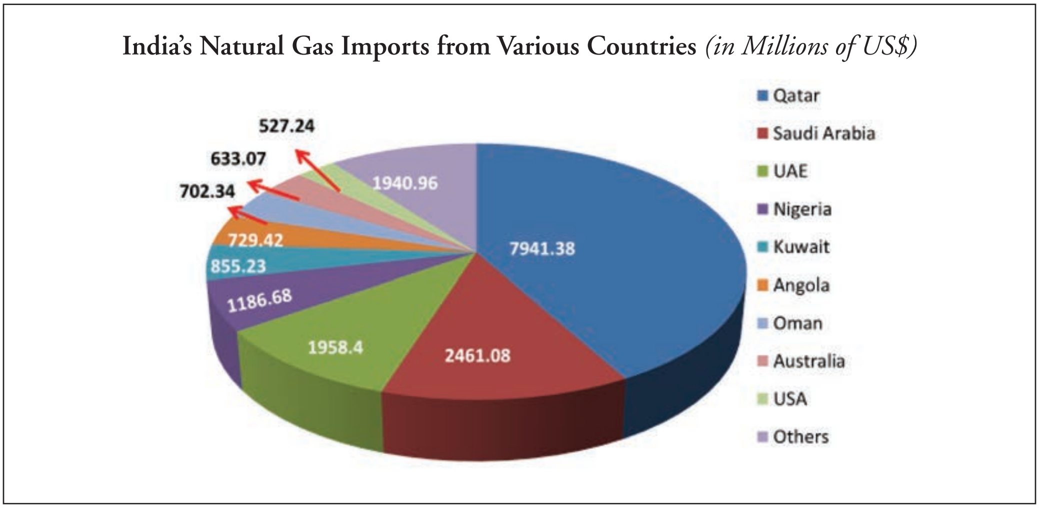


Figure 3: India's Natural Gas Imports from Various Countries (As on March 31, 2020)
Source: Department of Commerce, Ministry of Commerce & Industry, Government of India

feedstock, while 32 per cent was used for the production of electricity.[14] Both these values are predicted to rise in the years ahead. The population of India, which is already in excess of 1.3 billion people, is predicted to overtake that of China during the course of the coming decade.[15] These people will need to be fed. The consequent requirement to produce more food per acre of land that is cultivated will drive an increase in the demand for ammonia-based fertiliser (urea). As the population rises, there will also be an increase in the base demand for electricity. All sources of electric power generation will witness a rise in demand, and this will hold true for natural gas as well. Since close to 75 per cent of India's natural gas imports are sourced from West Asia, the geopolitical moves and countermoves being played out in this sub-region have, once again, obvious and significant strategic implications for New Delhi. Figure 3 depicts the top ten sources of India's import of natural gas.[16]

This demand for crude oil and natural gas gets compounded by several factors, including the volatility of oil markets and the associated price-fluctuation. In the aftermath of the Covid-19 pandemic, for instance, global and regional demand for oil and natural gas dropped substantially. Russia and the OPEC countries wanted to adopt a united stand, but the USA was clearly playing to its own interests and even threatened its ally Saudi Arabia that it could face tariff actions if it did not cut oil-production in order to help the USA's own shale-oil industry, which needed higher prices to break even. The US-Russian animosity introduced its own set of unhelpful dynamics into this already simmering geopolitical cauldron.[17] All this impacts India very substantially, especially given the high potential for armed conflict in West Asia.[18] Indeed, the ongoing conflict in Yemen and its impact upon the Strait of Bab-el-Mandeb offers a precursor that is, in and of itself, frighteningly ominous. Any deterioration in the situation that allows the present vituperative polemics to drift into military action can lead to serious disruptions of oil-bearing shipping flowing along some of the most important of the international shipping lanes (ISL) of the world. This would compel New Delhi to define new Sea Lines of Communication (SLOCs)[19] as it scrambles for energy resources elsewhere.[20]

If all these were not problems enough, the global dependence of fossil fuels for energy production has also resulted in an anthropogenic impact on climate leading to climate change.[21] Climate change and its maritime impacts such as sea level rise,[22] ocean acidification,[23] etc., can only be mitigated by reducing the overall carbon footprint. This reduction in the carbon footprint requires reducing the dependence on fossil fuels and adopting alternative sources of 'clean' energy.[24] According to the 2015 Paris climate change agreement, India is obligated to meet 40 per cent of its energy demand using clean energy sources by the year 2030, in order to achieve the current climate targets.[25] Sustainable Development Goal #7 (SDG #7) enjoins countries to focus upon using "Affordable and Clean Energy" to drive their economies.[26] How this might best be done and where exactly hydrogen-fuel fits in, are the very subjects of the next article in this ongoing series.

Guiding India's Inevitable Transition to the Replacement of Fossil-Fuels by Clean Renewable Energy

India's primary-energy basket and the geopolitical vulnerabilities arising from India's need to import a substantial proportion of these, particularly crude-oil from West Asia. It is important to remember that significant amounts of India's imports of crude-oil and natural gas, which are sourced from beyond West Asia (Nigeria, for example, is a major source), also face large geopolitical vulnerabilities. The ships carrying these imports must transit two major chokepoints, namely the Suez Canal (to enter the Red Sea) and the Strait of Bab-el-Mandeb located at the southern end of the Red Sea. Alternatively, this oil-and-gas bearing shipping must come around the Cape of Good Hope, which is a weather-determined chokepoint. Ships must remain within thirty-odd nautical miles of South Africa's southern coast so as to ensure navigational safety from the tumultuous seas that are encountered at greater distances from the land. Geopolitics, therefore, impacts the security of all of India's energy-bearing shipping as it treks along the world's International Shipping Lanes (ISLs). When strategic or operational risk so dictates, India might have to re-route its inbound energy-bearing shipping and instead of moving it along the ISLs, it might choose to move it along dynamically-determined Sea Lines of Communication (SLOCs).[27]

Once they reach their ports-of-destination in India, these imports of energy are merged with indigenous stocks and must now be converted into secondary sources of energy. Thus, the crude-oil is refined into a variety of products (e.g., fuel-oil, diesel, petrol, kerosene, etc.) which might then be used to propel various forms of land-based, airborne, or seaborne platforms, or be converted into electricity. In fact, outside of the transport sector (and some other major ones such as the fertiliser sector, wherein natural gas is used as a major form of feedstock), the vast bulk of India's primary energy (whether indigenous or imported) is used to generate electricity. This electricity is fed into the country's electricity (power) grids. There is a second source of electricity-generation, which is fed directly by sources such as diesel generators, domestic solar panels, micro-windmills, and so forth. The electricity that is generated in this way does not get distributed via an electricity grid but is consumed pretty much where it is generated. This sort of electrical generation is, of course, known as 'off-grid' power.[28]

Installed Capacity of Electricity-Generation

Figure 4 depicts the installed capacity of electricity production in India as of 30 April 2020.[29] As may be seen, the current contribution of renewables (solar, wind, bio power and small hydro power) to the production of electricity in India is 87027.68 MW (87.027 GW). In terms of percentage contribution, the figure stands at 23.51

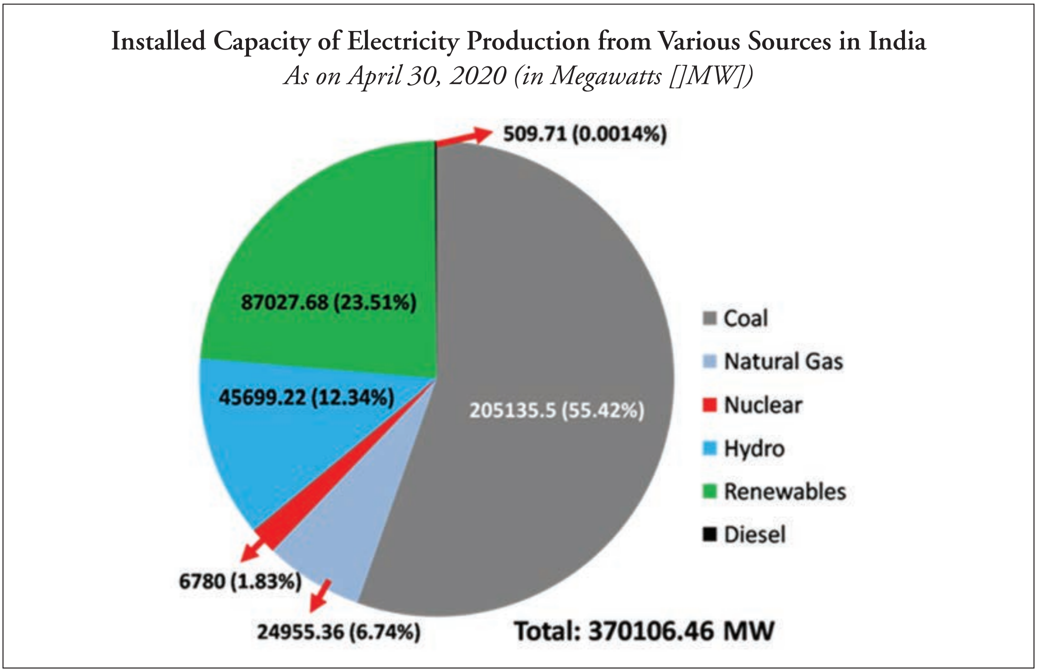


Figure 4: Figure 4: Installed Capacity of Electricity Production in India, as on 30 April, 2020
Source: Government of India, Central Electricity Authority (CEA)

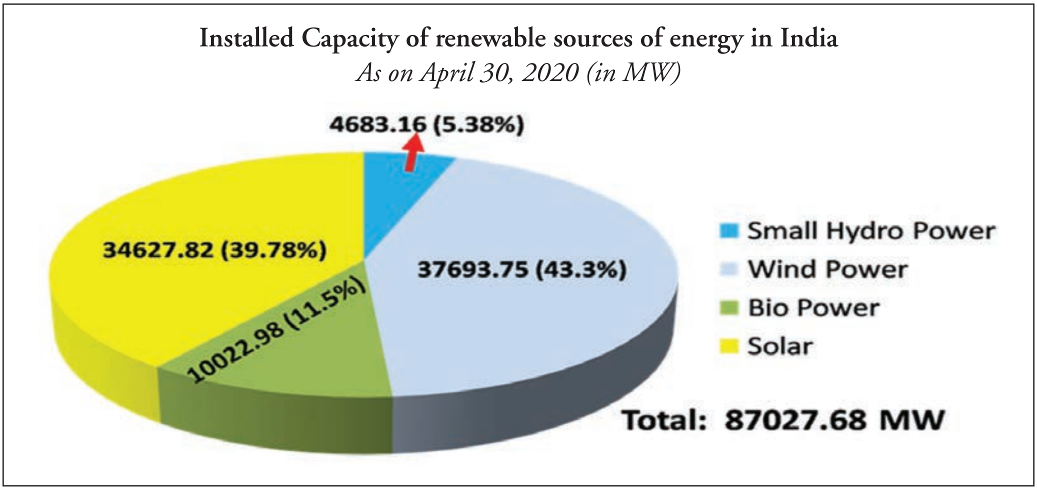


Figure 5: Contributory-Share of Various Types of Renewable Sources of Energy
Source: Government of India, Central Electricity Authority (CEA)

per cent. By including contributions from nuclear power and hydroelectric power, the overall contribution of renewables in percentage terms is 37.68 per cent.

Figure 5, on the other hand, indicates the individual contributions from various sources of renewable power. It is evident that amongst renewables, solar- and wind energy make up the lion's share of the contribution.[30]

One of India's three major commitments in the 2015 Paris Agreement,[31] as

Likely installed capacity by the end of 2029-30

Fuel Type	Capacity (MW) in 2029-30	Percentage Mix (%)
Hydro*	73,445	8.8
Coal + Lignite	2,66,827	32.1
Gas	24,350	2.9
Nuclear	16,880	2.0
Solar	3,00,000	36.1
Wind	1,40,000	16.8
Biomass	10,000	1.2
Total	8,31,502	1.2
Total	8,31,502	
Battery Energy Storage	34,000 MW/136,000MWh	
*Including small hydro of 5000 MW and hydro imports of 4356 MW		

Likely installed capacity (MW) in 2029-30

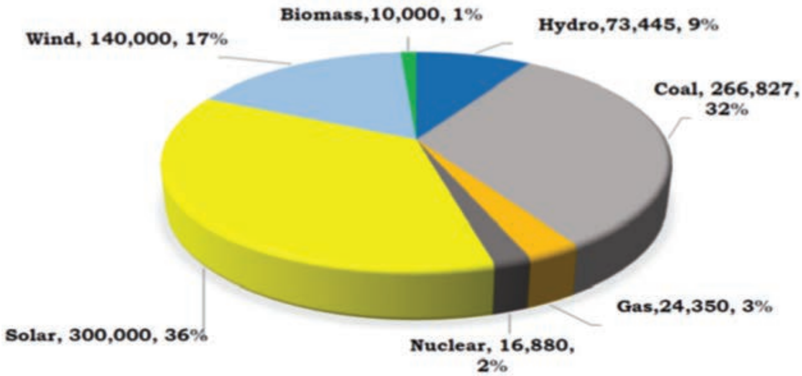


Figure 6: Installed Capacity Projection 2029-30
Source: CEA's "Draft Report on Optimal Generation Capacity Mix for 2029-30", January, 2020

embodied in the country's 'Intended Nationally Determined Contribution' (INDC), is for 40 per cent of its installed capacity to be from non-fossil sources by the year 2030.[32] New Delhi's commitment to its energy transition is genuine and its progress toward not merely meeting but exceeding this target is widely acknowledged.[33] Exercising commendable global vision and leadership, India, along with France, established the International Solar Alliance — a multilateral organisation headquartered in the Delhi NCR, which promotes the adoption of solar energy.[34] Advancing Prime Minister Narendra Modi's vision to effect India's speedy transition to renewable resources for the production of electricity, the Central Electricity Authority (CEA) has, in its Draft Report (of February 2019) on "Optimal Generation Capacity Mix for 2029-2030", projected that *"renewable energy sources (solar + wind) installed capacity will become 440 GW by the end of the year 2029-30, which is more than 50 per cent of the total* [projected] *installed capacity of 831 GW"*.[35] India's likely installed capacity by the end of 2029-30 is tabulated and graphically depicted in Figure 6.[36]

It is also encouraging that India's dependence upon fossil fuels for electricity production, in terms of absolute capacity *added* per annum, is declining and yielding a greater share of renewable resources of energy.[37] Figure 7 depicts the breakdown of the various forms of renewable energy, which, according to the CEA's projection,

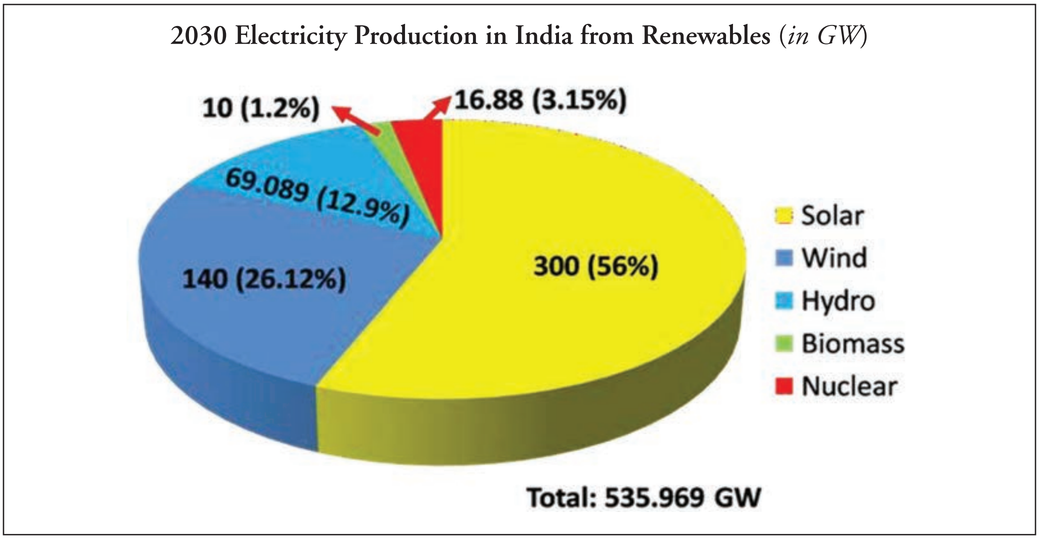


Figure 7: Renewable Sources of Electricity Generation in India by 2030
Source: Central Electricity Authority Report, 2019

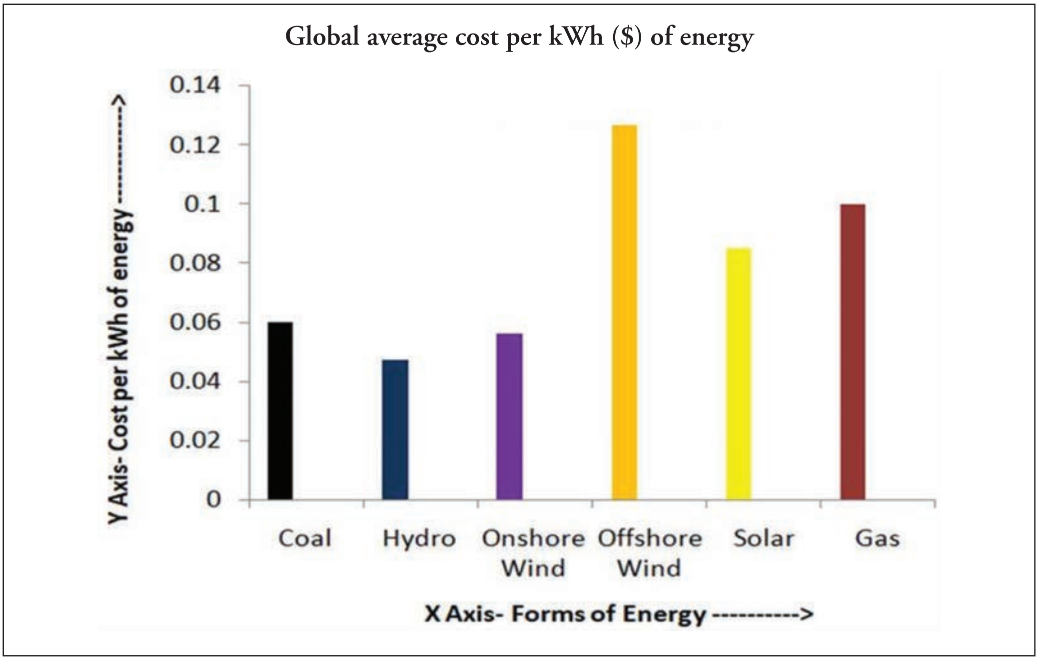


Figure 8: The Global Average Cost per kWh of Energy from Various Sources of Energy (in USD) in 2018.
Source: Renewable power generations costs in 2018

will feed into the country's installed capacity by the year 2030. It is envisioned that around 535 GW (close to 65 per cent) of electricity will be generated from renewables out of the total installed capacity of 831 GW by the year 2030.[38]

In considering sources of electricity generation, a very important factor is economic viability, as established by the cost per kilowatt-hour of electricity generated if the energy source in question were to be used. This is particularly germane in India, which is the cheapest in the entire Indo-Pacific region and in which the margins between one and another source of electricity generation are cutthroat. Technologies for the production of renewable energy, such as solar energy and wind energy, as also the development of their respective markets, have attained maturity, with electricity-costs being comparable to that for electricity generated through fossil fuels. As of 2018, the cost per kilowatt hour (kWh) of energy from fossil fuels, compared to solar and wind energy is given in the bar chart in Figure 8. The global average cost of solar-generated electricity was US$0.085 or ₹6.47 per kWh, displaying a reduction of 13 per cent from the previous year. In the case of electricity generated from offshore wind, it is US$0.127 or ₹9.67, displaying a dip of 1 per cent compared to the previous year.[39]

This downward trend is continuing and nowhere as rapidly as in India, where by the end of 2019, the "levelised cost of electricity generation from fossil fuel [was] around US$44.5 per MWh (₹3.05 per unit)..." while the "levelised cost of solar power generation [was] estimated at around US$38.2 MWh (₹2.62 per unit)..."[40] In September 2019, Prime Minister Modi announced that India would add 450 GW of electricity-generation capacity, exclusively from renewables, by the year 2030.[41] It is vital to explore various sources of renewable energy to enable this transition, keeping in mind the fact that India's demand for electricity is set to increase threefold by the year 2040.[42] This requires a concerted effort, especially considering the current share of renewables in India is currently only 87 GW (See Figure 2). Improving the share

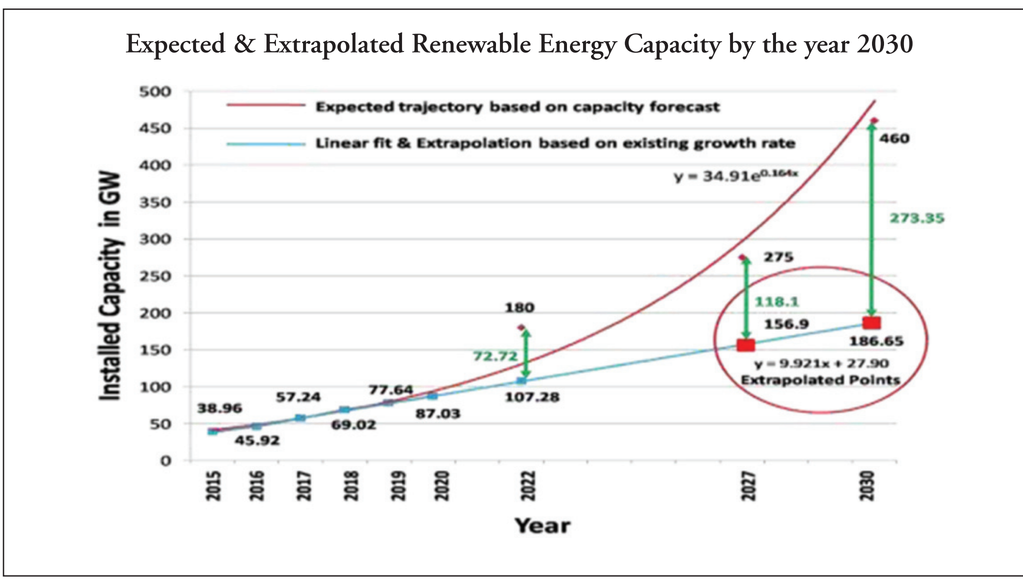


Figure 9: Dissonance between Government of India Projections and the Likely Growth-rate of Renewable Capacity. The Blue Exponential Curve represents the trajectory that must necessarily be followed to Achieve the Targets set by the Government of India
Source: Author

of renewables would not only reduce carbon emissions but would also play a major role in reducing India's dependence on energy imports per se. Therefore, exploring and exploiting every form of available renewable energy in India is an inescapable necessity. The projections by the CEA in terms of installed capacity and the share of various forms of energy, especially renewable forms of energy, to this installed capacity are extremely encouraging — but only if the government's projections are correct. The question, of course, is whether this is really the case.

Unfortunately, trend-analysis in terms of the contribution of renewables, undertaken by this author, does not bear out the CEA's optimism and yields a much grimmer picture that brings the credibility of the CEA's projections into some doubt. Figure 9 demonstrates, in blue, a 'linear' growth-rate of capacity-addition of renewable sources of energy over the last six years, which has been extrapolated for the years 2027 and 2030, so as to enable a comparison with the Government of India projections for these years, which are available and have already been referred to in this paper. The exponential curve, on the other hand, which is depicted in red, represents the trajectory that India will have to follow if it is to actually achieve the targets to which the Government of India has committed itself.

The growth-rate of renewable capacity-addition per annum has followed a linear trend over the last six years, with an average growth rate of 9.6 GW per annum. A linear extrapolation, based on the existing trend in growth-rate has been carried out in order to estimate the total renewable installed- capacities by the years 2027 and 2030. This yield figures of 156.9 GW and 186.65 GW, respectively, which fall far short of the ambitious projections of the CEA, which are 275 GW and 460 GW, respectively, for the two years under reference. In fact, in order to achieve these projected targets, the growth rate from here onward should assume an *exponential* trajectory (~5.73*exp [0.164x]). This discrepancy is demonstrated in Figure 9, where the Blue line represents the linear growth rate over the last six years and is extrapolated for the years 2027 and 2030. The Red curve represents the exponential trajectory that needs to be followed in order to achieve the capacity-addition targets that have been projected by the CEA for 2027 and those subsequently projected for 2030. The deviation from the projected targets (shown in Green in Figure 6) is

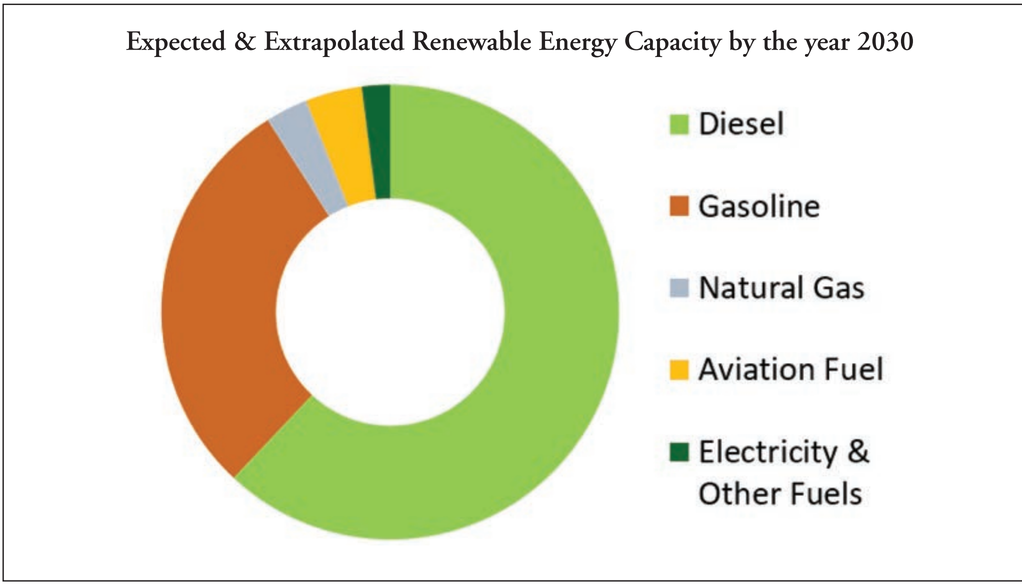


Figure 10: Percentage Share of Energy-Sources in India's Transport Sector
Source: International Energy Agency, "India 2020 Energy Policy Review", 2020

already evident by the year 2022, where the existing 'linear' trend yields a figure of a mere 107.28 GW as opposed to the projected (and hence 'targeted') capacity of 180 GW.

What this means is that the existing mix of renewable sources of energy will not take India to its declared targets. Some other source(s) will have to be identified. This is where Ocean Renewable Energy Resources (ORER) and hydrogen-fuel from the sea enter the picture. Before proceeding any further in this ongoing advocacy for the adoption by India of hydrogen-fuel as the most promising ORER, there is one very important aspect that needs to be continuously borne in mind — maritime geopolitics. For this geopolitical maritime piece to be correctly positioned in the reader's mind, it is critical to remember that electricity-generation alone does NOT constitute the entire Indian energy story. The transport sector (comprising surface-, airborne-, and seaborne transport) still largely relies on crude- oil imports and their refinement into petroleum-products. 98 per cent of energy for transportation is met using diesel, gasoline, natural gas and aviation fuel, as depicted in Figure 10.[43] If this return to petroleum-based import-dependence were not bad enough, the contribution of road-vehicles to air- pollution has significantly affected the Air Quality Index (AQI) in Indian cities, which figure prominently amongst the most polluted cities in the world.[44] According to a joint report by Greenpeace Southeast Asia, and the Centre for Research on Energy and Clean Air, the estimated cost of air-pollution in India stands at a whopping $150 billion (close to 5 per cent of India's GDP) and leads to the premature death of at the least a million people in India per year from pollution-related ailments.[45]

It may thus be seen that in the Indian context, a transition away from fossil fuels and in favour of renewables has to occur simultaneously not only in the generation of electricity but also in the transport sector. This is a major challenge unless the problem of electricity storage can be solved, because *"In 2018, around 70 gigawatt-hours (GWh) of battery cells were used for electric cars worldwide, while 8 GWh of stationary batteries were added to provide flexibility in the power sector...*[46] and insofar as the transport sector is concerned, *"India is going to need more battery storage than any other country for its ambitious renewables push"*.[47] Encouragingly, advances in technology are proceeding at a pace that can only be described as frenetic. Consequently, *"battery costs have fallen by over 80 per cent since 2010"*.[48]

All this notwithstanding, however, for India, as for much of the world, the problem centres upon the availability of cobalt. Despite *"a two-decade evolution in battery technology and increasing energy density from nickel-cadmium to nickel-metal hydride and to today's lithium-ion"* batteries, a critical ingredient for the cathode batteries used by all electrically-driven vehicles (EVs) continues to be cobalt, which constitutes 5 per cent to 30 per cent of the cathodic material.[49] *"A typical smart phone battery requires only 5 to 20 grams of cobalt, whereas an EV requires between 4 and 30 kg."* Since cobalt is in extremely short supply in India but abundant in the Democratic Republic of Congo, the geopolitical implications of India's desire to switch to EVs are obvious. This is a fact that ought not be lost sight of amidst the ongoing geopolitics of West Asia and its impact upon India's import of petroleum-based energy (crude-oil and natural gas). In an effort to mitigate this dependence (quite apart from the environmental aspects), India is seeking to switch to EVs. This makes new, but equally critical geographic areas the focus of the geostrategies that drive India's geoeconomics and hence shape its geopolitics.

Ocean Renewable Energy as a Viable Alternative

According to the renewable energy global status report of 2019, 64 per cent of new installations in 2018 were from renewable sources of energy (including solar and wind), marking the fourth consecutive year that net additions of renewable power were above 50 per cent.[50] For quite some time now, the MNRE's primary focus has appeared to be restricted solely to solar and wind energy.[51] However, the government's projections appear to be significantly optimistic, especially if they are to remain limited principally to these two forms of renewable energy alone. To that somewhat unreasonable optimism, if one were to add unpredictability in weather, temporality, operational and maintenance costs, as well as the predicted demand of an increase in energy requirements by 2040 due to rapid urbanisation, it would be clear that the solar-onshore-wind combine will simply not be enough, and, consequently, the exploration of additional sources of clean energy is both necessary and urgent.

India's Ocean Renewable Energy Potential

It is the authors' conviction that adding Ocean Renewable Energy Resources (ORER) and hydrogen fuel into the basket of renewable energy resources — alongside solar-, wind- and hydel-energy — offers a very substantial potential for the addition of requisite capacity in terms of green-energy installations. Fortunately, there is encouraging evidence of this view being accepted more widely now than has hitherto been the case. Indeed, the website of the Government of India's 'Ministry of New and Renewable Energy' (MNRE), accepts that all forms of renewable energy are necessary for achieving the Paris 2015 targets by 2030. In August of 2019, the MNRE finally declared that ORER were the "*energy resources of the future*", but added the caveat that this was subject to technological evolution and reduction in costs.[52] This cautious approach notwithstanding, the MNRE has invested in the research and development of ORER and is actively collaborating with several premier research institutions of the country such as the Department of Science and Technology (DST), the National Institute of Ocean Technology (NIOT), the Indian Institute of Technology (IIT), etc.[53]

ORER may be categorised into two principal subsets, which are differentiated from each other by the methods they employ to covert energy from the intrinsic nature of the ocean. These subsets are 'Ocean Mechanical Energy Conversion' (OMEC), and 'Ocean Thermal Energy Conversion' (OTEC). The former employs methods that convert kinetic energy from the oceans — in the form of waves, tides, and currents (whether tidal currents or ocean currents) — into electricity. The latter, on the other hand, utilises the temperature-differential (thermal-gradient) between warmer surface-water and colder deep-seawater to run a power-cycle and produce electricity.[54]

Wave Energy

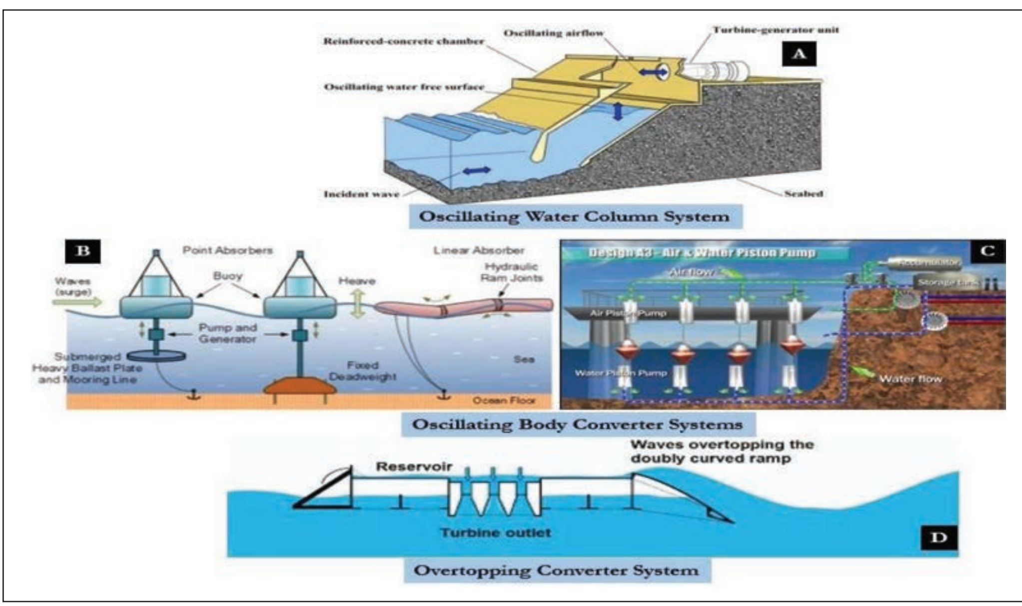


Figure 11: Wave-Energy Conversion Techniques:
(A) Oscillating Water Column; (B) & (C) Oscillating Body Converter Systems;
(D) Overtopping Wave Energy Converter Systems
Sources: 11(A) - Journal of Ocean Engineering, Vol 164; 11(B)- Alternative Engineering Tutorials (AET): "Wave Energy Devices"; 11(C) – "Blue Energy – Ocean Power", YouTube Video, 4:57, 20 October 2012; 11(D) – Parmeggiani *et al*, Energies, 2013, doi: 10.3390/en6041961

The natural generation of waves in the ocean is usually the result of disturbances caused by wind, although waves can also be generated by an underwater seismic event. Where wind is the source, waves result from the transfer of kinetic energy from the wind to the water. Wind blowing on the surface of the water also creates friction and the difference in pressure created between the upward wind movement and the leeward side of the wave-crest results in a shear-stress upon the water, which, in turn, causes the waves to grow in size.[55] The kinetic energy carried by the waves can be harnessed in a variety of ways. Common techniques (schematically depicted in Figure 11) include the Oscillating Water Column (OWC), the Oscillating Body Converter (OBC), and, the Overtopping Converter (OC), although, of course, these are not the only options.

Figure 11A[56] depicts the working principle of the OWC, which has a semi-submerged chamber with space within it for an air-column. The movement of the ocean waves results in the air in the chamber getting pushed out at a high velocity. This air is used to run a turbine to produce electricity. Figure 11B[57] and 11C[58], on the other hand, depict a simplified OBC, comprising either floating or submerged platforms, which exploit more the powerful 'swell-waves' that are generated underwater, in order to produce electricity. These platforms are positioned in the direction of wave propagation and are usually held in place by moorings attached to the sea floor. OBCs employ either hydraulic pumps or piston pumps such that they oscillate vertically (i.e., they bob up and down) when waves pass over. This causes the piston in the pump-assembly to similarly move either up or down, thereby compressing the air or hydraulic-fluid in the cylinder. This motion generates or releases pressure and, in either case, causes a suitable gear to be turned in one direction alone (either clockwise or counter- clockwise). This then drives one or more motors, which in turn run turbines to produce electricity. Figure 11D[59] shows that the working principle of an OC is quite similar to that of a hydroelectric dam, wherein water in a reservoir containing potential energy is released to flow rapidly down a slope and runs turbines to produce electricity. The OC achieves this by employing structures that force incoming waves to spill water into a smaller reservoir, which is thereafter released onto the blades of small hydro-turbines to produce electricity.[60] As has already been mentioned, there are other wave-energy devices that are in contemporary use.

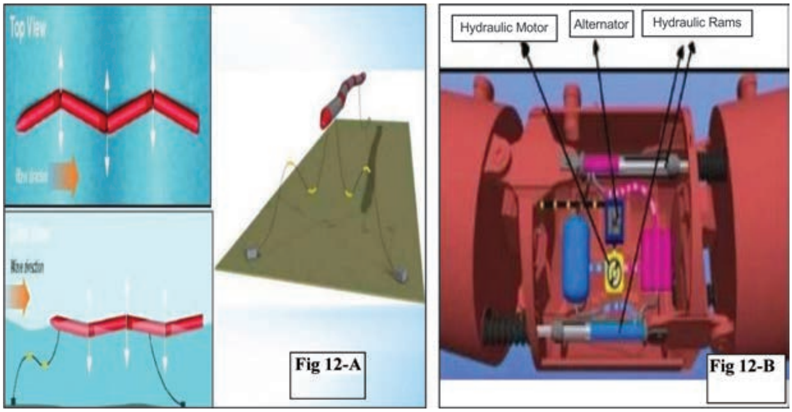


Figure 12: Working-principle of a Pelamis System
Source: P Swati & C Latha, "Wave Power Conversions Systems for Electrical Energy Production", Shri Krishnadevaraya University, Anantapuram, Andhra Pradesh

Notable amongst these is the 'Pelamis System' ('Pelamis' is the name of a sea-snake). This is depicted in Figure 12.[61] It comprises a series of articulated floating sections, each typically 120-150 metres long and 3.5 metres in diameter, slackly moored to the seabed such that the device aligns itself perpendicular to the prevailing wave-crests. Here, the waves are 'resisted' by a pair of hydraulic rams located with the articulated-joints and one or the other ram is compressed. The ensuing hydraulic pressure is used to pump high-pressure oil to drive hydraulic motors that in turn, drive electricl- generators.

Coastal sites deemed suitable for the installation of wave-energy devices are depicted in Figure 13.[62] India's annual potential power from wave-energy is currently assessed to be 41 GW.[63]

Figure 13: Indian Coastal Sites Suitable for the Installation of Wave-energy Devices
Source: CRISIL & IIT Madras

Tidal Energy

'Tides' are actually long-period oceanic waves that are caused by the gravitational pull exerted upon the oceans by the moon and sun. When these long-period waves approach the coastline, they appear to human beings as a regular and periodic rise and fall of the sea surface. When the highest part (the crest) of the wave reaches a particular location, 'high tide' occurs. By corollary, 'low tide' corresponds to the lowest part of the wave (the trough) reaching the same location. The difference in height between the high tide and the low tide is called the 'tidal range'. These natural phenomena can be exploited to generate electricity in several ways.

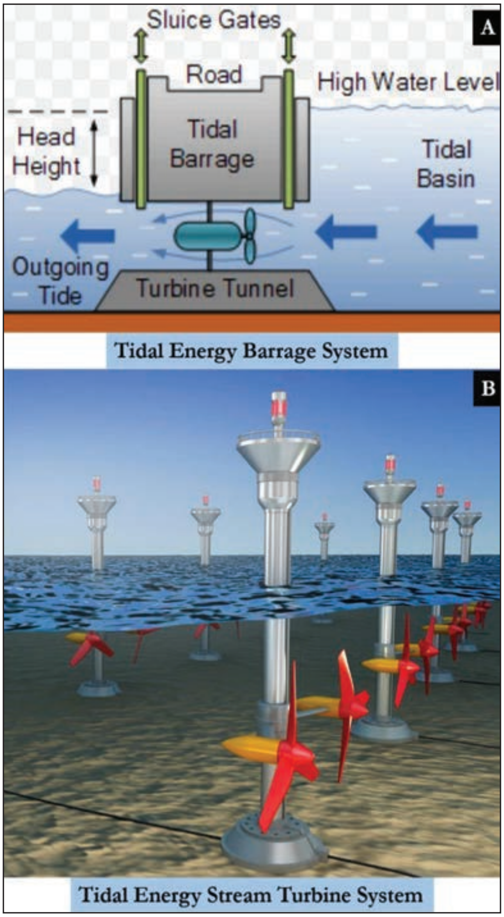


Figure 14: Ocean Tidal Energy Conversion Techniques
(A) Tidal Energy Barrage System;
(B) Tidal Energy Stream Turbine System
Sources: 4A – Alternative Energy Tutorials (AET), "Tidal Energy Devices"
4B – Clean Energy Ideas, "What is Tidal Power? Tidal Energy Explained"

The traditional method, depicted in Figure 14A[64], is to utilise a 'tidal barrage' preferably in a narrow passage connecting the sea to a bay or an estuary. The barrage acts as a dam between the sea on the one side and the bay / estuary (or even an artificially-built reservoir) on the other. Sluice-gates are lowered to prevent water from flowing from the sea into the estuary. As the tide rises, the level of the sea becomes higher than the water in the estuary. This creates a pressure differential. When the sluice- gates are raised, water from the higher level (in this case the sea) rushes into the estuary. This rush of water is used to drive a controllable pitch propellor. This acts as a rotor and, when spun within the coils fitted in the body in which it is housed (the stator), produces electricity. Once the two water- levels (in the sea and in the estuary) are the same, the propellor stops. The sluice-gates are lowered once more. As the tide recedes, the water level becomes higher in the estuary than it is in the sea. The sluice-gates are raised, the blades of the propellor are reversed and the turbine is made to run again, with the water now rushing from the estuary side into the sea. This working- principle is depicted in Figure 14A.

A somewhat newer approach is to do away with the tidal barrage and, instead, to install, a propellor- blade turbine underwater, in the path of the tidal stream. When the tide is rising, the tidal flow is from the sea to the shore and the turbine blades turn, driving the generator and producing electricity. When the tide is ebbing, the pitch of the propellor is reversed and electricity is once again generated. This is depicted in Figure 14B.[65]

Whatever the approach, in order to generate a sufficient pressure differential, a tidal range of at least five metres (and preferably seven metres or more) is needed if the operation is to be economically viable. power and for economical operation. There are very few locations on earth with tidal ranges that are this high. Amongst these, however, are the Gulf of Khambhat (Cambay) — which experiences a maximum tidal range of 11 metres and an average one of 6.77 metres — and the Gulf of Kachchh (Kutch) — where the maximum tidal range is 8 metres and the average is 5.23 metres.[66] Both these gulfs are located in Gujarat, on the west coast of India and have a combined potential of some 8,200 MW (7,000 MW for the Gulf of Khambat and 1,200 MW for the Gulf of Kachchh).[67] Likewise, the Ganges Delta in West Bengal's *Sunderbans* area is suitable for small-scale tidal power generation and has a potential of 100 MW.[68] A 2014 joint report by CRISIL and IIT (Madras) indicated that technological advancements had led to the achievable tidal potential being revised upwards to 12,445 MW.[69] Regrettably, however, current inputs (2019) are that the high capital cost of establishing tidal-power stations have led India to abandon this option, even though *"globally, many countries, mostly in Europe, have continued to invest in tidal and ocean energy projects. This has resulted in energy generation from these projects increase from 5 gigawatt-hours in 2009 to 45 gigawatt-hours in 2019"*.[70]

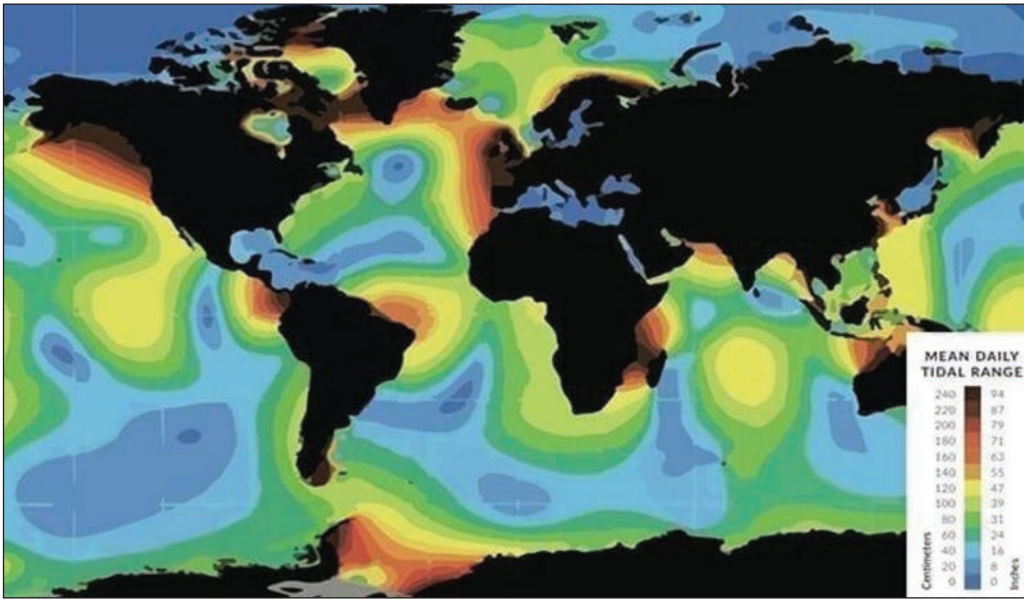


Figure 15: Global Distribution of Ocean Currents
Source: Power Magazine, Courtesy: Minesto AB, Sweden

Current Energy

The emergence of ocean currents can be attributed to a variety of natural factors that impact the oceans, such as the temperature gradient, the density differential, the salinity differential, etc., at different horizontal and vertical locations of seawater. Figure 15[71] shows the global distribution of ocean currents, where the colour-scale denotes tidal range differences, which essentially reflect the strength of tidal streams.

The movement of seawater in the form of ocean currents can be exploited to produce energy by placing energy-conversion devices such as underwater horizontal-axis turbines.[72] These turbines, depicted in Figure 16,[73] sit on the seabed and typically require currents following at velocities of 2.5 m/s (about 5 knots) or higher, in order to produce electricity cost-effectively. Such fast flowing currents are relatively uncommon in most close-coast areas of the world. Moreover, the capital cost involved in installing the turbines and their support-structures is fairly high.

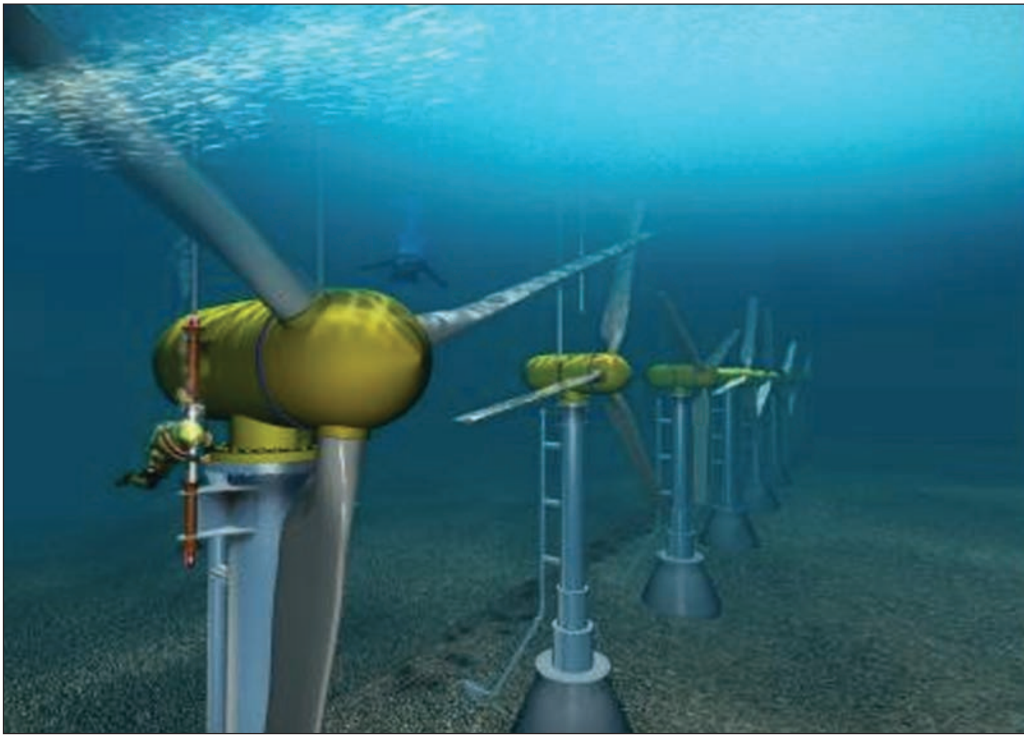


Figure 16: Underwater Horizontal-Axis Turbines Operated by Ocean Currents
Source: US Department of the Interior, Bureau of Ocean Energy Management (BOEM)

Consequently, their adoption for electricity-generation has been fairly low.

However, this limitation has now (since 2018) been overcome to a significant degree — specifically by a private company based in Sweden, Minesto AB, which was hived out of the well-known Swedish aircraft company, Saab. Minesto Company's 'Deep Green' subsea kite converts the kinetic energy present in marine currents into power via a turbine mounted beneath a wing that is anchored to the seabed (or a surface platform) by a tether. The wing is subjected to the lifting force of the underwater current, which propels the system through the water. The power plant moves on a figure-eight trajectory, using a control system and rudder. As it moves across the current, the surrounding water flows through the turbine at a speed several times that of the actual current velocity. This unique technology is presently the only one that can cost-effectively exploit low-flow marine streams (with velocities

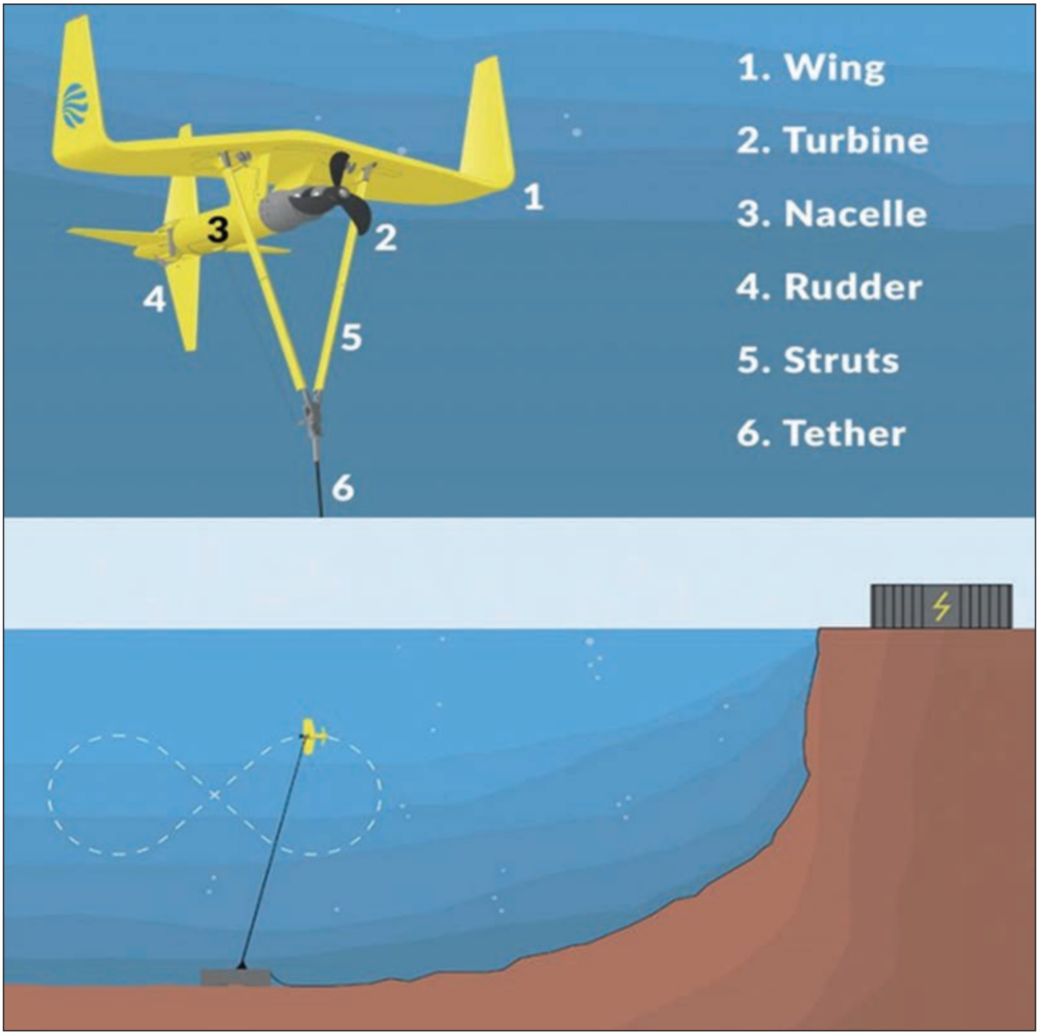


Figure 17: Ocean Current Energy using a Sub-sea Kite
Source: Minesto AB, "The Future of Renewable Energy"

of around 1.2 m/s (about 2¼ knots), which are encountered much more frequently across the globe.

Figure 17[74] depicts the working principle. The underwater current creates a hydrodynamic lift force on the wing and pushes the kite forward and, ultimately, steers it automatically in a 'figure-of-eight' pattern. As the kite 'flies' across the ocean current, it pushes the turbine through the water "at a speed several times faster than the actual flow rate, essentially multiplying the stream flow through the turbine and enables efficient energy conversion in low-velocity marine currents. Power produced in the onboard generator is then transmitted to shore via a cable in the tether that is attached to the wing.[75] Unfortunately, current- velocities off the Indian coast are assessed to be too low even for sub-sea kites. It must, however, be added that Indian scientific measurements have been extremely scanty.

Ocean Thermal Energy Conversion (OTEC)

OTEC systems exploit the temperature-difference between the seawater at the surface and that in the deep sea to run a thermodynamic heat-engine, in a process called the

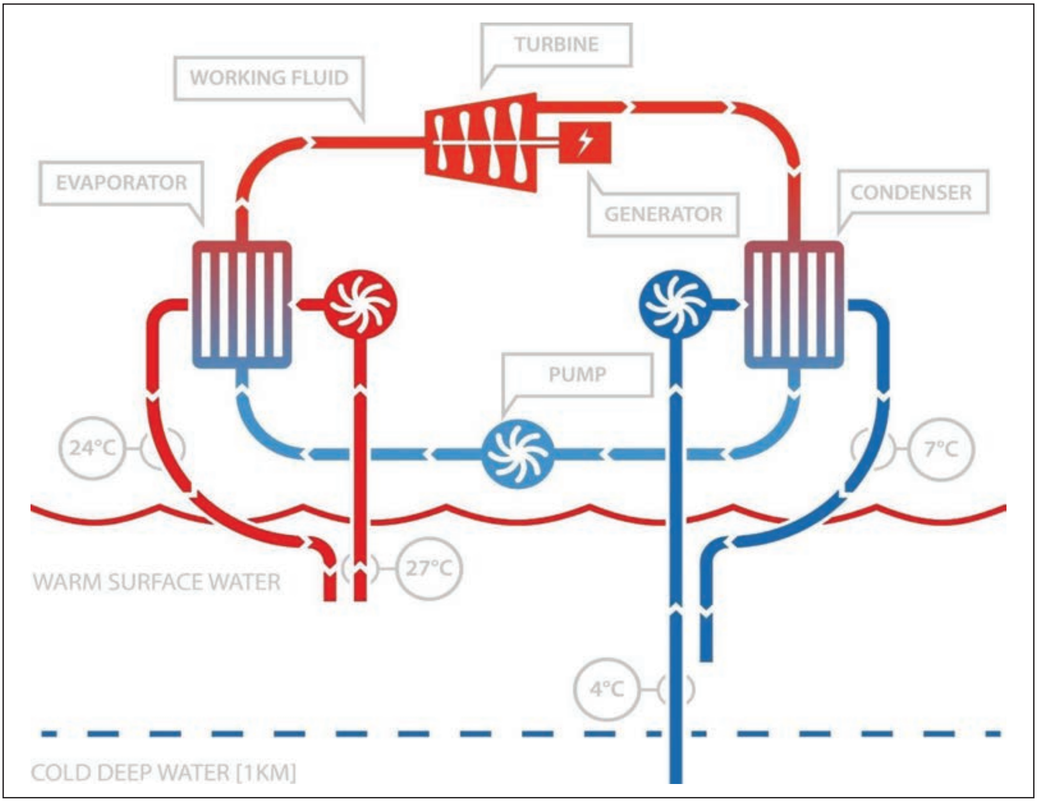


Figure 18: Working Principle of a Closed-cycle OTEC System
Source: Delft Technical University

‘Rankine Cycle’, to generate electricity. The working principle is depicted in Figure 18.[76]

The cycle may either be ‘open’ or ‘closed’. In the former, the working fluid is warm surface water itself, while in the latter fluids with low boiling-points, such as ammonia, for instance, are used. The process requires a temperature difference of at least 20° C if is to operate with any degree of efficiency. The working fluid is used to drive turbines to produce electricity. Tropical areas are ideal for locating OTEC plants, because in such areas, the temperature difference can be as great as 40° C. Even so, in order to produce power within such a low temperature-range, the working fluids used to drive the turbines must have very low boiling-points. Ammonia and R-134a have been found to be suitable for this purpose.[77] OTEC plants are operational in Japan, the USA, South Korea, France, etc.[78] Insofar as India is concerned, the theoretical estimate of the potential of OTEC is 180 GW, according to a study jointly carried out by the National Institute of Ocean Technology (NIOT) and IIT Madras.[79] A prototype OTEC plant, called *Sagar Shakti*, with a power generation capacity of One MW, was tested in India as long ago as the year 2002. However, it was dogged by poor engineering and has since been decommissioned.[80]

This premature abandonment of the Indian endeavour notwithstanding, a very important spinoff from OTEC plants is the production of fresh water, through an associated technology known as ‘Low Temperature Thermal Desalination’ (LTTD).[81] LTTD plants have a staggering potential to alleviate water-stress in volcanic islands that are surrounded by deep water on at least the windward side. A little-known, but hugely celebratory fact is that India has pioneered and matured its ability to manufacture and install LTTD-generated freshwater plants. On 26 December, 2018, Dr Harsh Vardhan, Minister, Ministry of Science and Technology and Earth Sciences, formally informed the Indian Parliament three LTTD plants, each with a capacity to generate 100,000 litres of drinking water per day, were functional in the Lakshadweep islands of Minicoy, Agatti, Lakshadweep and Kavaratti, and, that six additional plants had been approved to be installed on the islands of Amini, Androth, Chetlat, Kadamat, Kalpeni and Kiltan, within the Lakshadweep chain.[82] One such plant, installed on the island of Agatti, is depicted in Figure 19.[83]

Figure 19: LTTD Plant at Agatti Is., Lakshadweep
Source: NIOT

As such, India is extremely well-positioned to use LTTD as an invaluable tool of foreign-policy, by assisting volcanic island-States such as the Maldives and the Seychelles to generate very-nearly 'free' fresh water to alleviate their water-stress. That this possibility has not yet received attention — let alone policy-incentives — from India's Ministry of External Affairs, is astonishing, to say the least. In December of 2014, responding with its usual alacrity to an urgent request from the Government, the Indian Navy despatched two of its warships of, INS *Sukanya* and INS *Deepak*, to rush to the aid of Male, the beleaguered capital of the Maldives, which was facing a crippling water-crisis after its main water treatment plant was badly damaged in a fire. The two Indian Naval warships, ably assisted by an aircraft of the Indian Air Force, transported some 2,000 tonnes of fresh water to Male, once again demonstrating a very tangible manifestation India's avowed ability to be a net provider of security in the region. The Indian reaction was praiseworthy, as was the instantaneous response from the Navy and the Air Force. Yet, how much better — and how much more in keeping with India's effort to provide requisite leadership-by-example in the regional transition from a 'Brown' economy to a 'Blue' one — would it have been, had this emergency humanitarian-aid been vigorously followed-through with an offer to install an LTTD plant in Male? It would certainly have cut the ground from under the Chinese feet that were, at that point in time, stomping all over the Maldives much to Indian discomfiture, after President Xi Jin Ping's September-visit to the Maldives! Five-and-a-half years down the line, there is still little clarity that the mandarins of South Block or Jawaharlal Nehru Bhawan have fully grasped the enormous potential that India has in this regard.

Hydrogen Fuel: A Clean Energy Source for the Future

Energy-related CO2 emissions account for two-thirds of global greenhouse gas emissions and an energy transition is needed now to break the link between economic growth and increased CO2 emissions. Climate change is the fundamental driver for hydrogen in the energy transition in order to achieve a scenario of containing the average global temperature rise to below 2 degrees Celsius (°C) and requires CO2 emissions to decline by 25 per cent by 2030 — from 2010 levels — on the way to achieve net zero-emissions by around 2070, according to the Intergovernmental Panel on Climate Change (IPCC) Report of 2018.[84] To stay below 1.5 °C of warming, the net anthropogenic CO2 emissions should decline by around 45 per cent by 2030, from 2010 levels to achieve net zero by 2050. However, in contrast, it has been observed that over the last few years, emissions have only risen according to a report released in 2018 by the United Nations Environment Programme (UNEP).[85]

The G 20 Karuizawa Innovation Action Plan on Energy Transitions and Global Environment for Sustainable Growth of June 2019 calls upon the International Renewable Energy Agency (IRENA) to identify pathways to a hydrogen-enabled clean energy future.[86] Hydrogen and related synthetic organic fuels offer new prospects for a clean-energy future characterised by decarbonisation and carbon neutrality. Even though hydrogen comprises only a small fraction of Earth's atmosphere, it is abundantly available from other sources including fossil fuels and water (after electrolysis). It has the potential of revolutionising long-haul transport,

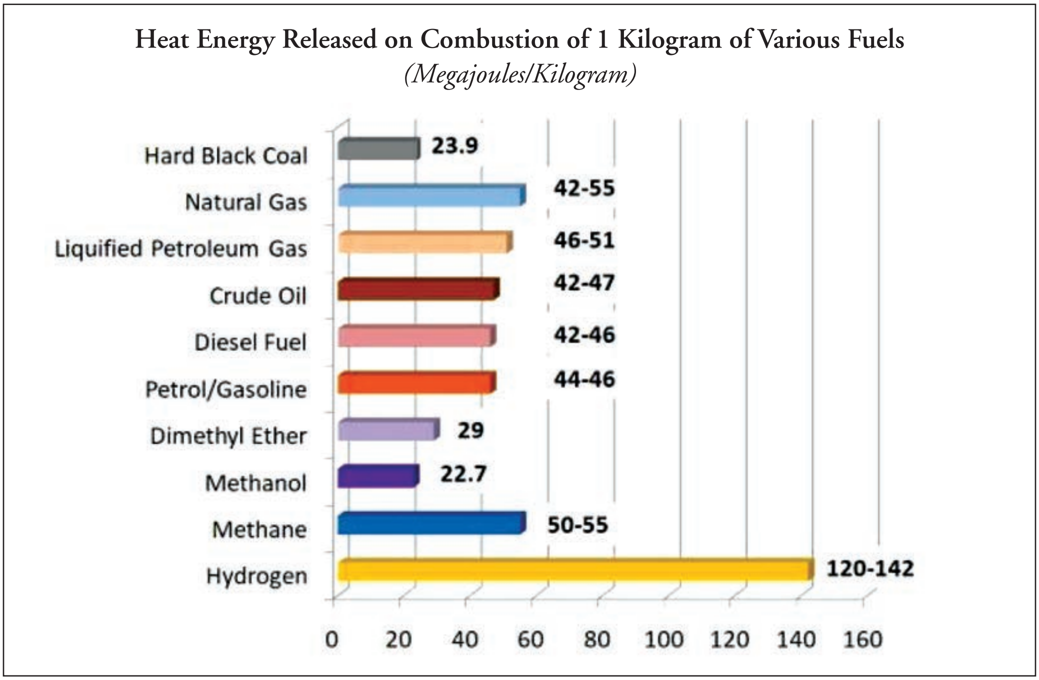


Figure 20: Comparative Heat-energy produced by burning 1 kilogram of various fuels
Source: Created by Dr Sameer Guduru with data from the World Nuclear Association, https://www.world-nuclear.org/information-library/facts-and-figures/heat-values-of-various-fuels.aspx

as also industries such as chemicals, iron and steel, and can play a major role in reducing emissions, thereby improving air-quality and enhancing energy-security in a paradigm of an ever-increasing demand for clean energy.[87]

According to a September 2019 joint report prepared by the 2nd Hydrogen Energy Ministerial Meeting and IRENA, renewable green production of hydrogen could be among the cheapest options even as of today.[88] The adoption of hydrogen fuel has several inherent advantages not the least of which is its higher energy output per kilogram of fuel burnt. Figure 20 compares the calorific value of hydrogen with other 'rival' fuels.

Added to this advantage of hydrogen are a much greater ease of storage, portability, the elimination of grid-connectivity and related ancillaries, the obviation of bulky

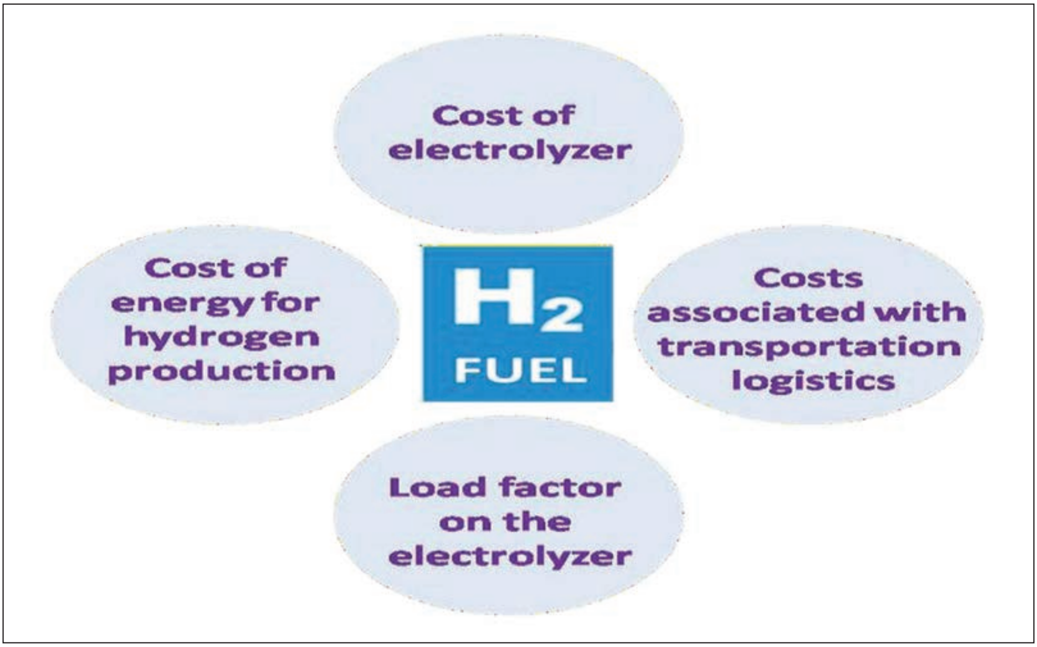


Figure 21: Determinants of the Final Price of Hydrogen
Source: Created by Dr Sameer Guduru, with data drawn from International Renewable Energy Agency (IRENA): "Hydrogen a Renewable Energy Perspective," 2019, https://www.irena.org/-/media/Files/IRENA/Agency/Publication/2019/Sep/IRENA_Hydrogen_2019.pdf

batteries, a green-energy output with water as the by-product of combustion, and a high prospect of achieving net carbon-neutrality. More than 90 per cent of hydrogen produced is from fossil fuels by stripping them of carbon via processes like steam reforming, methane oxidation and coal gasification.[89] As such, these processes of producing hydrogen themselves contribute to the net carbon footprint. Hence, a method of producing hydrogen from renewables is the need of the hour. With the cost per unit of energy from renewables such as solar and wind already competing with those of fossil fuels, the former can be exploited for producing hydrogen in a cleaner and carbon-free manner via electrolysis.

Figure 21 depicts major factors that affect the final price of hydrogen. It indicates that the most important variable for hydrogen production today is that of the cost of electrolyser that forms the heart of the electrolysis process used to break molecules of water down to their constituent elements, i.e., hydrogen and oxygen. Two other variables of importance are: the load-factor of the electrolyser, which ideally should be more than 50 per cent so as to achieve the lowest cost of production per kilogram of hydrogen, and, the cost of the logistics.

Hydrogen is typically transported in one of three ways: (a) in its gaseous form, (b) by liquefying it, (c) by storing it in the form of either toluene (commonly encountered as a solvent that is used in making paints, paint thinners, fingernail polish, lacquers, adhesives, and rubber) or ammonia. Each of these processes, such as the liquefaction of hydrogen (which occurs at very low temperatures of the order of Minus 250° C) or the reconversion of toluene and / or ammonia into hydrogen, expend energy, of the order of 45 per cent, 30 per cent and 13 per cent respectively. Obviously, this influences the end-price of hydrogen and need to be factored when making a comparison with other renewable sources of energy. This comparison is done through the concept of 'Levelized Cost of Energy' (LCOE). *LCOE measures lifetime-costs divided by energy-production. It calculates the present value of the total cost of building and operating a power plant over an assumed lifetime. It thus allows the comparison of different technologies (e.g., wind, solar, natural gas) of unequal life spans, project size, different capital cost, risk, return, and capacities. As such, it is critical to making an informed decision to proceed with development of a facility, community or commercial-scale project.*[90] According to IRENA[91] , in order to compete with other energy sources such as fossil fuels, the levelized cost of hydrogen production from renewables should be under US$ 2.5 per kilogram. The IRENA report of 2019 analysed two different scenarios of power tariffs relevant to wind-energy.

The first was a *"relatively low cost"* scenario, with the power-tariff being US$ 40/MWh, and the second, a *"very low cost"* scenario at US$ 20/MWh. The study also factored the current and the projected future-price of electrolysers at US$ 840/kW and US$ 200/kW, respectively. It concluded that the production of hydrogen from renewables in these scenarios could not compete with traditional methods of production of hydrogen from natural gas (US$ 5 per gigajoule, i.e., 1.8 US cents/kW[92]). But, renewable production of hydrogen can compete with natural-gas prices for non-household large-scale application, where the costs are in the range of (US$ 10/16 per gigajoule). IRENA also predicts that between 2020 and 2050, with the expected improvements in electrolyser efficiency and their consequent price-reduction, the cost of producing hydrogen will be brought down further. Further, taxation on carbon and the application of carbon credits will compel a faster transition towards hydrogen. The report concludes that the price of green renewable hydrogen will start competing with other fossil fuel-based production of hydrogen by the year 2035 and, in the most idealistic scenario in some parts of the world, this might even happen within the next five to six years.

Hydrogen-generation from ORER: A 'Hybrid' Approach

In India, the potential of electricity-generation from ORER remains largely untapped despite the fact that ORER is an abundant and constant source of energy. Hence, integrating hydrogen-production using ORER, could well provide economically viable alternative solutions for India in terms of both, mitigating the impacts of climate change as well as transitioning to clean energy for the transport sector. Given the impressive length of India's coastline (7,516 kilometres), there is an enormous potential for installing ocean-energy power-plants combined with electrolysis for hydrogen-production. However, ocean renewable energy resources have not yet attained maturity, and therefore, capacity augmentation and grid integration are not straightforward. Transporting power from an offshore location to the land requires the use of submarine cables, a solution that is likely to be expensive, thereby contributing to the LCOE.[93] In addition, the fluctuation in output, and, ancillary issues such as energy storage in batteries, compound the problem further.[94] These challenges notwithstanding, 'combined' approaches, which seek to produce hydrogen from ocean renewables sources of energy, are already being explored in Germany, Japan, Italy, Iran, etc.[95]

Figure 22 schematically depicts the utilisation of the electricity generated by various forms of ORER to power seawater-electrolysis, which, in turn, produces hydrogen. Producing hydrogen via the process of electrolysis is a 'clean' process in that, unlike traditional methods that employ fossil fuels, it does not contribute to carbon emissions. For example, one of the forms of ORER is Ocean Thermal-Energy Conversion (OTEC) and that an associated technology of OTEC is 'Low Temperature Thermal Desalination' (LTTD), which produces pure drinking water

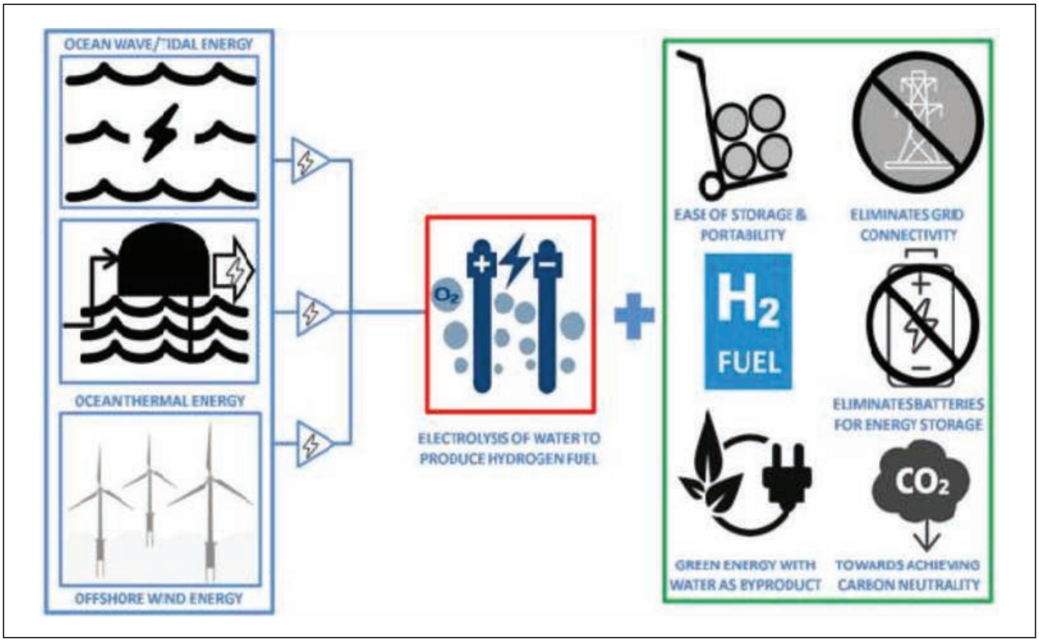


Figure 22: Utilisation of Power from ORER for Hydrogen-production by Electrolysis of Water.
Source: Created by Dr Sameer Guduru

using the principle of distillation.

Interestingly, India's 'National Institute of Ocean Technology' (NIOT), an organisation affiliated to the Ministry of Earth Sciences (MoES), is credited with being the global pioneer of LTTD technology. The water generated from LTTD, and the power from OTEC — and other forms of ORER — can be synergised to produce clean hydrogen-fuel, which can then be used to power various sectors of the economy.[96] However, this is not the only option available. Indeed, several interesting approaches of harnessing ORER for the production of 'green' hydrogen have been proposed and a few of them have even been demonstrated.

An increasing volume of serious literature indicates that the widely held contemporary belief that transport sector will have to be driven by fossil fuels may well need to be abandoned as an urban myth. For a country like India, this is a truly momentous opportunity and one that needs some significant advocacy amongst both, government bureaucracies and the lay public. For instance, Khosravi *et al*, have discussed a hybrid approach of utilising solar photovoltaic cells to power the pumping processes associated with an OTEC system and the electrolyser for hydrogen- production.[97] This particular study was conducted in the remote Iranian island of Lavan in the Persian Gulf and sought to evaluate the setting-up of such a hybrid power-system with hydrogen- storage capability. The study concluded that for such a system, the final cost of the power produced was US$ 0.1688 and the payback time was eight years.

In more practical terms, the city of Hamburg, Germany, has already demonstrated the use of offshore-wind energy to produce hydrogen, and to thus power intra-city public transport, as also private cars running on hydrogen fuel-cell technologies.[98] As a part of its 'green energy' initiative, and, with concerted efforts involving local government agencies and industry, the city has set itself the ambitious target of installing a 700 MW offshore-wind plant exclusively for the production of hydrogen to power the public transport entirely, as well as play a role in the aviation sector.[99]

Going a step further, Oldenbroek *et al* propose a novel model for a 100 per cent clean-energy-based 'smart city' by integrating vehicular fuel cells to the city's grid system for energy purposes. The authors discuss a scenario of using hydrogen to power the cities of Hamburg in Germany and Murcia in Spain, in their entirety. The study concludes that by the middle of the current century, the adoption of hydrogen would bring down the costs of household energy consumption by 65 per cent, when compared to the existing cost of energy produced through the use of fossil fuels. They forecast an expenditure of US$ 577-854 per annum on energy using green hydrogen. The study also concludes that the LCOE by mid-century will be between US$ 79 and US$ 115, per MWh of electricity, with the cost of hydrogen being US$ 2.8-3.3 per kilogram.[100]

Likewise, Franzitta *et al* discuss the utilisation of both Ocean Wave-Energy Conversion (OWEC) and offshore-wind energy-systems for hydrogen-production in a combined manner in the Italian islands of Sicily and Pantelleria, and conclude that this approach can significantly reduce carbon emissions.[101] Similar studies on the potential of applying OWEC are currently being carried out in North Carolina, USA.[102] However, since such approaches of using OWEC for hydrogen production are still in their nascent stages, no significant economic analysis is currently available.

Hydrogen-Fuel Applications in the Maritime Domain

The maritime-transportation sector (shipping) has, thus far, been stubbornly resistant to efforts to ensure a financially profitable transformation from fossil-fuel derivatives for propulsive power to one or another form of clean renewable energy. Yet, here, too, hybrid ORER-hydrogen-fuel offers extremely promising prospects for India. As things presently stand, mercantile shipping is a major contributor to carbon-based pollution. This is not to demean, in any way, the entirely laudable mitigation-efforts of the IMO-approved Energy Efficiency Design Index (EEDI), which is the first globally binding climate-change standard and entered into force on 01 January 2013. The EEDI requires new ships to become more energy efficient, by adhering to standards that will be made increasingly more stringent over time. A target of a 10 per cent improvement overall in terms of energy efficiency is already applicable to ships built between 2015 and 2019. Ships built between 2020 and 2024 will have to improve their energy-efficiency by 15 to 20 per cent, depending on the ship type; and ships delivered after 2024 will have to be 30 per cent more efficient.[103] These efforts notwithstanding, the carbon footprint of global shipping is high. In fact, a telling comment is that "If shipping was a country, it would be the sixth-largest polluter in the world".[104] The International Maritime Organization (IMO), which is the principal United Nations regulatory agency for global shipping, has, set a goal of reducing emissions by 50 per cent (from 2008 levels) by 2050.[105] The 2019 edition of the annual "Review of Maritime Transport" by the United Nations Conference on Trade and Development (UNCTAD), published in January 2020, goes a step further and tabulates efficiency- improvement measures to achieve zero-emission shipping by 2050.[106] Hydrogen fuel-cells, and, the adoption of hydrogen as a fuel for internal combustion engines, both figure prominently as options- of-choice.

In addition, ports enabled with clean hydrogen fuel technologies can reduce carbon emissions of berthed vessels by providing them auxiliary power. This is called 'cold ironing' and is being adopted globally to reduce emissions of vessels berthed at ports.[107] At present, berthed ships are forced to expend fuel to keep their engines running in order to facilitate energy-intensive activities such as cargo-operations, safety-lighting, powering routine activities on board, and so forth. It is estimated that the aggregate of carbon emissions from berthed ships is greater than that from the port's own activities.[108] Hence, cold ironing is one way forward. It will also contribute to reducing the level of Sulphur Oxide (SOx) emissions, in accordance with the MARPOL Annex VI of the International Convention for the Prevention of Pollution from Ships, 1973, which requires ships to use less than 0.5 per cent of sulphur-fuel, with effect from 01 January 2020.[109]

Efforts towards using clean energy resources for shipping, through the adoption

Figure 23: Utilisation of Hydrogen in Fuel-Cells and Port related Activities within Industry 4.0 in the Shipping Sector
Source: Created by Dr Sameer Guduru

of hydrogen-fuel, have fructified in Norway, United States, Switzerland and France. Most notably, NORLED, a Norwegian transportation company, is currently collaborating with vessel-manufacturer WESTCON in realising the world's first hydrogen-fuelled car-ferry, which is due for delivery later this year. Similar efforts in ferrying commuters, using ferries propelled by hydrogen-fuel for the first time ever, are currently underway in the San Francisco Bay Area of the United States, by a New York based investment firm named SW/TCH (pronounced Switch).

To this extent, the Swiss firm, ABB, and the French authority *Hydrogène de France*, have recently established a Memorandum of Understanding (MoU) for manufacturing megawatt-scale hydrogen fuel-cell systems that are capable of powering ocean-going vessels.[110] Figure 23 offers a generic depiction of the various applications of hydrogen fuel in the maritime domain.

Hydrogen-Fuel — The Option-of-Choice for India

With hydrogen-fuel finding increasing favour as the option of choice for mercantile shipping and port-activities, and, with the hydrogen itself being capable of being sourced from ocean renewable energy-resources such as OTEC and OWEC, two questions that now arise are: (a) What is the 'state of the art' when it comes to hydrogen-fuel being used to power ***warships***, i.e., both, surface combatants and subsurface ones? (b) How might this hybrid-option (of producing hydrogen from ORER and then using it to power the transport sector, thereby removing or reducing the sector's current reliance upon fossil-fuels), be adopted by India? These twin questions will be addressed in this concluding segment of this paper.

The Naval Context

When considering the naval environment in the context of 'sources-of-energy' and their applications, it is important to avoid three common mistakes: The first occurs when analysts project 'naval' energy-issues as being so unique as to be entirely divorced from the more generic 'maritime' ones. In actual fact, all naval issues are subsets of maritime ones. Hence, in terms of accepted Set Theory, what applies to the 'maritime' superset will apply to the 'naval' subset as well. It is obvious that this would remain true of energy-related issues as well.

The second error to be avoided is to think of such naval applications-of-energy solely in terms of the seagoing platforms. For instance, manned naval combatant-platforms, whether deployed on the surface (i.e., warships and auxiliaries) or subsurface platforms (submarines) must, like their civilian (mercantile) counterparts, be berthed in ports and harbours to enable them to carry out maintenance routines as well as to logistically replenish themselves. These 'naval' ports and harbours are often kept distinct from commercial ones in deference to the needs of security. Moreover, extensive repair and refitting facilities, complete with a variety of facilities for drydocking such ships, are frequently co-located with these naval ports and harbours, and as a result, go by the generic appellation, naval dockyards. It is true that the demand for energy to sustain and maintain a naval dockyard is far lower than that of a major port such as the JNPT, which operates ship and cargo services on a 24-hour basis. By way of comparison, the annual power requirement of the Naval Dockyard at Mumbai, for instance, is around 5,000 MWh,[111] while that of the JNPT is 84,000 MWh.[112] That said, neither is 5,000 MWh a small number in and of itself, nor is the Naval Dockyard at Mumbai the only naval port-facility — there are much larger ones, such as the new Indian Naval Base at Karwar on the western coast of India, and, extensive bases in and off Visakhapatnam on the eastern shore of the country.

The third error to be avoided concerns the combatant platforms themselves. Where major manned surface-platforms are concerned, it must be admitted that the scaling-up of hydrogen- powered fuel cells for warship propulsion, especially where the ships in question are high- performance frontline combatants such as frigates, destroyers, cruisers, etc., is still at an early design or trial phase. On the other hand, this is precisely the point in time for growing navies such as the Indian Navy, to invest its technical manpower in this cutting-edge development activity, especially if it is going to continue its progress from a buyer's navy to a builder's navy and thence to an innovator's navy. The error itself, however, would be to ignore the increasingly strong trend toward the incorporation by the navy, of unmanned-platforms. These include a variety of tethered (non-autonomous) drones as well as semi-autonomous and fully autonomous ones. This is a very significant trend when it comes to the adoption of hydrogen-fuel, since the prevailing state of the art is that the efficacy of hydrogen-fuel to drive medium-sized surface vessels, including passenger-ferries, is already well-proven, both technologically as well as commercially.[113] The usage of hydrogen-fuel cells to drive small, slender, Unmanned Surface Vessels (USVs) offers enormous advantages in terms of stealth, endurance, recharging-times.[114]

As navies, including the Indian Navy, realise that unmanned (autonomous / semi-autonomous) surface and subsurface drones can utilise hybrid propulsion-solutions that utilise hydrogen generated from ORER, the race to put these propulsion packages to sea will be well and truly joined. For India and its navy, this holds out the additional and nearly-irresistible attractive option of helping the country reduce its energy-dependence upon West Asia and hence its vulnerability to the possible closure of the Strait of Hormuz as a consequence of Great-Power politics.

Moreover, the additional power available through the adoption of hydrogen fuel-cells can be profitably utilised to accelerate the adoption of emerging technologies such as Artificial Intelligence (AI) and the Internet of Things (IoT).[115] Likewise, long-endurance UUVs powered by hydrogen-fuel cells are already being used to enhance Maritime Domain Awareness (MDA) and related applications, including both, civilian and military scientific observations, apart from their obvious utility in anti-submarine warfare. Further, the time taken to refuel UUVs, using hydrogen, is much lower than that involved in the recharging of batteries. To take an example from the road-transport sector, recharging electric car-batteries, given the existing state-of-the- art, takes multiple hours while hydrogen-refuelling can be achieved in a matter of minutes.[116]

In sum, while the use of hydrogen-fuel to power large, manned surface-combatants might well still lie in the middle-future, its usage to propel unmanned platforms is already a present reality. Thus, where India and the Indian Navy are concerned, both are already late off the blocks and considerable acceleration is clearly called for.

Where subsurface naval vessels are concerned, the adoption of hydrogen-fuel is already a reality in a few European navies. Both, the German Navy and the Italian

Navy currently deploy the Type 212A Class, air-independent propulsion (AIP)[117] submarine (the export version is known as Type 214 and is the successor to the Type 209 operated by the Indian Navy), which is propelled by Proton-Exchange Membrane (PEM) hydrogen-fuel cells.[118] Such submarines can have a sustained submerged operation period of three weeks and are ideal for stealth applications due to the sharply-reduced noise-levels from the engines. Coupled with nonmagnetic components used in their construction, these submarines can remain virtually undetectable and can even operate in shallow waters with depths as low as 17-metres, allowing them to operate much closer to the coast, as compared to other submarines.[119]

Hydrogen-Fuel Adoption — The Opportunities for India

'Green' hydrogen has the greatest potential to address India's quest for a clean, zero-emission fuel that could cater to the demands of the country's transport sector. As a transition towards clean energy resources is mandated by SDG 7 ('Affordable and Clean Energy for All') and the 2015 Paris Climate Change Agreement, a concerted effort towards framing policy for the adoption of hydrogen-fuel by the transport-sector in general and automobile manufacturers in particular, is likely to yield rich dividends for India, particularly over the long run. Not only will hydrogen-based clean fuel revolutionise transportation, but it will also play a major role in enhancing the quality of life of the ordinary urban Indian resident by improving the air quality index and reduce pollution-related diseases. 'Smart' vehicles, powered by hydrogen-fuel-cells that can meet the vehicle's propulsion-requirement as well as powering AI and IoT applications, can easily cater to the needs of the large and growing Indian middle class. This is also a great opportunity for the Indian automobile, energy, and defence industries to exploit the market potential not only domestically, but also abroad via the Government's 'Make in India' initiative.

Hydrogen-fuel can also play a noteworthy role in India's port-led development mega-project, SAGARMALA.[120] Connecting ports along India's coast line as well as the hinterland via inland waterways, using hydrogen-powered vessels, both for transhipment and multi-modal logistics, would be a definitive manifestation of the country's transition to a 'Blue Economy'. This will accelerate the process of adopting

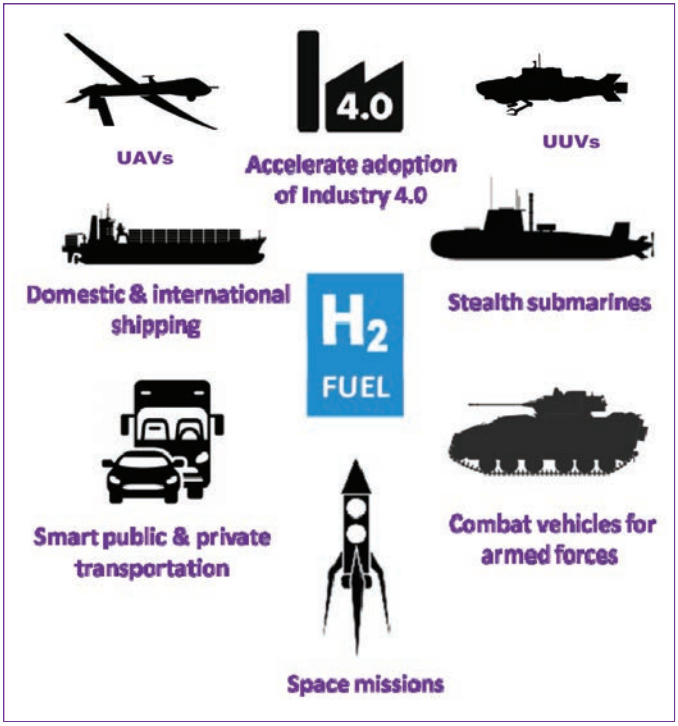


Fig 1: Potential Sectors for Hydrogen-fuel Utilisation in India
Source: Created by Dr. Sameer Guduru

clean energy in India and reduce emissions in line with Paris 2015 targets and in achieving the SDG #7. It will not only contribute to the economy explicitly, but also implicitly, by eradicating expenditure on climate change mitigating infrastructure. With enhanced connectivity, the likelihood of domestic and foreign investment in the country's proposed industrial corridors, such as the Vizag-Chennai Industrial Corridor (VCIC), will increase.[121] New opportunities can be seized to drive micro, small and medium enterprises (MSMEs) towards 'Industry 4.0'. Tourism — especially hydrogen-fuelled cruise-shipping and passenger ferries — is another are where significant benefits would accrue.

Space is yet another important sector where hydrogen-fuel would almost certainly play a critical role. With India's rapidly expanding exploratory activities in outer space, and given the missions already planned for the Moon and Mars, as also those as the space station, there is a clear need for more powerful and efficient engines.

This requires the use of hydrogen containing fuels such a methane and hydrogen peroxide. The India Space Research Organization (ISRO) is currently working on rocket-engines that are fuelled by methane, which can be produced by hydrogen reacting with carbon dioxide for such applications.[122] Figure 23 depicts a few of the more evident sectors that could gain demonstrably from the adoption of hyrogen-fuel by India.

Conclusion

It would be recalled that at the beginning of this article has set out the components of India's primary-energy basket and the geopolitical vulnerabilities arising from India's need to import a substantial proportion of these, particularly crude-oil, from West Asia. It has thereafter dwelt upon the principal form of secondary energy, namely, electricity. Importantly it has demonstrated that projections disseminated by the Government of India in respect of India's production-capacity of electricity were excessively optimistic. It has gone on to show that additional sources of energy (apart from solar and wind) would be required if India was to meet its targets for electricity-generation capacity, while simultaneously meeting the commitments it had made at the Paris COP, in 2015. It also addressed the country's transport sector, whose demand for energy by way of petroleum-products drives much of India's oil-based dependence upon imports, and hence makes a significant contribution to the country's geopolitical vulnerability. In an effort to mitigate this dependence (quite apart from the environmental aspects), it introduced India's ongoing drive to switch to Electrically-driven Vehicles (EVs). Since a critical ingredient for the cathodes of batteries used by all electrically-driven vehicles (EVs) is cobalt, the need for cobalt makes new, but equally critical geographic areas the focus of the geostrategies that drive India's geoeconomics and hence shape its geopolitics. Further it drew attention to the very substantial potential offered to India by Ocean Renewable Energy Resources (ORER) for the addition of requisite capacity in terms of 'green-energy installations' and provided substantive baseline information on the various forms of ORER. It also demonstrated that the economic and functional viability of hydrogen-fuel for the maritime sector had already been proven, and had advocated the adoption of a hybrid-model wherein the hydrogen could be sourced from ORER variants such as Offshore Wind, Ocean Thermal Energy Conversion (OTEC) and Ocean Wave Energy Conversion (OWEC).

It is clear from the arguments presented in this paper that the hybrid model of hydrogen-production from ORER is highly relevant not only to mercantile shipping and civilian ports, but equally to naval assets and their associated naval ports and dockyards. On the one hand, it is true that efforts to produce hydrogen using ORER still are in a nascent stage. On the other, if India is to ever stop being merely a supplicant for technologies that have been matured abroad, it is precisely at such nascent stages of technological-development that its investment by way of personnel, finance and policy-support must be the greatest. Once the technology is matured abroad, it will come at a price that will need to be measured not only in fiscal terms, but in geopolitical ones as well. Given that shipping — whether at sea or in ports — is a very major contributor to carbon emissions, the adoption by India of clean-energy alternatives for the maritime sector, is the need of the hour. A truly exciting prospect is the central role that hydrogen-fuel derived from ORER could play in realising the promise of port- led development under the aegis of the SAGARMALA mega-project. Hydrogen-fuel-powered ships, moving along India's inland waterways could be meaningfully utilised for the transhipment of cargo and its multi-modal transportation, as well as for passenger movement. Hydrogen fuel can also enable faster adoption of technologies related to Industry 4.0, such as AI and IoT. These are no longer technologies that lie in some distant and indeterminate future. That future is already upon us. For India to become self-sufficient in energy, it is necessary to wholeheartedly adopt an ORER-hydrogen hybrid model and to ride it as its future-ready solution.

ENDNOTES

1. T Wang, "Top 20 countries in primary energy consumption in 2018", https://www.statista.com/statistics/263455/primary-energy-consumption-of-selected-countries/.

2. Omer Esen and Metin Bayrak, "Does More Energy Consumption Support Economic Growth in Net Energy- importing Countries?", *Journal of Economics, Finance and Administrative Science* 22 (2017), 75-98.

3. Gunnar Fermann, “What is Strategic about Energy? De-simplifying Energy Security” in *Moe E., Midford P. (eds) ‘The Political Economy of Renewable Energy and Energy Security. Energy, Climate and the Environment’,* (Palgrave Macmillan, London, 2014), 21-45.

4. Samir Tata, “Deconstructing China’s Energy Security Strategy”, https://thediplomat.com/2017/01/deconstructing-chinas-energy-security-strategy/ see also: Ashok Sharma, “India’s Quest for Energy Security”, https://www.dailypioneer.com/2020/sunday-edition/india---s- quest-for-energy-security.html.

5. Government of India, Ministry of Commerce & Industry, Department of Commerce, https://commerce- app.gov.in/eidb/.

6. Mining Technology, “Countries with the Biggest Coal Reserves”, https://www.mining-technology.com/features/feature-the-worlds-biggest-coal-reserves-by-country/.

7. Government of India, Ministry of Coal, “Annual Report 2019-2020”, Chapter 6 *Coal and Lignite Production*. https://coal.nic.in/sites/upload_files/coal/files/coalupload/AnnualReport2019-20/Chapter6-en.pdf.

8. Swagat Bam, Lydia Powell and Akhilesh Sati, “Coal Beneficiation: Status and Way Forward”, ORF Policy Brief, 05 July 2017, https://www.orfonline.org/research/coal-beneficiation-in-india-status-and-way-forward/.

9. Daniel Workman, “Coal Imports by Country: India”, World’s Top Exports Website, http://www.worldstopexports.com/crude-oil-imports-by-country/ (accessed 05 May 2020).

10. Workman, “Crude Oil Imports by Country: India”, World’s Top Exports Website, http://www.worldstopexports.com/crude-oil-imports-by-country/ (accessed March 9,2020).

11. PTI New Delhi. “Crude oil imports from the US jump 72%, Iraq is top supplier” https://www.thehindubusinessline.com/markets/commodities/oil-imports-from-us-jump-72-per-cent-iraq-is-top- supplier/article29531296.ece# (accessed September 27, 2019).

12. Government of India, Ministry of Commerce & Industry, Department of Commerce, https://commerce-app.gov.in/eidb/.

13. The term ‘feedstock’ denotes any renewable, biological material that can either be used directly as a fuel, or, can beconverted to another form of fuel or energy product.

14. Gulf Petrochemicals and Chemicals Association, *“Changes in India’s Natural Gas Market and Implications for the Fertilizer Industry”,* 2017, https://gpca.org.ae/wp-content/uploads/2018/03/Changes-in-Indias-Natural-Gas-Market-and-Implications-for-the-Fertilizer-Industry.pdf.

15. Panjab Singh, “Feeding 1.7 billion”, Presidential Address, Founding Day and 26th General Body Meeting, NationalAcademy of Agricultural Sciences, New Delhi, June 5, 2019.

16. Government of India, Ministry of Commerce & Industry, Department of Commerce, “Export-Import Data Bank”. https://commerce-app.gov.in/eidb/.
17. Kalyeena Makortoff, “Oil Prices Fall Again despite OPEC+ Deal to Cut Production”, https://www.google.com/amp/s/amp.theguardian.com/business/2020/apr/10/opec-russia-reduce-oil-production- prop-up-prices.
18. Anisur Rahman, “Geopolitics of West Asia: Implications for India”, https://www.financialexpress.com/defence/geopolitics-of-west-asia-implications-for-india/1664354/.
19. It is important to remember that International Shipping Lanes (ISLs) and Sea Lines of Communication (SLOCs) are not interchangeable terms. While the geographical orientation of ISLs is determined by purely economic and navigational-safety considerations, the positioning and geographical orientation of SLOCs is determined by military-operational considerations.
20. Rishi Iyengar, and John Defterios, “India is Buying More US and Saudi oil because of Sanctions on Iran”, https://edition.cnn.com/2019/06/26/business/indian-oil-us-iran-sanctions/index.html.
21. United Nations, “Climate Change”, https://www.un.org/en/sections/issues-depth/climate-change/.
22. The National Aeronautics and Space Administration (NASA), “Sea Level”, https://climate.nasa.gov/vital- signs/sea-level/.
23. National Oceanic and Atmospheric Administration (NOAA), “What is Ocean Acidification?” https://www.pmel.noaa.gov/co2/story/What+is+Ocean+Acidification%3F.
24. Intergovernmental Panel on Climate Change (IPCC), *“Special Report on Renewable Energy Sources and Climate Change Mitigation”*, 2012, https://www.ipcc.ch/site/assets/uploads/2018/03/SRREN_FD_SPM_final-1.pdf.
25. Climate action tracker website. “India summary of pledges and targets.” climateaction-tracker.org. https://climateactiontracker.org/countries/india/pledges-and-targets/(accessed December 2, 2019).
26. Government of India, *Climate Change, Sustainable Development and Energy Report from Economic Survey-2016/17*, https://www.indiabudget.gov.in/budget2017-2018/es2016-17/echap05_vol2.pdf.
27. It is reiterated that International Shipping Lanes (ISLs) and Sea Lines of Communication (SLOCs) are not always interchangeable terms. While the geographical orientation of ISLs is determined by purely economic and navigational- safety considerations, the positioning and geographical orientation of SLOCs is determined by military-operational risk-based considerations..

28. United States Department of Energy. Off-Grid or Stand-Alone Renewable Energy Systems. https://www.energy.gov/energysaver/grid-or-stand-alone-renewable-energy-systems (accessed May 19, 2020).

29. Central Electricity Authority, 2020, "All India Installed Capacity (in MW) of Power Stations as on 30 April 2020" http://www.cea.nic.in/reports/monthly/installedcapacity/2020/installed_capacity-04.pdf.

30. Ibid.

31. Natural Resources Defence Council (NRDC) Issue Brief, "The Paris Agreement on Climate Change", NRDC, 01 November 2017, https://assets.nrdc.org/sites/default/files/paris-agreement-climate-change-2017-ib.pdf.

32. United Nations Framework Convention on Climate Change, "India's Intended Nationally Determined Contribution: Working Towards Climate Justice", https://www4.unfccc.int/sites/ndcstaging/PublishedDocuments/India%20First/INDIA%20INDC%20TO%20UNFC CC.pdf.

33. Madhura Joshi, "Transitioning India's Economy to Clean Energy", Anjali Jaiswal's Expert Blog, Natural Resources Defense Council (NRDC), 05 November, 2019, https://www.nrdc.org/experts/anjali-jaiswal/transitioning-indias- economy-clean-energy.

34. International Solar Alliance. https://isolaralliance.org/.

35. Government of India, Ministry of Power, Central Electricity Authority (CEA), "Draft Report on Optimal Generation Capacity Mix for 2029-2030", February, 2019, http://cea.nic.in/reports/others/planning/irp/Optimal_generation_mix_report.pdf.

36. Ibid.

37. International Energy Agency, "India 2020: Energy Policy Review", 2020 https://webstore.iea.org/download/direct/2933?fileName=India_2020-Policy_Energy_Review.pdf.

38. Central Electricity Authority, "Draft Report on Optimal Generation Capacity Mix for 2029-30", 2019. http://cea.nic.in/reports/others/planning/irp/Optimal_generation_mix_report.pdf.

39. International Renewable Energy Agency (IRENA). 2019. *Renewable power generations costs in 2018*. https://www.irena.org/-/media/Files/IRENA/Agency/Publication/2019/May/IRENA_Renewable-Power- Generations-Costs-in-2018.pdf.

40. Debjoy Sengupta, "India is APAC's Cheapest Power Producer", The Economic Times, 19 August 2019 https://economictimes.indiatimes.com/industry/energy/power/india-is-apacs-cheapest-power- producer/articleshow/70735458.cms?from=mdr.

41. Press Trust of India. "PM Modi vows to more than double India's non-fossil fuel target

to 450 GW.” https://www.indiatoday.in/india/story/pm-modi-vows-more-double-india-non-fossil-fuel-target-450-gw-1602422-2019- 09-24 (accessed September 24, 2019).

42. Nitin Kabeer, “Electricity Demand in India Will Almost Triple Between 2018 and 2040: World Bank”, MERCOM India (Grid, Market & Policy), MERCOM, 24 December 2018, https://mercomindia.com/electricity-demand-india- triple-2018-2040/.

43. International Energy Agency, “India 2020 Energy Policy Review”, 2020. https://webstore.iea.org/download/direct/2933?fileName=India_2020-Policy_Energy_Review.pdf.

44. Broom, Douglas. “6 of the world’s 10 most polluted cities are in India. “https://www.weforum.org/agenda/2020/03/6-of-the-world-s-10-most-polluted-cities-are-in-india/ (accessed March 5, 2020).

45. Greenpeace Southeast Asia. “Air pollution from fossil fuels costs the world US $8 billion every day: Greenpeace.” https://www.greenpeace.org/southeastasia/press/3586/air-poll ution-from-fossil-fuels-costs-the-world-us8-billion-every-day-greenpeace/ (accessed February 12, 2020).

46. Claudia Pavarini, “India is Going to Need More Battery Storage Than Any Other Country for its Ambitious Renewables Push”, IEA Commentary, 23 January 2020, https://www.iea.org/commentaries/india-is-going-to-need- more-battery-storage-than-any-other-country-for-its-ambitious-renewables-push.

47. Ibid.

48. Ibid.

49. Robin Goad, “New Cobalt Supply Central to Growing Electric Vehicle Market”, Canadian Mining Journal Commentary, 02 January 2019, https://s1.q4cdn.com/337451660/files/doc_downloads/in-the-media/190101- Canadian-Mining-Journal-Cobalt-Commentary.pdf.

50. REN21. 2019, “Renewables 2019 Global Status Report”, https://www.ren21.net/gsr-2019/chapters/chapter_01/chapter_01/.

51. Ministry of New and Renewable Energy, 2019, “2nd Global RE-Invest 2018 a resounding success!, Renewable Energy, *Akshay Urja*”, https://mnre.gov.in/img/documents/uploads/58f4da0f67ad455a89b5ab8e4db14174.pdf.

52. Ramya Ranganath, “Government Considers Ocean Energy under Renewable Resources”, https://mercomindia.com/government-ocean-energy-renewable-source/ (accessed August 26 2019).

53. International Energy Agency. 2020. *India 2020 Energy Policy Review*. https://niti.gov.in/sites/default/files/2020- 01/IEA-India%202020-In-depth-EnergyPolicy_0.pdf.

54. Vice Admiral Pradeep Chauhan, unpublished manuscript "India's Maritime Strategy — Part 1: India's Maritime Interests", June 2020.

55. MR Hashemi and SP Neill, "Fundamentals of Ocean Renewable Energy: Generating Electricity from the Sea", Cambridge Academic Press, 2018, https://doi.org/10.1016/C2016-0-00230-9.

56. I Hashem, HS Abdel Hameed, and MH Mohamed, "An Axial Turbine in an Innovative Oscillating Water Column (OWC) Device for Sea-Wave Energy Conversion", Ocean Engineering, Vol. 164, 536-562.

57. Alternate Energy Tutorials (AET), "Wave Energy Devices", https://www.alternative-energy-tutorials.com/wave- energy/wave-energy-devices.html.

58. Henry Teng Choy Lam, "Blue Energy - Ocean Power (Piston Pump & Racks)", YouTube Video, 4:57, 20 October 2012, https://www.youtube.com/watch?v=fYfs-qYGzvs.

59. Stefano Parmeggiani *et al*, "Experimental Update of the Overtopping Model Used for the Wave Dragon Wave Energy Converter", Energies 2013, 6, 1961-1992; doi:10.3390/en6041961.

60. International Renewable Energy Agency (IRENA), "Wave Energy Technology Brief, Ocean Energy Technology Brief 4 2014", https://www.irena.org/documentdownloads/publications/wave-energy_v4_web.pdf, (accessed June 2014).

61. P Swati & C Latha,"Wave Power Conversions Systems for Electrical Energy Production"; Shri Krishnadevaraya University (College of Engineering & Technology), Anantapuram, Andhra Pradesh, http://www.slideshare.net/chakri218/pelamis-wave-energy-convertor-ppt.

62. CRISIL Risk and Infrastructure Solutions Limited in Association with Indian Institute of Technology Madras, "Study onTidal & Waves Energy in India: Survey on the Potential & Proposition of a Roadmap Final Report", https://www.ireda.in/doc/publications/sarve2.pdf, (accessed December 2014).

63. Ibid.

64. AET, "Tidal Energy Devices", https://www.alternative-energy-tutorials.com/wave-energy/wave-energy-devices.html.

65. Clean Energy Ideas, "What is Tidal Power? Tidal Energy Explained", https://www.clean-energy- ideas.com/hydro/tidal- power/what-is-tidal-power-tidal-energy-explained/ (accessed July 23, 2019).

66. The Energy Research Institute (TERI), "Energy Supply: Tidal Energy", TERI Energy and Environment Data Diary and Yearbook (TEDDY) 2016/17 (TERI Press, New Delhi, India, 2018), Chapter 5, 80.

67. TEDDY 2016/17.

68. TEDDY 2016/17.

69. CRISIL Risk and Infrastructure Solutions Ltd in association with Indian Institute of Technology, Madras; “Final Reportof a Study on Tidal & Wave Energy in India” (Clients: Agence Française de Dévelopment [AFD] and Indian Renewable Energy Development Agency Ltd [IREDA]); 31 December 2014, 61-68 http://www.ireda.gov.in/writereaddata/AFD_Tidal.pdf.

70. Saurabh, “India Gives Up On Tidal Power”, https://cleantechnica.com/2020/03/30/india-gives-up-on-tidal- power/.

71. Sonal Patel, “Subsea Kite Technology Makes a Big Splash for Marine Power”, Power Magazine, 31 April 2020, https://www.powermag.com/subsea-kite-technology-makes-a-big-splash-for-marine-power/.

72. Bobby Zarubin, “Ocean Current Energy: Underwater Turbines”, http://large.stanford.edu/courses/2014/ph240/zarubin2/, (accessed January 24, 2015).

73. US Department of the Interior, Bureau of Ocean Energy Management (BOEM), “Ocean Current Energy”, https://www.boem.gov/renewable-energy/renewable-energy-program-overview.

74. Minesto AB, “The Future of Renewable Energy”, https://minesto.com/our-technology.

75. Sonal Patel, “Subsea Kite Technology Makes a Big Splash for Marine Power”, https://www.powermag.com/subsea- kite-technology-makes-a-big-splash-for-marine-power/ (accessed March 31, 2020).

76. Technical University of Delft, “Thermal Gradient (OTEC)”, https://www.tudelft.nl/ocean-energy/research/thermal- gradient-otec/.

77. M.A. Atmanand, “Ocean Technology Capacity Building in India.” *J Geol Soc India* 94, 447–452 (2019). https://doi.org/10.1007/s12594-019-1340-4.

78. IRENA, “Ocean Thermal Energy Conversion Technology Brief, Ocean Energy Technology Brief 1, 2014”, https://www.irena.org/documentdownloads/publications/ocean_thermal_energy_v4_web.pdf (accessed June 2014).

79. M. Ravindran, “The Indian 1 MW Floating OTEC Plant An Overview”, DOSSIER OCÉAN ET ÉNERGIE - ÉNERGIE THERMIQUE DES MERS Sommaire IOA News Letters, http://www.clubdesargonautes.org/otec/vol/vol11-2-1.htm#:~:text=INTRODUCTION,the%20OTEC%20potential%20is%20concerned.&text=Apart%20from%20this%2 C%20attractive%20OTEC,gross%20power%20for%20parasitic%20losses.

80. Vijay Sakhuja & Kapil Narula. *Perspectives on the Blue Economy*. New Delhi: Vij Books India Pvt Ltd, 2017.

81. M.A. Atmanand, "NIOT's Progressive Trends in Thermal Desalination." *J Geol Soc India 95*, 5–8 (2020). https://doi.org/10.1007/s12594-020-1380-9.

82. Government of India, Lok Sabha Unstarred Question No 2313, answered by the Hon'ble Minister, Ministry of Earth Sciences, 26 December 2018, https://moes.gov.in/writereaddata/files/LS_US_26122018_2313_ust.pdf.

83. National Institute of Ocean Technology (NIOT), Chennai, (Ministry of Earth Sciences, Government of India), "Technical Report on Design and Execution of Desalination Plants in Minicoy and Agatti, UT Lakshadweep", https://www.niot.res.in/img/Island_Desalination_Technical_Report.pdf.

84. Intergovernmental Panel on Climate Change (IPCC), "Summary for policymakers of IPCC special report on global warming of 1.5° Celsius approved by government", https://www.ipcc.ch/2018/10/08/summary-for-policymakers-of-ipcc-special-report-on-global-warming-of-1-5c-approved-by-governments/.

85. United Nations Environment Programme (UNEP). "Emissions Gap Report 2018",https://www.unenvironment.org/resources/emissions-gap-report-2018.

86. G20, "G20 Karuizawa Innovation Action Plan on Energy Transitions and Global Environment for Sustainable Growth", 2019, https://www.mofa.go.jp/policy/economy/g20_summit/osaka19/pdf/documents/en/annex_16.pdf.

87. Patrick Molloy, "Hydrogen Fuel Cells Can Decarbonize Heavy Transport", https://energypost.eu/hydrogen-fuel-cell- trucks-can-decarbonise-heavy-transport/.

88. International Renewable Energy Agency (IRENA), *"Hydrogen a Renewable Energy Perspective"*, IRENA Report, 2019, https://www.irena.org/-/media/Files/IRENA/Agency/Publication/2019/Sep/IRENA_Hydrogen_2019.pdf.

89. Planete-Energies, "Hydrogen Production." https://www.planete-energies.com/en/medias/close/hydrogen-production.

90. US Department of Energy, Office of Indian Energy, Slide-presentation, August 2015, https://www.energy.gov/sites/prod/files/2015/08/f25/LCOE.pdf.

91. IRENA Report, 2019, *Supra* 8.

92. One Gigajoule of energy = 1 GJ = 277.77 kWh.

93. Eva Segura et al. "Cost Assessment Methodology and Economic Viability of Tidal Energy Projects" *Energies* 10 (2017):1806; doi:10.3390/en10111806.

94. 2nd Hydrogen Energy Ministerial Meeting, "Hydrogen: A Renewable Energy Perspective",

2019, https://www.irena.org/-/media/Files/IRENA/Agency/Publication/2019/Sep/IRENA_Hydrogen_2019.pdf.

95. "Renewable Hydrogen Production in Hamburg", YouTube Video, 5:18, posted by Toyota Motor Corporation, 16 November 2015, https://www.youtube.com/watch?v=xOMBJ2H7bSA.

    See Also:

    (a) United Nations Climate Change Conference 24 (COP 24). "Floating offshore wind turbines and hydrogen system open-up the new era of the decarbonization." http://copjapan.env.go.jp/cop/cop24/en/pavilion/02/

    (b) Vincenzo Franzitta, et al, "Hydrogen Production from Sea Wave for Alternative Energy Vehicles for Public Transport in Trapani (Italy)" *Energies* 9 (2016): 850; https://doi.org/10.3390/en9100850

    (c) A Khosravi et al, "Thermodynamic and Economic Analysis of a Hybrid Ocean Thermal Energy Conversion/Photovoltaic System with Hydrogen-based Energy Storage System" *Energy* 172 (2019): 304-319; https://doi.org/10.1016/j.energy.2019.01.100

96. Marine Energy, "New Opportunities for OTEC in India", Offshore-energy.biz., https://www.offshore- energy.biz/new-opportunities-for-otec-in-india/ See also: National Institute of Ocean Technology (NIOT). "Energy and Fresh Water — OTEC",https://www.niot.res.in/niot1/efw_intro.php.

97. Khosravi, "Thermodynamic and Economic Analysis," 304-319, *Supra* 15(c).

98. "Renewable Hydrogen Production in Hamburg," YouTube Video, https://www.youtube.com/watch?v=xOMBJ2H7bSA.

99. Alicia Moore, "700-megawatt Green Hydrogen Plant to Provide Carbon Neutral Aviation Fuel", http://www.hydrogenfuelnews.com/700-megawatt-green-hydrogen-plant-to-provide-carbon-neutral-aviation- fuel/8538866/.

100. Vincent Oldenbroek et al, "Fuel Cell Electric Vehicle as a Power Plant: Techno-Economic Scenario Analysis of a Renewable Integrated Transportation and Energy System for Smart Cities in Two Climates", *Applied Sciences* 10 (2020):143; doi:10.3390/app10010143.

101. Franzitta et al, "Hydrogen Production from Sea Wave," 850; *Supra* 15(b).

102. Gagee Raut, "Technical Analysis of Hydrogen Production from Wave Energy: A Case Study for North Carolina",Master's Dissertation, The University of North Carolina, 2018, https://repository.uncc.edu/islandora/object/etd%3A257/datastream/PDF/download/citation.pdf.

103. International Maritime Organization (IMO), “Energy Efficiency Measures”, http://www.imo.org/en/OurWork/Environment/PollutionPrevention/AirPollution/Pages/Technical-and- Operational-Measures.aspx.

104. Rebecca Hersher, “The Dawn of Low Carbon Shipping”, *quoting Nerijus Poskus of the shipping-technology company, Flexport*, https://www.npr.org/2019/07/16/716693006/the-dawn-of-low-carbon-shipping.

See Also: Zoe Schlanger, “If Shipping were a Country, it would be the World’s Sixth Biggest Greenhouse Gas Emitter.” Weforum.org, https://www.weforum.org/agenda/2018/04/if-shipping-were-a-country-it-would-be-the-world- s-sixth-biggest-greenhouse-gas-emitter.

105. International Maritime Organization (IMO). “Greenhouse Gas Emissions”, http://www.imo.org/en/OurWork/Environment/PollutionPrevention/AirPollution/Pages/GHG-Emissions.aspx (accessed 2018).

106. United Nations Conference on Trade and Development (UNCTAD) “Review of Maritime Transport 2019”, 34 (Table 2.4), 31 January, 2020, https://unctad.org/en/PublicationsLibrary/rmt2019_en.pdf.

107. European Union Parliamentary Questions, “Sustainable Maritime Transport: Introduction of Cold Ironing”, https://www.europarl.europa.eu/doceo/document/E-9-2019-002668_EN.html.

108. International Maritime Organization (IMO), “UN Body Adopts Climate Change Strategy for Shipping”, http://www.imo.org/en/MediaCentre/PressBriefings/Pages/06GHGinitialstrat egy.aspx.

109. International Maritime Organization (IMO). “Sulphur 2020 – Cutting Sulphur Oxide Emissions”,http://www.imo.org/en/MediaCentre/HotTopics/Pages/Sulphur-2020.aspx.

110. Rebecca Moore, “Norway’s first Hydrogen-powered Car Ferries Take Shape”, https://www.rivieramm.com/news-content-hub/news-content-hub/norwayrsquos-first-hydrogen-powered-car-ferries-take-shape-55559.

See also:

(a) Erin Baldassari, “Nations First Hydrogen Fuel Cell Ferry to Transport Commuters Across San Francisco Bay Area”, https://phys.org/news/2019-06-nation-hydrogen-fuel-cell-ferry.html

(b) ABB Group Release, “ABB bring Fuel Cell Technology a Step Closer to Powering Large Ships”, https://new.abb.com/news/detail/60096/abb-brings-fuel-cell-technol ogy-a-step-closer-to-powering-large- ships

(c) John Snyder, “Hydrogen Fuel Cells Gain Momentum in Maritime Sector”, https://www.rivieramm.com/news-content-hub/news-content-hub/hydrogen-fuel-cells-gain-momentum-in-maritime-sector-56087#:~:text=Within%20five%20 years%2C%20vessels%20using,Hyon%20managing%20director%20Tomas%-20Tronstad

111. Value ascertained from senior functionaries of the Naval Dockyard, Mumbai, 15 September 2020.

112. Port Strategy Website, "Wind Power for JNPT", 12 July 2013, https://www.portstrategy.com/news101/world/asia/wind-power-for-jnpt.

113. Helge Weydahl et al "Fuel cell systems for long-endurance autonomous underwater vehicles – challenges and benefits." *International Journal of Hydrogen Energy* 45 (2020): 5543-5553; https://doi.org/10.1016/j.ijhydene.2019.05.035.

114. Weydahl et al, *Supra* 4.

115. Wingrove, Martyn. "Safer ship navigation with AI." Rivieramm.com. https://www.rivieramm.com/news-content-hub/news-content-hub/safer-ship-navigation-with-ai-55548 (accessed July 15, 2019).

116. Graham, Rachel. "Hydrogen fuel cells vs electric cars: What you need to know but couldn't ask." Euronews.com. https://www.euronews.com/living/2020/02/13/hydrogen-fuel-cell-vs-electric-cars-what-you-need-to-know-but- couldn-t-ask (accessed February 14, 2020).

117 Air-independent propulsion (AIP), is any form of marine propulsion technology which allows a non-nuclear submarine to operate underwater for a sustained period of time without access to atmospheric oxygen either bysurfacing or by using a snorkel.

118. Seaforces Online, "German Navy Type 212A Class Submarine", http://www.seaforces.org/marint/German- Navy/Submarine/Type-212A-class.htm Also See: Tom Kington, "Italy Matches French Naval Tie-up with German Sub Partnership", Defence News, 22 July 2019, https://www.defensenews.com/global/europe/2019/07/22/italy-matches-french-naval-tie-up-with- german-sub-partnership/.

119. Roblin, Sebastien. "Why Germany's New Super Stealth Submarines Could Take on Any Navy." https://nationalinterest.org/blog/the-buzz/why-germanys-new-super-stealth-subm arines-could-take-any-21021 (accessed June 6, 2017).

120. Sagarmala Project Website, Government of India, http://sagarmala.gov.in/.

121. Asian Development Bank (ADB). "Visakhapatnam–Chennai Industrial Corridor: Summary Of Regional Perspective Plan," https://www.adb.org/sites/default/files/linked-documents/48434-002-sd-02.pdf.

122. Ramesh, M. "ISRO is developing a methane-powered rocket engine." https://www.thehindubusinessline.com/news/national/isro-is-developing-a-methane-powered-rocket-engine/article29483292.ece (accessed September 3, 2019).

About the Authors

Dr Sameer Guduru, was an Associate Fellow at the National Maritime Foundation

Vice Admiral Pradeep Chauhan, AVSM & Bar, VSM, IN (Retd), is the Director-General of the National Maritime Foundation (NMF). He may be contacted at directorgeneral.nmfindia@gmail.com

Note

This article was first published on the Website of the National Maritime Foundation on 18 September 2020

India's Gas-Based Economy: A Bridge to a Transition or a Gateway to Energy Insecurity?

Dr Oliver Nelson Gonsalves

Until the mid-twentieth century, natural gas was mostly treated as a by-product of crude oil and "flared" (burned as a waste product) during the recovery of the latter.[1] Restricted to meeting the lighting needs of the local community, it only gained prominence after the viability of its transport over long distances and its subsequent storage was established. Moreover, although it was a better alternative to coal, natural gas was initially side-lined by inexpensive crude oil supplies from West Asia to meet the heating and lighting needs of the developed economies of North America, Europe, and East Asia. However, supply vulnerabilities and surging prices, arising out of the oil shock of 1973, exposed the risks associated with excessive reliance on any single source of energy to meet domestic requirements. In response, governments began to introduce different sources of energy, including fossil- and non-fossil fuels, into the economy to meet domestic energy requirements.

Success in the efforts to diversify the *primary energy mix* of a country relies on the latter's ability to integrate the "4 A's of energy security" (that is, availability, accessibility, affordability, and acceptability).[2] Thanks to its relatively wide geographical distribution, the imports of natural gas are perceived to be less vulnerable to geopolitical and geo-economic risks. This perception is particularly strong when comparing the source regions of natural gas with those of crude oil. The source regions of the latter are far more geographically limited and, within the Indo-Pacific, tend to be concentrated in geopolitically sensitive or turbulent sub-regions such as West Asia in general and the Persian Gulf in particular. Additionally, natural gas supplies from non-conventional sources, such as shale gas from the United States of America (USA), and also new discoveries, have dampened the high prices that were earlier (right up to the last decade) associated with natural gas.[3] Natural gas burns more cleanly than coal or petroleum, it emits less sulphur, carbon, and nitrogen compounds, and also releases far less particulate matter (ash and soot) into the atmosphere.[4] This last feature of natural gas has contributed to its widespread acceptance as an "environmentally friendly fossil fuel" that could, at the very least, "bridge" the gaps associated with renewable forms of energy.[5] In recent times, these features of natural gas have led to its being seen to be the fastest-growing fossil fuel in the world.[6] Increased global demand has thus far been led by China, which is attempting to combat severe air pollution in its cities by gradually replacing coal with natural gas in the heating and lighting and industrial sectors.[7]

India, too, has sought to capitalise upon the relative "cleanliness" of natural gas, despite it being a fossil fuel. However, while the preference for natural gas has been a consistent feature over the past two decades, there has been a very significant shifting of "goalposts" that is discernible over *time*, on the one hand, and also across the capstone policy documents published by the concerned departments / agencies of the government, on the other. An undue reliance upon merely the "latest" articulation by a given department of the government without cross-referencing it to other earlier documents leads to a loss of credibility of the data itself. For example, the *India Hydrocarbon Vision-2025*, which was *presented in the year 2000*, had, of course, promoted the "*use of natural gas, which is relatively a clean fuel*" and had acknowledged the need to supplement domestic sources with imports of Liquefied Natural Gas (LNG).[8] More importantly, however, it estimated that *20 per cent* of India's primary energy mix would comprise natural gas *by 2025*. Just six years down the line (in the year 2006), the *Integrated Energy Policy* projected that the share of natural gas would be *11 per cent* by *2032*.[9] In other words, it halved the estimation of percentage share (from 20 per cent to 11 per cent), even as it increased the time (from the year *2025* to the year *2032*) over which this sharply reduced target would be achieved. A further seven years later (in May 2013), one finds a third document, this one promulgated by the regulator of India's downstream (refining and distribution) sector, namely the Petroleum & Natural Gas Regulatory Board (PNGRB). This document — "*Vision 2030*"*: Natural Gas Infrastructure in India* — ramped up the percentage share being targeted in respect of natural gas (from *11 per cent* to *15 per cent*) and reduced the time (from the year *2032* to the year *2030*).[10] In the absence of any correlative or explanatory notes to justify these shifts of percentage-share targets and the time frame over which they are sought to be achieved, both monitoring and analysis tend to flounder.

It could be reasonably concluded that India tempered the optimism of the estimates promulgated via the *India Hydrocarbon Vision-2025* when it was forced to confront the reality that massive reforms in the industry were a precondition for this sort of expansion of the share of natural gas in the primary energy mix of the country. This might suffice to explain the first shifting of goalposts. However, if the second shift, increasing the percentage share and reducing the time frame, is to be afforded credibility, it would imply that these massive reforms and the concomitant development of infrastructure have been completed or are proceeding ahead of the estimations and faster than expected. Is this, in fact, the case?

As has already been stated, what has remained consistent is the country's commitment to natural gas, at least as a "bridging" strategy. In his inaugural address to the representatives of the global oil and gas industry at the Fourth India Energy Forum on 26 October 2020, Prime Minister Narendra Modi affirmed India's commitment to "shift to a gas-based economy".[11] This policy would encompass:

- An expansion of present efforts to develop indigenous sources of natural gas.
- The attainment of a dedicated and unified natural gas transmission network under the "One Nation One Gas Grid" policy.
- The implementation of Natural Gas Marketing Reforms to achieve a market price discovery of gas.

The first amongst seven other components of India's energy strategy for the future, the shift to a gas-based economy, eclipsed even the highly advertised expansion of the country's renewable energy target from 175 gigawatts (GW) by 2022 to 450 GW by 2030. By stressing the need to develop domestic sources of natural gas, Prime

Minister Modi has linked this feature of the new policy with the broader goal of achieving a 10 per cent reduction in (oil) imports by 2022. At the same time, this support for domestic sources of natural gas (and their exploitation by Indian entities) will form an integral element of the year-old *Atmanirbhar Bharat* (Self-reliant India) vision of indigenisation.[12]

The latest reiteration of an objective that has so far evaded three governments at the national level since 2000, the revised target is backed by a value chain that has matured over the past two decades. For instance, in 2000, India had no capacity to absorb LNG, and its Exploration and Production (E&P) efforts were limited to shallow depths. Today, more than half of India's gas consumption comprises LNG imports, and it can tap gas reserves trapped in reservoirs up to 3,000 metres below sea level. Hence, the shifting goalposts (targets) notwithstanding, India is in an advantageous position to attain its revised target. However, the country still faces an uphill battle to increase the share of natural gas in the economy. Envisaging a target audience comprising policymakers in India's energy sector, this article examines some internal challenges to India's objective of establishing a gas-based economy. Changing consumption patterns, which will determine the share of LNG imports, and infrastructure deficits, are vital to this study since these will influence India's capacity to absorb augmented supplies of natural gas, irrespective of its source. The article also underscores concerns arising from ongoing and future competition with other fossils- and non-fossil fuels. In continuation of the National Maritime Foundation's research studies on the maritime facets of India's energy security, the article also assesses the geopolitical implications of India's strategy.

Assessing the Indian Context

Supply of Natural Gas to the Indian Economy

Unlike the industrialised nations of Europe, North America, and East Asia, the consumption of natural gas in the Indian economy was very low, largely due to the limited available domestic supply, sourced mainly from gas fields in the country's North East. Only with the discovery of huge gas reserves off the west coast of India in the 1970s did the consumption of natural gas escalate.[13] Since climate change was not a priority for most governments and the flexibility to meet sudden spikes in power demand, known as "ramp-up capacity", was met primarily by large hydropower, the limited volumes of available domestic supply of natural gas were committed to the manufacturing sector. In short, these reserves were still inadequate to challenge the dominance of coal in power generation or crude oil in transportation. Later, however, the steadily rising demand for electricity compelled the Government of India (GoI) to divert natural gas supplies mainly to power generation and fertiliser production. This remained the case throughout the 1990s.[14]

Meanwhile, India's Public Sector Undertakings (PSUs), led by the Oil and Natural Gas Corporation (ONGC) and Oil India Limited (OIL), which hitherto had led India's exploration efforts, gradually began making way for private players, such as Reliance, British Petroleum (United Kingdom), ENI (Italy), and Cairn Energy (United Kingdom), under the erstwhile New Exploration Licensing Policy (NELP). The NELP, a profit-sharing regime that opened up E&P to private and foreign players, encouraged Foreign Direct Investment (FDI) of up to 100 per cent in E&P efforts. For the first time since Independence, this policy created a level playing field for all investors, which rejuvenated India's efforts to augment falling domestic petroleum and natural reserves.

The discovery of fresh domestic sources of natural gas from reserves off India's east coast in October 2002 led to another boom in terms of its adoption as a fuel for power generation (amongst other sectoral utilisation), in increasingly popular combined-cycle power plants. Moreover, its emergent consumption in the transportation sector in the form of Compressed Natural Gas (CNG) and as a household cooking fuel by way of Piped Natural Gas (PNG) strengthened the demand for a substitute for diesel / petrol, coal, and firewood, with a fuel that had very low particulate matter (PM).[15] So intense was the demand for an indigenous source of energy that Reliance Industries Limited (RIL), the lead investor in the KG-D6 (Krishna Godavari Dhirubhai 6) exploration block (See Figure 1), began large-scale commercial production in 2009 a record six and a half years after initial discovery.[16]

However, even after the latest boom phase in its popular adoption, natural gas's

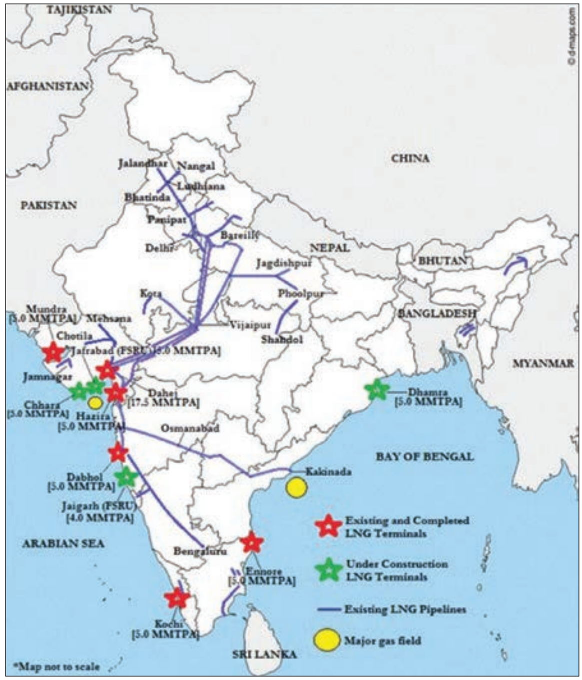


Figure 1: LNG Infrastructure in India

Source: Created by the author with data from the Corporate Profile of Petronet LNG Limited https://www.petronetlng.com/PDF/CorporatePresentation.pdf, and HEnergy http://www.henergy.com/project/natural-gas-pipeline-map-of-india/; map sourced from www.d-maps.com

*All figures in million metric tonnes per annum MMTPA

**FSRU: Floating storage and re-gasification unit

***The former state of Jammu and Kashmir (J&K) was reorganised into a Union Territory and bifurcated into the Jammu and Kashmir Union Territory and the Ladakh Union Territory in August 2019.

share of the total primary energy supply (TPES) — a key indicator of India's fuel mix — amounted to only 6.33 per cent in 2019-20.[17] In fact, in recent years, natural gas has never amounted to more than seven per cent of India's fuel mix (see Figure 2), while the global average was 23.71 per cent in 2019.[18]

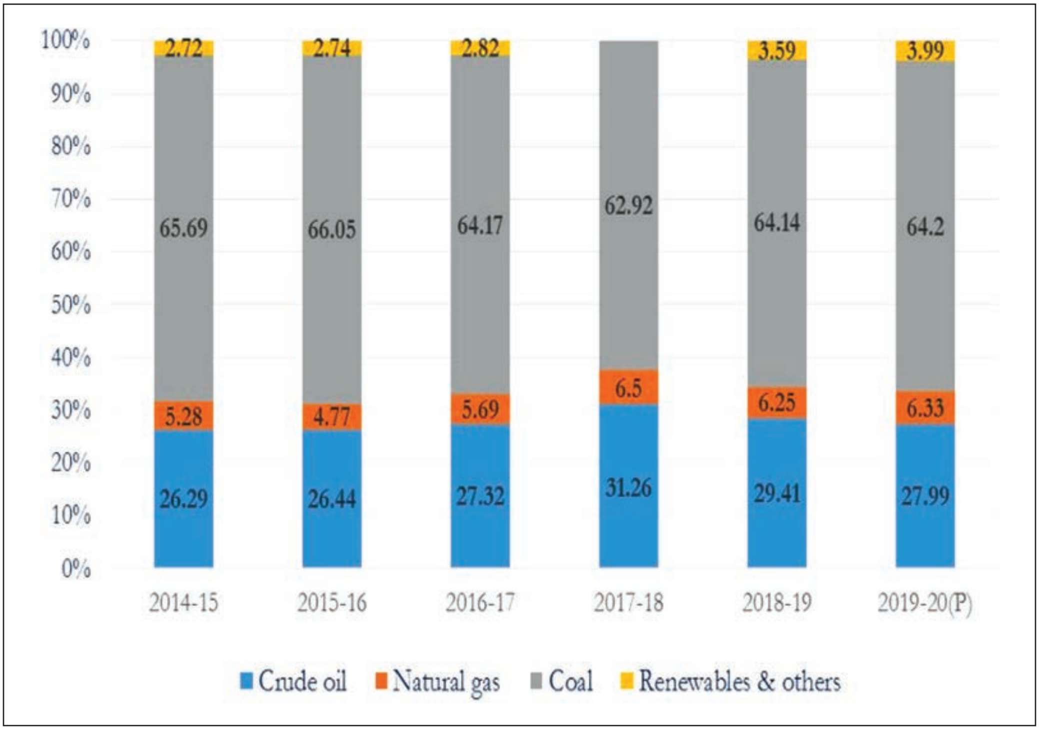


Figure 2: Fuel Shares in Total Primary Energy Supply
Source: Compiled by the author with data from Energy Statistics 2016–21, National Statistical Office, Ministry of Statistics and Programme Implementation, Government of India.

Exploration and Production (E&P) Activities

Geological complexities of deep-water production, and a massive over-estimation of available reserves, compounded by contractual disruptions, were largely responsible for the tremendous decline of output from KG-D6, which also contributed to the overall shrinkage of natural gas supply from domestic production.[19] Figure 3 draws attention to the diminishing production of natural gas within India since 2010. It also shows that even though domestic sources contributed a larger portion of the available supply, the net imports have been steadily rising.

Preliminary data from 2019–20 shows that LNG imports now comprise more than half the total supply, and this trend may continue if domestic production stagnates. Thus, as the demand for this low-carbon fuel grows, any failure to supply adequate volumes of this "in-demand" commodity from domestic sources will not only lead to a greater dependence on LNG imports to fill the vacuum but also necessitate the expenditure of considerable political and economic resources to access stable sources of supply.

The falling domestic production of a resource is a worry for any government attempting to balance the trade deficit. In the Fiscal Year (FY) 2019–20, India imported approximately US$ 8.9 billion of LNG.[20] Combined with crude oil (US$ 101.38 billion), oil and gas imports form the largest share of commodities imported by India.[21] Given India's status as a developing country, it is fairly obvious that energy demand will continue to grow. However, unrestrained energy imports could devalue the rupee and have a negative spill over into other sectors like education, health, defence, and so forth. *While it is certain that India cannot achieve the broader 10 per cent reduction in oil imports by 2022, the expansion of its effort to develop indigenous sources of natural gas signals the government's commitment to bolster energy security by reducing its dependence on expensive LNG imports.*

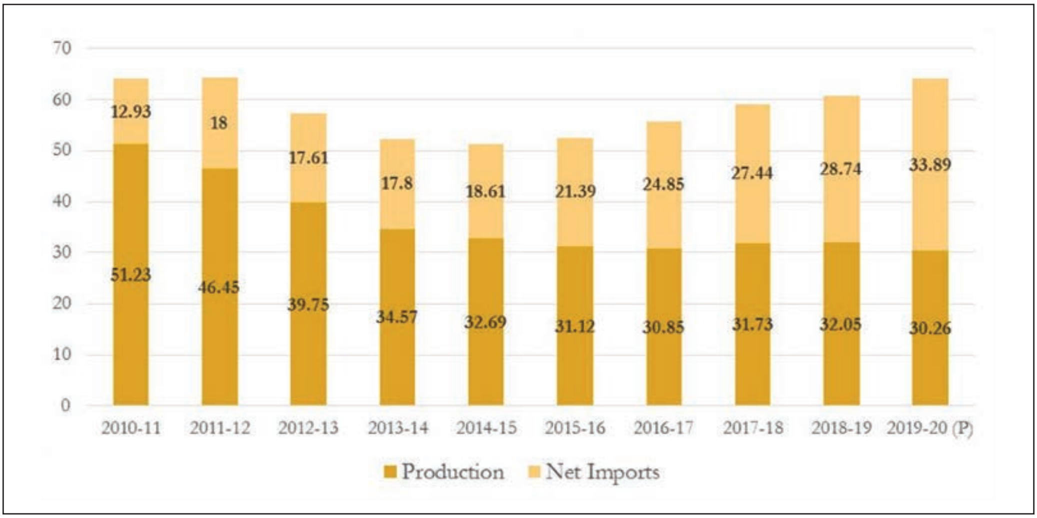


Figure 3: Availability of Natural Gas in India (billion cubic metres)
Source: Compiled by the author with data from Energy Statistics 2021, National Statistical Office, Ministry of Statistics and Programme Implementation, Government of India, 52.

Pricing of LNG Imports and Domestic Natural Gas Supplies

Since 2014, the price of natural gas extracted from domestic sources has been pegged with the existing prices from sources in the USA, Mexico, Canada, the European Union, and Russia. This price is less expensive than what producers in India would gain if their product was pegged to the Japan–Korea Marker for LNG, which prevails in the East Asian market. Natural gas prices from domestic sources are reviewed every six months, and are based on the past year's price and volume of supply. Conversely, supplies imported as a result of India's long-term LNG contracts are linked to the global crude oil price.

At present, domestically produced natural gas — priced at US$ 3.62/MMBTU (Metric Million British Thermal Unit) — and imported r-LNG (re-gasified Liquefied Natural Gas) — priced at an average of US$ 2.68/MMBTU in the spot market and an average US$ 9–10/MMBTU according to the long-term contract with Qatar — are the only two modes of natural gas supply in India.[22] Although the price differential between spot cargoes and long-term contracts is stark, the fluidity of the former, especially when the demand for heating increases in the northern hemisphere, is a deterrent to the expansion of LNG imports to India. For instance, the average price of spot cargo was close to US$ 18/MMBTU in January 2021.[23] Such a huge spike in the average price of LNG led to the shaving of demand from India in FY 2020–21, estimated at 1.8 Million Metric Tonnes (MMT) 2.44 BCM in January 2021, from a peak of 2.5 MMT 3.40 BCM in October 2020.[24] Such a sensitivity to global demand will have to be tempered by an expansion of indigenous production and the development of economies of scale in India.

Gas Infrastructure

There are two options available for the import of natural gas into India. The geographical proximity to the gas-rich West (Iran), Central (Turkmenistan), and Southeast (Myanmar) Asian regions stimulated a decades-long discussion for the establishment of cross-border and undersea gas pipeline networks. However, geopolitical rivalries with Pakistan and China and India's inability to circumvent the

US embargo on Iranian energy supplies, as well as the prohibitive costs of international pipelines, have frustrated any attempts to move beyond initial discussions.[25] This leaves LNG imports as the only viable alternative. With the capacity to process 42.5 million metric tonnes per annum (MMTPA) of natural gas (57.8 BCM), India is among the world's top-five importers of LNG.

An adequate transportation network is the most vital feature of the successful expansion of natural gas consumption.[26] In the case of India, the 17,000 kilometres of inter-state pipeline network, which currently favours developments around the LNG terminals located on the west coast, has been targeted for rapid expansion to facilitate natural gas use in the eastern regions under the "One Nation One Gas Grid" policy (see Figure 1).

An often-overlooked aspect of India's natural gas infrastructure is the shortfall in state-owned LNG carrier capacity. Presently, the state-owned Shipping Corporation of India (SCI) manages and operates four second-hand joint-venture-owned LNG carriers. In sharp contrast, as of 2019, China owned as many as thirty-eight LNG carriers. The SCI has leased its vessels on long-term time charters to Petronet and Exxon Mobil. In aggregate, these four vessels have a capacity of 604,000 cubic metres (m^3).[27] In comparison, the largest LNG carrier in the world can accommodate 266,000 m3 of LNG. The prohibitive costs of purchasing new LNG carriers and the absence of shipbuilding expertise have compelled India to opt for the services of foreign-owned vessels.[28] While this may seem a far less expensive option than purchasing a new LNG tanker, the events of the past few months showcase the volatility of the status quo. In January 2021, LNG spot charter rates touched an all-time high of US$ 300,000 on some routes due to surging demand for LNG supplies in winter.[29] India, which is increasingly purchasing LNG in the spot market, could lose potential cost advantages if the cost of shipping the cargo is excessive.

Domestic Consumption Patterns

Figure 4 shows that of the total natural gas supply in 2018–19, 22.30 per cent fed the 74 gas-fired plants in India.[30] Most of these types of thermal plants employ Combined Cycle Gas Turbine (CCGT) technology to generate electricity. In conjunction with the fertiliser industry (27.8 per cent), these two "anchor customers" of natural gas absorbed 50 per cent of the total available supply in 2018–19.[31] Moreover, along with the City Gas Distribution (CGD) network, power generation and fertiliser production receive priority domestic gas, according to India's Gas Utilisation Policy.[32]

In the case of power generation, gas-fired power plants are far more efficient than other thermal power plants that use coal, lignite, or diesel.[33] In India, the performance of a power plant is gauged on its ability to attain a high Plant Load Factor (PLF). PLF is defined as the "*percentage of sent out energy corresponding to installed capacity in that period*".[34] Gas-fired plants employing CCGT technology can attain more than 50 per cent PLF.[35] To understand the link between PLF and gas-fired generation, consider the following example: If the installed capacity of a thermal generation station is 1,000 megawatts (MW), it can produce a maximum of 24,000 megawatt-hours (MWh) of electricity in a 24-hour period 1000 MW x 24 hours = 24,000 MWh. It is extremely difficult for thermal generation units to achieve and maintain complete utilisation of available capacity. Assuming that a power plant utilised only 800 MW of its installed capacity in one day, the total electricity generated is 19,200 MWh (800 MW x 24 hours). Hence, the PLF of the thermal generation station is 80 percent (19,200 ÷ 24,000 = 0.8 80 percent).

Despite the obvious technological advantages over other thermal sources of electricity, gas-fired power plants in India have been running on an extremely low PLF since 2011–12. By FY 2017–18, the average PLF of gas-fired power plants in India had touched a low of 24 per cent.[36] The shrinking supply of domestic natural gas from the Krishna–Godavari basin and the inability to purchase expensive LNG imports from the international market left as many as 31 gas-fired plants, with a cumulative installed capacity of 14.30 gigawatt (GW), financially unviable. Shockingly, such rising cases of "stranded assets", in addition to the shortfall of as much as 70 per cent of the gas allocated to the industry, did not desist the addition of 3.7 GW of capacity, which would make these units fully dependent on LNG imports.[37]

On the other hand, CGD, which covers the supply of PNG and CNG, increased its share of natural gas consumption from 5,598.79 million metric standard cubic

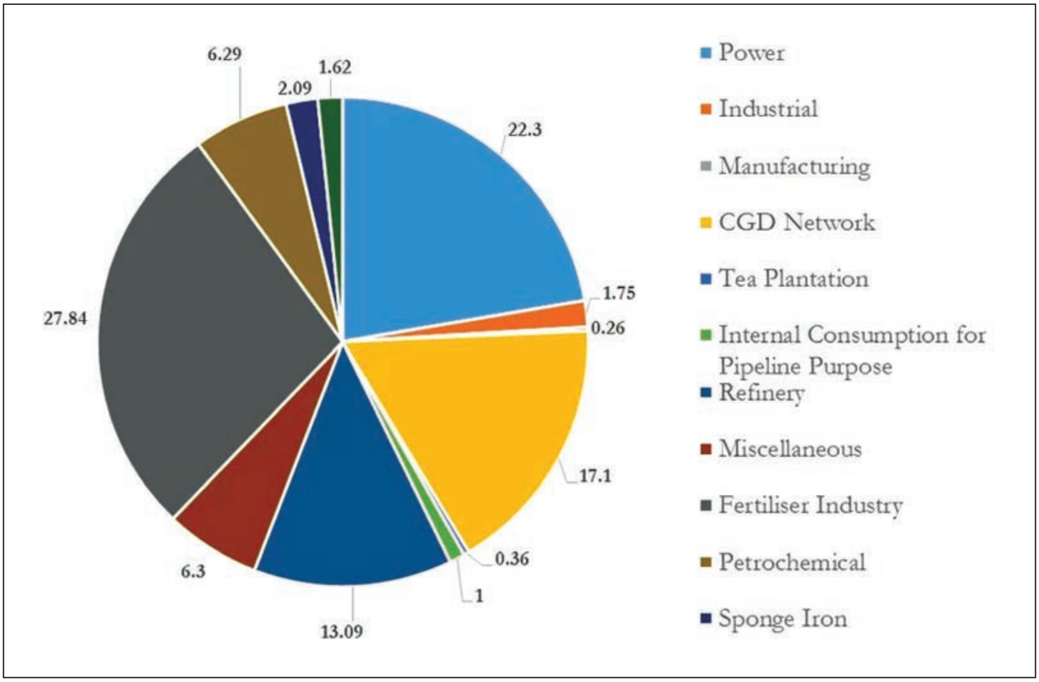


Figure 4: Sector-wise Percentage Consumption of Natural Gas for 2018–19
Source: Energy Statistics 2020, National Statistical Office, Ministry of Statistics and Programme Implementation, Government of India, 65.
Note: The provisional figures for 2019–20 are available, but are not comprehensive.

metres (MMSCM) in 2011–12 to 9,206 MMSCM in 2018–19 — a massive 64 per cent hike from one sector alone. Thus, the expansion of the PNG network to Tier-II cities and the switch to CNG-fuelled public transport due to urban air-quality concerns could ensure this sector's appetite for a larger share of India's natural gas supplies.[38]

India's LNG Import Strategy

Emulating the diversification strategies of Japan, South Korea, and China, India has expanded its sources of imports from well-established sources in West Asia and Europe to emerging players from North America, Africa, Southeast Asia, and Oceania. Since the early 2000s, the share of LNG imports in India's energy mix has increased significantly. For instance, at the turn of the century, India imported less than US$ 1 million of LNG, and from just one country — Belgium.[39] Only with the commissioning of the re-gasification terminal at Dahej, Gujarat, in 2004, could India opt to expand LNG imports for its booming economy. The US$ 18 million shipment, which arrived from Qatar that year, was in and of itself emblematic and offered a revelation into future dependencies, especially with West Asia.[40]

Table 1 shows the dominance of LNG imports from Qatar — with which India has signed a 25-year long-term contract till 2028 — almost a decade after the first shipments arrived in India. Effectively, the top five sources of imports alone contributed a whopping 99 per cent of the total imports.

Table 1: Sources of India's LNG imports in FY 2011–12

Country	Quantity (BCM)	Share (in per cent)
Qatar	13.96	82.02
Nigeria	1.83	10.8
Egypt	0.7	4.11
Trinidad and Tobago	0.42	2.48
Algeria	0.02	0.12
Others (11)	0.08	0.47
Grand Total	17.02	100

Source: Department of Commerce, Ministry of Commerce & Industry, Government of India, "Export-Import Data Bank", 2021.

In FY 2019–20, nearly two decades after the arrival of that first shipment from Qatar, India imported US$ 9.66 billion of LNG from as many as 16 countries.[41] Subsequent contractions of imports to US$ 7.06 billion in FY 2020–21 (April–February) due to the impact of the COVID-19 pandemic on domestic demand did not stop India's drive to diversify its imports.

In the ten-year period from FY 2011–12, India increased the number of LNG sources to eighteen — partaking of the abundance of shale gas supplies from the

USA as well as a larger share of natural gas from Australia and the African continent (Nigeria, Angola, Egypt, Cameroon, Equatorial Guinea, and Algeria) (see Table 2). Imports from these six African sources comprised 21.04 per cent of the total LNG imports. At the same time, one cannot ignore the fact that while imports from Qatar have halved over a decade, supplies from West Asia — due to upgrades in gas liquefaction and storage facilities in the United Arab Emirates (UAE) and Oman — contributed more than 55 per cent of India's total LNG imports.[42] Besides Qatar, India has also signed long-term LNG contracts with Australia, Russia, and the USA.

Table 2: Sources of India's LNG imports in FY 2020–21 (Apr.–Feb.)

Country	Quantity (BCM)	Share (in per cent)
Qatar	12.34	40.07
United Arab Emirates	3.86	12.55
United States of America	3.74	12.14
Nigeria	2.74	8.89
Angola	2.42	7.85
Others (13)	5.69	18.50
Grand Total	30.79	100

Source: Department of Commerce, Ministry of Commerce & Industry, Government of India, "Export-Import Data Bank", 2021.

Geopolitical Implications of India's Energy Strategy

The success of India's diversification strategy can be gauged from the increasing availability of LNG imports in the energy basket. With the commissioning of the LNG terminal at Ennore and the East–West pipeline connecting Hazira to Kakinada, natural gas from Asia and Africa can reach the supply-starved power stations on India's east coast. A 2018 study by the International Energy Agency (IEA) that examined the abilities of LNG suppliers to overcome demand shocks or supply interruptions classified India as a "diversified gas importer" (with considerable indigenous production) that is moving to become a "diversified LNG importer" (dominated by LNG imports).[43]

The recent spat with Saudi Arabia over the obstinacy of the Organization of the Petroleum Exporting Countries and its allies (OPEC+) to adhere to pre-determined production cuts exposed India's soft underbelly — oil-import dependency, primarily on West Asian producers. Feeble efforts to diversify away from Saudi Arabian supplies were limited to purchases from the USA and Africa. In the case of LNG, India has reduced its dependence on Qatari imports by increasing its reliance on American imports. However, inadequate reserves of shale and the burgeoning demand from American consumers will be a cause of concern for Indian policymakers. Furthermore, the US administration, under the leadership of President Joe Biden, may curtail shale gas production in favour of accentuating climate-change mitigation policies.[44] A reversal of US policy may compel a return to traditional suppliers with production and export capacities that are resilient to political change.

Over the past decade, India has undertaken several risky investments in geopolitically sensitive countries to access alternative sources of supply. India's US$ 6.5 billion investment for a 30 per cent stake in the Rovuma gas field in Mozambique remains stuck due to the prolonged political and security challenges arising from the Islamic State-led insurgency in the northern part of the country.[45] Similarly, India's US$ 400 million play to develop the ONGC-discovered Farzan-B offshore gas field could not disentangle itself from the threat of repercussions of challenging the US-led sanctions on Iran's energy exports.

Finally, strong political commitment to develop alternate and indigenous energy sources may trigger misgivings among energy suppliers who are focussed on preserving their markets by cultivating their security of demand. For instance, Qatar reduced the price of its LNG supplies to India in 2015 only after India agreed to absorb additional volumes of the commodity. Similarly, the USA's development of indigenous shale reserves led to the recalibration of West Asian exports to North America and Europe in favour of the Indo-Pacific region, where countries like India and China offer suppliers the opportunity to expand their production.

Challenges Arising from the Competition with Non-Fossil and (Other) Fossil Fuels

Role as a Bridge Fuel

As a fossil fuel cleaner than coal but dirtier than renewables, natural gas could suffer the fate of Buridan's donkey if its diffusion in India is not managed well. Energy analysts — at least those who position natural gas as a "bridge fuel" — argue that ample supplies of natural gas in global markets will sustain the prevailing trend of low prices, at least in the near future. This is indeed true. Consider this: reflecting the decadal growth in global crude oil discoveries, global proven reserves of natural gas rose from 187.1 trillion cubic metres (TCM) in 2011 to 198.8 TCM in 2019.[46] The market, which is awash with shale gas from the USA and natural gas from newly-developed fields in Russia, Australia, and China, is currently witnessing reduced demand following the outbreak of the COVID-19 pandemic. Hence, apart from ballooning demand after the world emerges completely out of the shadow of lockdowns, any other future price spikes, apart from the annual weather-driven demand escalations, would probably originate from demand in countries of the Indo-Pacific, which are considering an expansion of natural gas imports.

Threat of "Technological Lock-in"

Climate-change experts contend that price complexities and a need for massive financial and technical support make natural gas more of a short-term substitute fuel. Its transitionary disposition to act as a "bridging fuel" to simultaneously meet the energy security needs of a country along with local pollution mitigation could increase the threat of a "technological lock-in".[47] This is a scenario wherein any development in new energy systems stagnates on account of past investments in entrenched technologies.[48] Chandra Bhushan, Chief Executive Officer (CEO) of the International Forum for Environment, Sustainability & Technology (IFOREST), uses this template to suggest that the prevalence of institutional support and the length of the value chain to supply one unit of energy are the principal factors that determine how sustainable a fuel really is. To accentuate his point, he questions the viability of expanding the national natural gas grid — under the "One Nation One

Gas Grid" — even as India has amplified its renewable energy target to 450 GW by 2030. He summarises his argument by saying, "*The idea of the energy transition will have to be juxtaposed with political considerations, which will prove more of a challenge to surpass than the transition to low-carbon fuel sources*."

On the other hand, Jitendra Roychoudhury, Research Fellow, King Abdullah Petroleum Studies and Research Center (KAPSARC), counters this narrative by arguing:

> "*The competition between fuels is not an apple-to-apple comparison. Even though climate change analysts may feel that the transition to a gas-based economy may be a wasted development, bidding for expanding the CGD network is still going strong. As far as pricing is concerned, even prices set by the Government of India (with regard to domestic natural gas) are periodically revised. These developments underscore the significance of the market and its realisation of the tough road ahead for the transition to renewables*."[49]

Until 2019, the PNGRB extended CGD "coverage" to 228 Geographical Areas (GAs), covering 402 out of India's 718 districts, through the 10th CGD Bidding Round. Approximately 70 per cent of India's population resides in these GAs. Apart from laying more than 58,000 kilometres of steel pipeline, this "coverage" includes the addition of approximately 20 million domestic PNG connections and more than 3,500 CNG fuelling stations by 2029.[50] The forthcoming 11th Round will be developed around a pipeline from Mumbai, on the west coast, to Angul (Odisha), on the east coast. Furthermore, the Union Minister for Petroleum & Natural Gas and Steel, Mr Dharmendra Pradhan, expects to develop 10,000 CNG fuelling stations by 2025.[51]

Obscuring the Clean Energy Transition in the Transportation Sector

CNG-fuelled vehicles emit smaller amounts of greenhouse gases (GHG), such as carbon monoxide, carbon dioxide, nitrogen oxides, and particulate matter, than do vehicles that run on liquid fuels. Yet, even as natural gas's role in air-pollution mitigation is extolled by local governments, the adoption of CNG-fuelled vehicles has not fared well.[52] The sale of these vehicles is restricted by the geographical distribution of CNG fuelling stations in states that are connected to the national natural gas grid. Moreover, these vehicles require larger fuel tanks (that are stored in the boot space) than their liquid fuel-running competitors because the latter deliver three-quarters more energy per litre.[53] Consequently, despite empathising with air-pollution mitigation and climate-change objectives — the well-known "co-benefits" of natural gas adoption — consumers often opt for vehicles running on petrol or diesel.[54] Such limitations have presently constrained its mass adoption largely to urban public transport services. Given these arguments, the successful adoption of CNG will depend on the pace of expansion of distribution infrastructure and the implementation of other associated policies, such as tax rebates, that will bring down the cost of CNG-fuelled vehicles (factory-fitted CNG-fuelled vehicles are more expensive than petrol and diesel variants).

However, what are the implications of India's much-debated plan to scale up the penetration of Electric Vehicles (EVs) to 30 per cent by 2030?[55] CNG, which is less expensive than diesel and petrol, could derail the National E-Mobility Programme's objective of saving more than 300,000 barrels of oil per year and reducing carbon emissions by 0.5 tonnes annually. With only 933 EV charging stations (0.1 per cent of the world's total), the need for a competitive EV policy that blends the advantage of CNG dispersion with the overall effort to reduce crude oil consumption is the need of the hour.[56]

Weak Resistance to Coal

What about coal? The fuel which natural gas substituted to meet the heating and lighting needs of most developed economies has proven much more resilient in a developing economy like India. Unsurprisingly, the second component of India's energy strategy, mentioned earlier in this article, stresses the *efficient* consumption of coal. So, why is this not surprising? A close examination of India's Intended Nationally Determined Contribution (INDC), which was submitted to the United Nations Framework Convention on Climate Change (UNFCCC) as part of the Paris Agreement of 2015, has no mention of natural gas.[57] It, however, commits to the implementation of Clean Coal policies — including supercritical technologies for coal-based power plants — among several other mitigation measures. Indeed, in the intervening period, India has mirrored the trend among other Asian economies by encouraging intensive coal use through the increase in the share of coal within the total installed capacity of power stations, from 185.17 GW in FY 2015–16 to 202.67 GW in FY 2020–21.[58] This is particularly worrying, given that renewables (wind + solar), which have received tremendous institutional and financial support since 2015, have only minimally impacted the dominance of coal in the country's primary energy mix (see Figure 2).

Recent Alterations to India's Strategy for Establishing a Gas-Based Economy

The Promise of the Future?

The success of any energy source in India requires close policy support and reforms (commitment). For instance, the absence of a coherent policy on EVs has frustrated the industry's attempt to expand manufacturing capacities. Likewise, the recent interest in its development notwithstanding, natural gas must overcome severe apprehensions by end-use customers in India. India's power generation industry has already burned its fingers once. Despite increasing LNG imports, continued idle gas-fired capacity indicates that pricing will play a significant role in changing this commodity's image as a disruptive fuel undergoing an identity crisis. It could either outdo clean and emerging sources of energy or succumb to more secure and established indigenous fuels like coal. Thus, the pathway to a gas-based economy is contingent on the realisation of the following:

Infrastructure: In February 2021, Prime Minister Narendra Modi announced the infusion of Rs 7.5 trillion (US$ 100 billion) over five years to expand oil and gas infrastructure in India with a stated aim to encourage the adoption of clean — albeit conventional — fuels and reduce the reliance on imports.[59] Of this amount, about US$ 9.5 billion is already earmarked under the "One Nation One Gas Grid" scheme for the development of infrastructure dedicated to natural gas production, transport and re-gasification on the east coast. In particular, the Gas Authority of

India Limited (GAIL) hopes to develop 17,000 kilometres of pipeline networks in this region.

India should also prioritise capability enhancement in the field of LNG carrier construction. It could invite domestic stakeholders to enter into a Public-Private Partnership (PPP) to share the costs of projects and thereby manage risk under the *Atmanirbhar Bharat* scheme. As global demand for this fuel increases, the corresponding stress on transport will be visible, along with the need to access supplies from geopolitically sensitive regions.

Interest by Private Players: Following India's declared intent to transition to a gas-based economy, the joint-venture between RIL and British Petroleum (BP) commenced the production of gas from the R Cluster — the first of three deep-water projects in the Reliance-owned KG-D6 field. According to media reports, the output from this field alone is expected to form 10 per cent of the country's current production from domestic fields.[60] An outcome of the Open Acreage Licensing Policy (OALP) under the Hydrocarbon Exploration and Licensing Policy (HELP) which succeeded the NELP, contractors may exploit blocks that are not included in the tender. Private players will keenly observe the operations of the RIL–BP joint venture to measure the government's commitment to allow a level playing field.

Pricing and Tariff Structure.: The promulgation of the Natural Gas Marketing Reforms in October 2020 will enable what is termed the "market price discovery of natural gas".[61] Under this provision, contractors are allowed to sell natural gas through a supervised online bidding process that will ensure transparency. Further, to avoid price manipulations, subsidiaries or affiliates of the seller will not be able to participate in the bidding process.

The most important aspect of these reforms is that contractors will now not be compelled to sell their products to public sector entities. Instead, they may sell their product to any buyer in the world as long as both parties participate in the supervised online bidding process. A complement to the pricing freedom allowed under the Production Sharing Contract (PSC), these measures will allow contractors to recover their investments at a quicker pace.

The PNGRB has also introduced a unified gas tariff structure to transport natural gas via the National Gas Grid. On the one hand, seeking to incentivise the adoption of natural gas in India's interior regions with investments for the expansion of the gas grid, this policy levies a higher tariff on a consumer *within* 300 kilometres of an LNG terminal or gas field.[62] On the other hand, the introduction of such a tariff system would lead to cross-subsidisation and reduced savings for industrial units along the west coast.

Conclusion

Although the target to expand the share of natural gas in India's primary energy mix to 15 per cent by 2030 and the objective of creating a "gas-based economy" are the *leitmotifs* of this study, the conceptual disconnect between them is undeniable. A gas-based economy implies the dominance of natural gas in India's primary energy mix. This objective depends on the success of India's efforts to augment the natural gas supply from indigenous sources. In this scenario, the target to increase the share of natural gas in the primary energy mix appears incapable of supporting the shift.

Capacity enhancements are already underway. The expansion of the transmission network *before* the discovery of new indigenous supplies resembles the overconfidence of the last decade when surplus, and, eventually, underutilised gas-fired power-plant capacity was developed. In contrast, additional LNG terminal capacity will be significant if India fails to locate ample indigenous supplies of natural gas. Furthermore, the success of India's LNG diversification strategy depends on the pattern of low spot prices due to the prevailing supply glut. The diffusion of natural gas through CGD will shrink high oil imports marginally, but at the same time, it will also increase its susceptibility to price shocks that arise from increasing global demand and geopolitical disturbances. Hence, with India's decarbonisation efforts hanging in the balance, and the looming reality of additional import dependence, India's policymakers will have to outline a detailed roadmap for the absorption of greater LNG imports or indigenous supplies into the economy.

ENDNOTES

1. According to Speight, "*the term* natural gas *is the generic term that is applied to the mixture of gaseous hydrocarbon derivatives and low-boiling liquid hydrocarbon derivatives that is commonly associated with petroliferous (petroleum-producing, petroleum-containing) geologic formations*". James G Speight, *Natural Gas: A Basic Handbook* (Cambridge, MA: Elsevier, 2019), 4. Methane is the main constituent of natural gas along with propane, butane, and pentane, which may be found in natural-gas liquids.

2. Asia Pacific Energy Research Centre, A Quest for Energy Security in the 21st Century (Tokyo: Institute of Energy Economics, 2007), 1–100. https://aperc.or.jp/file/2010/9/26/APERC_2007_A_Quest_for_Energy_Security.pdf.

3. Due to its natural occurrence — in varying proportions — in natural gas fields, oil fields, tight rock formations (like shale rock), and biological sources (landfills and bio-gas plants), natural gas is separated into two categories. Conventional gas is found in geological formations that are highly permeable (porous) and can be extracted through traditional methods (vertical and slant drilling). Unconventional gas is found in formations with less permeability and can be recovered only through non-traditional methods, such as hydraulic fracking, horizontal drilling, and so forth..Gas hydrates, shale gas, coalbed methane, bio-gas are examples of unconventional gas.

4. Speight, *Natural Gas*, 361.

5. Shawn Olson Hazboun and Hilary Schaffer Boudet, "Natural Gas – Friend or Foe of the Environment? Evaluating the Framing Contest over Natural Gas through a Public Opinion Survey in the Pacific Northwest", *Environmental Sociology* (March 2021): 9–10, https://doi.org/10.1080/23251042.2021.1904535.

6. British Petroleum, *Statistical Review of World Energy 2011*, 60th Edition, 20, and *Statistical Review of World Energy 2020*, 69th Edition, 4. http://large.stanford.edu/courses/2011/ph240/goldenstein1/docs/bp2011.pdf.

7. The State Council, "Notice of the State Council on Issuing the Air Pollution Prevention and Control Action Plan", People Republic of China, No 37 (September 2013), http://www.gov.cn/zwgk/2013-09/12/content_2486773.htm.

8. Group of Ministers, *India Hydrocarbon Vision-2025* (Government of India, 2000), 4–5. http://petroleum.nic.in/sites/default/files/vision.pdf. See also, Kapil Narula, *The Maritime Dimension of Sustainable Energy Security* (Singapore: Springer Nature, 2019), 106–108. Natural gas, in its gaseous form, is refrigerated at –162°C to create a liquid consistency at a liquefaction plant near the source of supply before being transferred to an LNG carrier. In

its liquid form, that is, LNG, natural gas is reduced by 600 times, which makes it easy to transport over long distances in insulated tanks on board LNG carriers. Once the ship reaches the re-gasification terminal at the destination port, the LNG is re-gasified for transport using pipelines.

9. Planning Commission, *Integrated Energy Policy: Report of the Expert Committee* (Government of India, Delhi, August 2006): 44.

10. Ministry of Petroleum & Natural Gas, "Shri Dharmendra Pradhan Chairs First Meeting of Consultative Committee of Ministry of Petroleum & Natural Gas", Press Information Bureau, Government of India, Delhi, 06 December 2019.

11. Narendra Modi, "Text of PM's Address06 Decemberuguration of India Energy Forum", Prime Minister's Office, Press Information Bureau, Government of India, Delhi, 26 October 2020.

12. Narendra Modi, "India Energy Forum".

13. P R Shukla et al., "Assessment of Demand for Natural Gas from the Electricity Sector in India", Program on Energy and Sustainable Development, Working Paper, No 66 (October 2007): 1. https://www.researchgate.net/publication/316928381_Natural_Gas_in_India_An_Assessment_of_Demand_from_the_Electricity_Sector.

14. Natural-gas-based power plants have faster ramp-up rates that lend flexibility to the electricity grid in the case of a sudden spike in demand. It is also used as a feedstock (raw material) to manufacture ammonia-based urea, a widely used fertiliser in India.

15. Rahul Tongia, "Revisiting Natural Gas Imports for India", *Economic and Political Weekly* 40, No 20 (14–20 May 2005): 2032–2033. Compressed Natural Gas (CNG), a derivative of natural gas, comprises methane stored at high pressure and ambient temperature..
Natural gas may be converted to CNG by compressing it to 3000 psi (pound-force per square inch) to 1 per cent of the volume the gas would occupy at normal atmospheric pressure..
In this form, it can feed an internal combustion engine and act as an alternative to petrol and diesel.. Liquefied Petroleum Gas (LPG) is a natural gas liquid (NGL) comprising propane and butane, whereas natural gas from KG-D6 comprises primarily methane, which feeds fertiliser production.

16. Reliance Industries Limited, "India Has Never Been Here Before: Facts You Didn't Know about KG-D6," *Flame of Truth Series* (2014): 7. In the case of deep-water exploration projects, the average project timeline from discovery to production is 10 years.

17. National Statistical Office, Government of India, Ministry of Statistics and Programme Implementation, *Energy Statistics 2021*, No. 28, 89. file:///E:/Jobs/Master%20Data_Oliver/India_Energy%20Statistics_MoSPI_2011-20/Energy%20Statistics%20India%202021.pdf.

18. Sanjay Kumar Kar and Ayush Gupta, eds., *Natural Gas Markets in India: Opportunities and Challenges* (Singapore: Springer Nature, 2019), vii. Data from 2017–18 in *Energy Statistics 2019* (page 97) indicates that the total share of Renewable Energy and Others (including nuclear energy) was –0.67 per cent. This document calculates the share of fuels in energy by weighing the relation between consumption/production of the fuel with total energy use or production. Based on this explanation, the author *assumes* that biomass (cow dung and wood), which comprises a large share of renewable energy in India, was greatly displaced by the introduction of Liquefied Petroleum Gas (LPG) subsidies, starting in 2016, to 50 million households under the *Pradhan Mantri Ujjwala Yojana* (PMUY) scheme. Intensified LPG-use is reflected in the surge in the share of crude oil.

19. Manish Vaid and Sanjay Kumar Kar, "India's Active Engagement with Natural Gas: Imperatives and Challenges", in *Natural Gas Markets in India: Opportunities and Challenges*, eds Sanjay Kumar Kar and Ayush Gupta (Singapore: Springer Nature, 2019), 13.

20. Twesh Mishra, "India Saved over Rs 30,000 Cr despite Rising Petro Product Imports in FY21", *Business Standard*, 22 April 2021. https://www.business-standard.com/article/econo22 Aprily/india-saved-over-rs-30-000-cr-despite-rising-petro-product-imports-in-fy21-121042201160_1.html.

21. Data for Crude and Products, Petroleum Planning & Analysis Cell, Ministry of Petroleum & Natural Gas, Government of India. https://www.ppac.gov.in/content/212_1_ImportExport.aspx.

    See also: "Share of Leading Commodities Imported by India in Financial Year 2020", Statista, accessed 05 June, 2021, https://www.statista.com/statistics/650509/share-05 Junerts-by-commodities-india/.

22. Petroleum Planning and Analysis Cell, "Gas Price Ceiling for the Period April, 2021-September, 2021", Ministry of Petroleum and Natural Gas, Government of India, 31 March 2021. https://www.ppac.gov.in/WriteReadData/userfiles/f31 March20Price%20Ceiling%20for%20the%20period%20April%202021%20to%20September%202021.pdf.

    See also: Press Trust of India, "India Wants Qatar to Lower Gas Price; Qatar Says No to Reopening Existing Contracts", *The Economic Times*, 28 January 2020. https://energy.economictimes.indiatimes.com/news28 Januaryas/india-wants-qatar-to-lower-gas-price-qatar-says-no-to-reopening-existing-contracts/73683411.

23. Sambit Mohanty and Srijan Kanoi, "LNG's Unprecedented Surge to Apply Brakes on India's Imports, Consumption", S&P Global Platts, accessed 24 April, 2021, https://www.spglobal.com/platts/en/market-insights24 Aprilnews/natural-gas/011121-lngs-unprecedented-surge-to-apply-brakes-on-indias-imports-consumption.

24. Petroleum Planning and Analysis Cell, "Import of Liquefied Natural Gas", Financial Year 2020–21 (April to March), Ministry of Petroleum and Natural Gas, Government of India.

25. Sanjay Kumar Pradhan (2020), *India's Quest for Energy through Oil and Natural Gas Trade and Investment, Geopolitics, and Security* (Singapore: Springer Nature), 151–170.

26. David G Victor, "Natural Gas and Geopolitics," in *Security of Energy Supply in Europe: Natural Gas, Nuclear and Hydrogen*, eds Francois Leveque, Jean-Michel Glachant, Julián Barquín, Christian von Hirschhausen, Franziska Holz and William J Nuttall (Cheltenham: Edward Elgar Publishing Limited, 2010), 91 92.

27. The Shipping Corporation of India, "Tankers", accessed 02 June, 2021, https://www.shipindia.com/services/servicepage/spec02 June-vessels.

28. In 2020, the cost of a 215,000 m^3 LNG carrier was US$ 250 million. Read: M Habib Chusnul Fikri et al., Estimating Capital Cost of Small Scale LNG Carrier , *Proceedings of the 3rd International Conference on Marine Technology*, (2020): 225–226. doi: 10.5220/0008542102250229.

29. Ross Wyeno and Josh Zwass, "Spotlight: LNG Charter Rates Drop to Record Lows, Support Strong US LNG Dispatches This Spring", S&P Global Platts, accessed 17 May, 2021, https://www.spglobal.com/platts/en/market-insights/lat17 Mayws/shipping/031021-spotlight-lng-charter-rates-drop-to-record-lows-support-strong-us-lng-dispatches-this-spring.

30. National Statistical Office, Ministry of Statistics and Programme Implementation, Government of India, *Energy Statistics* 2020, No. 27, 65. "Current List of Gas Power Plants", Global Energy Observatory, accessed 13 October, 2020, http://globalenergyobservatory.org/list.php?db=Powe13 Octoberpe=Gas.

31. Apart from its uses in electricity generation, transport, cooking, and heating, natural gas is also used as a raw material for the production of fertiliser, dyes, paints, medicines, photographic films, explosives, plastics and anti-freeze.

32. Press Information Bureau, Ministry of Petroleum & Natural Gas, Government of India, "Demand and Supply of Natural Gas", 07 January, 2019, https://pib.gov.in/Pressreleaseshare.aspx?PRID=1558885.

33. S Can Gülen, *Gas Turbines for Electric Power Generation* (Cambridge: Cambridge University Press, 2019), 2.

34. Central Electricity Regulatory Commission, Notification Number No. L-1/144/2013/CERC, dated 21 February, 2014, 14.

35. Gülen, *Gas Turbines for Electric Power Generation*, 2. In a combined-cycle power plant, which is primarily fed by natural gas, the waste heat generated by the gas turbines after the production of electricity is re-routed to steam turbines to produce additional electricity.. In this way, a combined-cycle power plant can produce approximately 50 per cent more electricity than its predecessor, the simple-cycle gas plant.

36. Standing Committee on Energy, *Stressed/Non-Performing Assets in Gas based Power Plants*, 42nd Report, Ministry of Power (New Delhi: Lok Sabha Secretariat, 2018), 8.

37. Standing Committee on Energy, *Stressed/Non-Performing Assets in Gas based Power Plants*, 11–13.

38. Lydia Powell and Akhilesh Sati, "Natural Gas in India: From Cinderella to Goldilocks", accessed 21 March, 2021, https://www.orfonline.org/expert-speak/natural-gas-india-cinderella-goldilocks-66385/.

39. Department of Commerce, Ministry of Commerce & Industry, Government of India, "Export-Import Data Bank", 2000.. https://tradestat.commerce.gov.in/eidb/default.asp. This purchase could have originated from a third party and resold to India at the Zeebrugge Hub in Belgium.

40. Department of Commerce, "Export-Import Data Bank", 2004. https://tradestat.commerce.gov.in/eidb/default.asp.

41. Department of Commerce, Ministry of Commerce & Industry, Government of India, "Export-Import Data Bank", 2021. https://tradestat.commerce.gov.in/eidb/default.asp.

42. Department of Commerce, "Export-Import Data Bank", 2021.

43. International Energy Agency, *India 2020: Energy Policy Review*, (2020): 271–282.

44. Hazboun and Boudet, "Natural Gas", 10.

45. Saurabh Kumar, "Why Indian Investments in Mozambique Are Facing Bad Weather", *The Financial Express*, 20 January 2018. https://www.financialexpress.com/economy/why-indian-investments-in-mozambique-are-facing-bad-weather/1022670/.

46. British Petroleum, *Statistical Review of World Energy 2011*, 32.

47. Chandra Bhushan, "SDGs for Energy Security and Governance – Examining Impact of Energy on SDG Goals in India", online panel-discussion on *Climate Change and Sustainable Development in India's Energy Security Agenda*, webinar organised by The Energy and Resources Institute (TERI), 19 November 2020.

48. Timothy J Foxon, "Technological and Institutional 'lock-in' as a barrier to sustainable innovation", *ICCEPT Working Paper* (November 2002): 2–4, https://www.imperial.ac.uk/media/imperial-college/research-centres-and-groups/icept/7294726.PDF.

49. Jitendra Roychoudhury, "SDGs for energy security and governance – Examining impact of energy on SDG goals in India," online panel-discussion on *Climate change and sustainable development in India's energy security agenda*, webinar organised by The Energy and Resources Institute (TERI), 19 November 2020.

50. Press Release by the Petroleum and Natural Gas Regulatory Board, New Delhi, accessed 22 February, 2019, https://www.pngrb.gov.in/pdf/cgd/bid10/PressRelease26022019.pdf.

51. Press Trust of India, "India to Launch 11th City Gas Licensing Round Soon: Dharmendra Pradhan", *Livemint*, 10 September 2020. https://www.livemint.com/industry/energy/india-to-launch-11th-city-gas-licensing-round-soon-dharmendra-pradhan-11599730402140.html.

52. "What is the Status of Air Pollution in Delhi?", Q&A, Centre for Science and Environment, accessed 21 May, 2021, https://www.cseindia.org/what-is-the-status-of-air-pollution-in-delhi-835.

53. Speight, *Natural Gas*, 20–21.

54. According to Mayrhofer and Gupta (2016), co-benefits may refer to "*the positive effects that a policy or measure aimed at one objective might have on other objectives, irrespective of the net effect on overall social welfare*".. Jan P Mayrhofer and Joyeeta Gupta, "The Science and Politics of Co-benefits in Climate Policy", *Environmental Science and Policy* 57 (2016): 22–30, http://dx.doi.org/10.1016/j.envsci.2015.11.005.

55. Ronak Shah, "Government Finally Wakes up: Sets a Realistic Goal of 30% Electric Vehicles by 2030 from Existing 100% Target", *The Financial Express*, 08 March 2018. https://www.financialexpress.com/auto/car-news/government-finally-wakes-up-sets-a-realistic-goal-of-30-electric-vehicles-by-2030-from-existing-100-target/1091075/.

56. Shalini Sharma, "India Has So Far Installed 933 EV Charging Stations across the Country: CEA", PSU Watch, accessed 01 May, 2021, https://psuwatch.com/india-installed-ev-charging-stations-933-cea#.

57. "India's Intended Nationally Determined Contribution: Working Towards Climate Justice", INDCs as communicated by Parties, United Nations Framework Convention on Climate Change, accessed 04 May, 2021, https://www4.unfccc.int/sites/ndcstaging/PublishedDocuments/India%20First/INDIA%20INDC%20TO%20UNFCCC.pdf.

58. Central Electricity Authority, "Installed Capacity Report, March 2016 and March 2021", Ministry of Power, Government of India, accessed 29 April, 2021, https://cea.nic.in/installed-capacity-report/?lang=en.

59. T E Narasimhan, "India to Spend Rs 7.5 Trillion on Oil and Gas Infra in Next 5 Yrs: PM Modi", *Business Standard*, 17 February 2021. https://www.business-standard.com/article/economy-policy/india-to-spend-rs-7-5-trillion-on-oil-and-gas-infra-in-next-5-yrs-pm-modi-121021700989_1.html.

60. Karunjit Singh, "Explained: What Start of Gas Production in KGD6 Means for India", *The Indian Express*, 20 December 2020. https://indianexpress.com/article/explained/explained-what-start-of-gas-production-in-kgd6-means-for-india-7110542/.

61. Ministry of Petroleum and Natural Gas, "Natural Gas Marketing Reforms," *The Gazette of India*, 15 October, 2020. http://dghindia.gov.in/assets/downloads/5ffbe7fa78f17NaturalGasMarketingReforms15102020.pdf.

62. Press Trust of India, "Oil Regulator PNGRB Simplifies Gas Pipeline Tariff", *The Indian Express*, 26 November 2020. https://economictimes.indiatimes.com/industry/energy/oil-gas/oil-regulator-pngrb-simplifies-gas-pipeline-tariff/articleshow/79431453.cms?from=mdr.

About the Author

Dr. Oliver Nelson Gonsalves is a Research Fellow and the Head of the Maritime Energy-Security and Security-of-Energy (MESSE) Cluster at the National Maritime Foundation (NMF). He leads the NMF's study into the maritime facets of energy. He can be contacted at associatefellow1.nmf@gmail.com

Note

This article was first published on the Website of the National Maritime Foundation on 10 August 2021

Crude-Oil Storage in an Era of Plenty: India's Strategic Petroleum Reserves

Dr Oliver Nelson Gonsalves

In April 2020, the US, China and India – the world's three largest oil consumers – evinced keen interest to fill their respective Strategic Petroleum Reserve (SPR) sites with cheap oil that had flooded the market after Saudi Arabia and Russia went on a production overdrive to increase their market share. As the world's third largest crude oil consumer, oil-deficient India is heavily dependent on imports. In 2018, India imported 83 per cent of its total annual crude oil requirement.[1] In Financial Year (FY) 2019-20, India imported crude oil worth Rs. 7,16,627 crores (US$ 101.38 billion). In the same period, India also imported petroleum products worth Rs. 1,26,954 crores (US$ 17.85 billion).[2] Such a high dependence on imports to support its burgeoning economy makes India particularly sensitive to an increase in global crude oil prices. India's import bill surges by US$ 1 billion for every US$ 1 increase in the price of crude oil per barrel.[3]

Events since January 2020 have revealed an unfamiliar corollary to the debate on energy security – the issue of excess oil during the interruption of supply. Here, the SPR, with the largest storage capacity in India, is expected to play a pivotal role in absorbing large volumes of cheap crude oil for Indian refiners. With excess crude oil in the global market, coupled with the drastic reduction of consumption in the wake of the COVID-19 pandemic and the resultant curtailment of seaborne transport, have led to a phenomenon hitherto unseen in the 160 years since the beginning of the mass production of crude oil. The resulting historically low oil prices have set off a panicked scramble to acquire suitable capacity for the storage of surplus crude oil stocks, be this by way of oil tankers, rail wagons, surface / underground tanks or caverns. In this context, this article focuses on the SPR — its features, relevance to large crude-oil importing nations and its significance in enhancing India's energy security. It assesses the impact of low oil prices on global oil trade in general and storage capacity in particular.

Features of a Strategic Petroleum Reserve

A Strategic Petroleum Reserve (SPR) is a stockpile / hoard of crude oil and petroleum products. It is the primary emergency response measure to assuage brief interruptions in a country's import of crude oil and petroleum products. Designed by the International Energy Agency (IEA) as the first of a two-part system to hedge against geopolitical threats to the supply of crude oil imports from the oil-producing nations in West Asia, this mechanism is increasingly being adopted by countries other than those belonging to the Organisation for Economic Co-operation and Development (OECD) for whom it was originally intended.[4] Demand-restraint measures like fuel rationing, prioritising fuel for essential services, fuel switching, etc., are secondary measures to moderate interim supply disruptions.

Diesel, petrol (gasoline), aviation turbine fuel (jet fuel), heavy fuel oil (HFO),[5] kerosene, naphtha,[6] heating oil, lubricants, liquid petroleum gas (LPG) and asphalt are some of the commodities that are derived from refining crude oil. These petroleum products are essential not only for the transportation sector but also for construction, manufacturing, defence, agriculture, and households. However, the relatively short shelf life of most petroleum products makes crude oil (with a shelf life of more than five years) the most suitable commodity for long-term SPR. Conversely, liquefied natural gas (LNG) simply cannot be stored for an extended period.[7]

Crude oil and petroleum products are stored in underground caverns (deep subterranean cavities), tanks and even oil tankers. Among these alternatives, caverns offer the most viable option for the long-term storage of crude oil. It entails the injection of free-flowing unrefined crude oil into deep cavities drilled into salt domes or rock. The oil can be maintained in a liquid state for years, even decades![8] SPR costs vary. In 2017, the cost of the construction of storage tanks on the surface was

US$ 15-18 per barrel, while the construction of storage capacity in rock caverns amounted to more than US$ 30 per barrel. At US$ 1.5 per barrel, storage in underground salt caverns is by far the cheapest storage option due to their capacity to store very large volumes of crude oil and their low-maintenance requirements.[9]

Cavern storage is optimum for the long-term storage of crude oil and its associated products. Nevertheless, experts caution against frequent withdrawals of SPR inventories. Contrary to popular belief, each underground cavern storage unit is designed for a limited number of *drawdown cycles*.[10] Each cycle comprises a large-scale withdrawal of the stockpiled commodity for dissipation on the open market or directed to the refineries of the country that owns either the stock or the storage capacity.

Typically, the location of the site hinges on three crucial elements:[11]

- **Ease of Transport**: Ports — with adequate facilities to offload crude oil — should connect to an SPR site through the most convenient mode of transport (rail, road, pipeline or shipping). Adequate connectivity should also be created with immediate refineries.

- A site should be sufficiently protected from external attack and resilient to extreme climatic and geological conditions.

- **Location distribution**: Proximity to several major centres of demand as well as arterial supply routes can ensure rapid dispersal and re-supply.

At the time of its inception, the IEA determined that member countries should create a stockpile of crude oil that could last up to three months following the disruption of regular supply. This 90-day stockpile was to be adjusted according to demand from the previous year. Mindful of the risk of misuse, the IEA recommends that stocks from the SPR be released only to counter *physical shortages* of crude oil. These emergency stocks are *not* to be used as instruments to neutralise price volatility or bridge long-term supply deficits. Countries with SPRs must shepherd resources against their misappropriation to satisfy domestic populist objectives.[12] But, the downward trend of oil prices for the past two years — reflecting the availability of alternate sources — exposes the vulnerabilities of this mechanism and its high sunken costs. That brings one to the question of how India justifies its pursuit of such a venture.

Strategic Petroleum Reserves of India – Making the Most of Marginal Capacity

At present, India's SPR sites at Padur (Karnataka), Vishakhapatnam (Andhra Pradesh) and Mangaluru (Karnataka), have a combined capacity of 39.14 million barrels (MMbbl) [Figure 1]. These facilities were completed in 2015, under Phase I of India's SPR programme, which began in 2008. To streamline the construction of

Figure 1. Strategic Petroleum Reserves of India (established and proposed)
Base Map: https://d-maps.com/carte.php?num_car=284&lang=en; along with the author's inputs.

this critical infrastructure, India established the Indian Strategic Petroleum Reserve Limited (ISPRL), a Special Purpose Vehicle (SPV), as a wholly-owned subsidiary of the Oil Industry Development Board (OIDB).[13] The OIDB, in turn, is under the administrative control of the Ministry of Petroleum & Natural Gas (MoP&NG), which, among its other responsibilities, synchronises the conveyance of crude oil and its storage in India.[14] As of March 2019, the ISPRL had invested Rs 4098.35 crore (around US$ 661 million; US$ 1 = ₹62) in the three facilities under Phase I.[15]

Figure 1 also depicts Phase II of India's SPR programme, which envisages an additional 47.64 MMbbl of storage capacity.[16] This includes the construction of a new facility at Chandikhol and the expansion of storage capacity at Padur on the west coast to store 36.65 MMbbl instead of the previous 18.37 MMbbl capacity. Such an expansion of petroleum storage capacity is expected to enhance the country's stockpile within these strategic reserves to last for twenty two days instead of the earlier ten days (based on consumption figures for 2016-17).[17]

Although India planned to stockpile 132 million barrels, protracted delays in processing approvals have led to just a marginal creation of the initial target capacity.[18] Early analyses of the use of India's SPR speculated that available stocks would be used to reduce price volatility for domestic refiners.[19] However, the high costs of crude oil prevailing at the time of the commissioning of these facilities prevented the immediate filling of these facilities. Instead, India has decided to *lease* these storage capacities to Indian refiners and foreign suppliers.[20] For instance, under the terms of the 7-year agreement signed during Prime Minister Narendra Modi's visit to Abu Dhabi in February 2018, the Abu Dhabi National Oil Company (ADNOC) may sell one-third of its inventory to Indian refiners and can only re-export it after the termination of the contract. Additionally, during an emergency, India has the first right to purchase this inventory at the prevailing market price.[21]

Such an operating model encompasses the following attributes:

- As oil production increases, the lessee (any oil-producing nation / Indian refiner) has a large and safe storage space available near its centres of demand.

- The lessor (ISPRL) earns revenue as the lessee pays for maintenance of the inventory, which can also be made available to Indian refiners during an emergency.

At first, Iraqi Basra Light crude oil was contracted by Hindustan Petroleum Corporation Limited (HPCL) for storage in the Vishakhapatnam SPR in June 2015.[22] India also sourced Iranian crude oil from the National Iranian Oil Company (NIOC) to fill up one storage unit at the Mangaluru SPR at the cost of Rs. 1754 crore (roughly US$ 230 million) in 2016. However, the re-imposition of the US-led trade embargo on Iran drove India to rely heavily on the benchmark Murban oil supplied by ADNOC.[23] Out of the 11 MMbbl capacity available at the Mangaluru SPR, ADNOC was contracted to supply 5.8 MMbbl by November 2018. Furthermore, Saudi Arabia's national oil company (NOC) – Saudi Aramco – leased a portion of the Padur SPR in October 2019 to store 4.6 MMbbl of crude.[24]

Initial optimism to fill India's SPR with leases to Saudi Arabia and the United Arab Emirates were dampened after the latter two countries sought larger incentives to store their oil. With the Chinese making a large play to secure cheap oil into their SPR, the two countries probably figured that they could get a better price for their product. Consequently, in the second week of April 2020, instead of making direct purchases, India's MoP&NG diverted a part of the oil already purchased by Indian refiners from Iraq, Saudi Arabia and the United Arab Emirates (UAE) – some 19 MMbbl – for storage in the SPRs.[25] Diversion of purchases saves the refiners' freight charges for floating storage (tankers) since onshore tanks are at capacity due to the nearly 70 per cent fall in demand following the imposition of a nationwide COVID-19 lockdown in India on 25 March, 2020.[26,27]

The drastic fall in crude oil prices allows India to source cheaper oil that can be stored for a rainy day. To put it simply, India has struck gold. With average oil prices falling below US$ 20 per barrel by end-March 2020, ISPRL's resistance to filling up the half-empty SPR capacity when average prices were less than US$ 60 per barrel seems to have hit pay dirt. For instance, the entity could have purchased crude oil at US$ 45 per barrel in June 2017 or at US$ 51 per barrel in December 2018. Yet, its forbearance has led to billions of dollars in savings for India, and, for the first time since their commissioning in 2015-16, India's SPR inventory is at its maximum storage capacity.[28]

What about the US? How is the US faring with its desire to soak up cheap oil into their own SPR inventories? This section addresses this question and analyses the significance of the SPR amongst the world's two largest oil consumers. The USA, which was, like India, one of the top importers of crude-oil and had consequently created the world's largest SPR, before turning into a net exporter and is now reinventing the SPR concept as a whole.

USA's Strategic Petroleum Reserve

Spread across the states of Texas and Louisiana, the Strategic Petroleum Reserve (SPR) of the USA consists of four sites, all close to the Gulf of Mexico, where crude oil is stored in 60 underground salt caverns (Figure 1).[29] These caverns range in capacity from 6 to 37 million barrels. A typical cavern holds 10 million barrels and is cylindrical in shape, with a diameter of 200 feet and a height of 2,500 feet.[30]

Map Source: US Department of Energy, Sandia National Laboratories, as cited in John Shages's *The Strategic Petroleum Reserve: Policy Challenges in Managing the Nation's Strategic Oil Stock*

Strategic Petroleum Reserve of the USA

> *"Besides being the lowest cost way to store oil for long periods of time, the use of deep salt caverns is also one of the most environmentally secure. At depths ranging from 2,000 to 4,000 feet, the salt walls of the storage caverns are 'self-healing'. The extreme geologic pressures make the salt walls rock hard, and should any cracks develop in the walls, they would be almost instantly closed. An added benefit of deep salt cavern storage is the subsurface temperature differential between the top of the cavern and the bottom, a distance of approximately 2,500 feet. The temperature differential keeps the crude oil continuously circulating in the caverns, maintaining the oil at a consistent quality. The fact that oil floats on water is the underlying mechanism used to move oil in and out of the SPR caverns. To withdraw crude oil, fresh water is pumped into the bottom of a cavern. The water displaces the crude oil to the surface. After the oil is removed from the SPR caverns, pipelines send it to various terminals and refineries around the nation."*[31]

The establishment of the USA's SPR came about in the immediate aftermath of the decline of domestic oil production in the late 1970s, after its peak of 9.637 million barrels of oil per day (MMbbl/d) that had been registered at the very beginning of that decade. This decline in indigenous production was doubly worrying, since it coincided with the 1970s oil crises (the 1973 crisis was triggered by the Yom Kippur War, while the 1979 crisis resulted from the Iranian Revolution),[32] as also with the intensifying of the domestic demand for crude oil and petroleum products in the mid-to-late 1970s (the demand was 18.43 MMbbl/d in 1977, peaked at 20.80 MMbbl/d in 2005 and was an estimated 20.46 MMbbl/d in 2019).[33] *President Gerald Ford established the SPR when he signed the Energy Policy and Conservation Act into law. This was done in response to the oil embargo of 1973-1974 and the severe effect it had on the US economy. It mandates that the United States maintain a stockpile of one billion barrels of petroleum, which is the largest emergency supply in the world. The first import-shipment of oil, from Saudi Arabia, was delivered into the USA's SPR on 21 July, 1977.*[34]

Although the US SPR was initially planned to accommodate one billion barrels of crude oil, limitations in physical design restricted the storage capacity of each SPR site to a maximum of 750 MMbbl, which was achieved in 1991 after the anticipated shortfall of supply from West Asia due to the First Gulf War.[35] Based on consumption data, inventories in the SPR must consist a minimum stock of 350 MMbbl.[36] The Department of Energy (DOE) manages the SPR of the United States.

Consequently, the commodities held within the SPR are government-owned stocks.[37] Physical limitations notwithstanding, the stockpile held by the US is the world's largest. In December of 2009, the SPR sites, taken in aggregate, accommodated 726.6 MMbl — the largest volume ever held.[38] This build-up of the US SPR was probably a response to the 'Demand Shock' of 2008-09 — it would be recalled that in July of 2008, the international price of crude oil had hit an all-time high of US$ 148 per barrel. Absorption of larger volumes also coincided with the requirement to *re-stock* an estimated 16.07 MMbbl of crude oil inventory that had been released to US refineries in the aftermath of the massive supply disruptions caused by Hurricane *Katrina* in 2005, and Hurricanes *Ike*, and *Gustav* in 2008.[39]

In addition, the SPR received 8.7 MMbbl from the long-deferred Royalty-In-Kind (RIK) programme. This programme mandates that companies involved in Exploration and Production (E&P) activities in the USA's Outer Continental Shelf must pay the US federal government up to 16.7 per cent in royalties in the form of crude oil.[40] Thus, through a combination of the repayment of supplies that had been loaned to US refineries — including 120,000 barrels in interest — after Hurricanes *Gustav* and *Ike*, direct purchases were made from the revenue that had been earned from the sale of crude oil following Hurricane *Katrina*, and, the RIK oil, the inventory of the USA's SPR grew by a staggering 24.8 MMbbl in 2009 alone.[41] The decision to stockpile such large volumes of crude oil, in excess of the USA's daily consumption in 2009, was vindicated just two years down the line — in June of 2011 — when, following the disruption of sweet crude supplies from Libya during the civil war there, the US federal government released 30 MMbbl of sweet crude oil from the SPR to US refiners.[42] Once American refiners absorbed these inventories — released in conjunction with the International Energy Agency's (IEA) Emergency Response Drawdown — it reduced their demand for sweet crude, thereby preventing any surge of international sweet crude oil prices as had occurred in 2008-09.[43]

At present (April, 2020), the maximum available storage capacity of the USA's SPR is 713.5 million barrels.[44] As of 17 April, 2020, the inventory held in the USA's SPR was 635 million barrels, which is the equivalent of more than 1069 days of net US oil imports (import protection). This means that if all supply of crude oil imports to the USA were to be totally disrupted, the country's SPR can supply crude oil to US refineries for an astounding 1069 days![45][17] The USA's inventory of the

SPR far exceeds the 90-day minimum stipulated requirement for import protection based on the previous year's consumption as laid down by the IEA.[46] How did the USA land up in this situation? Even more importantly, how might it seek to get out of it and how might its choices impact the very concept of an SPR?

In 1975, at the time of the creation of the first SPR site, the US was importing 4.099 million barrels of crude oil per day (MMbbl/d). (By way of comparison, this is only slightly less than the 4.55 MMbbl/d that India currently imports).[47] By 1977, US imports had climbed to 6.56 MMbbl/d. They peaked, in 2005, at 10.09 MMbbl/d (which amounted to almost 48.50 per cent of the total US crude-oil demand. This, in turn, corresponded with the USA's lowest ever level of indigenous production of crude oil, which, in 2005, was 3.81 MMbbl).[48] The USA's indigenous production of crude oil remained a dismal one and even in 2008, when the 'demand shock' hit, indigenous production was still a paltry 3.84 MMbbl/d.[49] Fortuitously, however, this was precisely when the science underpinning the extraction of shale oil (and shale gas) was established as being a commercially viable process. This launched the 'shale revolution' as it was called, and US indigenous production of crude-oil sky-rocketed.[50] In just a decade, the US reversed its high import dependence by expanding the domestic production of crude oil. In February of 2020, the country produced an all-time high of 13 MMbbl/d.[51] and now meets 94 per cent of its total daily consumption needs.[52]

Escalating domestic oil production and decreasing domestic demand for imported petroleum products have bolstered the country's position as a net oil exporter since 2010.[53] This newfound role of being a net exporter of crude oil has led to major criticism — comprising appeals for extensive contraction of capacity and even complete closure — of the vast and expensive SPR programme.[54] The expense factor cannot be underplayed. In 2017 alone, the annual maintenance costs of the USA's SPR — the world's largest artificial reserve of crude oil — totalled US$ 220.8 million.[55]

Seeking a way out, successive US administrations have been trying to transform the conceptual rationale underpinning the creation of the SPR. It was no longer to be a cushion designed to protect the USA by allowing it to continue to meet its domestic demand by dipping into a 'reserve' even when faced with supply disruptions resulting from external geopolitical instability. Instead, it was to now be merely a gigantic storage facility that could meet the demand of the US refineries at an appropriate cost. In other words, it would now be a 'revenue earner' for the US Treasury. It would, additionally, be able to compensate for disruptions to the production and supply of domestically-produced crude-oil as a result of natural disasters.[56]

Accordingly, the federal government negotiated the reduction of SPR inventories, so as to earn revenue for the US Treasury and to simultaneously pay for the cost of modernising a smaller but more technologically roust SPR.[57] The technical modernisation of the SPR sites was necessary because, as things currently stood, minor but frequent withdrawals of SPR stocks tended to cause geological and structural damage to the storage caverns.[58] Since 2017, the regulated sale, in the open market, of crude oil from SPR sites has increased the generation of revenue for a string of initiatives in healthcare, roadways, water resources development, etc.[59] The federal government intends to *sell* over 250 MMbbl of crude oil from its SPR inventories by 2028.[60] As of 2019, the US government has earned more than US$ 1.5 billion in revenues from the sale of SPR crude oil.[61] Further, the monetisation of surplus storage capacity by leasing it, on commercial terms, to American oil producers and foreign governments is expected to bring in additional revenue for the federal government.[62] In March 2020, Australia was negotiating a ten-year lease of storage capacity – worth US $59 million – from the US SPR as the former's commercial storage, comprising surface tanks, were already filled to their maximum capacity.[63]

The current global economic collapse, engendered by the COVID-19 pandemic, has very serious implications for US shale-oil manufacturers. The average breakeven price for shale-oil drilling and production is between US$ 45 to US$ 50 a barrel.[64] *"Just five shale drillers—Exxon, Chevron, Occidental, and Crownquest—can drill new wells at a profit at $31 per barrel of West Texas Intermediate."*[65] It is for this precise reason that President Trump attempted to make a U-turn on the whole SPR reassessment by trying to purchase an estimated 77 MMbbl for the SPR — a bid to increase global crude oil prices by creating an artificial demand. The idea was to assist small American shale oil producers affected by plummeting crude oil prices. However, the administration failed to acquire the requisite funding from the US Congress, which, in turn, felt that any federal assistance would resemble a populist Band-Aid solution to a failing industry, unable to compete with cheap oil from foreign sources.[66]

After the US Congress rejected the Trump administration's proposal for direct purchases in March 2020, the President floated the idea of leasing storage capacity (for up to 30 MMbbl) to American shale oil producers. However, the lukewarm response to the government's new proposal suggests the industry's concern about who will foot the bill for transport. So, what does all this say about the future of SPRs? It seems obvious that once a country's dependence upon the import of crude oil becomes negligible, the rationale for the creation of an SPR no longer holds. But what of SPR facilities that were already created when the need was great, but the need then diminishes to nearly zero? How much SPR should a nation create if it hopes, in the near future, to achieve a sharply-reduced import-dependence upon crude-oil? What lesson should Indian policy-makers draw in this regard? As has been shown, maintaining an SPR is an expensive business. The larger the SPR capacity and the more geographically-dispersed the sites are, the costlier is the maintenance. If India is seriously hoping for near-term success in substituting crude-oil with natural gas or with renewables, then should the government not adopt a 'minimalist' approach to SPR? If the US example is anything to go by, the difference in scale notwithstanding, the answer appears to be a 'Yes'.

ENDNOTES

1. India 2020: Energy Policy Review, International Energy Agency, 2020, 251. https://webstore.iea.org/download/direct/2933?fileName=India_2020_Energy_Policy_Review.pdf.
2. Data for Crude and Products, Petroleum Planning & Analysis Cell, Ministry of Petroleum & Natural Gas, Government of India, https://www.ppac.gov.in/content/212_1_ImportExport.aspx.
3. Kapil Narula, "Time to fill up India's strategic oil reserves," *Oxford Energy Forum*, Issue 99 (February 2015): 10-12 https://ora.ox.ac.uk/objects/uuid:5d99813d-7b62-4a55-9b0d-c1b12563de72.
4. The Organisation for Economic Co-operation and Development (OECD) is a 36-member international organisation that was formed in 1961 with the objective of promoting economic development through the adoption of co-ordinated international policies. Its member

nations are drawn from the world's developed economies. The International Energy Agency (IEA) was created in 1974 to foster energy security among the oil-importing nations in the developed world. Non-OECD members cannot become gain membership of the IEA.

5. Heavy Fuel Oil (HFO) or marine/bunker fuel is the most common fuel in shipping.

6. Naphtha has several applications. It may be used as a raw material to produce solvents or gasoline, or for the dilution of heavy crude oil to enable its transportation through ship or pipeline.

7. Suguru Kurimoto, "Hidden threat: Japan has only 2-week stockpile of LNG," *Nikkei Asian Review*, 23 April 2020. https://asia.nikkei.com/Business/Energy/Hidden-threat-Japan-has-only-2-week-stockpile-of-LNG2.

8. John Shages, "The Strategic Petroleum Reserve: Policy Challenges in Managing the Nation's Strategic Oil Stock," accessed April 12, 2020: 3-6. https://eprinc.org/2014/07/strategic-petroleum-reserve-policy-challenges-managing-nations-strategic-oil-stock/#sthash.QEWiwDcS.dpbs.

9. Xilin Shi, Wei Liu, Jie Chen, et al., "Geological Feasibility of Underground Oil Storage in Jintan Salt Mine of China," *Advances in Materials Science and Engineering*, Volume 2017: 2, https://doi.org/10.1155/2017/3159152.

10. John Shages, "The Strategic Petroleum Reserve," 3.

11. H Li, Sun, R., Dong, K. et al., "Selecting China's strategic petroleum reserve sites by multi-objective programming model," Petroleum Science 14, 2017: 623, https://doi.org/10.1007/s12182-017-0175-0.

12. Varun Sivaram, "The Strategic Petroleum Reserve: A Policy Response to Oil Price Volatility?," Council on Foreign Relations, June 15, 2016, blog post, https://www.cfr.org/blog/strategic-petroleum-reserve-policy-response-oil-price-volatility.

13. A Special Purpose Vehicle (SPV) is an entity created to focus on one task alone. In this case, ISPRL is charged only with the construction of storage capacity and the management of inventory.

14. Annual Report, Oil Industry Development Board (OIDB), Ministry of Petroleum & Natural Gas, Government of India, 2018-2019: 7 http://www.oidb.gov.in/WriteReadData/LINKS/Annual_Report_201984be2034-4e81-4521-a9e7-de7327943909.pdf.

15. "Key Features," Indian Strategic Petroleum Reserves Limited (ISPRL), accessed April 14, 2020, http://www.isprlindia.com/vishakhapatnam-site.asp.

16. “Cabinet approves establishment of additional 6.5 MMT Strategic Petroleum Reserves at Chandikhol in Odisha and at Padur, Karnataka,” Press Information Bureau, Government of India, accessed April 15, 2020, https://pib.gov.in/newsite/PrintRelease.aspx?relid=180215.

17. Ibid.

18. Blake Clayton, “Lessons Learned From the 2011 Strategic Petroleum Reserve Release,” Council on Foreign Relations, Working Paper, September 10, 2012, https://www.cfr.org/report/lessons-learned-2011-strategic-petroleum-reserve-release.

19. Blake Clayton, “Lessons Learned From the 2011 Strategic Petroleum Reserve Release,” 17.

20. Kapil Narula, “Time to fill up India’s strategic oil reserves,” 11.

21. Florence Tan, “ADNOC to fill up Mangalore oil reserves in Nov: Indian officials,” *Reuters*, in *The Economic Times*¸ October 28, 2020. https://energy.economictimes.indiatimes.com/news/oil-and-gas/adnoc-to-fill-up-mangalore-oil-reserves-in-nov-indian-officials/66397925.

22. “IOC to import Iraqi oil for India’s maiden strategic reserve,” PTI, *The Economic Times*, last updated June 03, 2015 https://economictimes.indiatimes.com/industry/energy/oil-gas/ioc-to-import-iraqi-oil-for-indias-maiden-strategic-reserve/articleshow/47529587.cms?from=mdr.

23. Annual Report, Oil Industry Development Board (OIDB),

24. “Saudi Aramco to store 4.6 Mn barrels of oil in India’s Padur reserve,” *Reuters*, in *Business Today*, last updated October 30, 2019 https://www.businesstoday.in/current/economy-politics/saudi-aramco-to-store-46-mn-barrels-of-oil-in-indias-padur-reserve/story/387458.html.

25. “India uses low crude prices to stockpile 32 million tonnes of oil,” PTI, *Business Insider India*, May 05. 2020, https://www-businessinsider-in.cdn.ampproject.org/v/s/www.businessinsider.in/india/news/india-uses-low-crude-prices-to-stockpile-32-million-tonnes-of-oil/amp_articleshow/75545968.cms?usqp=mq331AQFKAGwASA%3D&_js_v=0.1.

26. “India shuns Gulf producers, diverts refiners’ oil to SPR”, *Reuters*, in *Energy World*, April 09, 2020, https://energy.economictimes.indiatimes.com/news/oil-and-gas/india-shuns-gulf-producers-diverts-refiners-oil-to-spr/75063458.

27. “Oil, gas demand 70% down but India filled its strategic reserves: Pradhan,” ANI, *Hindustan Times Auto News*, May 4, 2020, https://auto-hindustantimes-com.cdn.ampproject.org/v/s/auto.hindustantimes.com/auto/news/oil-gas-demand-70-down-but-india-filled-its-strategic-reserves-pradhan/amp-41588591926405.html?usqp=mq331AQFKAGwASA%3D&_js_v=0.1#aoh=15886986182814&referrer=https%3A%2F%2Fwww.google.com&_tf=From%20%251%24s&share=https%3A%2F%2Fauto.hindustantimes.

com%2Fauto%2Fnews%2Foil-gas-demand-70-down-but-india-filled-its-strategic-reserves-pradhan-41588591926405.html.

28. "India uses low crude prices to stockpile 32 million tonnes of oil," PTI, *Business Insider India*, May 05. 2020, https://www-businessinsider-in.cdn.ampproject.org/v/s/www.businessinsider.in/india/news/india-uses-low-crude-prices-to-stockpile-32-million-tonnes-of-oil/amp_articleshow/75545968.cms?usqp=mq331AQFKAGwASA%3D&_js_v=0.1.

29. US Department of Energy, "SPR Storage Sites," Strategic Petroleum Reserve, Office of Fossil Energy, US Department of Energy https://www.energy.gov/fe/services/petroleum-reserves/strategic-petroleum-reserve/spr-storage-sites.

30. Ibid.

31. Ibid. Strategic Petroleum Reserve: SPR Storage Sites.

32. Time Magazine Archives, "Oil Squeeze: Ripples from Iran", 05 Feb 1979, https://web.archive.org/web/20080307085655/http://www.time.com/time/magazine/article/0%2C9171%2C946222%2C00.html.

33. US Energy Information Administration, Monthly Energy Review, Table 3.1, March 2020, preliminary data for 2019.

34. CNN Editorial Research, "Strategic Petroleum Reserve Fast Facts – Timeline" (updated on 30 January 2020). https://edition.cnn.com/2013/09/02/us/strategic-petroleum-reserve-fast-facts/index.html.

35. Robert Pirog, "Strategic Petroleum Reserve: Mandated Sales and Reform," Congressional Research Service, updated October, 1, 2020, https://fas.org/sgp/crs/misc/R45577.pdf.

36. "Public Law 115-123 – Bipartisan Budget Act of 2018," 115th Congress (2017-2018), Section 30204, https://www.congress.gov/115/plaws/publ123/PLAW-115publ123.pdf.

37. US Department of Energy, "About the SPR", Strategic Petroleum Reserve, Office of Fossil Energy, https://www.energy.gov/fe/services/petroleum-reserves/strategic-petroleum-reserve.

38. Pirog, "Strategic Petroleum Reserve: Mandated Sales and Reform," (Supra Note 7).

39. US Department of Energy, "History of SPR Releases," Strategic Petroleum Reserve, Office of Fossil Energy, https://www.energy.gov/fe/services/petroleum-reserves/strategic-petroleum-reserve/releasing-oil-spr#2005Katrina.

40. US Department of Energy, "Filling the Strategic Petroleum Reserve," Strategic Petroleum Reserve, Office of Fossil Energy, US Department of Energy, https://www.energy.gov/fe/services/petroleum-reserves/strategic-petroleum-reserve/filling-strategic-petroleum-reserve.

41. US Department of Energy, *Strategic Petroleum Reserve Annual Report for Calendar Year 2009*, Office of Petroleum Reserves, DOE/FE – 0538, https://www.energy.gov/sites/prod/files/2015/02/f20/2009%20SPR%20Annual%20Report.pdf.

42. *Crude oil is broadly divided into sour (heavy) crude and sweet (light) crude based on their sulphur content. Sweet crude is easier to refine due to its low sulphur content and is thus more expensive than sour varieties.*

43. Clayton Blake, "Lessons Learned From the 2011 Strategic Petroleum Reserve Release," Council on Foreign Relations, Working Paper, September 10, 2012, 3-5, https://www.cfr.org/report/lessons-learned-2011-strategic-petroleum-reserve-release.

44. US Department of Energy (DOE), "SPR Quick Facts" https://www.energy.gov/fe/services/petroleum-reserves/strategic-petroleum-reserve.

45. *Ibid.* https://www.energy.gov/fe/strategic-petroleum-reserve.

46. International Energy Agency (IEA), "Oil security: The Global Oil Market Remains Vulnerable to a Wide Range of Risk Factors", https://www.iea.org/areas-of-work/ensuring-energy-security/oil-security.

47. Government of India, Ministry of Petroleum & Natural Gas, Petroleum Planning & Analysis Cell, "Import/Export", https://www.ppac.gov.in/content/212_1_ImportExport.aspx.

48. Macrotrends website, "U.S. Crude Oil Production – Historical Chart", https://www.macrotrends.net/2562/us-crude-oil-production-historical-chart.

49. Macrotrends *Ibid*.

50. US Energy Information Administration, *Monthly Energy Review*, Table 3.1, March 2020, preliminary data for 2019.

51. Macrotrends website (Supra Note 15).

52. US Energy Information Administration, *Monthly Energy Review*, Tables 3.3b and 3.3e, April 2020, preliminary data for 2019 https://www.eia.gov/energyexplained/oil-and-petroleum-products/imports-and-exports.php.

53. Carlos Pascual, "The New Geopolitics of Energy," Center on Global Energy Policy, School of International and Public Affairs, Columbia University (September 2015), https://relooney.com/NS3040/000_New_2395.pdf.

54. Steve Hanke, "Trump: Transform the U.S. Strategic Petroleum Reserve into An Oil Bank," Forbes, 27 September 2019. https://www.forbes.com/sites/stevehanke/2019/09/27/trump-transform-the-us-strategic-petroleum-reserve-into-an-oil-bank/#4602dbc93279.

55. "Strategic Petroleum Reserve Annual Report for Calendar Year 2017," Report to the US Congress, US Department of Energy, December 2018, 28, https://www.energy.gov/sites/prod/files/2019/02/f59/EXEC-2018-001277%20-%202017%20SPR%20Report.pdf.

56. Robert Pirog, "Strategic Petroleum Reserve," 1.

57. “History of SPR Releases,” Strategic Petroleum Reserve, Office of Fossil Energy, US Department of Energy, accessed May 06, 2020https://www.energy.gov/fe/services/petroleum-reserves/strategic-petroleum-reserve/releasing-oil-spr#FY-2017-Mandated-Sales.

58. John Shages, “The Strategic Petroleum Reserve,” 6. Storage in salt domes was designed only for five drawdown (removal) cycles.

59. Robert Pirog, “Strategic Petroleum Reserve,” 1.

60. Robert Pirog, “Strategic Petroleum Reserve,” 4.

61. Robert Pirog, “Strategic Petroleum Reserve,” 5.

62. “H.R.6511 – Strategic Petroleum Reserve Reform Act,” 115th Congress (2017-2018), Sec. 2, accessed April 26, 2020, https://www.congress.gov/bill/115th-congress/house-bill/6511.

63. Sonali Paul, “Australia to Spend $60 Million Buying Oil to Store in U.S. reserve,” Reuters, https://www.reuters.com/article/us-australia-oil/australia-to-spend-60-million-buying-oil-to-store-in-us-reserve-idUSKCN2240AA.

64. “The Lowest Shale Breakeven Costs Are Here”, Oil & Gas 360, Oilprice.com website, https://oilprice.com/Energy/Crude-Oil/The-Lowest-Shale-Breakeven-Costs-Are-Here.html.

65. Irina Slav, “Only 5 Shale Drillers are still Profitable at $31 Oil”, Oilprice.com website, 10 March 2020 https://oilprice.com/Latest-Energy-News/World-News/Only-5-Shale-Drillers-Are-Still-Profitable-At-31-Oil.html.

66. Devika Krishna Kumar, “Drowning in Crude, US Drillers say Trump Strategic Reserve Plan is No Lifeline,” *Forbes*, April 23, 2020 https://in.reuters.com/article/global-oil-usa-reserves/drowning-in-crude-u-s-drillers-say-trump-strategic-reserve-plan-is-no-lifeline-idINKCN2251X9.

About the Author

Dr. Oliver Nelson Gonsalves is a Research Fellow and the Head of the Maritime Energy-Security and Security-of-Energy (MESSE) Cluster at the National Maritime Foundation (NMF). He leads the NMF’s study into the maritime facets of energy. He can be contacted at associatefellow1.nmf@gmail.com

Note

This article was first published on the Website of the National Maritime Foundation on 6 May 2020

Floating Oil-Storage and its Implications on India's Energy Security

Dr Oliver Nelson Gonsalves

The disadvantages of using regular tankers for offshore storage, instead of purpose-built floating structures such as 'Floating Production, Storage, and Offloading' (FPSO) vessels. It is reiterated that the option of 'floating storage' adopted by India needs to be viewed against the backdrop of Strategic Petroleum Reserves (SPR) *per se*. While this article concentrates upon 'floating storage' as India's option of choice, the overarch is that of Strategic Petroleum Reserves (SPR). It analyses the manner in which the intersection of two extraordinary events — the COVID-19 pandemic and the oil-price war between Saudi Arabia and Russia — produced a sequence of outcomes that significantly impacted India's crude-oil vulnerability and the mitigating measures that the country adopted, with particular regard to its resort to 'floating storage'. Therefore, in charting the events that led to the creation of the most recent — and ongoing — floating storage experience in India, this article aims to offer relevant inputs to India's policymakers within the shipping and energy sectors, highlighting arguments against what, at face value, might seem like a good stop-gap measure to deal with a temporary glut of crude-oil at cheap prices in a situation where the country's limited shore-based storage facilities are full.

A brief recapitulation of the very basic features of the offshore oil-and-gas process may be useful before proceeding any further. Like its onshore counterpart, the 'offshore' production of crude oil commences with a variety of geological surveys, which are followed by the drilling of exploratory wells at specific locations within the continental shelf, which the surveys have indicated as being promising. These exploratory-wells are created by a variety of purpose-build platforms, collectively known as 'drilling rigs', whose designs vary according to the depth of water in which the drilling must be done, the nature of the seabed at the location of the exploratory well(s), and, the hydrologic and weather conditions that are expected. Once it is established that an oil-well can generate crude-oil in economically viable volumes, the 'drilling rigs' that were used for exploratory drilling are replaced by more permanent 'production platforms', and production commences. This entire set of activities — involving geological surveys, exploratory drilling, the establishing of the economic viability of the production envisaged, and, the actual production of crude-oil — is carried out by what is called the *'upstream'* sector of the oil and gas industry, and is undertaken by commercial entities that are commonly known as 'Exploration and Production' (E & P) companies or consortia. The obvious next step is to store the oil being produced until it can be sold. Storage facilities are typically located in shore-based complexes. These could be storage-tank-farms or within the premises of oil refineries.

Consequently, the oil has to be transported from the offshore production sites (the production platforms) to storage facilities ashore. This transportation could be done either via undersea pipelines laid from the production platform to the storage facilities ashore, or via specialised ships known as 'crude-oil tankers', which take the oil to designated ports, where it is discharged for further transportation (via shore-based pipelines or via tanker-lorries or specially-designed railway wagons) to the requisite storage facilities. This set of activities — involving the transport and storage of the crude oil — is carried out by what is called the *'midstream'* sector of the oil industry, comprising specialised companies that are often (but not always) distinct from the E&P companies or consortia. The actual refining of the crude oil into usable 'products' and the subsequent distribution and marketing of these 'products' are parts of the *'downstream'* sector.

Storage tanks facilitate the accommodation of large volumes of hydrocarbons as well as the finished products (such as petrol, diesel, asphalt, etc.). They are often located within oil refineries, although, as mentioned earlier, they may also be located within specially designated 'tank-farms' that then feed the refineries. Without storage tanks, the petrochemicals industry would be unable to safely store and process the roughly 101.18 million barrels per day (mb/d) of crude oil that was consumed globally in the year 2019 or, for that matter, even the Covid-induced lower consumption figure of 92.21 mb/d for the year 2020.[1]

When the crude oil is retained within tanks aboard ships for purposes of 'storage' rather than for 'transportation', it is said to be in 'floating storage' — also known as 'oil on water'. There are two primary reasons why crude oil may be stored in 'floating storage'. The first is if the owner of the cargo on board a tanker is unable to secure adequate storage in onshore facilities such as surface tanks, railway wagons, pipelines, or even the occasional Strategic Petroleum Reserve (SPR) reservoir / cavern. The second is if the owner of the cargo — mostly likely an oil trading firm – is playing what is known as a 'long game' and wishes to store his holding of oil in anticipation of a future surge in oil-prices.

It is important that 'floating storage' is not confused with 'Floating Production, Storage, and Offloading' (FPSO) or 'Floating Storage and Offloading' (FSO). The development of FSOs and FPSOs may be traced to the mid-1970s, when offshore 'Exploration and Production' (E&P) operations were experiencing a sudden boom. The refineries that needed this crude oil being produced could well be located in a distant location or even in another country altogether. So as not to waste time and money in first transporting the crude oil from the offshore production platforms to one's own shore-based storage facilities, and then 're-shipping' the oil to the eventual buyer, E&P companies began to anchor or moor oil-tankers in the close proximity of production platforms. These tankers were known as Floating Storage Units (FSUs). They could remain anchored (or moored), for several days or weeks. Once a buyer was found, and the sale concluded, the tanker would transport the oil directly to the buyer's port-facility. This eliminated the need to construct dedicated – and expensive – undersea pipelines and also reduced the frequency of offloading operations by tankers at one's own ports. Soon enough, transportation economics dictated the need to have larger and larger quantities of crude oil being stored in the proximity of the offshore production platforms for longer periods of time — months and years, rather than weeks and months. Mid-sized tankers were found to be insufficient in size as well as in their ability to store crude oil for the protracted periods envisaged. This latter point will be elaborated on later in this article. At this stage, suffice it to state that the need for larger volumes of crude oil to be stored for longer periods of time drove the construction and deployment of large, purpose-built vessels for offshore deployment. It now became necessary for these vessels to periodically transfer some portion of their stored crude oil for its transportation to destination ports. This was done by smaller 'shuttle-tankers'. Thus, these large vessels became known as 'Floating Storage and Offloading' (FSO) vessels. Inevitably, the thought arose of eliminating production platforms by incorporating production-functions within the FSOs. In other words, the FSO was now envisaged not merely as a vessel that could store large volumes of crude oil for protracted periods of time and periodically offload some portion of its stored crude oil to shuttle tankers, but as one that could additionally undertake the production itself. Thus was born the purpose-built 'Floating Production, Storage, and Offloading' (FPSO) vessel. To bridge the time-gap separating the requirement and the construction of specially-built FPSOs, initially FPSOs were *"typically a tanker type hull or barge, often converted from an existing crude oil tanker (VLCC or ULCC)".*[2] In more contemporary times, however, countries such as Japan and Singapore, which have a paucity of available land for the construction of large structures, have created Very Large Floating Structures (VLFS) to serve as offshore oil storage bases. These steel and concrete structures are permanently moored to the seabed. (See Figure 1)

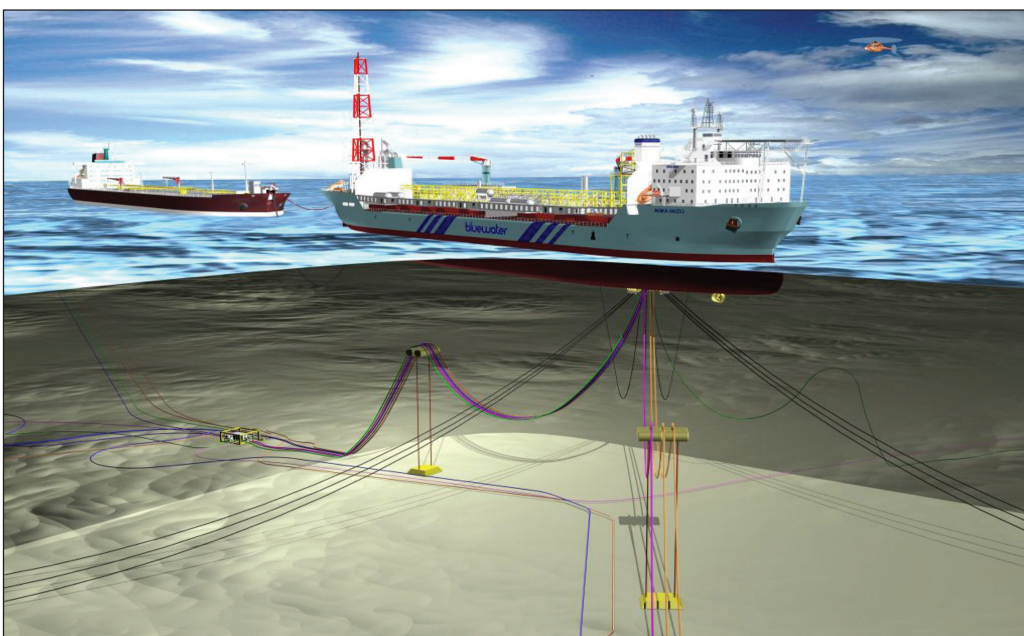


Fig 1: Schematic depiction of an FPSO. Credits: Bluewater Energy Services B.V.; https://www.bluewater.com/fleet-operations/what-is-an-fpso/

A major difference between FSOs, FPSOs, VLFS, and 'floating storage' in the context of this discussion is that while an FSU is characterised by its permanence, floating storage is a short-lived temporary phenomenon. Another significant difference is that while a regular seagoing ship (tanker) is used for floating storage, FSOs, FPSOs, and VLFS are complex floating structures made in the form of a ship's hull and purpose-built to produce and store oil for protracted periods of time. They are not self-propelled. However, towed by tugboats, FSOs / FPSOs can remain moored at a single position at sea for more than ten years! They are an integral segment of offshore E&P operations, especially those carried out in remote and ultra-deep waters. However, these platforms are not impervious to dangers at sea.[3] The risk of collision between an FPSO and a shuttle tanker is a very real one, which is significantly exacerbated by bad weather and rough sea conditions. Equally grim and equally probable are the risks of fire and / or explosion. Failure of one or more auxiliary-engines on the FPSO, tug-boat failure, towing cable failure, and failure of the dynamic positioning system are other potentially-catastrophic risks.[4]

Drivers of 'Floating Storage'

What, then, could drive a decision to opt for 'floating storage' using commercial tankers rather than purpose-built FSO, FPSO, or VLFS structures? The answer lies in crude-oil 'futures'. 'Futures markets' or 'futures exchanges' are where products (crude oil, for example) are bought and sold — for delivery at some agreed-upon date in the future, but with a that is price fixed at the time of making the deal. Here an investor predicts the price of a commodity at some future date and pays *that* price at the present time. A particularly attractive feature of a futures contract in terms of crude oil is that until the delivery date, the buyer is not physically in possession of the oil, and so does not have to worry about storing it. However, once that delivery date arrives, it becomes the buyer's property and will remain so until the oil is sold on to others. So far, so good. But what if the market has unexpectedly weakened, to the point where the market price for the commodity is lower on delivery than upon? (The market is then said to be 'in contango'). In such a scenario, oil-traders do have to take physical delivery of the oil. If they were to sell the oil at this lower price, they would, of course, suffer a heavy loss. So, they seek to store their purchases until they can obtain a better price. Where to store this oil? now becomes a pressing question.

> *"It is no coincidence that, at times when crude oil prices fall, maritime freight prices for the carriage of oil also often fall. This is due to there being a glut of oil on the international markets… which depresses oil freight-rates. Oil-tanker operators often find it difficult to obtain good charters for their vessels at exactly the time when oil-traders are looking for somewhere to keep their newly delivered (or about to be delivered) oil…"* Thus, what occurs is *"a maritime contango marriage of convenience".*[5]

The trader (this may well be a government-body) charters idle oil-tankers to store the oil, while the shipowner finds a cheap way of employing his tankers, simply anchoring the vessels and offering these otherwise idle ships to be used as 'floating storage units'. This is known as 'floating storage'.

This 'marriage of convenience' is fine as long as the period of floating storage is short. This is because problems in both, the ship's cargo tanks as well as the ship's propulsion machinery start to become very serious issues as time passes. To begin with, crude oil is actually a suspension of numerous hydrocarbon compounds. If stored for long periods of time, undisturbed crude oil will begin to settle. The heavier hydrocarbons (such as bitumen) sink and coalesce at the bottom, while the lighter hydrocarbons (such as methane and ethane) rise to the top and, if permitted, escape as vapour. In other words, the crude oil begins to degrade. This can lead to a loss of quality as well as quantity, because of excessive sediment (or sludge) forming at the bottom of the cargo, which becomes unpumpable, leading to residues remaining on board (ROB) issues. Moreover, unlike purpose-built FSOs, FPSOs and VLFS structures, oil tankers that are used as storage units are far more exposed to climatic conditions prevailing at the locations where they are anchored. There can be considerable temperature-variations during the day and the night, which leads to a loss of cargo due to the release of gases such as methane and ethane into the atmosphere. Thus, the volume of the cargo on board is gradually reduced over time and the longer the oil is in storage on the vessel, the greater the possible loss.[6] If these were not problems enough, the accumulated 'sludge' within the ship's cargo tanks causes problems when tankers are sought to be brought into normal use, necessitating considerable and expensive cleaning.

Moreover, hydrogen sulphide, which is a naturally-occurring constituent of crude oil, significantly adds to the deleterious effects of protracted storage aboard tankers. Depending upon the place from where the crude oil has been sourced, the proportion of hydrogen sulphide varies. Crude oil that has a high content of hydrogen sulphide is called 'sour', while that with a low content of hydrogen sulphide is called 'sweet'. However, whether sour or sweet, all crude contains hydrogen sulphide, and, when crude oil is retained in the ship's tanks for protracted periods of time, this hydrogen sulphide causes considerable structural damage to the steel that the tanks are made from, as well as to the piping and the pumps of the ship. The longer the period over which the ship in which the crude oil remains at anchor, the more serious the problems encountered when the vessel is attempted to be returned to its normal pattern of deployment. The ship's propulsion and auxiliary machinery are never designed for long periods of idleness, and past experience has repeatedly and conclusively shown a sharp increase in the frequency and gravity of machinery breakdowns when the ship returns to active duty.

The initial months of the pandemic witnessed sluggish demand in large oil-importing economies such as those of China and India, with many countries, including these two, having imposed 'lockdowns' of varying durations and intensity, at a pan-national level. This ignited what we might call a 'crisis' phase in terms of floating storage. In this initial phase — beginning in February of the year 2020 and lasting until early-March of that year — contracted shipments of crude-oil could not reach their destinations because of *force majeure* (the non-performance or non-completion of an obligation or contract due to unforeseeable circumstances, without any liability to the party that invokes it). Issues of liability notwithstanding, several shipments of crude oil were left stranded aboard tankers, even as charterers frantically searched for alternative buyers. On the other hand, the second phase — the 'boom' phase — saw the demand for oil pick up as oil-importing countries sought to purchase large volumes of crude oil, which was being sold at historically low prices in the aftermath of the destructive price war waged between Saudi Arabia and Russia, in early March 2020. The ensuing demand for cheap oil led to one of the greatest storage problems of recent times.

Although *force majeure* has been invoked within the commodities trade as a consequence of the outbreak of armed conflict, the occurrence of natural disasters, and other debilitating economic circumstances, its invocation because of a pandemic was novel. Energy companies were thrown into a tizzy by unsold cargoes and mounting inventories. Initially, these companies rejected and opposed the legal explanations offered by China's National Oil Companies (NOCs), such as the China National Offshore Oil Corporation (CNOOC) and PetroChina. Several, if not most, suppliers felt that an economic slowdown and a milder-than-usual winter were the real reasons for China's refusal to take possession of the oil cargoes.[7] However, the closure of port terminals and resistance by crew members on board the stranded ships compelled suppliers to come to terms with this extraordinary situation and explore alternative markets in Asia. Therefore, the uncertainty of demand following the outbreak of COVID-19 in China, and the consequent search for alternative buyers were the initial triggers — in February 2020 — for the decision to use ships that were already laden with unsold energy-supplies as floating storage units.

On 06 March 2020, negotiations, between the Organisation of Petroleum Exporting Countries (OPEC) — led by Saudi Arabia — and Russia, to limit crude-oil production failed. This set off a chain of events that eventually led to the greatest decline in global crude-oil prices in history. Pre-empting Russian moves to capture additional market share, Saudi Arabia retaliated the next day by announcing massive discounts on its 'Arab Light' and 'Arab Medium' grades of crude oil, specifically targeting European, American, Chinese and Indian refiners, who were thus far processing Russian oil. Unsurprisingly, global demand for Saudi oil — priced at an amazing US$ 25 per barrel, a price last seen in 1998 — rose drastically.[8]

Responding to this demand, Saudi Arabia's national shipping company, Bahri, chartered approximately 20-30 large tankers — mostly VLCCs — to transport this discounted oil to its buyers. Other major oil producers, such as the United Arab Emirates (UAE), Nigeria, Russia and Iraq, immediately joined the fray to transport cheap oil on large ships. As a consequence, the daily charter rates of available VLCCs on the popular West-Asia-to-China route skyrocketed from less than US$ 25,000 per day in the beginning of February to an average of US$ 243,000 per day in early March.[9] Concurrently, higher charter prices compelled several refiners — such as those from Malaysia and India — to charter smaller 'Suezmax' and 'Aframax' tankers, which hold one million (MMbbl) and 650,000 barrels (bbl) of crude oil, respectively.[10]

Soon, all this excess output caused the average global price of per barrel to plunge from US$ 32 in March to US$ 18.38 per barrel in April 2020.[11] In the US, the average price of the West Texas Intermediate (WTI) benchmark for the month of May 2020 fell to a historic low of US$ -37.63 per barrel.[12] This effectively meant that a US supplier would have to pay a buyer to evacuate the oil! These low prices were not only hurting American producers (as Russia had originally intended) but *all* major producers, who saw their revenues fall to a trickle, and feared that a sustained price war, coupled with low demand due to the COVID-19 pandemic, would cripple their economies. Consequently, on 12 April 2020, in a deal brokered by the USA, OPEC members and Russia agreed to an unprecedented production-cut. According to the terms of the deal, the OPEC+ nations (OPEC + Russia) would cumulatively cut production by 9.7 mb/d in May and June 2020; 7.7 mb/d from July-December 2020; and, 5.8 mb/d from January 2021 to April 2022.[13]

Despite these massive production cuts, approximately 80 large tankers (55 VLCCs and 24 Suezmax ones) were speculated to remain as floating storage into June 2020.[14] At its peak, an estimated 150-200 MMbbl were stored in crude oil tankers at sea. At the same time, approximately 70 MMbbl of refined petroleum products — aviation turbine fuel (ATF), gasoline, diesel, lubricants, etc., — were in storage in 'product tankers', with most such vessels remaining anchored near oil trading hubs in the USA, Singapore, and West Asia.

Not a Novel Phenomenon

Since the 'Demand Shock' of 2008-09, when the price of per barrel of crude oil skyrocketed to an all-time historic high of US$ 148, the world has experienced multiple cycles of a supply glut stemming from the competition between major oil-producing countries — including the US — to gain a larger share of the global crude oil demand, mainly from Asia's emerging economies.[15] The ongoing glut is certainly not the first. However, what distinguishes this episode from its predecessors is the sheer scale at which crude oil is sitting in tankers at sea. In 2014-2016, an estimated 120 MMbbl was held in floating storage. Similarly, in February 2009, approximately 100 MMbbl were stored at sea soon after average global oil prices touched US$ 148 per barrel.[16] Demand, however, did not drop as abysmally as in 2020.[17]

In the present context, the early scramble for tankers shaped an impression that – despite *force majeure* declarations – crude oil was *moving* to various centres of demand; but, as consumption within the large Asian economies dropped significantly, more tankers became available to *store* the record surplus of crude oil that was still being produced. Net importers like India, China, Japan, South Korea etc. understood the financial implications of this cheap oil and promptly set off the scramble for floating storage with their large purchases.

Meanwhile, in India…

By the first week of February 2020, the global average price of crude oil had fallen to US$ 55 per barrel from US$ 68 per barrel in the previous month after demand from China collapsed. This meant that the futures market was in 'contango'. As had been explained in the above section that, in a 'futures market' involving crude-oil, the trader in oil futures predicts the price of the crude oil at some future date and pays *that* price at the present time. Now, until the agreed date of the delivery date arrives, the buyer is not physically in possession of the oil. Obviously, until this point in time, the buyer so does not have to worry about storing it, and he then sells it, thereby making a profit without ever actually taking physical delivery of the oil. But in the instant case, the market had unexpectedly weakened, to the point where the market price for the was lower on the delivery-date than had been anticipated. If the trader were to sell the oil at this lower price, he would suffer a heavy loss. So, the oil-traders now have to take physical delivery of the oil and need to store their purchases somewhere until they can obtain a better price. Floating storage is now opted-for. So, VLCCs suddenly find themselves in hot demand and the cost of cratering a VLCC skyrocket. In India, national refiners like Hindustan Petroleum Corporation Limited (HPCL) and Bharat Petroleum Corporation Limited (BPCL) opted to transfer cheap crude oil purchases, mostly on smaller vessels, due to the high charter rates of VLCCs and the short distance between West Asia and India (which can be covered in less than a week).[18] This brought the oil to Indian ports at rates cheaper than would have been imposed had the oil come in VLCCs. But what was to be done thereafter? Where was the oil to be kept? Clearly, every shore-storage option had to first be utilised, and if this proved inadequate, floating storage would need to be resorted-to.

Thus, India's scurry to purchase cheap crude oil led to the saturation of more than 210 million barrels of onshore storage encompassing storage tanks at refineries, inter-state pipelines and inland depots by early-May 2020. Further, the country's Strategic Petroleum Reserves (SPR), with its present total capacity being 39.14 million barrels, was also filled by cheap oil purchased from Iraq, Saudi Arabia and the United Arab Emirates (UAE).[19] On the other hand, with economic activity within the country being hamstrung by COVID-induced restrictions that had remained in place since 25 March 2020, domestic demand was low. This demand meant that the oil that had been stored onshore could not be refined immediately, due to the narrow shelf-life of petroleum products. Consequently, the twin conditions of saturated onshore storage and low domestic demand, compelled refiners to opt for the storage of as much as 50 million barrels of oil on tankers at sea.[20] Even this desperate measure was insufficient, and, finally, Indian refiners were compelled to declare *force majeure* on several contracted purchases from Saudi Arabia, Iraq, UAE and Kuwait.[21]

A Practical Solution – but not Quite the *Right* One

Storage at sea is a 'sponge' to absorb excess oil when onshore storage has reached its capacity. For the reasons that had been elaborated in this article, this form of storage must, if it as adopted at all, necessarily be a short-term measure. This very ability to accommodate sudden gluts is also its shortcoming because over-production on such a large scale is not very common. This gives rise to several criticisms regarding its inelasticity:

First, floating storage is an expensive way to store crude oil and petroleum products. For instance, let us assume that a refiner purchased two million barrels of oil at US$ 20 per barrel, for a total price of US$ 40 million. At its peak in April, the daily charter rate of a VLCC was US$ 250,000. If the VLCC took a maximum of seven days to reach India's west coast from Saudi Arabia, then the total value of the cargo would be US$ 41.75 million by the time it reached Indian shores

(US$ 250,000 x 7 days). If the refiner now maintained the vessel as 'floating storage' for a month, the total value of the commodity would shoot up by US$ 7.5 million. Thus, at the time of the eventual offloading of the cargo to a shore-based facility, the total value of the crude oil would now be US$ 47.50 million (US$ 40 million + [US$ 250,000 x 30 days]). In addition, the importer would have to account for increased port-related charges, enhanced demurrage (a waiting fee paid to the ship-owner for delays in unloading), augmented insurance-costs of the raw crude, etc., in addition to the fixed costs involved in transporting the port to the refinery, and, the cost of the refining process, as also the transport of the refined product to centres of demand. Thus, although the refiner might still turn out a profit, the high cost of floating storage significantly diminishes this margin.

Second, crude oil — under the right conditions — has a shelf life of approximately five years, it degrades if left undisturbed in a ship's tank for a prolonged period. Such a degradation will likely lead to the formation of a thick residue or 'sludge' at the bottom of the tank, which cannot be pumped out, as also the loss of naturally-occurring gases within the crude oil, such as methane and ethane. In aggregate, this creates variations in the volumes purchased and those delivered, raising a host of potentially-damaging contractual complications and, insurance-based and legal claims. Equally significantly, the quality of the crude oil gets altered.

Third, oil tankers that are used as floating storage units are themselves susceptible to extensive damage by the cargo they hold. For instance, the hydrogen sulphide in crude oil, especially in 'sour' varieties of crude, corrodes the ship's tanks, pipelines, pumps, and machinery, with which it comes into contact. Further, repeated washing operations to clean any leftover sludge tends to damage the tanks themselves. Ship owners are, therefore, very chary of chartering their ships for use as floating storage for extended durations. In the case of a refusal by the owner to extend the charter of the ship as a floating storage unit, the owner of the cargo will have to risk a ship-to-ship transfer of the stored commodity at sea. This is especially dangerous given the vulnerability of these oil-tankers to the risk of collision and pollution, especially during inclement weather.

Conclusion

The prolonged storage of crude oil on board tankers results in higher operating costs for the owner of the vessel, and the partial loss of cargo — along with future revenue — for the owner of the cargo. Thus, unlike onshore crude oil and petroleum product terminals, or purpose-built offshore Floating Storage Units (FSUs) such as Floating Storage and Offloading (FSO) units, Floating Production, Storage and Offloading) vessels, or VLFS (Very Large Floating Structures), the short-term storage of crude oil on board tankers is a risk-prone activity for marine insurance as well as the environmental and safety regulations of the port state.

Fortunately, floating storage is likely to reduce significantly as we move through the opening months of 2021.[22] Countries like India and China are now rapidly opening up their economies, which signals not only future demand but also the freeing-up of onshore storage. However, production cuts agreed upon by the major oil producers are not commensurate with the fall in global demand[23] and *"with a persistent oversupply expected to carry into 2021, the rise and fall of floating storage, looks set to keep making waves"*.[24]

Analysts speculate about the motives behind high oil-production and continuing — albeit sluggish — demand from importing nations for a commodity that is already in surplus.[25] The answer is simple: uncertainty. Countries that are still under lockdown are eager to revive their economies and expect oil consumption to climb sharply once manufacturing kicks into high gear, and travel restrictions are relaxed. They fear that as the supply of crude oil becomes tighter due to production cuts, the price of oil will rise steeply, as it traditionally does during the winter months when Europe and North America consume higher volumes of energy in order to stay warm.

The re-opening of India's economy coincides with the push for self-reliance within India's manufacturing sector. Coming a few weeks before a violent confrontation with Chinese troops in mid-June of 2020 along the country's north-eastern border, *Atmanirbhar Bharat,* or 'Self-reliant India', is a mission that prioritises financial support for Medium, Small and Micro Enterprises (MSMEs), agriculture, technology and infrastructure projects among other sectors. In the coming months, India hopes to continue to attract foreign investments through its 'Make in India' initiative and to reduce its dependence on Chinese imports in several key sub-sectors like agri-products. Establishing secure energy-supplies is a pre-requisite to the success of this mission. For instance, India is on the brink of achieving complete self-reliance in urea production. Urea is a key ingredient in fertilisers and animal feed and is manufactured in plants that use natural gas as a feedstock (raw material).[26] Therefore, India's aspiration to build an economy that is resilient to geopolitical upheavals is contingent upon the ready availability of cheap energy in secure and versatile installations in the near future.

The global floating storage phenomenon of 2020 and India's role in it is a revelation that oil-storage in such volumes is not always a sign of desperation but could well be one of anticipation of large profits once international global prices stabilise. However, it also points to the inadequacy of storage infrastructure within the world's third-largest consumer of crude oil.

ENDNOTES

1. US Energy Information Administration (EIA), "Short Term Energy Outlook", 12 January 2021, https://www.eia.gov/outlooks/steo/report/global_oil.php See also: M El-Samanody, A Ghorab and AS Noaman, "Design and Study of Floating Roofs for Oil Storage Tanks," Mechanics and Mechanical Engineering 21, No 1 (2017): 118, http://www.kdm.p.lodz.pl/articles/2017/21_1_11.pdf.

2. Håvard Devold, "The Oil and Gas Production Handbook", p 10, https://www.controlglobal.com/assets/knowledge_centers/abb/assets/1705/Oil-and-gas-production-handbook-ed3x0-web.pdf.

3. Utkarsh Bhardwaj, AP Teixeira, and Carlos Guedes Soares, "Review of FPSO Accident and Incident Data", 2017, https://www.researchgate.net/publication/317074849_Analysis_of_FPSO_accident_and_incident_data doi 10.1201/9781315157368-88.

4. Ibid.

5. "The Contango Conundrum", Marsh & McLennan Insights, September 2015, iverwyman.com/content/dam/marsh/Documents/PDF/UK-en/The-Contango-Conundrum-2015.pdf.

6. Ibid.

7. Jessica Jaganathan and Chen Aizhu, "China's biggest liquefied gas importer suspends some contracts as virus spreads," Reuters, 06 February 2020 https://in.reuters.com/article/china-health-lng-cnooc/chinas-biggest-liquefied-gas-importer-suspends-some-contracts-as-virus-spreads-idINKBN2001HB.

8. Saudi Arabia had a spare production capacity, which could produce 2.6 mb/d. On the other hand, Russia could only increase output by 200,000 bpd. That said, Saudi Arabia requires a much higher breakeven price (estimated at US$ 82 per barrel) than does Russia (estimated at US$ 42 per barrel) to balance its budget. Hence, although the Kingdom gained larger a larger market share, the Federation could better sustain itself during the ensuing months of low oil revenues. **See:** "What's Behind Saudi Arabia's Oil Price War with Russia,", Reuters, 15 March 2020. https://www.aljazeera.com/programmes/countingthecost/2020/03/saudi-arabia-oil-price-war-russia-200315114308947.html] **Also See:** "Saudis sell oil at $25 in market share grab from Russia: Reuters," *Al Jazeera*, 14 March 2020.

9. Alex Longley, Jack Wittels and Firat Kayakiran, "Saudis' Oil Tanker Spree Drives 700% Surge in Ships' Earnings," BloombergQuint*,* 13 March 2020 (updated 16 March 2020). https://www.bloombergquint.com/business/saudis-send-oil-tanker-rates-soaring-with-huge-booking-spree.

10. Debjit Chakraborty and Sharon Cho, "Asian Oil Buyers Hiring Smaller Ships as Supertanker Rates Soar," BloombergQuint, 16 March 2020. https://www.bloombergquint.com/business/asian-oil-buyers-hiring-smaller-ships-as-supertanker-rates-soar.

11. "Average monthly Brent crude oil price from July 2019 to July 2020 (in U.S. dollars per barrel)," Statista, https://www.statista.com/statistics/262861/uk-brent-crude-oil-monthly-price-development/.

12. Catherine Ngai, Olivia Raimonde, and Alex Longley, "Oil Plunges Below Zero for First Time in Unprecedented Wipeout," Bloomberg, 20 April 2020. https://www.bloomberg.com/news/articles/2020-04-19/oil-drops-to-18-year-low-on-global-demand-crunch-storage-woes.

13. "The 10th (Extraordinary) OPEC and non-OPEC Ministerial Meeting concludes," Organization of the Petroleum Exporting Countries, No. 6/2020, Press Release, 12 Apr 2020, https://www.opec.org/opec_web/en/press_room/5891.htm.

14. Ian Taylor, "Global: Drewry: Tanker Rates Will 'Hit the Roof' if Producers Outside OPEC+ Fail to Curb Output," Bunkerspot, 16 April 2020. https://www.bunkerspot.com/global/50318-global-drewry-tanker-rates-will-hit-the-roof-if-producers-outside-opec-fail-to-curb-output#.

15. "How Much Petroleum does the United States Import and Export?," US Energy Information Administration, https://www.eia.gov/tools/faqs/faq.php?id=727&t=6#:~:text=In%202019%2C%20the%20United%20States%20exported%20about%208.57%20MMb%2Fd,0.53%20MMb%2Fd%20in%202019.

16. Jonathan Saul, "Oil Held in Storage at Sea Approaching 2009 Record as Glut Builds Up," Reuters, 01 April 2020. https://www.reuters.com/article/global-oil-tankers/oil-held-in-storage-at-sea-approaching-2009-record-as-glut-builds-up-idUSL8N2BP4OA.

17. Fotios Katsoulas, Karim Fawaz and Krispen Atkinson, "Floating Storage: How much of the Oil Supply Surplus can be Stored by Tankers?", IHS Markit, 17 April, 2020, https://ihsmarkit.com/research-analysis/floating-storage-how-much-oil-surplus-can-be-tanker-stored.html.

18. Debjit Chakraborty and Sharon Cho, "Asian Oil Buyers Hiring Smaller Ships as Supertanker Rates Soar," BloombergQuint, 16 March 2020. https://www.bloombergquint.com/business/asian-oil-buyers-hiring-smaller-ships-as-supertanker-rates-soar.

19. Oliver Nelson Gonsalves, "Crude-Oil Storage in an Era of Plenty: Part 1: India's Strategic Petroleum Reserves," National Maritime Foundation, May 06, 2020, https://maritimeindia.org/crude-oil-storage-in-an-era-of-plenty-part-1-indias-strategic-petroleum-reserves/.

20. "India devises a unique way to store cheap oil as storage tanks are now 100% full," Live Mint, 05 May 2020. https://www.livemint.com/politics/policy/india-devises-a-unique-way-to-store-cheap-oil-as-storage-tanks-are-now-100-full-11588640854536.html.

21. "IOC Declares Force Majeure on Oil Purchases from Saudi, UAE, Iraq, Kuwait," The Economic Times, 01 April 2020 https://economictimes.indiatimes.com/industry/energy/oil-gas/ioc-declares-force-majeure-on-oil-purchases-from-saudi-uae-iraq-kuwait/articleshow/74932510.cms?from=mdr.

22. Max Tingyao Lin, "2021 Will See End of Floating Storage with Oil Recovery", Trade Winds News, 14 January 2021, https://www.tradewindsnews.com/tankers/2021-will-see-end-of-floating-storage-with-oil-recovery-analyst-says/2-1-944288.

23. Yoshinobu Ono, Kazuhiro Kida, Hidemitsu Kibe and Shuji Nakayama, "Global crude inventories to max out in 2 months amid coronavirus," Nikkei Asian Review, 27 April 2020. https://asia.nikkei.com/Spotlight/Datawatch/Global-crude-inventories-to-max-out-in-2-months-amid-coronavirus.

24. "2020: The rise and fall of Floating Storage", Tanker Operator Magazine, 17 December 2020, https://www.tankeroperator.com/news/2020-the-rise-and-fall-of-floating-storage/12047.aspx.

25. Jo Borrás, "Millions of Barrels of Oil Nobody Wants are Floating in The Ocean," Clean Technica, 08 April 2020. https://cleantechnica.com/2020/04/08/millions-of-barrels-of-oil-nobody-wants-are-floating-in-the-ocean/#:~:text=Millions%20Of%20Barrels%20Of%20Oil%20Nobody%20Wants%20Are%20Floating%20In%20The%20Ocean,-April%208th%2C%202020&text=That's%20where%20they%20are%20storing,gills%20(with%20oil).%E2%80%9D.

26. "Atmanirbhar Bharat's first boost to be made in China; 5 new urea plants to make India self-reliant," *Financial Express*, 13 July, 2020. https://www.financialexpress.com/economy/atmanirbhar-bharats-first-boost-to-be-made-in-china-5-new-urea-plants-to-make-india-self-reliant/2022079/.

About the Author

Dr. Oliver Nelson Gonsalves is a Research Fellow and the Head of the Maritime Energy-Security and Security-of-Energy (MESSE) Cluster at the National Maritime Foundation (NMF). He leads the NMF's study into the maritime facets of energy. He can be contacted at associatefellow1.nmf@gmail.com

Note

This article was first published on the Website of the National Maritime Foundation on 2 February 2021

The Role of Oil in the Security Architecture of the Persian Gulf and the Impact of the Current Dual Oil-Shock on Regional Stability

Commodore Somen Banerjee

The year 2020 is an epoch in modern history that stands not only for the fatal impact of the pandemic but also for the disruption of societies and economies. The Gulf countries have been severely hit by the dual shocks of the plunge in oil prices and shrunken demands. The Brent crude spot price fell to less than US$ 19 in April 2020, and the futures price is likely to hover around US$ 40 in 2020-21, which is significantly less than the fiscal breakeven price of all Gulf countries. These developments have unfolded ominously against the pervasive backdrop of fragile states, regional instability, and the prospects of US retrenchment from the Gulf region. This article examines the role of oil in defining the security architecture of the region. It establishes the effect of dual shock on the Gulf economy. Finally, it evaluates the impact of the oil price tumble and US retrenchment on regional stability.

Role of Oil in the Security Architecture of the Gulf Region

The 1916 Skyes-Picot Agreement between Great Britain, France, Italy and Russia structured the security architecture of the Middle East during the World War I, by artificially dividing the region into states that did not cohere with the nationalistic sentiments of its people. Vestiges of fault-lines implanted then continue to ferment the regional instability even today, and manifests by way of the Arab Spring of 2011-12, the rise of Islamic State (IS) between 2014 to 2018, proxy wars in Yemen and

Syria, and intrastate conflicts.[1] The United States of America made an entrance into the region immediately after World War II. The US-Saudi relationship was formalised by an agreement between President Roosevelt and King Abdulaziz, that assured exclusive US access to Saudi oil in return for the protection of the Al-Saud regime.[2] At this stage, the US indigenous production was nearly equal to its consumption (Figure 1).

Various attempts to establish Pax-Americana during the Cold War had failed. The anti-Soviet alliance of the Baghdad Pact of 1955, popularly known as the Central Treaty Organisation (CENTO), was dented by the Czech arms deal treaty (1955). In 1979, the Kremlin also managed to forge an anti-Camp David coalition. Moreover, the superpower rivalry, had given a degree of autonomy to the Gulf States that was disproportionate to their intrinsic power.[3]

Notwithstanding the Soviet-US contestation for strategic influence in the Middle East, until the early 1970s, the Gulf's security architecture had an overbearing influence on the United Kingdom (UK), after which the US stepped into the British shoes.[4] Western oil companies exploited the oil wealth at the expense of the local populace until the early 1970s, with the backing of their governments. The first

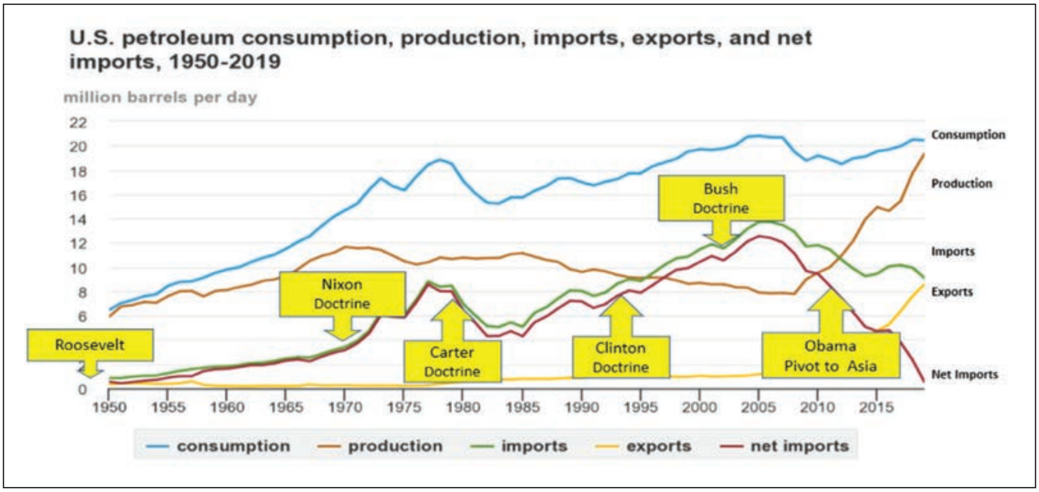


Figure 1: US Petroleum Consumption, Production, Imports, and Exports 1950-2019
Source: U.S. Energy Information Administration, *Monthly Energy Review*, Table 3.1, March 2020, preliminary

high-profile opposition to western oil companies was spearheaded by the elected Prime Minister of Iran, Dr Mohammad Mosaddeq, who tried to nationalise the Iranian oil in 1951, which led to his removal from office in 1953[5]. This incident vindicates the primacy of oil as a motivation for western presence in the region.

The gap between US oil consumption and production started to widen in the 1970s (Figure 1). Simultaneously, Iraq signed Iraq had signed a friendship treaty with the Soviet Union in April 1972. Thus, a combination of oil and strategic factors, kept the US engaged in the region despite its entanglement in Vietnam. The Nixon Doctrine envisaged drawing down on the US presence in Asia and propping up amiable proxies to protect its interests. As a result, the Shah of Iran, was afforded support to assume the mantle of the Guardian of the Gulf [6].

After the Iranian revolution in 1979, Saddam Hussain was projected as the regional policeman briefly.[7] However, in response to the Soviet invasion of Afghanistan and the taking of 66 hostages in 1979 by Iran, the Carter doctrine came into effect.[8] "An attempt by any side to gain control of the Persian Gulf was regarded as an assault on the vital interests of the US".[9] Thus, the Carter Doctrine established hegemony to a degree unmatched by the British imperialism.[10] During Carter's presidency, oil imports had started to dwindle, but the strategic imperatives forced the US to dominate the security architecture of the Gulf.

Between the first Gulf War in 1991 and the terror attack on the World Trade Centre in 2001, the Clinton administration adopted a strategy of dual containment of Iraq and Iran.[11] During this period, the US oil imports had grown steadily. Since the post-Cold War, the US had no strategic competitor in the Gulf; protecting oil exploration, production, and transportation was the only justifiable rationale for the US presence in the Gulf. Especially so, in light of steadily rising oil imports between 1985 and 2005, a large component of which was imported from the Gulf (Figure 2).

After 9/11 (2001), the Bush Doctrine authorised pre-emption and preventive actions.[12] Democracy deficit was considered the primary reason for the world-trade-centre attacks. Democracy deficit in the Middle East was considered as the primary reason for instability.[13] Though the US dependence on Gulf oil remained

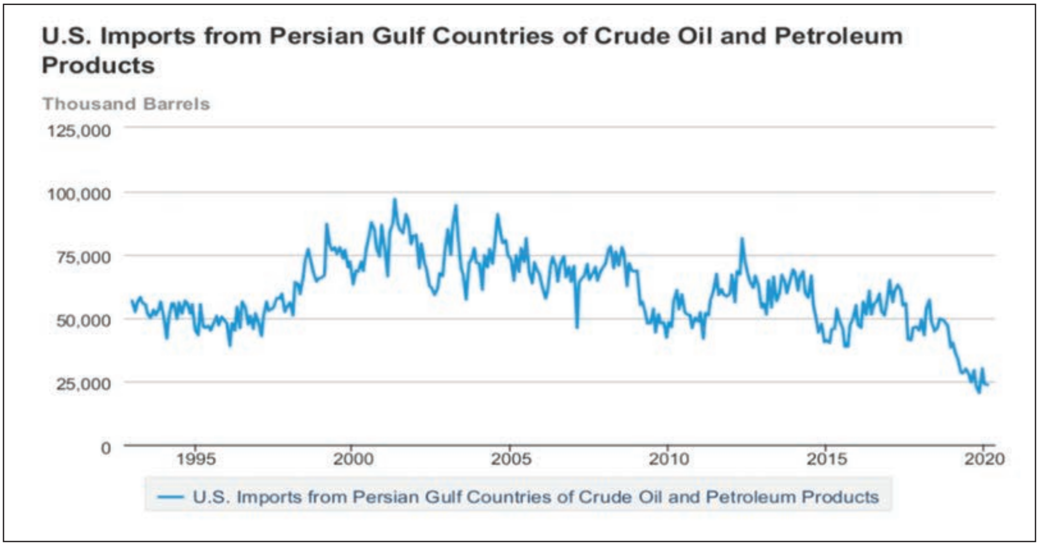


Figure 2: US Imports from the Gulf Countries of Crude Oil and Petroleum Products
Source: U.S. Energy Information Administration

an important driver, the imposition of democracy and liberal values outweighed all others, post-9/11.

After 2005, US oil imports continued to dwindle, and domestic production started to climb (Figure 1). Concomitantly, dependence on Gulf oil had also started to shrink (Figure 2). A significant foreign policy milestone that signifies the US' receding strategic interests in the Gulf is President Obama's Pivot to Asia in 2011. At this juncture, the US net import of oil had declined to levels of 1973. Under the Trump administration, successive attacks on oil tankers in the Gulf in May and June 2019 and missile attacks on Saudi Aramco oil fields in September 2019 did not provoke the usual retaliatory actions from the US.[14] It has also been reported that the US has removed two of the four Patriot missile batteries from Saudi Arabia and 24 aircraft from the Middle East.[15] Presidents Trump's declining commitment to security is being widely perceived as a retrenchment from the Gulf. When evaluated against the backdrop of US net imports, it can be found that US net imports in 2019 have declined to the 1953 levels (Figure 1), and so has its motivation to disinvest in the region's security architecture.

Amidst the ups and downs of US foreign policy in the Gulf, the US-Iran tensions have remained fairly consistent since 1979. It has only escalated after the Trump administration decided to withdraw from the 2015 Joint Comprehensive Plan of Action (JCPOA). The killing of Qasem Soleimani, the commander of Iran's Islamic Revolutionary Guard Corps-Quds Force (IRGC-QF), on 3 January 2020 has further deteriorated the relations. Attacks on the critical oil infrastructure in Saudi Arabia in September 2019 have demonstrated that Iran is capable of inflicting considerable damage on the US and its allies.[16]

Conflicts between Iran and Saudi Arabia have more roots than the traditional Sunni-Shi'a divide. An imminent US retrenchment has provided them with greater space and intensified the competition for influence and hegemony in the region. Iran played a decisive role in halting IS expansion into Iraq and Syria. It has also supported the Houthis in order to resist Saudi Arabia and its allies. Saudi Arabia considers Yemen as its backyard, and does not appreciate Iranian influence in its southern neighbourhood. Likewise, Iran does not want Saudi Arabia to undermine the Houthis and Zaydis. Saudis also accuse Iran of interference in Arab politics and of creating proxy groups like Hezbollah in Lebanon.[17]

The Discovery of oil has brought prosperity to the Gulf states. But it has also attracted major powers into the region and made the region hostage to great power interests. However, under the overhang of the US hegemony, Iran and Saudi allies have contested for influence in the region. This trend can be expected to aggravate post-US retrenchment.

Impact of Dual Oil Shock on Gulf Economy

According to the International Monetary Fund (IMF), the fiscal breakeven price per barrel for 2019 was: US$67 for UAE, US$ 83 for Saudi Arabia, US$ 45 for Qatar, US$ 53 for Kuwait, US$ 56 for Iraq, US$ 93 for Oman, US$ 106 for Bahrain, and US$ 245 for Iran.[18] If the oil prices go below this, the countries face a budget deficit.[19] The unprecedented crash of oil prices in 2020 saw the prices of the Organisation of Petroleum Exporting Countries (OPEC) basket tumble from an average spot price of US$ 66 per barrel in January 2020 to US$ 18 in May 2020.[20] Portentously, the price war with OPEC Plus coincided with the COVID-19 outbreak, which also impacted the oil demands. As a result, the futures oil price through 2020 and 2021 is expected to hover around US$ 40 per barrel.[21] This implies that the deficit between the futures price and the fiscal breakeven price is likely to accumulate for at least the next 18 months. Oil is the backbone of the Gulf economy, as it forms a substantial share of their net exports. For example, petroleum exports of OPEC Gulf countries as a share of their net export constitute – 81 per cent for Kuwait, Iran 56 per cent, Iraq 72 per cent, Saudi Arabia 66 per cent, and UAE 18 per cent (Table 1). Hence the dual shock of oil would have an impact on their real income, which in turn will have a cascading effect on their economies and military spending. As a corollary, it would affect their ability to influence the region's security architecture, in a manner witnessed earlier in 2019.

	Net Export US$ Million	Petroleum Export US$ Million	Petroleum as percentage of net export
Kuwait	71,931	58,393	81
Iran	107,435	60,198	56
Iraq	95,256	68,192	72
Saudi Arabia	294,544	194,358	66
UAE	388,179	74,940	19

Impact of Oil Price Tumble and US Retrenchment

Military expenditure of Gulf Countries as a percentage of Gross Domestic Product (GDP) (2018) has been relatively high.[22] Figure 3 shows the correlation between the crude oil price of the OPEC basket vis-à-vis the variations in defence budgets as a percentage of GDP between 2010 to 2018. It can be found that the defence expenditures of all Gulf countries increased, without exception, from 2010 to 2015. This can be corroborated by the increase in real income of these countries due to high crude oil prices between 2010 to 2014. As the crude oil price declined, defence

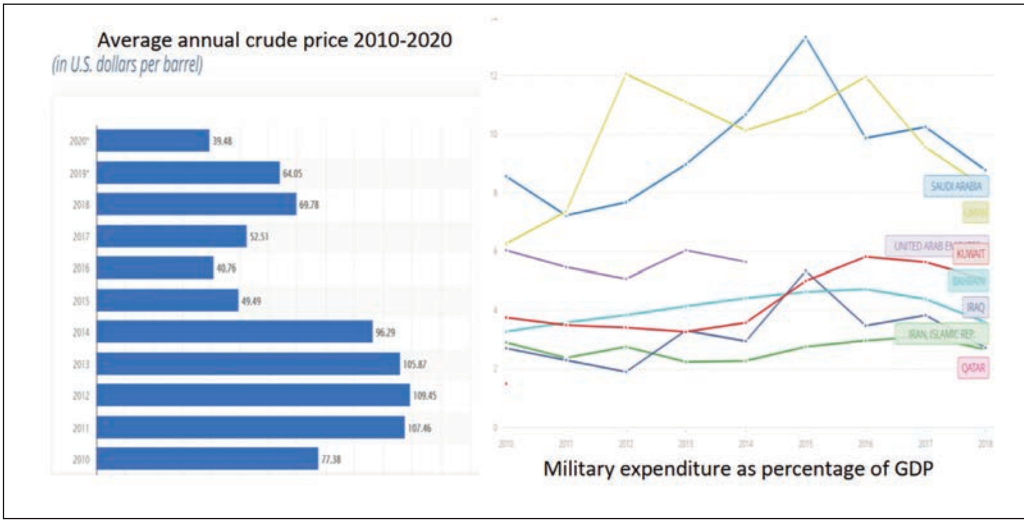


Figure 3: Crude oil price vis-à-vis Defence Expenditure as percentage of GDP 2010-2018
Source : Statista and World Bank

spending as a percentage of GDP also started to shrink. Hence, it would be safe to assume that the dual oil shock is likely to have a considerable impact on the defence budgets of these countries. As a result, regional competition for influence is likely to see a decline. This provides an opportune moment to put in place a collaborative security mechanism in the region.

Dwindling security commitments of the US have convinced some Gulf states that the US is no longer willing to defend them and is unlikely to initiate military action against Iran. This has triggered an attitudinal change amongst the Gulf Cooperation Council (GCC) states. The United Arab Emirates (UAE) has withdrawn from the war in Yemen. It has also begun talks with Iran to decrease tensions in the Gulf. Even the Saudis are being urged for reconciliation with Iran. Hence, the US policy of retrenchment and harsh economic conditions are forcing the Gulf region to rethink its foreign policies.[23]

Sensing US retrenchment, Russia had proposed a "Collective Security Concept for the Persian Gulf Region" to the United Nations Security Council (UNSC) in 2019.[24] China was prompt in backing the Russian proposal.[25] A joint military exercise ensued in the Gulf of Oman by China, Russia and Iran in December 2019.[26] However, the proposal did not garner much support from states in the region, except Iran. Collective security requires consensus between states to respond against an aggressor. It is often difficult for states to decide on the definition of an aggressor and hence the corresponding response. Instead, Cooperative Security is a more flexible option. It broadens the definition of security beyond traditional military challenges to include environmental, economic, and social concerns. It also encompasses a process of confidence-building through consensus.[27] Thus, amidst the economic recession, Cooperative Security would be more prudent than collective security.

The US is heavily committed to the region. The US operates drones from Saudi Arabia, hosts an Air Force Command Centre in Qatar, and its Navy's Fifth Fleet is based in Bahrain. So, a retrenchment from the region is unlikely soon. However, its recent restraint from direct escalations might continue. The Russian and Chinese model of collective security has not found much traction. Very nascent signs of a thaw in hostilities between the Gulf countries are visible due to the harsh economic recession. Hence, the situation is just ripe for introducing a mechanism of Cooperative Security, similar to one in the Association of South Asian Nations (ASEAN). Stability in the Gulf is vital for India's energy interests. India could advocate the concept of a Cooperative Security mechanism for the Gulf region.

Concluding Remarks

The Discovery of oil at the turn of the 20th century had enhanced its salience by many folds. The region has been dominated by the extra-regional players. Post-Cold War, the US emerged as the sole power and arbiter of security in the region. Oil has always remained the underlying reason for the US presence in the Gulf. However, the predominant narrative of the US foreign policy has fluctuated between geo-strategy, imposition of democracy and protection of energy interests. But Gulf states, too, have been contesting for regional hegemony. This has become especially relevant against the backdrop of an impending US retrenchment.

A dual shock of oil would have an impact on their real income, which in turn will have a cascading effect on their economies and military spending. As a corollary, it would affect their ability to influence the region's security architecture, in a manner witnessed earlier in 2019.

The US is heavily committed to the region. So, a retrenchment from the region is unlikely soon. Besides, the Russian and Chinese model of collective security has not found much traction. Hence, the situation is just ripe for introducing a mechanism of Cooperative Security, similar to one in the Association of South Asian Nations (ASEAN). India could advocate the concept of a Cooperative Security mechanism for the Gulf region.

ENDNOTES

1. Santoshi Ikeuchi, "Transformation of the International Order in the Middle East – Varying Degrees of Stateless and Three directions of the New Order" Society of Security and Diplomatic Policy Studies" http://ssdpaki.la.coocan.jp/en/proposals/53.html.

2. Askari Hossein, Collaborative Colonialism: The Political Economy of Oil in Persian Gulf (New York: Palgrave Macmillan, 2013), 3-39.

3. Benjamin Millar, "The International System and Regional Balance in the Middle East" in Balance of Power, eds T V Paul, James J Wirtz, and Michel Fortmann, (California: Stanford University Press, 2004), 244-246.

4. Emma Soubrier, "Gulf Security in Multipolar World: Power Competition, Diversified Cooperation" The Arab Gulf States Institute in Washington, 24 March 2020, https://agsiw.org/gulf-security-in-a-multipolar-world-power-competition-diversified-cooperation/.

5. Darioush Bayandor, The Shah, The Islamic Revolution and The United States (Nyon: Palgrave Macmillan, 2019), 10-11.

6. Cooper Andrew Scott, The Oil Kings: How the US, Iran and Saudi Arabia Changed the Balance of Power in the Middle East (New York: Simon and Schuster, 2011), 5-53.

7. Markakis Dionysis, US Democracy Promotion in the Middle East: The Pursuit for Hegemony, (London: Routledge, 2016), 104.

8. FRUS, "Foreign Relations of the United States, 1977-1980, Volume XVIII, Middle East Region; Arabian Peninsula. 45. Editorial", 1979, https://history.state.gov/historicaldocuments/frus1977-80v18/d45.

9. Simon Tisdall, “Why Instinct and Ideology Tell Trump to Get Out of the Middle East”, The Guardian. 11 January 2020, https://www.theguardian.com/us-news/2020/jan/11/why-instinct-and-ideology-tell-trump-to-get-out-of-the-middle-east-suleimani-iran.

10. Gause F Gregory, “Hegemony Compared: Great Britain and the United States in the Middle East”. Security Studies, 28 (3), (2019): 565-587.

11. Richard D Sokolsky, The United States and The Persian Gulf: Reshaping Security Strategy for the post-Containment Era. (Washington DC: National Defence University Press, 2003), 125.

12. White House, “National Security Strategy of the USA”, September 2002. https://2009-2017.state.gov/documents/organization/63562.pdf.

13. Markakis, US Democracy Promotion in the Middle East: The Pursuit for Hegemony, 65.

14. Arab Centre for Research and Policy Studies, “Unpacking Saudi-US Response to the Aramco Attack”, 23 September 2019, https://www.dohainstitute.org/en/PoliticalStudies/Pages/Iran-Saudi-Crisis-Aramco-Attacks-and-Potential-Escalation.aspx.

15. Tony Capaccio and Glen Carey, “US withdraws some Patriot missiles from the Middle East as tensions with Iran ease”. The Print, 08 May 2020, https://theprint.in/world/us-withdraws-some-patriot-missile-batteries-from-middle-east-as-tensions-with-iran-ease/416898/.

16. Katzman Kenneth, Mclnnis J Kathleen, Thomas Clayton, “US-Iran Conflict and Implications for US Policy” Congressional Research Service. R45795, 08 May 2020, https://fas.org/sgp/crs/mideast/R45795.pdf.

17. Seyed Hossein Mousavian, “The Widening Saudi-Iran Divide”, The Cairo Review of Global Affairs, Winter 2018, https://www.thecairoreview.com/essays/the-widening/.

18. International Monetary Fund, “Table 6. Breakeven Oil Price: US Dollars”, 2020, https://data.imf.org/regular.aspx?key=60214246.

19. Blake Clayton and Michael A Levi, Fiscal Breakeven Oil Prices: Uses, Abuses, and Opportunities for Improvement, Council on Foreign Relations, https://www.cfr.org/content/newsletter/files/Breakeven_Oil_Summary.pdf.

20. N Sonnichsen, “Average Monthly OPEC Basket Crude Oil Price from May 2019 to May 2020”, Statista, 16 June 2020, https://www.statista.com/statistics/277914/monthly-average-prices-of-the-opec-crude-oil-basket/.

21. Rabah Arezki and Nguyen Ha, “Coping with Dual Shock: COVID-19 and Oil Prices”, VOX CEPR Policy Portal, 01 April 2020, https://voxeu.org/article/coping-dual-shock-covid-19-and-oil-prices.

22. Anthony H Cordesman and Nicholas Harrington, "Military Spending, Modernisation, and the Shifting Military Balance" CSIS. 12 December 2018, https://www.csis.org/analysis/arab-gulf-states-and-iran-military-spending-modernization-and-shifting-military-balance.

23. Hal Brands, Steven A Cook, Kenneth M Pollack, "Rip the Carter Doctrine, 1980-2019" American Enterprise Institute, 13 December 2019, https://www.aei.org/articles/rip-the-carter-doctrine-1980-2019/.

24. Permanent Mission of the Russian Federation to the United Nations. "Press Conference by Charge de Affaires of the Russian Federation Dmitry Polvavansky "Russia's Collective Security Concept for the Persian Gulf", 08 August 2019, https://russiaun.ru/en/news/press_conference080819.

25. Abhishek G Bhaya, "China Backs Russian Plan for 'Collective Security' in Persian Gulf", CGTN. 26 July 2019 https://news.cgtn.com/news/2019-07-26/China-backs-Russian-plan-for-collective-security-in-Persian-Gulf-IDEJRWKHLy/index.html.

26. Reuters. "Russia, China, Iran start joint naval drills in the Indian Ocean", 27 December 2019, https://www.reuters.com/article/us-iran-military-russia-china/russia-china-iran-start-joint-naval-drills-in-indian-ocean-idUSKBN1YV0IB.

27. Craig Snyder, Contemporary Security and Strategy, (London: Macmillan Press, 1999), 107-114.

About the Author

Commodore Somen Banerjee is a serving Indian Naval Officer, and was a Senior Fellow at the National Maritime Foundation. The views expressed are the author's and do not reflect the policies or position of the Indian Navy or the Government of India

Note

This article was first published on the Website of the National Maritime Foundation on 26 June 2020

Assessing India's "Security-Of-Energy" in the Face of Hybrid Warfare

Aadil Sud

In recent years, hybrid warfare has developed into a major regional and national threat, and threatens to become a global challenge. Hybrid warfare refers to a combination of conventional and unconventional warfare capabilities, used by non-State actors, along with non-military operations, which challenge mainstream military practice and strategic thinking.[1] These capabilities consist of, but are not limited to, actions such as applying diplomatic pressure, economic manipulation, and the use of non-State actors.[2] Hybrid warfare actors tend to escalate vertically or horizontally activities. 'Vertical escalation' refers to the '*intensity*' of actions when using any one of the five instruments of power, namely, 'military', 'political', 'economic', 'civil', and 'informational' (MPECI). At the same time, 'horizontal escalation' refers to the usage of more than one of these instruments. The choice of which (and how many) MPECI instruments are used by a hybrid warfare actor depends *"on the capabilities of the hybrid warfare actor and on the perceived vulnerabilities of its opponent, as well as the political goals of the hybrid warfare actor and its planned ways to achieve those goals. As with all conflicts and wars, the character of hybrid warfare depends on the context"*.[3] It has been observed that horizontal escalatory activities create a larger overall impact as compared to the vertical escalation of any given instrument. Hybrid warfare leads to a loss of control by centralised authorities in the region, causing a rise in conflict and regional instability, which can directly affect countries and partners that operate in the affected areas. Some of the most severely affected areas are West Asia and East Africa, which happen to be especially important for India's energy supply. Much of India's energy originates from West Asia, passes along the Arabian Peninsula, or traverses the Mozambique Channel. This paper will view the expression 'security of energy' as the physical and fiscal security of the actual flow of energy and attempt to analyse how national and regional instability caused by hybrid warfare has impacted India's approach to ensuring the more commonly encountered expression, 'security of energy'.

India's Energy Bouquet

Three of the most important energy resources imported by India are coal, oil, and natural gas. India has witnessed a continuous rise in the imports of these commodities to meet India's needs in terms of the production of electricity and consumption by other sectors, such as the transport sector and the fertiliser sector. For example, Indian coal imports have steadily increased over time, and reached 209 million tonnes (Mt) in 2017 (see Figure 1[4]).

India's biggest suppliers of coal are Australia (for metallurgical coal), Indonesia and South Africa (for thermal coal). Due to the poor quality of Indian coal, imports from these countries are vital to meet the rising domestic consumption demands.[5] India also relies heavily on oil imports— these imports were of the order of 4.2 million barrels per day in October 2020.[6] Net oil-imports have increased by almost 90 per cent over the past decade. As of 2018-19, all three of India's largest oil suppliers were located in West Asia, with Iraq supplying 970 kb/d (thousand barrels per day), Saudi Arabia supplying 800 kb/d, and Iran supplying 521 kb/d (see Figure 2[7]).

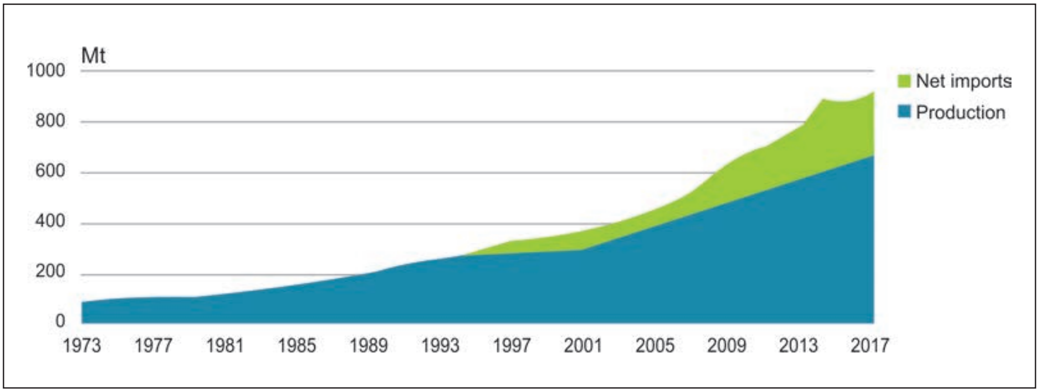


Figure 1: India's Coal Supply Sources, 1973-2017
Source: India 2020: Energy Policy Review, 256, https://www.iea.org/reports/india-2020

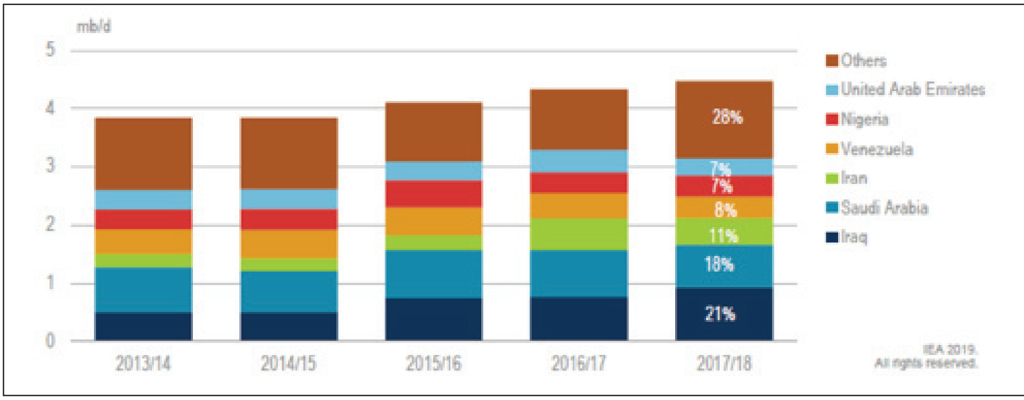


Figure 2: Indian Crude Oil Imports, 2013-2018
Source: India 2020: Energy Policy Review, 256, https://www.iea.org/reports/india-2020

In December of 2020, India's largest suppliers were Iraq, Saudi Arabia, and the United Arab Emirates (UAE).[8] Two other major regions from where India's oil imports are sourced are West Africa and South America. Much of this oil passes through the Mozambique Channel en route to destination-ports in India.[9] The oil industry remains extremely important for Indian trade, as while India is a net importer of crude oil, the country is also a net exporter of refined oil products, and has, in fact, been Asia's largest exporter of petroleum products since 2009.[10]

While the share of natural gas in India's energy supply and consumption has remained small, domestic supply has not kept up with demand. Hence, in recent years, imports of LNG have increased to account for around 43 per cent of the total LNG consumed in the country. In 2017, 49 per cent of India's imports came from Qatar, once again underscoring the important role that West Asia plays in India's energy imports. India has started to diversify its supply sources in recent years, including over 13 countries in 2017 (see Figure 3)[11]. Other significant suppliers include Nigeria, Equatorial Guinea, and Australia.[12]

It is apparent that India's three biggest energy imports either originate from or pass through the shipping lanes in the proximity of East Africa and West Asia. The major routes are through the Mozambique Channel, around Yemen via Bab-el-Mandeb, or through the Strait of Hormuz (see Figure 4)[13].

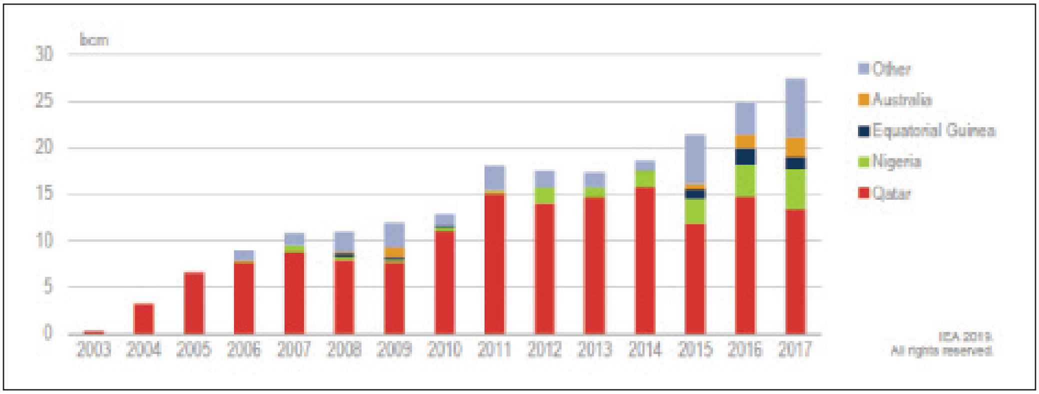


Figure 3: Natural Gas Imports into India, 2003-17
Source: India 2020: Energy Policy Review, 256, https://www.iea.org/reports/india-2020

Due to the high degree of dependence on these energy imports, it is in India's national interest to ensure its security-of-energy, especially as the source regions are subject to long periods of societal, ethnic and geopolitical instability. One of the growing threats stemming from this instability is hybrid warfare, which, in turn, adds to the overall instability. Instability in the maritime areas off Mozambique and Yemen, significantly impacts India's security-of-energy calculus, and consequently, the origins, risks, and threats emanating residing within this calculus need to be analysed.

The Mozambique Dilemma

Mozambique has a troubled history of conflict that owes its origins to the country's independence movement, which began in 1964, followed by the post-Independence civil war, which lasted until 1992. The Rome General Peace Accords of 1992 led to the establishment of liberal democracy — an arrangement which, until the early-2010s, seemed to have stabilised the country and placed Mozambique on the path to development, with economic growth averaging around 8 per cent per year in the period from 2001 to 2010.[14] However, after the discovery of large offshore gas reserves by oil consortia — such as the Anadarko Petroleum Corporation (now amalgamated into the Occidental Petroleum Corporation) of the USA, and Eni Energy Company

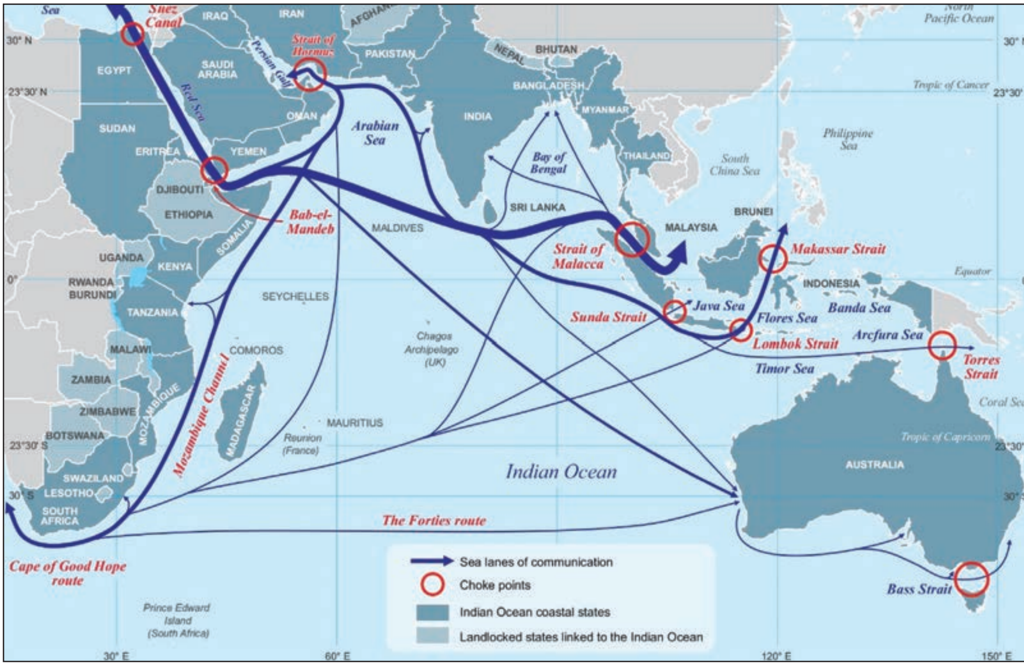


Figure 4: Major Energy Sea Lanes
Source: Denis Venter, Fluid Networks and Hegemonic Powers in the Western Indian Ocean

(an Italian consortium) — in October 2011,[15] the peace deal broke down and hostilities between the two previously-squabbling political factions (RENAMO, the opposition party, and FRELIMO, the ruling party) resumed their violent competition for political power.[16] Hostilities continued until mid-2019, when the leaders of these factions signed another peace deal, which brought an end to the six-year long conflict. Along with the discovery of fresh gas-reserves around the Rovuma Basin off the Cabo Delgado region, there has also been a rise in Islamic extremism,[17] with the presence of insurgent factions, and the Islamic State (IS) becoming active in the region. During this crisis, it was feared that RENAMO's actions could result in the disruption, or loss of control of Mozambican energy deposits[18] and, by extension, export / trade routes — a concern that now also applies to terrorist activities in the same areas. RENAMO's leader at the time, Afonso Dhlakama, had declared in 2017 that six provinces should be under their autonomous control. An attempt was made to legitimise this demand by claiming the support of the majority of the population of those regions. In 2016, RENAMO had claimed close to 67 per cent

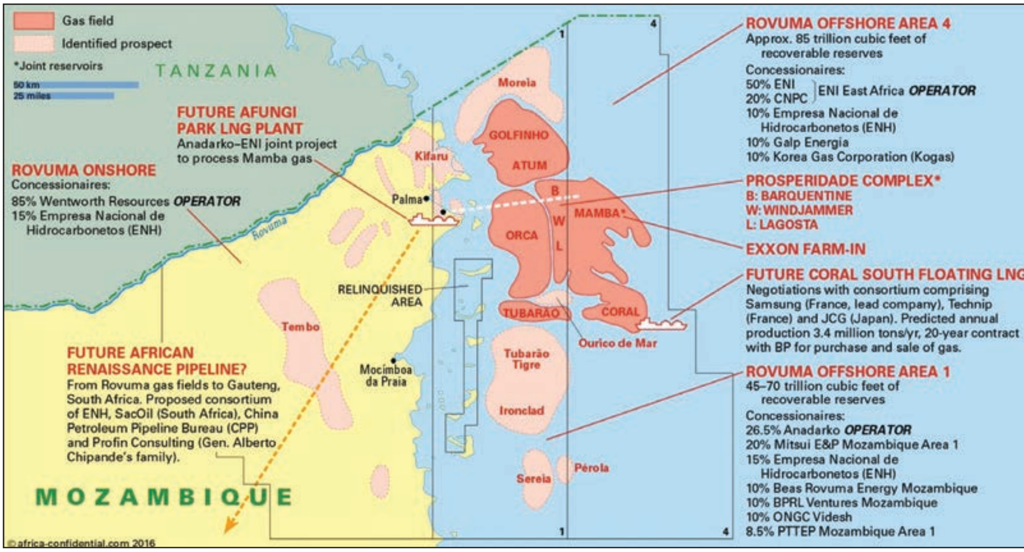


Figure 5: Proposed and Current Energy Projects in North-eastern Mozambique
Source: Liam Carmody, "LNG in Mozambique: Resources Saviour or Curse?", https://www.futuredirections.org.au/publication/lng-mozambique-resources-saviour-curse/

of Mozambican territory, home to almost 70 per cent of the total population[19]. This simmering instability poses yet another threat to the supply lines of Mozambique's neighbours, as well as to those of India (see Fig[20]).

Hostile actions taken by both RENAMO, and Islamic insurgents have destabilised the region and raised the risk of the disruption of supply lines. In particular, the proximity of RENAMO territory to the Rovuma Basin gas deposits could threaten both the exploitation and transport of energy. It also creates the possibility of extortion and / or hostage crises of critical personnel prospecting in the region, and even shipping originating or passing through the Mozambique Channel, carrying energy cargoes such as gas, coal, and oil. It hardly bears reiterating that Mozambique is extremely important to India's security of energy. For example, Oil India Limited (OIL) and its foreign partners have secured a $15 billion investment to partially finance their LNG project in the Rovuma Basin[21]. Moreover, Indian energy supplies from South America and West Africa passing through this area run the risk of being impacted by growing instability in the Mozambique Channel and its immediate environs. Even gazing across a longer time horizon, India ought not to countenance instability in and around the Mozambique Channel. This is because future imports of natural gas from onshore and offshore gas fields in Mozambique, Tanzania, and Madagascar could significantly reduce Indian dependence on sources such as Qatar in the Persian Gulf, or Nigeria in West Africa. India has sought to diversify its import-sources of natural gas and Nigeria has been identified as an economically viable option. However, imports of natural gas from Nigeria will have to transit a number of unstable sea areas and choke points, such as the Suez Canal, the Red Sea, the Strait of Bab el Mandeb, and the Gulf of Aden. All in all, when seen through the lens of Indian investments in the region, the presence of non-State actors (NSAs) certainly threatens the sustainability of energy supply.

With the increase in the number of NSAs and Private Military Contractors (PMCs) engaging in hybrid warfare, the level of instability in the region is likely to increase further. On 05 August 2020, insurgents attacked the strategic port of Mocímboa da Praia (depicted in Figure 5), killed over 50 soldiers, sank a Mozambique Naval Ship with a rocket-propelled grenade, and, eventually took physical control of the port by 11 August 2020.[22] This had led to a more direct role for PMCs such as the Wagner Group and the Dyck Advisory Group (DAG). Hired by governments in the region for election security, counterinsurgency operations, as well as to provide security for sensitive sites, such NSAs often give short shrift to international humanitarian law, and their presence and involvement have raised concerns of human rights abuses in the region, accentuated by the lack of accountability of such groups. This latter characteristic of NSAs has also been utilised by governments to carry out actions against growing domestic insurgency. The accompanying "plausible deniability" has allowed States to deny responsibility for any State-sponsored abuse, since such abuse can be conveniently laid at the door of the PMCs. This growing instability and ethnic divisions amongst the local population have pushed more and more people into joining one or another insurgent faction, further destabilising the region.

Therefore, the presence and hostile actions of NSAs raises concerns regarding the security of energy, especially energy originating from the region or passing through the Mozambique Channel. For India, these can have severely adverse consequences as instability in the region and increase in hostile actions due to the growth of hybrid warfare will impact India's security of energy, both 'originating from', and 'transiting' the Mozambique Channel and adjoining areas.

The Yemen Crisis

Following the resignation of President Ali Abdullah Saleh in 2012, the new regime struggled to unite various political factions. In late 2014, the Iranian backed Houthi insurgency morphed into a full scale civil war, with rebels capturing the capital of Sana'a in 2015 and forcing Abdrabbuh Mansur Hadi, the leader of the government, to resign.[23] The Arab League, the Gulf Cooperation Council (GCC), the UN, and the USA, all refused to recognise the new Houthi regime. While Hadi managed to escape to Saudi Arabia, the latter, along with some other countries (principally the UAE) announced that it was launching military operations in Yemen against the Houthi rebels.[24] These operations initially comprised airstrikes, which later escalated to a naval blockade and the deployment of ground forces into Yemen, and resulted in exchange of artillery and rocket fire across the border between Saudi Arabia and Yemen.

Control and influence of Yemen is currently divided amongst four major groups, resulting in significant instability (see Figure 6)[25]. This situation is further complicated by the presence of ISIS and *Al-Qaeda*, who control and influence large sections of territory in Yemen, and are engaged in offensive action against both parties to the conflict[26].

Long viewed as a proxy war between Saudi Arabia and Iran, the conflict in Yemen has resulted in near-constant risk to critical supply lines, with the Houthi rebels widely thought to be supported by the Iranian regime,[27] a claim that Iran has denied. The Houthi-controlled areas are a constant target for military action by the Saudi-led coalition, and these actions, combined with Houthi rebel offensives, endanger shipping through the Red Sea and the Gulf of Aden. Even civilian ships (flying the flag of countries of the Saudi coalition and their allies) have been targets of attacks, such as that of July 2018, when Houthi rebels attacked a Saudi-flagged civilian oil tanker, the MT *Arsan*[28], and, of December 2020, when the MV *Hasan*, a 'Sierra Leone'-flagged ship heading to Oman was attacked.[29]

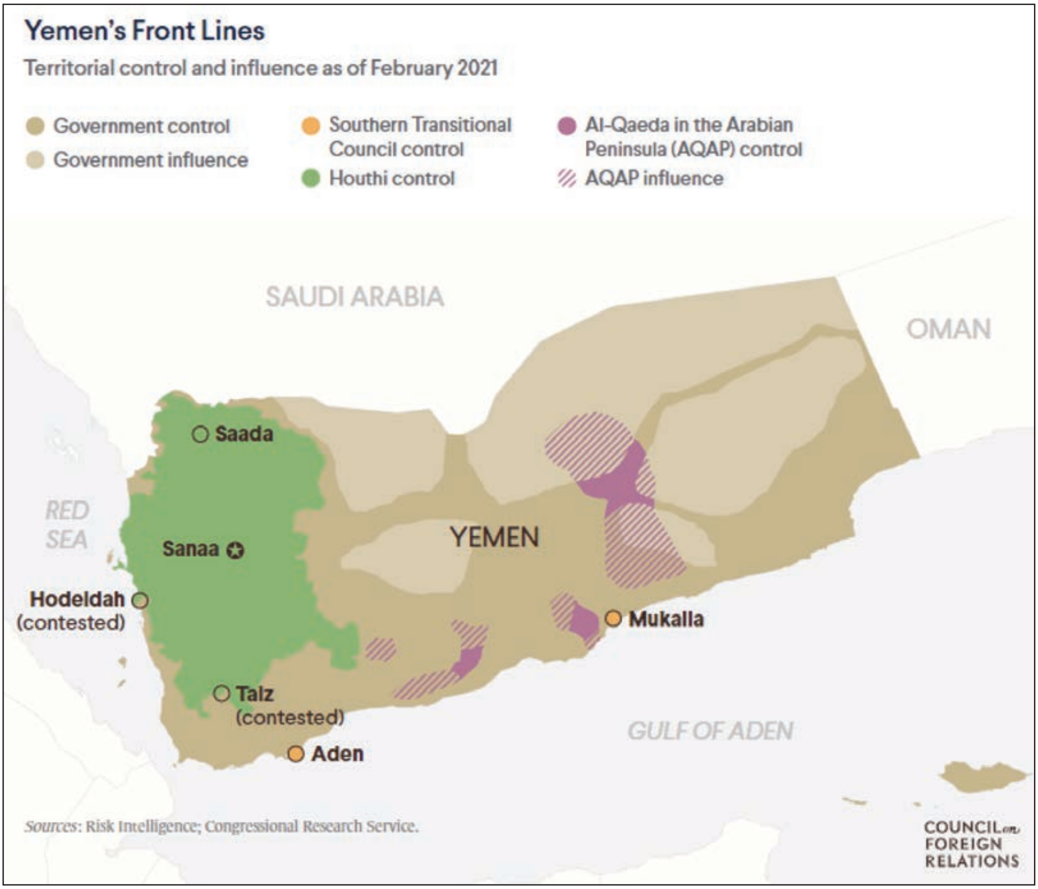


Figure 6: Territorial Control and Influence (as of Feb 2020)
Source: Kali Robinson, "Yemen's Tragedy: War, Stalemate, And Suffering", Council on Foreign Relations, https://www.cfr.org/backgrounder/yemen-crisis

This conflict has seen hybrid warfare being used against Saudi Arabia and its allies. For example, UN investigators had previously warned that Houthi rebels had acquired advanced drones with estimated ranges of over 900 miles.[30] This input proved prescient when, in September 2019, airborne drones attacked Saudi Aramco oil installations in Eastern Saudi Arabia, with the Houthi rebels claiming responsibility for the attack.[31] This attack exposed a new dimension of the threat to the security of energy in the region, and was of special concern and relevance to India, whose energy lines from West Asia and the Red Sea (see Figure 7)[32] were shown to be extraordinarily vulnerable.

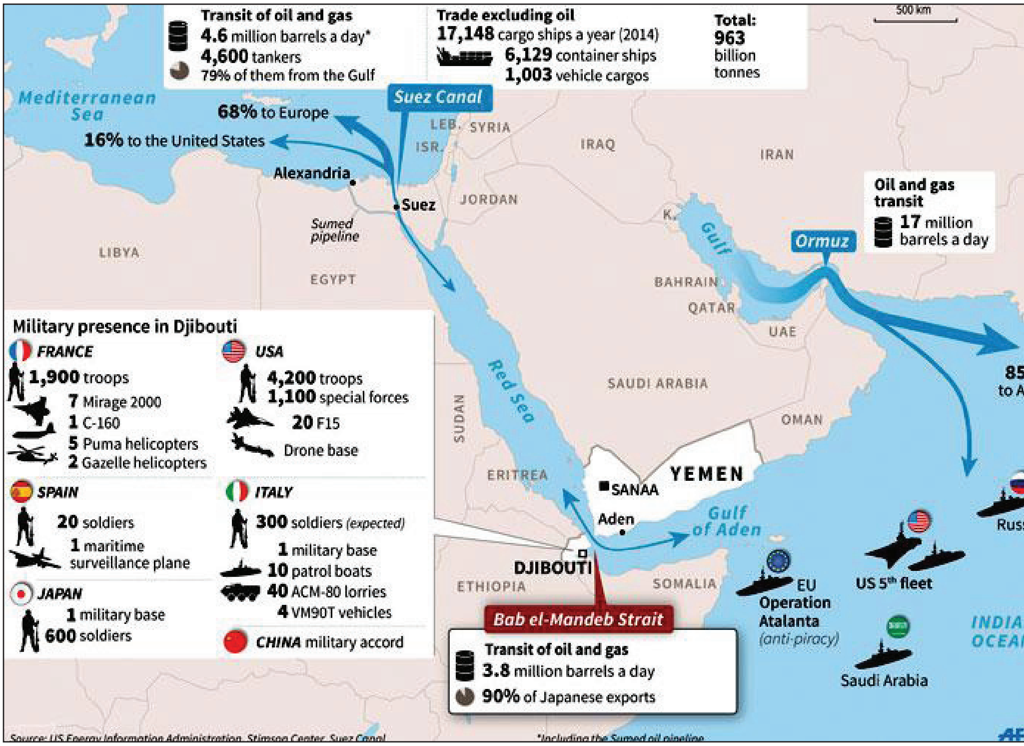


Figure 7: Passage of Resources in Western Asia

Source: Gregory Aftandilian, "In Yemen, Egypt Balancing Its Interests", The Arab Weekly, 17 April 2015, https://thearabweekly.com/yemen-egypt-balancing-its-interests

This new threat would, in all probability, adversely impact shipping in maritime choke points such as the Strait of Bab-el-Mandeb and the Strait of Hormuz, by targeting shipping in an extremely cost-effective manner. Mitigation of such a threat requires the development and fitment of suitable countermeasures on warships to provide protection to merchant shipping. Such countermeasures would also have to be added to the design of future warships. A single successful strike, or even a serious attempt at a strike, could be enough to disrupt shipping in the area, either due to blocking or restricting available space in existing navigable areas by damaging or sinking a ship. This could lead to shipping avoiding the area and, instead, choosing the longer passage via the Cape of Good Hope. The impact on energy lines originating from the area would be even greater as the risks to such shipping would increase, resulting in an increase in insurance premiums, and hence, in the initially final cost of the energy. This also brings to the fore the challenges arising from plausible deniability, making it difficult to identify and assign responsibility to any specific NSA or even to a State one. This was noticeable in the two Gulf of Oman incidents in 2019, where Iran was blamed but could not be conclusively proven to have been responsible (and hence accountable) for the attack on four commercial ships and two oil tankers, through the alleged use of limpet mines.[33]

Two-thirds of India-bound oil, and half of India's LNG imports pass through the Strait of Hormuz.[34] Any disruption in the import of energy will impact India, with the worst-case scenario being a shortage of such severity and duration that it leads to an actual energy crunch. Additionally, there is a danger of terrorist groups and / or NSAs acquiring advanced and cheap-to-produce asymmetrical warfare capabilities, which would significantly enhance this threat.

Mitigation Avenues

To address the above issues, India needs to continuously examine how to reduce the threat to the country's security of energy. As India has good relations with most of the players, both intra and extra regional, a continued benign approach is probably the most appropriate overall policy-approach.

India's grand strategy in the Indian ocean has been based upon five Hindi words all beginning with the sound "Ess" – *Sammaan* (respect), *Samvaad* (dialogue), *Sahayog* (cooperation), *Shaanthi* (peace) and *Samriddhi* (prosperity).[35] India's stand on strategic autonomy and respect for the sovereignty of other nations have been cornerstones of the country's foreign policy. Hence, India has, more often than not, adopted a stance of remaining carefully neutral in its approach to conflicts and internal strife of nations and has always advocated peaceful resolutions. This approach has stood India in good stead, as manifested in the Non-combatant Evacuation Operations (NEO) undertaken in Lebanon in 2006, and in Yemen in 2015, wherein Indian warships were permitted to enter the war-torn ports and evacuate Indian citizens as also foreign nationals.[36]

Maintaining a neutral and benign approach would ensure that Indian investments, such as those made by ONGC *Videsh* in partnership with companies such as Saudi Aramco, ADNOC or SABIC remain safe. In comparison, the awarding of exploration rights in the Rovuma Basin to Oil India Ltd and its partners requires the existence of a stable and friendly government to assure success, security, and support of the Indian venture. India could offer benign assistance that supports nation-building through the medical, education and basic infrastructure routes, to name just a few.

The Indian Navy's mission-based deployments[37] also add to the acceptability of India's presence in the region as they support the perception of India as a 'preferred security partner'[38] and 'first responder in the maritime domain'.[39] This acceptability stems from the inherent flexibility of warships, which enables Indian naval ships to be seamlessly switched from whatever mission they might be undertaking to one involving disaster relief efforts and the projection of India's soft power. An example of this was the mission to Port Beira in Mozambique, where Indian ships were diverted to render assistance and provide dry provisions, epidemic-related medicines, clothes, and ready-to-eat meals in the aftermath of Cyclone *Idai*.[40] Other notable examples are Operation RAHAT, involving the evacuation of both Indian and foreign nationals from Yemen after the recommencement of hostilities in the country,[41] and Operation SAMUDRA SETU, involving the evacuation and repatriation of Indian citizens from the Maldives, Sri Lanka, and Iran, stranded there as a result of travel-restrictions ensuing from the COVID-19 pandemic.[42] This was an immense success in a number of ways, not the least being that there was not a single case of COVID positivity amongst any of the hundreds of personnel, naval and civilian, throughout the operation. These operations showcase the benign role of the Indian Navy, its ability to adapt to the situation, and its flexible organisational capabilities.

Conclusion

For India, assuring the security of its energy supplies is vital for the country's economy. Towards this end, India has engaged in efforts to increase its standing in the region by working hard and visibly to enhance stability and reduce tensions in times of crisis, thereby becoming a strategic partner to other countries whose own lines of energy supply countries transit through the subregions involved. All this is inextricably linked to India's principal maritime interests. However, the rise of hybrid warfare in areas critical to India's energy supply has resulted in increased risks for India's continued security of energy and has constrained India from taking on a more active role, especially in view of keeping its investments and supply lines safe.

This perhaps stems from cautiousness. First, so as not to endanger existing economic assets, and secondly to avoid India being perceived as belligerent and having Indian assets perceptually positioned as legal targets, mainly by State actors. As seen in the ARAMCO incident, energy resources are not free from threat, and India has a vested interest — both strategically and economically — to ensure the safety of its investments and supply lines. The availability or supply of cost-effective weaponry and equipment aid the hybrid warfare capability of NSAs, especially when supported by regional powers. Iran, for example, has repeatedly been accused of providing groups such as the Houthi and Hezbollah with anti-ship and coastal-defence cruise missiles, as well as short-range ballistic missiles such as the several SCUD variants,[43] possibly with an aim to project power into the Strait of Bab el-Mandeb and its environs.

The maritime areas that lie off West Asia and East Africa are vital to India's continued security of energy, and India needs to engage all nations, especially resource-rich ones within these areas, on multiple fronts. The very nature of hybrid warfare requires cooperative mechanisms to ensure that energy supply lines remain unimpeded and unaffected by regional tensions. India also needs to work on a policy on countering the challenges posed by such hybrid warfare, so as to ensure the security of its energy flows.

Hybrid warfare is difficult to address but an overall benign approach that focusses primarily on non-military measures that enhance goodwill, such as naval diplomacy, material and infrastructure support, and humanitarian aid, would probably yield the most attractive dividends for New Delhi.

ENDNOTES

1. Patrick J Cullen and Erik Reichborn-Kjennerud, *MCDC Countering Hybrid Warfare Project: Understanding Hybrid Warfare* (Multinational Capability Development Campaign, 2017), 8-9.

2. Ibid, 9.

3. Ibid, 10.

4. International Energy Agency, *India 2020: Energy Policy Review* (IEA Publications, 2020), 232.

5. Ibid, 233-234.

6. Sachin Dave, "India's Oil Consumption Jumps Marginally in October indicating Mild Economic Recovery", *The Economic Times*, 01 December 2020, https://economictimes.indiatimes.com/industry/energy/oil-gas/indias-oil-consumption-jump-marginally-in-october-indicating-mild-economic-recovery/articleshow/79512114.cms?from=mdr.

7. International Energy Agency, *India 2020: Energy Policy Review,* 256, https://www.iea.org/reports/india-2020.

8. "India's Oil Imports Reach 3-Year High in Dec 2020 at 5 million Bpd", *Businesstoday.In*, 20 January 2021 https://www.businesstoday.in/current/economy-politics/india-oil-imports-reach-3-year-high-in-dec-2020-at-5-million-bpd/story/428443.html.

9. International Energy Agency, *India 2020: Energy Policy Review*, 250.

10. Nishi Vasudeva, "India Leads Asia in Exports of Petroleum Products", *Refining and Petrochemicals*, 2014.. http://firstforum.org/DownloadSpecialistPublicationDetail.1896.ashx.

11. International Energy Agency, *India 2020: Energy Policy Review,* 273.

12. Ibid.

13. Denis Venter, "India and Africa: Maritime Security and India's Strategic Interests in The Western Indian Ocean", in *Fluid Networks and Hegemonic Powers in the Western Indian Ocean* eds, Iain Walker, Manuel João Ramos et Preben Kaarsholm (Centro de Estudos Internacionais, 2017), https://books.openedition.org/cei/469.

14. The World Bank, "GDP Growth (Annual %) – Mozambique", https://data.worldbank.org/indicator/NY.GDP.MKTP.KD.ZG?locations=MZ.

15. Delia Robertson, "Massive Gas Fields Discovered Off Mozambique", *Voice of America*, 09 November 2011, https://www.voanews.com/africa/massive-gas-fields-discovered-mozambique.

16. Stephanie Regalia, "The Resurgence of Conflict in Mozambique. Ghosts from the Past and Brakes to Peaceful Democracy", Notes d'Ifri, 04 May 2017, https://www.ifri.org/sites/default/files/atoms/files/regalia_resurgence_conflict_mozambique_2017_v2.pdf.

17. Cristina Krippahl, 2020, "Peace in Mozambique: Third Time Lucky?", DW, 05 August 2020, https://www.dw.com/en/peace-in-mozambique-third-time-lucky/a-54444504.

18. Giovanni Faleg, "Conflict Prevention in Mozambique", Iss.Europa.Eu, 10 April 2019, https://www.iss.europa.eu/content/conflict-prevention-mozambique#_the_elephants_in_the_room__natural_gas_and_rubies.

19. Andrew Korybko, "Incipient Hybrid War in South Central Africa and Mozambique", Global Research, 28 January 2017, https://www.globalresearch.ca/incipient-hybrid-war-in-south-central-africa-and-mozambique/5571374.

20. Liam Carmody, "LNG in Mozambique: Resources Saviour or Curse?", *Future Directions International*, 11 July 2018, https://www.futuredirections.org.au/publication/lng-mozambique-resources-saviour-curse/.

21. "Mozambique Gas Project Of OVL, OIL Ties Up $14.9 Billion Debt for LNG Project Financing", *The Economic Times*, 16 July 2020, https://economictimes.indiatimes.com/industry/energy/oil-gas/mozambique-gas-project-of-ovl-oil-ties-up-14-9-billion-debt-for-lng-project-financing/articleshow/76997657.cms?from=mdr.

22. "The Conflict in Mozambique Is Getting Worse", *The Economist*, 26 August 2020 https://www.economist.com/middle-east-and-africa/2020/08/26/the-conflict-in-mozambique-is-getting-worse.

23. Tom Allinson, "Yemen's Houthi Rebels: Who Are They and What Do They Want?", *DW*, 01 October 2019, https://www.dw.com/en/yemens-houthi-rebels-who-are-they-and-what-do-they-want/a-50667558.

24. "Saudi and Arab Allies Bomb Houthi Positions in Yemen", *Aljazeera*, 26 March 2015, https://www.aljazeera.com/news/2015/3/26/saudi-and-arab-allies-bomb-houthi-positions-in-yemen.

25. Kali Robinson, "Yemen's Tragedy: War, Stalemate, And Suffering", Council on Foreign Relations, 05 February 2021, https://www.cfr.org/backgrounder/yemen-crisis.

26. "Yemen Conflict: Al-Qaeda Seen at Coalition Battle for Taiz", *BBC News*, 22 February 2016, https://www.bbc.com/news/world-middle-east-35630194.

27. Kali Robinson, "Yemen's Tragedy: War, Stalemate, And Suffering", *Council on Foreign Relations*, https://www.cfr.org/backgrounder/yemen-crisis.

28. Michael Knights and Farzin Nadimi, "Curbing Houthi Attacks on Civilian Ships in the Bab Al-Mandab", *The Washington Institute*, 27 July 2018, https://www.washingtoninstitute.org/policy-analysis/curbing-houthi-attacks-civilian-ships-bab-al-mandab.

29. Jon Gambrell, "Cargo Ship Attacked Off Yemen Under Unclear Circumstances", *AP NEWS*, 05 December 2020.. https://apnews.com/article/bahrain-gulf-of-aden-dubai-united-kingdom-united-arab-emirates-65fc8730659acce8e375c698168cbd6f.

30. Ben Hubbard, Palko Karasz, and Stanley Reed, "Two Major Saudi Oil Installations Hit by Drone Strike, and U.S. Blames Iran", *The New York Times*, 14 September 2019, https://www.nytimes.com/2019/09/14/world/middleeast/saudi-arabia-refineries-drone-attack.html.

31. "Houthi Drones Hit Saudi Aramco Oil Facilities", *Aljazeera*, 14 September 2019, https://www.aljazeera.com/economy/2019/9/14/houthi-drone-attacks-on-2-saudi-aramco-oil-facilities-spark-fires.

32. Gregory Aftandilian, "In Yemen, Egypt Balancing Its Interests"*, The Arab Weekly*, 17 April 2015, https://thearabweekly.com/yemen-egypt-balancing-its-interests.

33. Anthony H Cordesman, "The Strategic Threat from Iranian Hybrid Warfare in The Gulf", *Center for Strategic and International Studies*, 13 June 2019, https://www.csis.org/analysis/strategic-threat-iranian-hybrid-warfare-gulf.

34. "India Faces Biggest Impact of Tensions in Strait of Hormuz: IEA", *The Economic Times*, 20 July 2019, https://economictimes.indiatimes.com/news/economy/foreign-trade/india-faces-biggest-impact-of-tensions-in-strait-of-hormuz-iea/articleshow/70301376.cms?from=mdr.

35. Vice Admiral Pradeep Chauhan, "India's Maritime Domain: An Overview", Presentation, NMF Delhi, 2021.

36. Bhargav Acharya, "The Indian Navy and India's Overseas Citizens: Operations Sukoon and Rahat", *The National Maritime Foundation*, 22 May 2017, https://maritimeindia.org/the-indian-navy-and-indias-overseas-citizens-operations-sukoon-and-rahat/.

37. "Navy has Carried Out Mission-based Deployment to Protect Maritime Interests: Rajnath Singh", WION News. 19 August 2020, https://www.wionews.com/india-news/navy-has-carried-out-mission-based-deployment-to-protect-maritime-interests-rajnath-singh-321663.

38. "Mission Sagar: INS Kesari Arrives Kochi," Ministry of Defence, 28 Jun 2020, https://pib.gov.in/PressReleasePage.aspx?PRID=1635090.

39. "Mission Sagar-II", Press Information Bureau, Ministry of Defence, 06 November 2020, https://pib.gov.in/Pressreleaseshare.aspx?PRID=1670740.

40. Abhishek Mishra, "India-Africa Maritime Cooperation: The Case of Western Indian Ocean", ORF, 04 November 2019, https://www.orfonline.org/research/india-africa-maritime-cooperation-the-case-of-western-indian-ocean-57250/.

41. Hari Kumar, "India Concludes Evacuation of its Citizens from Yemen", *Nytimes.Com*, 10 April 2015, https://www.nytimes.com/2015/04/11/world/asia/india-concludes-evacuation-of-its-citizens-from-yemen.html?nytmobile=0.

42. Anantha Narayanan K, "Indian Navy Completes Operation Samudra Setu", *The Times of India*, 08 July 2020,. https://timesofindia.indiatimes.com/india/indian-navy-completes-operation-samudra-setu/articleshow/76858148.cms.

43. Kenneth Katzman, "Iran's Foreign and Defense Policies," Congressional Research Service, 11 February 2021, https://fas.org/sgp/crs/mideast/R44017.pdf.

About the Author

Mr. Aadil Sud is a young Adjunct Research Associate with the NMF, he completed the "WINTER 2020-21 (Extended)" internship programme at the national Maritime Foundation. He is currently pursuing a postgraduate degree in International Security from the Paris School of International Affairs, at Sciences Po, Paris. He may be contacted at adi.sud@gmail.com

Note

This article was first published on the Website of the National Maritime Foundation on 14 June 2021

The American Sanctions on Iran and Implications for India

Rajesh Soami

The decision of the Trump administration to end waivers for the import of Iranian oil to India has ended the almost 12-year-long diplomatic tightrope that India has been walking since sanctions were first imposed on Iran through UN resolution 1737 in December 2006. The 'on-again, off-again nature of the sanctions had provided India, the breathing space it required to maintain its ties with both Iran as well as the United States, the latter being the major driving force behind the curbs. The occasional waivers granted to India by the US helped along the way. After 01 May 19, however, India can no longer import Iranian oil without adverse economic consequences. According to statements emanating from the Government of India, it intends to comply with the sanctions. If correct, this will be a first for the country. In the past, New Delhi has never supported Western non-UN-mandated sanctions against individual States.

This development should come as no surprise. Ties between India and the US have been growing stronger since the start of the millennium. The two countries now agree on a host of issues, including but not limited to, China, Afghanistan and international terrorism. The US has helped India become a *de facto* nuclear power through the 123 agreement. It has also helped Delhi join the Wassenaar Arrangement, the Australia Group, and the Missile Technology Control Regime (MTCR). India, for its part, has signed three of the four foundational military cooperation agreements with the US. The latest one was the COMCASA, signed last year (in 2018). However, American hostility towards Iran puts India in a serious bind. The importance of Iran to New Delhi rivals that of the US. The geographic location of Iran is itself a major factor. A difficult relationship with Pakistan means that India is compelled to access Central Asia through Iranian territory. India also intends to connect itself to countries in West Asia, the Caucasus, and Eastern Europe, through its International North-South Transport Corridor. Iran is at the centre of all such plans.

Secondly, Iran is also a vital source of petroleum imports. The Indian economy depends heavily upon both, the import of raw crude and the export of processed petroleum products, to fuel its rapid economic growth. After coming under pressure from American sanctions, Teheran has been offering deep discounts to buyers of its oil. India has benefitted from these. Moreover, some refineries in India are designed to handle only Iranian sour crude. The US sanctions mean that these refineries will now have to make technical changes to crude from other countries, thereby incurring extra costs.

Despite these issues, India is gearing up to comply with the US sanctions. The Minister for Petroleum and Natural Gas, Dr Dharmendra Pradhan, said on Twitter:[1] *"Govt has put in place a robust plan for adequate supply of crude oil to Indian refineries. There will be additional supplies from other major oil producing countries; Indian refineries are fully prepared to meet the national demand for petrol, diesel & other Petroleum products".* In the last decade, India has markedly improved its relations with other oil-producing countries in West Asia. This was evident when recently, Prime Minister Modi was awarded[2] the Zayed Medal, the highest civilian honour of the United Arab Emirates. Saudi Arabia, the largest oil-producing nation in the world, has also become friendlier to India. The two States are cooperating on the anti-terrorism front. Riyadh has also promised to build[3] a refinery in India with an estimated investment of US$44 billion. These developments suggest that India may, indeed, manage to get supplies from other countries, as Dr Pradhan has stated.

However, Indian compliance with the American sanctions on Iran is almost certainly going to lead to its deterioration of ties with Tehran. India already has the image of an unreliable friend within Iran. This is due to the partial fulfilment of American sanctions in the past by way of reduced oil imports. From the Indian point of view, it is Iran that has acted with little concern for Indian sensitivities. Despite an Indian consortium discovering gas deposits at Farzad B gas field, Iran has dithered on giving exploitation rights to Indian companies. This prompted New

Delhi to instruct[4] its oil importers to reduce their take from Iran in 2017. In the past, Iran has also criticised India on its policies in Kashmir, which has not been seen positively in Delhi. The mutual disillusionment between Iran and India is likely to lead to geopolitical challenges for both States. Iran has, in the past, threatened to revoke[5] special privileges to India if its oil is replaced by those of other countries in West Asia. This did not go down well with New Delhi. Iran does have leverages it can exploit. The Indian investment in Chabahar could be put under pressure. In the past, Iran has changed the terms of the Indian investment in Chabahar, causing delays. A sizable portion of Indian investments in Afghanistan, both capital and material, would be endangered if Iran pursues this path.

Moreover, if and when sanctions are lifted, India may not be offered favourable financial terms by Iran for the purchase of Iranian oil. Considering the very large volumes India requires to sustain its robust growth, and this could have significant financial implications. This is not to say that the Indian decision to comply with American sanctions is incorrect. As the sole superpower, the US wields enormous influence around the world. States, big and small, have faced economic problems when they have ended up on the wrong side of American policies. Turkey, Pakistan and Russia are relevant examples. It would not be too prudent for India, whose ties with the US are growing fast, to alienate the US for the sake of its ties with Iran.

That having been said, India must try to convince the US of its need to keep Iran engaged. Although Delhi cannot expect waivers of the kind it has received in the past, it must talk to the Americans to allow for the import of some oil from Iran. A correct (even if token) amount will not change the effect of sanctions very substantially. At the same time, it would enable India to continue managing its goodwill in Teheran, which is necessary for other projects both at present and in the future. The decision of the US government to end waivers to eight countries for import of Iranian oil will come into effect on 01 May 2019. Although some of these countries may well defy the unilateral American sanctions, most, including India, are likely to comply. This will reduce India s Iranian oil imports substantially, squeezing the money that Iran could earn. Iran is already facing economic problems due to continued pressure from the US (among other factors). Its problems are likely to get compounded after 01 May 2019.

Earlier, the United States also designated Iranian Revolutionary Guards Corps (IRGC) as a terrorist force. Although this may have been done due to IRGC's involvement in the civil war in Syria, it led to accusations that the US was preparing for a broader war with Iran. The USA's Secretary of State, Mike Pompeo, denied that America was seeking a regime change. Even if one assumes that this is not the case, increasing pressure on Iran may eventually lead to an armed conflict.[6] Iran is heavily dependent on petroleum exports to sustain itself economically. The American sanctions are already biting hard and have led to large-scale problems for Iran. The country's Gross Domestic Product (GDP) has been shrinking gradually. The Iranian currency Rial has lost 60 per cent of its value since 2018. Inflation is running high, leading to less purchasing capacity for the population, which, in turn, has led to a downward spiral in the economy. In fact, net inflation is expected to reach upwards of 40 per cent after the removal of waivers on 01 May 2019.

Unfortunately, Iran, as well as other countries caught in the crossfire, are finding it difficult to find a solution to the problem. The US, together with the other five major powers, had come to an agreement with Iran culminating in a deal in 2015 called the 'Joint Comprehensive Plan of Action' (JCPOA). This was aimed at Tehran discontinuing the Iranian nuclear programme in return for relief from sanctions. The Trump administration has withdrawn from this agreement and unilaterally slapped the sanctions again. Despite the other powers continuing to adhere to the JCPOA, the agreement looks dead. The resumption of the Iranian nuclear programme, therefore, is likely to be one of the fallouts of the US action. Iran has threatened to block the Strait of Hormuz. Although these threats have often been articulated by Iran in the past, the frequency and the seriousness of the threat has multiplied after the recent American move. This is a matter of serious concern for both oil-exporting countries and oil importing ones. The Iranians have admitted that this would be their last resort. Unfortunately, they don't have many options left.

Iran will need to take a decision on its course of action before the economy crashes completely. The choices are all harsh. Either Teheran will have to bear the current hardships until a more conciliatory President comes to power in Washington DC, or it will be forced to do what the current Trump administration seeks. The 12 demands made by the Trump administration on Iran before the slapping of sanctions are perceived to be rather harsh. Succumbing to American pressure may not be acceptable to the hardline '*ayatollahs*' in Teheran. The ruling elite has fed the public on a staple anti-American diet and built its reputation on its ability to stand up to the US. The smaller, moderate faction in Iran, which is in favour of negotiations, has suffered a loss of credibility after the unilateral withdrawal of the US from the JCPOA. The hardliners, with reasonable justification, have accused the moderates of continuously bending backwards to accommodate increasing American demands. *"The enemy wants to drag us to the negotiating table through economic pressure,* said General Qasem Soleimani, Commander of the overseas arm of the Iranian Revolutionary Guard Corps (IRGC). *"Any negotiations under the current circumstances will be mere surrender, and we definitely will not undergo this humiliation."*

The evolving situation, therefore, seems to be leading only in one direction, that of an armed conflict. The Strait of Hormuz, which Iran controls, is the easiest outlet for Iran to express its frustration. Any hindrance in the free flow of maritime traffic through the strait will adversely affect the economies of all oil exporting countries of the Persian Gulf region. This includes Iran's arch rival, Saudi Arabia, as well as other States hostile to it, such as the United Arab Emirates (UAE). The Chief of Staff of Iran's armed forces, Major-General Mohammad Baqeri, has been quoted as saying: *"If our oil does not pass, the oil of others shall not pass the Strait of Hormuz either".* The threat by Iran to choke the Strait of Hormuz, therefore, needs to be taken seriously. Other stakeholders in the Gulf have specifically expressed their concerns vis- à-vis the Iranian threat.

These developments are extremely relevant to India, which is clocking impressive economic growth year after year, on the back of its rapidly increasing trade. The importance of the Persian Gulf as a factor in this process of economic development cannot be overstated. Not only does India import almost all of its oil from the Gulf, but it also exports much of its merchandise to the Gulf countries. The United Arab Emirates (UAE) alone is India's second largest export destination. Any disruption of shipping in the Strait of Hormuz would snap a vital bridge, which has made India the fastest-growing large economy in the world.

If Iran chooses this path, it would mean war with other Gulf countries and perhaps with the major non-resident powers. This would lead to skyrocketing petroleum prices in the global market. If oil infrastructure is damaged during the course of the conflict, it could have a serious and lasting impact. The Indian economy is extremely sensitive to fluctuations in the price of crude. A large part of a country's economic growth is dependent on public spending on infrastructure by the government. The depletion of FOREX reserves will dry this investment up and stall the momentum of the Indian growth story. Unfortunately, there seems to be no meeting ground between the US demands and the Iranian position. New Delhi can only prepare for worst-case scenarios without an immediate solution in the offing. India must make alternative arrangements to source its petroleum imports. At the same time, of course, New Delhi must also overcome its addiction to fossil fuels by investing in renewables and nuclear energy.

Iran has threatened to close down the Strait of Hormuz. This is in response to the US decision to end waivers for eight major oil-importing countries for buying oil from Iran, starting from 01 May 2019. Similar threats have emanated from Tehran in the past. However, the continuing US efforts to strangulate the Iranian economy and the loss of credibility of the moderate faction in Iran increase the likelihood of the recent threats being realised. It seems that Iran is now left with very few cards in its hand , and Hormuz is one of them. The Strait of Hormuz is considered one of the most critical maritime chokepoints in the world. It connects the Persian Gulf to the Gulf of Oman. At its narrowest, it is 33 km wide, but the width of its navigable channel is only three km. Around 17 million barrels of oil passed through the strait every day in 2018.[7] This is anywhere between 20 per cent to 30 per cent of all crude shipped in the world, depending on global oil consumption. Over 300 million cubic metres of LNG (liquefied natural gas) also passes through the strait every day, which includes all of Qatar s LNG. It is to be noted here that Qatar is the largest LNG exporter in the world.[8]

Apart from Iran, Saudi Arabia, the United Arab Emirates (UAE), Bahrain, Kuwait and Iraq, all use the strait to export their oil. The economies of all these countries are highly dependent on the sale of petroleum extracted from their oil fields, which also lie close to the strait and near the shores of the Persian Gulf. Any disruption or hindrance in shipping across the Strait of Hormuz will have cascading effects on the Gulf countries. Therefore, the oil importing countries will also be affected severely. India is in a particularly vulnerable position as it imports 80 per cent of its petroleum-based energy needs, largely from the Gulf. Its rapidly growing economy does not have many viable alternatives. Many other non-Gulf oil exporting countries are facing their own problems. Venezuela, like Iran, is under rigid American sanctions. Libya has not recovered from the civil war, and continues to be politically unstable. The United States has emerged as the largest oil-producing country in the world. However, its export potential remains limited because the development of export infrastructure in the form of pipelines, ports, etc., will take another couple of years to be fully developed.

Indian Minister for Petroleum and Natural gas, Dr Dharmendra Pradhan, has stated that India has a robust plan to supply crude to its industries. There will be additional supplies from other major oil-producing countries", he added. No details of such a plan have been divulged. One can only assume that India would try to increase its oil imports from Saudi Arabia and the United Arab Emirates (UAE). India's relations with these states have markedly improved in recent years. However, the downside of this plan is that all oil-exporting countries are dependent on the Strait of Hormuz.

Saudi Arabia has invested in building pipelines to diversify its oil distribution system away from the Persian Gulf to the Red Sea. The East-West pipeline, also known as Petroline, starts from Abqaiq in the east to Yanbu on the Red Sea coast. However, the carrying capacity of this pipeline is insufficient to cater for all Saudi oil exports. Similarly, the UAE, too, has constructed the Abu Dhabi Crude Oil Pipeline (ADCOP) from Habshan in Abu Dhabi to Fujairah. Fujairah is the only emirate of the seven in the UAE, which has a coastline on the Gulf of Oman that bypasses the Strait of Hormuz. The ADCOP feeds into the petroleum export terminal at the newly constructed port of Fujairah. Again, this pipeline cannot carry all the oil that UAE presently exports. Saudi Arabia and the UAE have assured that they will increase the production of their own petroleum to make up for the Iranian oil that is expected to disappear from the market after 01 May. In such a scenario, the importance of the Strait of Hormuz will only increase, considering the limited capacities of the pipelines in the Gulf area.

It is estimated that the Indian economy is so heavily dependent on oil imports that the annual GDP growth of the country goes down by 0.1 per cent for every US$10 increase in the per-barrel price of oil. Therefore, the Iranian threat to the Strait of Hormuz presents a nightmarish scenario for India. Even a partial disruption of maritime traffic across the strait will lead to skyrocketing the price of oil. The earlier geopolitical instabilities and conflicts in the West Asian sub-region have had severe effects on the Indian economy. The first Gulf War of 1991 led to a balance of payments crisis and forced Delhi to seek a financial bailout from the IMF.

Besides this import dependence, the Persian Gulf is also a major destination for Indian exports, including refined petroleum products. The UAE alone is the second largest export partner for India. States, such as Saudi Arabia, Qatar and Kuwait, also import Indian merchandise in substantial quantities. All this trade will be adversely affected if Iran makes good on its threat to close the Strait of Hormuz. Therefore, it is vital for India to ensure that the maritime traffic in the Persian Gulf remains insulated from the geopolitical power-play involving the US and Iran. However, this is easier said than done. The American sanctions are acting as a screw, piling pressure on Iran slowly. The more the pressure increases, the more likely it is for Iran to give effect to its threat on Hormuz since this may be its only option to change the behaviour of its adversaries. From the Iranian perspective, the Trump administration's demands are harsh and unrealistic. They call for an entire reversal of Iranian policies and its complete surrender on the West Asian chessboard. It is highly unlikely that even the most moderate of Iranians will accept such conditions in return for the removal of sanctions. In such a scenario, there seems to be little common ground between the two camps. India, having good relations with both the camps, must attempt to bring the two sides to a realistic 'meeting ground'.

At the same time, the Government of India must also have other options on the table in case such efforts fail. India must explore the option of obtaining oil from other regions of the world. It already imports a sizeable amount from Nigeria. Increasing this amount along with that from other oil-producing countries such as Angola must be prioritised. Hopefully, the Government of India indeed has a viable plan to solve the 'Hormuz Dilemma' that the current situation poses, as claimed by the Indian Petroleum Minister.

ENDNOTES

1. Dr Dhramendra Pradhan, Twitter post, April 23, 2019, 10:11 a.m., https://twitter.com/dpradhanbjp/status/1120548102119804929.
2. "PM Narendra Modi Awarded UAE's Highest Civilian Honour Zayed Medal. *The Economic Times*. https://economictimes.indiatimes.com/news/politics-and-nation/pm-narendra-modi-awarded-uaes-highest-civilian-honour-zayed-medal/articleshow/68718753.cms.
3. "Saudi Aramco To Invest $44B In Giant India Oil Refinery". 2019. *Gulfnews.Com*. https://gulfnews.com/business/energy/saudi-aramco-to-invest-44b-in-giant-india-oil-refinery-1.2204164.
4. Verma, Nidhi. 2019. "India-Iran Row Over Farzad B Gas Field Takes Toll On Oil Imports". *Mint*. https://www.livemint.com/Industry/E0pe4GCRhCl557Xy6oVL2N/IndiaIran-row-over-Farzad-B-gas-field-takes-toll-on-oil-imp.html.
5. "India Will Lose 'Special Privileges' If It Buys Crude From Saudi Arabia, U.S.: Iranian Diplomat". 2019. *Thehindu.Com*. https://www.thehindu.com/news/national/iranian-diplomat-warns-india-of-losing-oil-privileges/article24381075.ece.
6. "Pompeo: US Not Pushing For Regime Change In Iran". 2018. *VOA*. https://www.voanews.com/a/pompeo-us-not-pushing-for-regime-change-in-iran/4408363.html.
7. Ghaddar, Ahmad, and Kirsten Donovan. 2018. "Strait Of Hormuz: The World's Most Important Oil Artery". *The Thomson Reuters*. https://www.reuters.com/article/us-iran-oil-factbox/strait-of-hormuz-the-worlds-most-important-oil-artery-idUSKBN1JV24O.
8. "US To End Iran Sanctions Waivers In May; Iran Threatens To Shut Strait Of Hormuz". 2019. *Spglobal.Com*. https://www.spglobal.com/commodityinsights/en/market-insights/latest-news/oil/042219-us-to-end-iran-sanctions-waivers-in-may-iran-threatens-to-shut-strait-of-hormuz.

About the Author

Rajesh Soami was an Associate Fellow at National Maritime Foundation, New Delhi. The views expressed in the article are his own and do not reflect the position of the NMF. He can be reached at rajesh96_isg@jnu.ac.in

Note

This article was first published on the Website of the National Maritime Foundation on 20 May 2019

Trade and SLOC Security

Physical Protection of India's Critical Maritime Infrastructure

Vice Admiral Pradeep Chauhan

The protection of critical infrastructure has become a subject of the most intense concern, thanks to rise of the malevolent non-State actor (as also its fraternal twin, the State- sponsored non-State actor). The malevolent actions of these entities are frequently and collectively subsumed in a single word — 'terrorism'. An internationally accepted definition of 'terrorism' and, consequently, that of a 'terrorist'continues to elude us, largely because of the persistence with which the cliché that "one man's terrorist is another man's freedom-fighter" is trotted out. This cliché can easily be shown to be riddledwith flaws, but for the purposes of this article, it might be sufficient to note that, as Mr. Ronald Reagan, the former President of the United States of America pointed out on 31 May 1986, *"Freedom fighters do not need to terrorize a population into submission"*.[1]

In the wake of horrific terrorist attacks visited upon the United States of America on 11 September 2001 — an event that has embedded itself into the global lexicon simply as "9/11" the United Nations Security Council (UNSC) has been wrestling with issues relating to the protection of critical national infrastructure such as communications, emergency services, energy, dams, finance, food, public services, industry, health, transport, gas, public communications, radio and television, information technology, commercial facilities, chemical and nuclear sectors, and water.[2] In seeking the protection of such critical infrastructure, the more significant of the resolutions passed by the UNSC include the following:

- Paragraph 2 (b) of Security Council Resolution 1373 (2001).[3] This resolution calls on all Member States to "take necessary steps to prevent the commission of terrorist acts, including by provision of early warning to other States by exchange ofinformation".

- Security Council Resolution 1566 (2004):[4] This resolution calls on States to prevent criminal acts, including against civilians, committed with the purpose of provoking a state of terror in the general public or in a group of persons, intimidating a population, or compelling a government or an international to do commit, or abstain from committing any act.

- Security Council Resolution 2341 (2017):[5] This resolution, inter alia, invites member States to consider possible preventive measures in the developing nationalstrategies and policies.

And yet, there are a number of complications in any attempt to arrive at a uniform or commonunderstanding of how all these resolutions might best be implemented. To begin with, each sovereignnations-state determines for itself what constitutes its critical infrastructure. This, in and of itself, is a challenge of no small proportions and there are a number of problems in the determination of which assets should be considered 'critical'.

- First, because of the myriad interconnections, networks, nodes, links and interdependencies that exist between sectors — most of which are both facilitated and complicated by cyber pathways — it is often difficult to prioritise one infrastructural element over another.

- Secondly, which segment of infrastructure is — or should be — considered 'critical' is quite likely to change over time. Although this lack of permanence isacknowledged and recognised, bureaucracies, and even practitioners — such as the police or the defence forces — are, more often than not, unwilling to accept the huge political risk of removing items from a 'critical list',[6] even though this can — and often does — result in a waste of precious resources.

- Thirdly, priorities accorded within a 'critical list' of infrastructure are political in nature and mirror popular fears without necessarily or accurately reflecting prevailing risks or probabilities. For instance, control-systems in respect of trafficlights on city- roads might well be included along with roads in critical urban infrastructure even though the roads themselves may well continue to be functional despite the fact that the traffic lights have gone out.[7] Such ambiguities adversely impact the development of security-measures.

- Fourthly, an increasingly large quantum of what might intuitively be considered to be critical infrastructure is owned by the private sector. It is estimated that in the case of western democracies, more than 80 per cent of the critical infrastructure is owned and operated by the private sector.[8] As a consequence, the State itself may no longer be able to ensure comprehensive security of critical infrastructure and could well become almost entirely dependent on the private sector for this purpose.[9]
- Finally, many States increasingly depend on infrastructure and assets that are partially or completely located outside their jurisdiction and over which they have little or no control.[10]

It is obvious that determining which infrastructure-assets are 'critical' requires careful judgement and detailed calculation, and, in addition, calls for an extremely well-defined public / private partnership for the creation and implementation of a policy on the protection (both physical and informational) of this critical infrastructure. In seeking to integrate these considerations into national and international security frameworks, nation-states must carefully factor the relationship between the public and private sector on the one hand, and the importance of a particular area of critical infrastructure, on the other. This is a daunting task and one that requires the continuous engagement of all participants concerned.[11]

As in much of the world, in India, too, the subject of the protection of critical infrastructure has been receiving a great deal of attention. This is hardly surprising given that India has been subjected on a continual basis to the horrors of State-sponsored terrorism from across its western border ever since the late Prime Minister of Pakistan, Zulfikar Ali Bhutto, in the wake of his country's resounding defeat to Indian Arms in 1971, laid down the doctrine of 'bleeding India through a thousand cuts'. Pakistan's Inter-Service Intelligence (ISI) has assiduously explicated this doctrine over the half-a-century or so that has since elapsed.

It is a well-established fact that the physical protection of critical infrastructure can prevent the commission of high-impact terrorist attacks. Consequently, it is quite distressing, and more thanlittle perplexing, to note that while there is a reasonable body of Indian literature covering the protection of critical information-infrastructure, and while organisational structures such as the Delhi-based National Critical *Information* Infrastructure Protection Centre (NCIIPC) have been put in place to coordinate the protection of information-infrastructure, there is very little Indian writing that addresses the physical protection of critical infrastructure. This void is even larger when it comes to the physical protection of critical ***maritime*** infrastructure. All this is in sharp contrast to the largebody of literature on this subject that abounds in the West — including Europe and the USA.

India's Critical Sectors

India defines *Critical Sectors* as those *that are critical to the nation and whose incapacity or destruction will have a debilitating impact on national security, economy, public health or safety.*[12] In 2015 the National Critical ***Information*** Infrastructure Protection Centre (NCIIPC) presented a list of twelve critical sectors. It needs to be noted that this is the list of information-infrastructure. There could well be critical infrastructure that lies outside the limits of information-infrastructure. That said, the identified sectors are:[13]

1. Energy
2. Transportation
3. Banking & Finance
4. Telecommunication
5. Defence
6. Space
7. Law enforcement, security & intelligence
8. Sensitive Government organisations
9. Public Health
10. Water supply
11. Critical manufacturing
12. E-Governance

Of this dozen, six — 'energy', 'transportation', 'telecommunication', 'defence', 'space' an, 'law-enforcement, security and intelligence' — are especially relevant to the maritime domain. However, even a relatively cursory examination of issues and processes relevant to the physical protection of each of these sectors is a formidable task that will need far more elastic a word-length limit than that permitted for this piece of writing. And yet, there is no gainsaying that such an examination is necessary.

Consequently, the subsequent sections will present the reader with an overview pertinent to the physical protection of a specified sector of critical infrastructure that is relevant to India's maritime domain.

Maritime Energy Sector

The impact of the energy sector upon other sectors of the economy, especially in a severely energy- deficient country like India, is inordinately large. As such, its criticality is commensurately high. The production and supply of energy resources relies on a complex system of [14] infrastructure that includes Exploration and Production [E&P]) — commonly known as the 'upstream' sector — involving alarge variety of drilling rigs, processing and control platforms, pipelines, and numerous types of support ships and vessels. Transportation of petroleum-based energy involves specialised ships, pipelines and associated manifolds, dedicated oil terminals and berths in ports, Single Point Moorings (SPMs), etc. The storage of these products involves strategic oil storage fuel-storage tanks and underground cisterns, above-ground tank-farms, flow stations, and other such infrastructure. Finally, the refining and distribution infrastructure involves refineries (India has the fourth-largest refiningcapacity in the world)[15] and a network of crude-oil pipelines, product pipelines, natural gas pipelines, and so on. Much of this infrastructure is either 'maritime' in nature or has close relational linkages to 'maritime' infrastructure. This is true of non-petroleum-based energy as well. For example, many nuclear power stations use seawater for cooling and are located along the coast. Likewise, in India,the promise of solar energy notwithstanding, it is offshore wind energy that holds the greatest potential. "At a wider level, *the global* interdependence of the energy industry – and its impact on the globaleconomy as well as directly upon that of India – demands that serious consideration be given to addressing its multifarious vulnerabilities".[16]

"Terrorist movements and organisations such as the Al Qaeda and the ISIS have attacked facilities and personnel of oil companies in Algeria, Iraq, Kuwait, Pakistan, Saudi Arabia and Yemen, and have also captured numerous oil fields".[17] At one point in the recent past (2015) crude oil extraction, storage and refining facilities was estimated by the UN to be generating income to Al Qaeda of the order of $500 million. As the awareness of 'easy pickings' to be had from attacks on energy infrastructure spread within terrorist circles, there has been a sharp rise in the interest shown by terrorist groups in oil and gas infrastructure. According to START[18] (Consortium for the Study of Terrorism and Responses to Terrorism), between 2010 and 2014, Pakistani energy infrastructure was the target "of almost as many attacks (439) as the next three States — Yemen (170), Colombia (161), and Iraq (146) — combined. The Philippines, with 73 attacks, rounds out the top five".[19] The preferred modus operandi has been bombings, though arson and sabotage have also been witnessed in significant numbers of cases.[20]

Insofar as 'Maritime India' is concerned, some 56 per cent of India's proven oil reserves are located offshore. Offshore production accounts for some 45 per cent of overall indigenous production but only some 16 per cent of India's overall demand. These figures mean that not only is it critical to protect infrastructure pertaining to the indigenous exploration and production of offshore oil and its transportation to

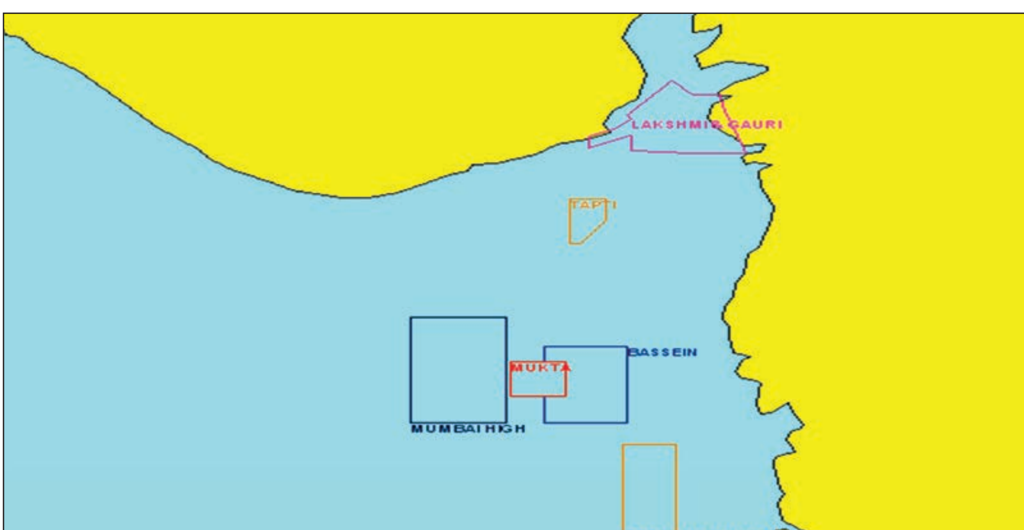


Figure 1: Western ODAs

the shore, but it is equally if not more important to ensure the 'security-of-energy' in terms of the oil being imported. In both cases, the associated infrastructure encompasses a complex mix of shore-based, underwater, and sea-based assets.

Insofar as indigenous offshore production is concerned, there are ten Offshore Development Areas (ODAs) on the western seaboard. These are Mumbai High North, Mumbai High South, Bassein, Panna, Mukta, Heera, Neelam, Laxmi, Gauri and Tapti. These ODAs, which are located at average distances of between 40 nm and 130 nm (i.e., 75-240 km) from the coast are depicted in Figure 1. They contain some 15 process complexes, 7 SBMs, 214 well head platforms, 25-30 oil rigs and a varying number of support vessels. The replacement cost of this infrastructure is estimated tobe well upwards of Rs 200,000 crores.

Likewise, as shown in Figure 2, ODAs are located on India's eastern seaboard within the Krishna Godavari, Mahanadi and Cauvery basins. Active production is ongoing in the KG D6 block being exploited by Reliance; the Ravva field being exploited by Cairn and ONGC, and, the PY 1 & 3 fields being exploited by HOEC and Hardy, respectively. As in the case of the western ODAs, here, too, there are a number of valuable albeit scattered assets, including, *inter alia*, two floating Processing Platforms, ten well

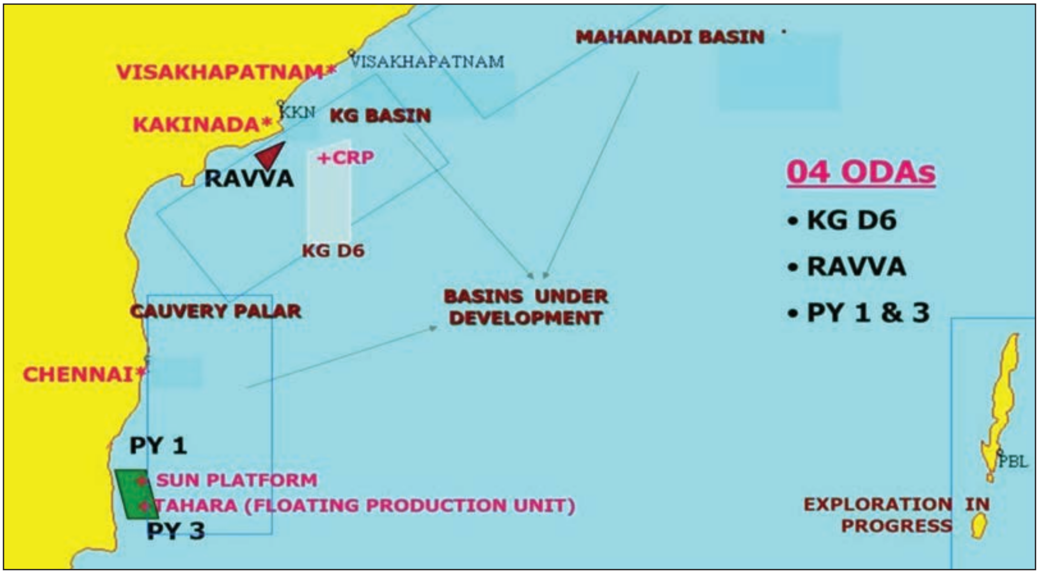


Figure 2: Eastern ODAs

platforms, some 15 oil-rigs and / or drill-ships, and over a hundred support vessels of varying sizes, descriptions and functions.

The defence of offshore all offshore assets (including the offshore exploration and production infrastructure) is the responsibility of the Indian Navy's Flag Officer Defence Advisory Group (FODAG), who, since June of 2002, is also the advisor on offshore defence to the Government of India as a whole.[21] Since there are a number of agencies and organisations that are involved in the security, safety and protection of these offshore energy assets in times short of inter-State armed conflict, coordination in respect of the physical protection of this critical infrastructure is sought to be ensured through an 'Offshore Security Co-ordination Committee' (OSCC),chaired by the Director General of the Indian Coast Guard.[22] The OSCC was constituted 1978 and is the apex body for reviewing and evaluating Offshore Security in India. It meets every six months and comprises members drawn from the Indian Navy, the Indian Air Force, the Indian Coast Guard, the IB, the MEA, various echelons of the police, and the ONGC. At a slightly more granular level is the Regional Contingency Committee, which is chaired by the respective Chief of Staff of the Indian Navy's Western and Eastern Naval Commands and also meets every six months. In addition to the organisations represented in the OSCC, the RCC has representatives from private players in the upstream oil and natural gas sector.

Physical security is ensured through continuous patrol effected by some 21 light but armed patrol craft, known as 'Immediate Support Vessels' (ISVs), manned by Indian Naval personnel. Apart from routine dissuasive and deterrent patrolling, the actual 'doing' of whatever needs to be done in the face of a heightened threat is regularly practised via a series of exercises culminating in a contingency-based simulated 'emergency' exercise, conducted six-monthly, which bears the generic name "Exercise PRASTHAN". Emergencies that are practised include, *inter alia*, anti-hijacking drills and bomb disposal procedures involving the Indian Navy's Marine Commandos (MARCOS) and Explosive Ordnance Disposal (EOD) Teams, while testing and honing skills required to combat consequent outbreaks of fire, structural damage, damage from premediated and inadvertent collisions, etc.

Around-the-clock surveillance is crucial to the protection of such critical infrastructure. This is because the UNCLOS limits Coastal States to buttressing the 'navigational safety' of artificial islands (which includes, *inter alia*, drill-rigs, process-platforms, etc.), by creating 500-metre' safety zones' around them. This radius of 500-metres is clearly inadequate for purposes of security. For instance, an explosive-laden speedboat traveling at 30 knots that entered this safety zone would physically collide with the offshore asset in about 32 seconds. Within these 32 seconds, even if a fully-trained security-team with an equally fast interceptor-craft were to be available at the offshore asset itself, it is clearly impossible to realistically identify the vessel as friend or foe, attempt to establish communications, await a response, and, if no response or an unsatisfactory response is received, to then dispatch the security team to intercept the vessel. Although UNCLOS does state that the "*safety zone… shall not exceed a distance of 500 meters…except as authorized by generally accepted international standards or as recommended by the competent international* organization*"*, the International Maritime Organisation (IMO) has yet to approve" [23] a single request for an increase in this radius. All that the IMO has done is to task "Flag States with ensuring that their vessels do not wrongly enter established safetyzones"[24]. It is utterly silent on the question of non-State entities and other threats to offshore assets. Consequently, ever since 9/11, noting the failure of international treaty law to provide specific authority for an "immediate response to vessels that pose imminent threats to"[25] an offshore-asset, *S*tates have opted for security measures under the universally recognized concept "of right of self- defence to protect life and property from imminent risk of harm"[26]. India, too, is using these broad tenets of international law to strengthen its legal framework in protecting its offshore assets. However, the paucity of police-officials, lawyers and judges who are well versed in international maritime law is a major national infirmity that our contemporary strategy must actively address.

For all that, the security of energy-assets is not limited to upstream segments of the oil and natural gas sector alone. As an example, the FODAG is also responsible for the security of OTEC and Offshore-Wind installations, as stipulated in the "National Offshore Wind Energy Policy – 2015". Likewise, OTEC-based Low-Temperature Thermal Desalination (LTTD) plants currently provide almost all potable water in Kavaratti, Agatti and Minicoy islands, while similar ones are planned in another six of the islands of this chain, viz., Androth, Amini, Kalpeni, Chetlat, Kadmat and Kalpeni. These invaluable offshore assets, too, form part of India's critical maritime infrastructure within the energy sector.

<table>
<tr><td>APR</td><td>MAY</td><td>JUN</td><td>JUL</td><td>AUG</td><td>SEP</td><td>OCT</td><td>NOV</td><td>DEC</td><td>JAN</td><td>FEB</td><td>MAR</td></tr>
<tr><td colspan="12">2014-15: 1,89,432 Thousand MT ÷ 1000 = 189.432 Mn MT x 7.33 = 1388.53656 Mn bbl
÷ 365 days = 3.80 Mn bbd</td></tr>
<tr><td>16902</td><td>14905</td><td>16211</td><td>14222</td><td>15990</td><td>15989</td><td>16193</td><td>15005</td><td>16820</td><td>17560</td><td>12991</td><td>16645</td></tr>
<tr><td colspan="12">2015-16: 2,02,850 Thousand MT ÷ 1000 = 202.850 Mn MT x 7.33 = 1486.890 Mn bbl
÷ 365 days = 4.073 Mn bbd</td></tr>
<tr><td>15535</td><td>17454</td><td>15619</td><td>17732</td><td>17235</td><td>15787</td><td>15568</td><td>16636</td><td>17726</td><td>18129</td><td>16882</td><td>18546</td></tr>
<tr><td colspan="12">2016-17: 2,13,932 Thousand MT ÷ 1000 = 213.932 Mn MT x 7.33 = 1568.121 Mn bbl
÷ 365 days = 4.296 Mn bbd</td></tr>
<tr><td>18127</td><td>17903</td><td>17666</td><td>17320</td><td>18207</td><td>17529</td><td>18897</td><td>19051</td><td>19641</td><td>20066</td><td>17631</td><td>18405</td></tr>
<tr><td colspan="12">2017-18: 220434 Thousand MT ÷ 1000 =220.434 Mn MT x 7.33 = 1615.781 Mn bbl
÷ 365 days = 4.427 Mn bbd</td></tr>
</table>

Figure 3: India's Oil Imports

India's imports of crude oil constitute perhaps the most glaring criticality in terms of maritime infrastructure. Figure 3 documents the fact that India is currently importing some 4.4 million barrels of oil per day, yielding an import dependency of 80 per cent. With 7.33 barrels of oil being considered to be equal to one 1 Metric Ton (or 'Tonne'), India is importing approximately 220,434 thousand tonnes annually. Dividing this value by 365 (days in a year), yields a requirement of 604 thousand tonnes per day. Now, an average crude-oil tanker carries about 80,000 tonnes of crude oil (≈ 0.6 million barrels), while an average Very Large Crude-oil Carrier (VLCC) carries about 250,000 tonnes of crude oil (≈ 1.8 million barrels). So, to bring in 604 thousand tonnes of oil per day, 8 standard oil tankers must call at Indian ports per day. If all of this oil were to come on VLCCs, the requirement would be for 2.5 VLCCs per day — i.e., one every 8-12 hours!

These huge VLCCs are needed to feed, for the most part, the northern refineries at Jamnagar, Vadinar, Mathura, Bina, Babina, Bathinda and Koyali, to which list will soon be added Barmer. In order to discharge their cargo of 250000 to 300000 tonnes of crude oil, each of these oil-laden giant ships tie up to large, purpose-build buoys known as Single Point Moorings (SPMs). Each SPMs is "anchored offshore and serves as a mooring point as well as an interconnection for tankers loading or offloading liquid products"[27]. The crude oil is transferred from the ship into the buoy using a floating

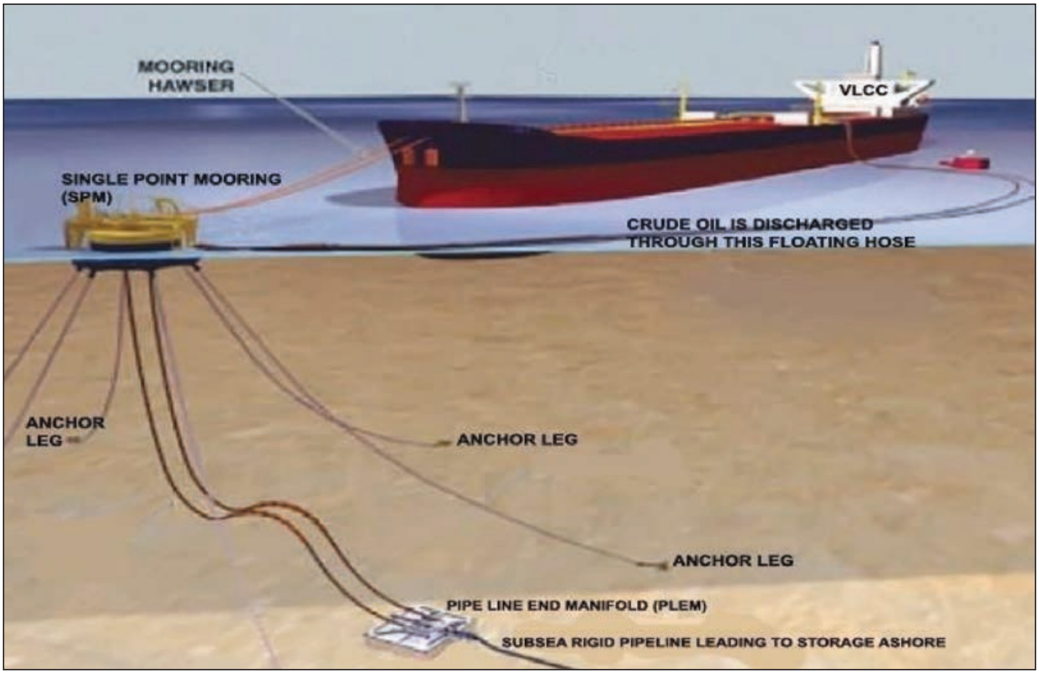


Figure 4: Single Point Mooring (SPM)

hose. It then enters the SPM, which is connected to a submarine pipeline between the pipeline end manifold (PLEM) on the seabed and the buoy.[28] The oil is then led to storage tanks ashore via a rigid submarine pipeline. Figure 4 offers a schematic depiction of an SPM:

It takes no great imagination to realise the criticality of this segment of maritime infrastructure related to the energy sector. At present, the safety and security of each SPM, as also that of the VLCC(s) moored at the SPM, is the responsibility of the port authority concerned and, as such, it is the Central Industrial Security Force (CISF) that physically discharges this responsibility. However, challenges remain as the CISF claims that the organisation lacks requisite assets and trained personnel. Ships smaller in size than a VLCC can, of course, go directly to a designated alongside berth (a quay or jetty). Within the limits established by the concerned port, the safety and security of all assets, including the tankers themselves, is that of the port authority, and this responsibility, once again, is physically discharged by the CISF.

Then there is the whole business of the country's Strategic Petroleum Reserve (SPR) which must be factored while considering energy as a critical infrastructural sector. However, since this is located ashore rather than in 'floating tankage' as is the case with some other countries, it is not directly a maritime issue and, as such, has not been dealt-with in this piece. It is not just imports of crude oil that the protection of India's energy-based critical infrastructure must encompass. "India has nearly doubled its refining capacity over the last decade to almost 5 million barrels per day, making it the world's fourth largest refining centre after the US, China and Russia"[29]. As a result, the export of refined petroleum-products constitutes India's second-largest export-commodity. It is only the very recent rise in the domestic consumption of petroleum products that has brought the export ranking of this commodity down from the Number One position to Number Two.

With India's external 'merchandise-trade to GDP ratio' (imports plus exports divided by GDP) now standing at an impressive decadal average of 36 per cent, and with 95 per cent by volume (and 77 per cent by value) of this merchandise trade moving by sea, the criticality of the nodes of this trade, namely, ports, can hardly be overstated[30]. However, this aspect concerns maritime transportation and to some extent, of course, there is an overlap with energy imports and exports, which are, after all, a type of merchandise-trade that requires to be 'transported'.

Maritime Transport: Shipping

The physical protection of merchant ships, which form an important part (if not the predominant one) of critical maritime-infrastructure relevant to the 'transportation' sector. Of course, the physical protection of maritime shipping-infrastructure involves not only merchant ships but also ports, which are the nodes from and to which these ships move their merchandise-cargo. It also touches marginally upon the physical protection of warships when they are in ports or harbours, whether berthed alongside or at anchorage. Issues relating to the physical protection of ports (including naval and coast guard harbours and their allied facilities) will be addressed in the next article in the current series.

To establish the criticality to India of its ship-and-port infrastructure, one has only to look at the sharp rise over the years of the country's 'Merchandise Trade-to-

GDP' Ratio. The data at Table 1 brings this out quite clearly. It also shows that in all cases, the average of this Trade-to-GDP Ratio has risen in the period from 2000 to 2018, when compared with the decadal average from 2001 and 2010. What this implies is that with the passage of time — the concomitant increase in trade in 'services' notwithstanding — more goods are moving by sea than they were before. This has very significant maritime ramifications for India. On the one hand, our merchandise trade (imports + exports) now accounts for some 35 per cent of our GDP. On the other, 95 per cent of this merchandise trade by volume — and 77 per cent by value — is seaborne. In other words, should the infrastructure that supports this transport of our merchandise trade, namely, the merchant ships carrying Indian cargo and the Indian ports at which they load or discharge this cargo, be significantly compromised, the economic effect would be catastrophic.

Table 1: Merchandise Trade-to-GDP-Ratio of Selected Countries

Year	India	Decadal Average	China	Decadal Average	USA	Decadal Average	UK	Decadal Average	Australia	Decadal Average	Japan	Decadal Average	ROK	Decadal Average
2018	30.7		34.0		20.9		41.0		34.4		29.9		70.4	
2017	28.2		33.8		20.3		41.1		34.6		28.2		68.7	
2016	27.3		33.1		19.8		39.3		32.1		25.4		63.7	
2015	31.4	35.4	35.9	39.37	21.0	22.05	37.5	41.3	29.3	33.08	29.0	28.5	69.7	76.22
2014	38.5		41.2		23.0		39.4		32.5		31.0		77.8	
2013	42.0		43.5		23.3		43.6		31.4		30.0		82.4	
2012	43.0		45.3		24.0		43.6		33.5		27.2		87.3	
2011	42.1		48.2		24.1		44.9		36.9		27.3		89.8	
2010	34.4		48.9		21.7		41.1		36.1		25.7		81.5	
2009	31.5		43.3		18.4		36.5		34.5		21.7		76.1	
2008	43.0		55.8		23.5		38.9		36.8		30.6		85.5	
2007	31.2		61.3		21.9		35.0		36.0		29.6		64.5	
2006	31.9	28.79	64.0	52.61	21.3	19.92	39.4	36.96	35.2	34.67	27.1	23.43	62.7	65.47
2005	29.6		62.2		20.2		36.0		33.4		23.4		60.8	
2004	24.9		59.0		19.2		34.0		32.0		21.2		62.5	
2003	21.6		51.3		17.7		34.5		34.2		19.2		54.8	
2002	20.5		42.2		17.3		36.3		34.9		18.3		51.7	
2001	19.3		38.1		18.0		37.9		33.6		17.5		54.7	
2000	20.0		39.2		19.9		38.4		32.6		17.6		59.2	
1990	12.9		32.0		15.3		37.3		26.3		16.7		48.3	
1980	12.6		19.9		16.9		39.9		29.6		24.6		61.3	

Source: http://databank.worldbank.org/data/reports.aspx?source=2&series=TG.VAL.TOTL.GD.ZS&country=

Where merchant shipping is concerned, the Indian Ocean is a particularly busy place. Over 120,000 merchant ships (a.k.a. 'merchantmen') traverse the waters and seas of this ocean on an annual basis, wending their way upon the several International Shipping Lanes (ISLs) that crisscross this maritime expanse. Since unlike the Atlantic and Pacific oceans, ingress into and egress from the Indian Ocean is effected only through a finite number of narrow 'chokepoints', all this maritime trade is especially vulnerable as it passes through the straits that constitute these chokepoints. For instance, the Strait of Bab-el-Mandeb, which connects the Red Sea and the Gulf of Aden witnesses the annual passage of some 22,000 ships, while the Strait of Malacca accounts for shipping transits in excess of 90,000 every year. India is by no means immune to these vulnerabilities. Some 60 billion US dollars-worth of Indian exports and some 50 billion US dollars- worth of Indian imports — a staggering 110 billion US dollars-worth of Indian merchandise-cargo—transits the Strait of Bab-el-Mandeb on an annual basis. India's second-largest export partner on the planet is the UAE. Consequently, the sensitivity and criticality to India of the geopolitically- turbulent Strait of Hormuz is not limited solely to the import of crude-oil from West Asia, but equally so in terms of the provision of denial of access to vital UAE ports such as Al Khalifa and Jebel Ali. Likewise, some 190 billion US dollars-worth of Indian trade runs across the South China Sea — and this value excludes our merchandise maritime trade with Indonesia, Malaysia, Thailand and Singapore.

That our mercantile ships and our ports are very significant components of India's critical maritime infrastructure is undeniable. Let us now turn to the threats that

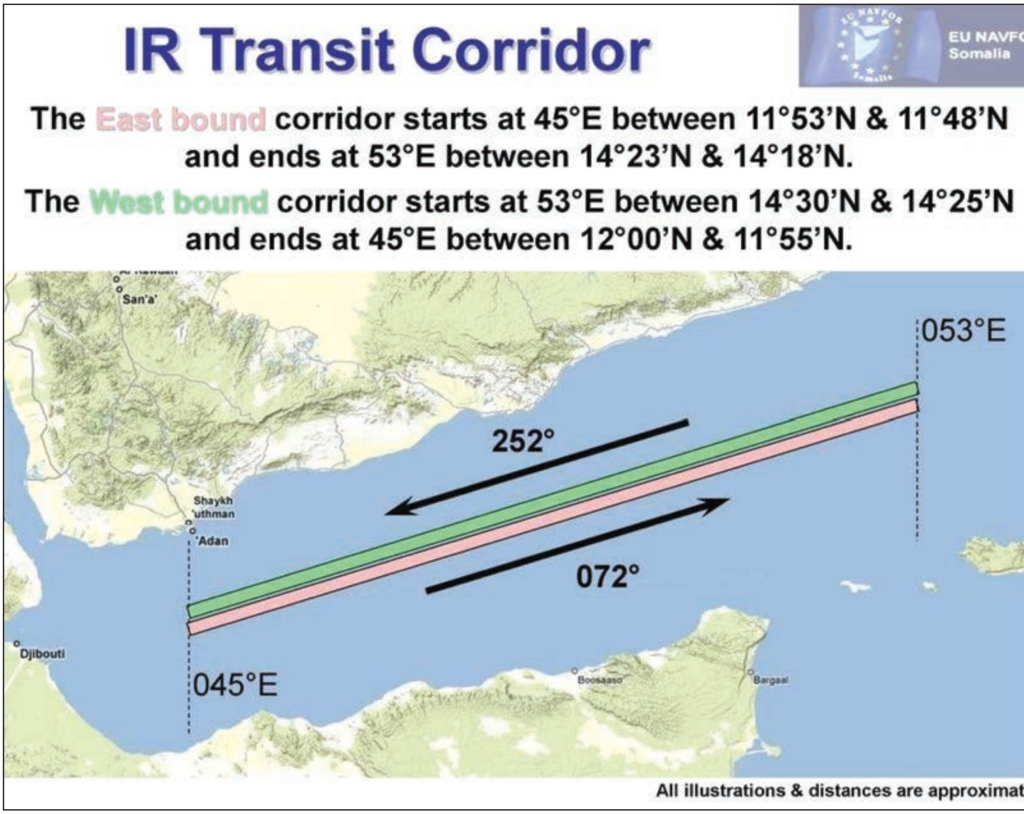
confront the merchant- shipping component of this critical maritime infrastructure. There are, of course, several ***natural*** threats to merchant ships. These include undersea earthquakes that generate the huge and tremendously destructive swell- waves that characterise *tsunami*s. More frequent are weather- generated massive disturbances at sea, such as tropical-revolving storms (TRS), several variants of which, such as cyclones, typhoons, and hurricanes, are well known to the public at large. Somewhat less well known in India but nevertheless devastating for seafarers are large squalls, sea-storms generated by weather fronts, and 'derecho' storms. The safety of ships in the face of natural weather conditions is a function of ship-construction, machinery-reliability, the extent and quality of the safety-gear on board, and, most perhaps the most important of all, crew-training and experience. Contemporary maritime Search and Rescue (SAR) is organised, on a global basis, through the provisions of the "International Convention on Maritime Search and Rescue (SAR)", commonly known as the 'SAR Convention', which was adopted in Hamburg on 27 April1979 and entered into force on 22 June 1985. Although the obligation of ships to go to the assistance of vessels in distress has long been enshrined in tradition, the SAR Convention is the first to formally create an international system for safety and succour at sea. With the coming into force of this convention, the 'Maritime Safety Committee' of the international Maritime

Organisation (IMO) — which is effectively the UN-at-sea — divided the world's oceans into 13 'Search and Rescue Areas'. These areas have then been further segmented into 'Search and Rescue Regions' (SRRs). A specific authorityhas been assigned lead-responsibility for the monitoring of distress in each SRR and for coordinating search and rescue efforts. The Indian Coast Guard is a particularly proactive and efficient safety-provider in all situations requiring distress at sea within the vast sea-area encompassed by the Indian Search and Rescue Region (ISRR) depicted below. The Director General, Indian Coast Guard (DG ICG) is the 'National Maritime SAR Coordinating Authority' (NMSARCA).

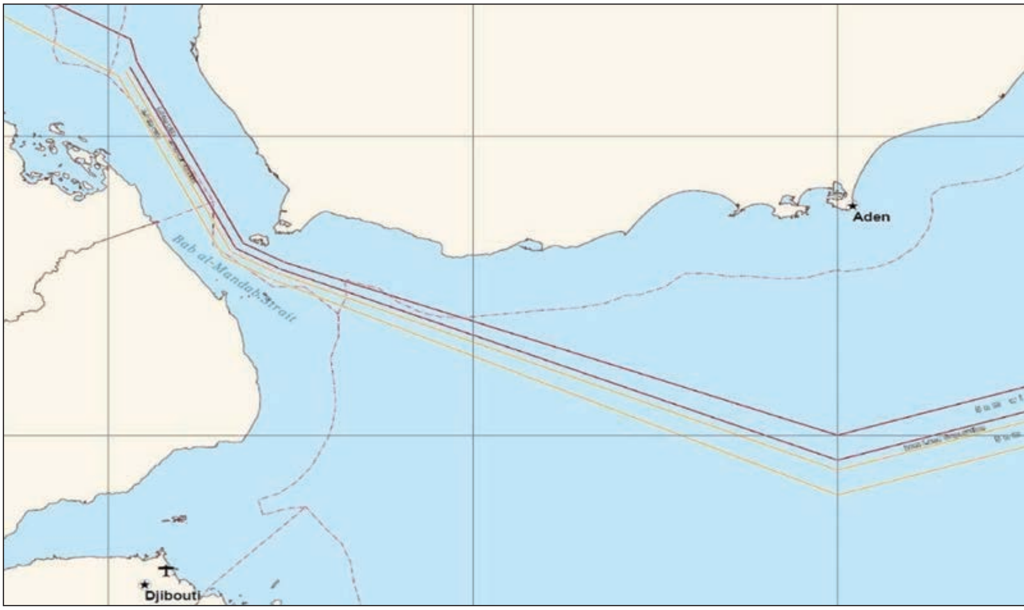
Important and devastating as natural threats to shipping are, this article seeks to concentrate upon more sinister dangers — those posed by human predation. Predatory activities at sea by a variety of human predators such as pirates, privateers, brigands, smugglers, and a variety of maritime criminals, are perhaps as ancient as seafaring itself. As if this was not long enough a list, maritime terrorists have now made the most recent addition.

Modern-day piracy, which has become all too familiar a risk to shipping operating to our west — in the Gulf of Aden, off the coast of Somalia, and in and off the Gulf of Guinea — and to our east — particularly in the Sulu and Sulawesi seas north of the archipelagos of Indonesia and the Philippines. As a consequence, physical security has become an important requirement for merchant's vessels. The principal security-providers are, of course, navies. To narrow down the area over which such security needs to be provided, an International Recommended Transit Corridor (IRTC) for east-bound traffic as well for west-bound traffic has been established in the Gulf of Aden as depicted below. Merchant ships that need to cross the Strait of Bab-el-Mandeb, send out advance-intimation to naval coordinating-authorities of the date- and-time at which they expect to arrive at pre-designated rendezvous-points established at either end of the IRTC. The IRTC is subdivided into a grid comprising a number of adjacent areas each of which has an alpha-numeric identifier.

In September of 2017, in recognition of the enhanced risk to merchant ships transiting the Strait of Bab-el-Mandeb and proceeding through the southern portion of the Red Sea, the Internationally Recommended Transit Corridor was subsumed into a new 'Maritime Security Transit Corridor' (MSTC), as shown



There are two basic forms of naval protection offered to such merchant ships. On the one hand is a formalised grouping of warships, known as the 'Combined Maritime Forces' (CMF), which has been set-up under US-aegis, and, on the other, are navies — such as those of India, China, ROK, Russia, etc., which undertake independent counter-piracy escorts and operations. The CMF actually comprises three subordinate task forces, each of which has a distinct identifying-number and a specific purpose: CTF-150 caters to the USA's 'Operation FREEDOM's SENTINEL' (this is the successor of the earlier Operation 'ENDURING FREEDOM', which was in place from 2001 to December 2014, and was designed to prosecute maritime facets of the USA's Global War on Terror). CTF-152, too, is a US-led multinational naval task force, which was set-up in 2004 in order to coordinate maritime security operations within the Persian Gulf. CTF-151, once again US-led, is a multinational naval task force, but this one concentrates specifically on countering piracy in the Gulf of Aden and its environs.



In terms of the provision of physical security through naval actions, it is important to note that although a given ship of CTF-151 can be ordered to deploy in a given area within the IRTC, once it is there, it's operations and actions will be governed by the Rules of Engagement (ROE) of the country to which it belongs. Since these ROE vary with the legal, societal, and ethical constructs that obtain in each contributing-country, the counter- piracy actions that the warship is permitted to take may vary from 'mild' to 'robust'. As a result, India, which seeks 'assured levels' of protection — especially to merchantmen flying the Indian tricolour — involving 'dissuasive', 'deterrent', 'preventive', 'curative', and 'punitive' actions, has chosen to operate outside of the CTF-151. Another collective grouping is the European Union Naval Force (EUNAVFOR), which has a longstanding counter-piracy and maritime- security operation called 'Operation ATALANTA' in place in the Gulf of Aden.

The Indian Navy maintains very close cooperation and coordination with the navies that constitute both, CTF-151, and Op ATALANTA and regularly participates in the hugely-useful 'Shared Awareness and De-confliction' (SHADE) conferences held in Bahrain every six months. SHADE is an unclassified forum that brings together nations, international organisations and members of the shipping industry who share a common interest in combating Somali based piracy and broader Maritime Security issues. It is co-chaired by the EUNAVFOR and the CMF and is also attended by NATO and many other nations and associations outside of these organisations. In recognition of the fact that such information flows from and to merchantmen (and the companies that either own or manage them) are useful not just for the countering of piracy but for the promotion of regional security as well, there are a few other mechanisms as well, for the collation and dissemination of information that enhances secure safe and secure transits of merchantmen through piracy-prone areas within the Gulf of Aden and its environs. All such mechanisms are important facilitators of physical security even beyond the confines of piracy alone. This is because piracy and maritime crime generate regional instability, which in turn, introduces other maritime threats such as the deliberate targeting of ships by extremist groups (such as *Al Shabaab* and *Al Qaeda*), and the imposition of collateral damage arising from regional conflict. An example of such a mechanism is the British Royal Navy's 'United Kingdom Marine Trade Operations' (UKMTO), which provides an information conduit between counter-piracy security forces and international maritime shipping. Another example is the EUNAVFOR's 'Maritime Security Centre — Horn of Africa' (MSC- HOA), which is located in Brest, France. Merchantmen transiting the area in and off the Gulf of Aden are monitored 24 hours a day. An interactive website enables the Centre to communicate the latest counter-piracy guidance to the ships and the companies that own and operate them, as also to direct naval assets as required, in the event of any emergency. Although it operates outside these collective security- constructs (and is what is known as an 'independent deployer'), Indian Naval warships deployed in the Gulf of Aden and its environs maintain constant communication with all these mechanisms and in so doing, enhances the provision of physical security to Indian-flag merchantmen — and foreign-flag ones, too!

A great deal in terms of preventive actions can, of course, be done by the merchant ships themselves. Consequently, a large conglomerate of shipping companies and agencies have collectively issued a succession of comprehensive guidelines to global merchant shipping. The current (fifth) edition, titled, *"Best Management Practices to Deter Piracy and Enhance Maritime Security in the Red Sea, Gulf of Aden, Indian Ocean and Arabian Sea"* (BMP-5) lays down a number of guidelines that are advisory rather than mandatory, but whose adherence (or lack thereof) impacts insurance and other fiscal-compensation measures. Hence, merchantmen and the companies that own and manage them try hard to adhere to the provisions of BMP-5. This is as true of Indian-flag vessels as it is of any others.

The primary layer of ship-board self-protection involves a high standard of Bridge watchkeeping and enhanced vigilance through the provision of extra lookouts, diligent radar- watchkeeping, the use of thermal-imagery optics and night-vision aids, the placement of mannequins / dummies at strategic locations around the ship so as to give the impression that there are a greater numbers of crew on watch, the provision of a CCTV-system, the fitment of fixed searchlights, the fitment of barbed / razor-wire along the ship's railings and outboard of the ship's structure, the deployment of water / foam cannon to deter boarding, etc. In addition to these physical measures, merchantmen are advised to effect tactical measures such as carry out evasive manoeuvres that create hydrostatic pressure-waves along the shipside, making it very difficult for a pirate boat or skiff to remain close enough to the ship for a boarding to be attempted.

The second layer of physical ship-board self-protection presumes that the ship has been successfully boarding by pirates / criminals / terrorists has been successful. It accordingly focusses upon denying access to the ship's internal spaces with special attention being paid to compartments such as the navigation-bridge, the communications-equipment compartments, and the machinery- control room, access to any or all of which would yield control over the ship's propulsion, navigation and internal / external communication. Towards this end, BMP-5 recommends measures such as the application of blast-resistant film on bridge-windows that provide a view ahead, as well as steel / aluminium plates to cover bridge-windows that provide views to the sides or the rear; the fitment of chain-link fencing to guard against the effects of rocket-propelled grenades (RPGs); fitment of sandbags in the bridge-wings; ensuring that doors and hatches that provide access to the ship's bridge, superstructure, machinery-spaces and internal compartments are capable of being locked such that they cannot be opened from the outside; the fitment of steel bars to portholes and windows; the creation of a well-designed citadel within the ship within which the crew can lock themselves-in for a protracted period, while remaining well-provisioned with canned-food, water, provisions, sanitation, and means of internal and external communications.

It should not be assumed that the physical-protection mentioned in the foregoing sections are specific solely to the Gulf of Aden and its maritime environs. The scourge of piracy, armed-robbery, hijacking, kidnapping-for-ransom, and maritime-depredations related to terrorism, have been witnessed in a number of areas ranging from off the Gulf of Guinea to the Sulu and Sulawesi seas north of the Philippines and Indonesia. Collective approaches to the provision of naval physical- protection of shipping in the latter areas, for instance, has led to combined-patrols being instituted by the navies of Indonesia, Malaysia and the Philippines (INDOMALPHI). As has been the case in and off the Gulf of Aden, these combined patrols have proven to be very effective in curbing the incidences of maritime crime.

A much more contentious and potentially-disastrous measure that has been adopted by a number of shipping companies is to hire Private Armed Security Guards and position them aboard merchantmen that are scheduled to transit through crime-infested waters. Several security companies have started to provide maritime security services, which they claim to be custom-made for modern piracy at sea. Some countries have introduced legislation and rules to help shipping companies to place armed guards on board the vessels to provide physical protection, while others have done the opposite. In India's case, the DG Shipping has left it up to individual companies but has issued a cautionary input against this practice, thereby typically seeking to have its cake and eat it too! In actual fact, this apparently attractive solution raises a number of very problematic concerns. A merchantman receives protection from warships precisely because the former is meant to be unarmed. This is what allows the merchantman to freely access ports and coastal reaches of a littoral State with navigational-safety and labour-laws being the principal concerns that it needs to address. Once it embarks arms, there is a huge question as to the precise legal status that is holds. What all constitutes' small arms' and how would any such definition remain immune to the gallop of technology — especially the miniaturisation that comes in its wake? How are the risks of the proliferation of small-arms to a host of non-State actors to be mitigated? A merchantman that has armed personnel on board might well comply with the legal provisions of its 'Flag State', but how does it ensure such compliance in the case of a variety of Coastal States, and Port States? The *Enrica Lexie* imbroglio, which involved two Italian marines who shot and killed Indian nationals aboard an Indian fishing boat, albeit outside India's Territorial Sea, allegedly-misidentifying them as part of the crew of a boat about to engage in piratical-activity, is still fresh in public memory. Likewise, the MV *Seaman Guard Ohio* — which was a merchantman owned by an American company, AdvanFort, but flying the Sierra Leone flag (a flag-of-convenience), and was being used as a 'floating armoury' to store weapons and security guards on private anti-piracy contracts — was impounded in 2013 for violating Indian regulations. This led to the ship's crew (three Ukrainians, six ex-military British nationals, 14 Estonians and 12 Indians) being incarcerated in a Chennai prison for four years (2013-2017). These are just two examples of the host of legal challenges that face those shipping companies that choose to deploy private armed guards on board their merchantmen. Some sense finally seems to be dawning, as witness the fact that amidst the latest tensions in the Persian Gulf, involving the effects of US sanctions on the export of oil from Iran, shipping associations have strongly discouraged the exercise of this option.

The criticality to India of merchant-shipping infrastructure is a function of the Indian cargo being carried to and from ports across the world. Given that Indian-flag shipping carries just about 7 per cent of Indian cargo and that foreign-flagged merchantmen(including several that fly 'flags-of-convenience') carry the remaining 93 per cent, the physical protection of mercantile-shipping is not an imperative that is limited to India-flag merchant ships alone.

Critical Sectors are those that are critical to the nation and whose incapacity or destruction will have a debilitating impact on national security, economy, public health or safety. However, it is quite distressing and perplexing to note that there is very little Indian writing that addresses the physical protection of critical infrastructure. This stands in stark contrast to the abundance of writing on the issue in the West. Therefore, even a relatively cursory examination of issues and processes relevant to the physical protection of these sectors is a formidable task that will need far more elastic a word-length limit than that permitted for this piece of writing.

Endnotes

1. Ronal Reagan. Radio Address to the Nation on Terrorism, May 31, 1986, Presidential Library and Museum; available at url: https://www.reaganlibrary.gov/research/speeches/53186a, accessed on 01 Nov 19.

2. United Nations Security Council Report. "Physical Protection of Critical Infrastructure against Terrorist Attacks", March 2017 p.2; available at url: https://www.un.org/sc/ctc/wp-content/uploads/2017/03/CTED-Trends-Report-March-2017-Final.pdf, accessed 08 Nov 19.

3. United Nations Security Council, Counter Terrorism Committee, Resolution 1373 (2001); available at url: https://www.un.org/sc/ctc/resources/databases/recommended-international-practices-codes-and- standards/united-nations-security-council-resolution-1373-2001/, accessed on 10 Nov 19.

4. United Nations and the Rule of Law, Counter Terrorism Committee, "Security Council Resolution 1566 (2004) on Threats to International Peace and Security caused by Terrorist Acts"; available at url: https://www.un.org/ruleoflaw/blog/document/security-council-resolution-1566-2004-on-threats-to- international-peace-and-security-caused-by-terrorist-acts/, accessed on 10 Nov 19.

5. Ibid.

6. United Nations Security Council (UNSC) Counter Terrorism Committee Executive Directive (CTED) March 2017. "Physical Protection of Critical Infrastructure against Terrorist attacks"; available at url: https://www.un.org/sc/ctc/wp-content/uploads/2017/03/CTED-Trends-Report-March-2017-Final.pdf, accessed on 10 Nov 19.

7. Ibid, p. 2.

8. Balaji Srimoolanathan. "Adopting a holistic approach to Protecting Critical Infrastructure"; Janes 360, 18 June2014; available at url: http://www.janes.com/article/39495/adopting-a-holistic-approach-toprotecting- critical-infrastructure-es14e3, accessed on 10 Nov 19.

9. *Op Cit* (See Supra Note 6).

10. Dave Clemente. "Cyber Security and Global Interdependence: What is Critical?" Chatham House. February 2013; available at url: https://www.chathamhouse.org/sites/files/chathamhouse/public/Research/International%20Security/0213pr_cyber.pdf, accessed on 10 Nov 19.

11. Ibid (See Supra Note 10).

12. National Critical Information Infrastructure Protection Centre (NCIIPC) Workshop, 2015; available at url: http://workshop.nkn.in/2015/sources/speakers/sessions/NKN_NCIIPC.pdf, accessed on 10 Nov 19.

13. Ibid (See Supra Note 12).

14. Cted,Physical Protection, March 2017, 4.

15. Press Trust of India India to Continue Growing Fastest; Be Second-largest Economy by 2030: PM." Business Standard, February 11, 2019. Accessed June 9, 2019. https://www.business- standard.com/article/pti- stories/india-to-continue-growing-at-fastest-pace-could-be-second-largest- economy-by-2030-pm- 119021100314_1.html.

16. Cted,Physical Protection, March 2017, 4.

17. Ibid.

18. START is a university-based research and education Centre comprising an international network ofscholars committed to the scientific study of the causes of human consequences of terrorism in the USA and the world. 19 Cted,Physical Protection, March 2017, 4.

20. Ibid.

21. Indian Navy, *Flag Officer Defence Advisory Group*, Accessed 02 December2019, https://www.indiannavy.nic.in/content/fodag-0.

22. Indian Coast Guard, *Maritime Surveillance*, Accessed 28 November, 2019, https://www.indiancoastguard.gov.in/content/1718_3_MaritimeSurveillance.aspx.

23. Simon O William "Offshore Installations: Practical Security And Legal Considerations." *CIMSEC* (blog), October 11, 2013. Accessed June 10, 2019.http://cimsec.org/offshore-installations-practical-security-legal-considerations/7872.

24. Ibid.

25. Ibid.

26. Simon O William, Offshore Installations.

27. Ocean State Forecast *Ocean State Forecast.*Publication. Center for Ocean Information Services, Government of India. Accessed June 10, 2019. https://www.incois.gov.in/portal/osf/osf.jsp.

28. Raunek "How Single Point Mooring (SPM) Offshore Operation Works?" *Marine Insight*, October 26,2017. Accessed June 9, 2019. https://www.marineinsight.com/offshore/how-single-point-mooring- spm-offshore- operation-works/.

29. BP Statistical Review of World Energy 2015. As quoted in Jacob Gronholt Pedersen, "India Starts up 300,000 Bpd Paradip Refinery - Sources." Online Posting. April 26, 2015. Reuters. Accessed June10, 2019. https://in.reuters.com/article/india-refinery-idINKBN0NH0N320150426.

30. "Building Support for a Response." *Foreign Policy Bulletin*, February 13, 2009. Accessed June 10, 2019. https://www.cambridge.org/core/journals/foreign-policy-bulletin/article/ii-september-12october-6-2001-building-support-for-a-a-response/F6861A4C38A723B1F3AA977C4A0E75AB.

About the Author

Vice Admiral Pradeep Chauhan AVSM & Bar, VSM, IN (Retd.), is the Director General, National Maritime Foundation (NMF), New Delhi. He may be contacted at directorgeneral.nmfindia@gmail.com

Note

This article was previously published in the "South Asia Defence & Strategic Review" (DEFSTRAT) magazine (May-June 2019 Volume 13, Issue 2) and is reproduced with permission of the editor, DEFSTRAT. DEFSTRAT is a Media Partner of the National Maritime Foundation

ISPS Code and Maritime Security of India

Dr Bhanu Krishna Kiran Ravella

The International Ship and Port Facility (ISPS) Code is of utmost importance for the safety and security of India's maritime sector, as it safeguards international trade relations, and this, in turn, ensures the growth of the Indian economy. The ISPS Code incorporates different levels of security, government obligations, and the responsibility of ports, the shipping industry, and other stakeholders. This article demonstrates the implementation of salient features of the ISPS Code in India through the Merchant Shipping Act, 1958, as amended in 2004, and DGS circulars. It will demonstrate the administration of the ISPS Code in India and the major obligation of the Indian government to set up security levels. It will further explain the ship and port security of India in compliance with the ISPS Code. It will also examine whether the implementation of the ISPS Code in India has fulfilled the core principles of the Code and will also evaluate whether any gaps remain to be filled.

The International Ship and Port Facility (ISPS) Code

The ISPS Code was introduced as part of Chapter XI-2 (as amended from time to time) of the International Convention on Safety of Life at Sea 1974 (SOLAS),[1] in 2002, by the International Maritime Organization (IMO), and came into force in the year 2004. SOLAS Chapter XI-2 has been periodically amended to include special measures designed to enhance maritime security on board vessels, within ports and particularly when a port-ship interface takes place. These regulations are supported by the ISPS Code, so as to establish an international framework for maritime security measures designed to enhance the security of ships and port facilities.[2] Part A of the ISPS Code[3] specifies a list of mandatory requirements, while Part B[4] provides recommendations on how best to accomplish the obligations set out in Part A.

The objectives of the ISPS Code are:

> *"…establishment of an international framework that fosters cooperation between Contracting Governments, Government agencies, local administrations and the shipping and port industries, in assessing and detecting potential security threats to ships or port facilities used for international trade, so as to implement preventive security measures against such threats; determining the respective roles and responsibilities of all parties concerned with safeguarding maritime security in ports and on board ships, at the national, regional and international levels; to ensure that there is early and efficient collation and exchange of maritime security-related information, at national, and regional and international levels; to provide a methodology for ship and port security assessments, which facilitates the development of ship, company and port facility security plans and procedures, which must be utilised to respond to ships' or ports' varying security levels; and to ensure that adequate and proportionate maritime security measures are in place on board ships and ports."*[5]

The ISPS Code currently applies to 167 States that are contracting parties to SOLAS.[6] India, being a signatory to the IMO Convention, has ratified the ISPS Code and implemented its provisions through the *Merchant Shipping Act 1958* as amended in 2004 (MS Act).[7] By the stipulations of this Act, for the 'maritime security of India',[8] the Indian government must set 'security levels'[9] and provide relevant information to port facilities within India, as also to every ship entering an Indian port. The Indian government must carry out port-facility assessments. Every 'company,'[10] ship or 'port facility'[11] must comply with the relevant requirements under the MS Act,[12] in compliance with SOLAS and the ISPS Code. The MS Act grants the Indian government the power to make rules for the carrying-out of such activities.[13]

Administration of the ISPS Code in India

To facilitate the implementation of the ISPS Code, the Indian government, as also port authorities and shipping companies within India, are required to appoint suitable security officers and staff on each ship, port facility and shipping company. These officers, include a 'Port Facility Security Officer' (PFSO), a 'Ship Security Officer' (SSO), and a 'Company Security Officer' (CSO). They are assigned with the duties of evaluating, organising and implementing effective security plans that are prepared to handle every probable security threat.[14] The Indian government is required to nominate a "Designated Authority"[15] and a "Recognized Security Organization" (RSO)[16] to implement the ship and port facility security plans designed under ISPS Code. The Directorate General of Shipping (DGS) has been nominated as the 'designated authority', while the Indian Register of Shipping (IRS) has been nominated as the RSO.[17] DGS deals with the approval of ship-security plans and is responsible for the verification of prerequisites of plans, and also for issuing a standardised 'International Ship Security Certificate' (ISSC),[18] and a 'Continuous Synopsis Record' (CSR).[19] Whenever necessary, DGS issues circulars with the aim of providing guidance to the maritime sector on the application of the MS Act, 1958 (amended in 2004) and the ISPS Code. The DGS is vested with statutory powers under Section 7 of the MS Act, 1958.

Security Levels

Part A of the ISPS code contains detailed, mandatory requirements of ship security,[20] and port-facility security,[21] and specifies the responsibilities of the Indian government.[22] Part B, which is advisory in nature rather than being mandatory, provides guidelines and recommendations on how to meet the requirements in Part A. However, the Indian government is required to give these recommendations due consideration. A major responsibility of the Indian government, as stipulated in Part A, is the setting of security levels; and Indian-flag ships, as well as Indian port facilities, must act upon these security levels set by the Indian government.[23] Apart from setting these security levels, the Indian government has also to provide guidance for protection from security incidents, and is required to approve port facility assessments and port facility security plans.[24]

At 'Security Level 1', basic preventive security measures must be carried out.[25] Security Level 2 provides for appropriate additional protective security measures to be maintained, usually for a longer period of time, due to the increased risk of a security incident.[26] Security Level 3 invokes further specific security measures to be maintained for a limited period of time when a security incident is probable and imminent, even though it may not always be possible to identify the possible target.[27] At Security Levels 1 and 2, additional measures must be put in place with the approved security plans. In addition, at Security Level 3, the Indian government may issue security instructions to which the ship and port facility must respond, and which they must implement.[28] Ships must acknowledge instructions on the various security levels in force.[29]

'Part B', which is, as has already been mentioned, recommendatory in nature, stipulates more detailed regulations in respect of 'Part A'. In particular, 'Part B' stipulates the precise security measures of ship and port facilities under Security Levels 1, 2 and 3, respectively.[30] In the case of India, some portions of 'Part B' have been made mandatory through the circulars issued by DGS. For instance, the security levels of some major ports, such as Mumbai Port Trust, Kolkata Port Trust, Jawaharlal Nehru Port Trust, Deendayal Port Trust, and some other non-major ports, are retained at 'Level 2', in preparation for possible terrorist attacks.[31]

Prior to the promulgation of the ISPS Code, there was no consensus within the international community on how exactly to cooperate on issues of maritime security. The provisions of the ISPS Code, on the other hand, now direct the Indian government and all stakeholders of the maritime sector on how exactly to enhance their security measures. If the ISPS Code is not implemented, it will be difficult for Indian-flagged ships to secure entry into the ports of other maritime nations, and also for foreign-flag merchant ships to call at Indian ports. Consequently, the MS Act was amended in 2004 so as to incorporate the provisions of the ISPS Code relating to security measures to be adopted by ships and port facilities.

Ship Security

A 'Ship Security Plan' (SSP) indicates the minimum security measures the ship should employ or enforce at various levels. The plan must be developed to ensure the application of security measures on board the ship, which are designed to protect persons on board, cargo, cargo transport units, ship's stores or the ship itself from the risks arising from a potential security incident.[32] Every ship is required to carry on board an approved SSP.[33] The requirements to be met by the SSP are set out in the

ISPS Code.[34] The security plans must additionally be protected from nm authorized access.[35] The "Recognized Security Organization" (RSO) itself may prepare SSPs,[36] and in the case of India, the government may also entrust the review, approval, and execution of SSPs to the RSO.[37] This option notwithstanding, shipping companies are obligated to appoint a 'Company Security Officer' (CSO), who is based ashore and a 'Ship Security Officer' (SSO), who is placed aboard each ship.

The CSO is required to check that ships conduct regular 'Ship Security Assessments' (SSA), and these SSAs then guide the development of the SSP.[38] The ISPS Code itself provides guidance on the basic requirements of an SSA.[39] Although the RSO may itself carry out SSAs, [40] specific responsibility to ensure that SSAs have, indeed, been diligently carried out vests with the CSO.[41] Each SSA should take existing security measures to be a base-reference and, using this reference, must thereafter assess all possible risks involving persons, activities, services and operations. SSAs are included with security surveys and other elements listed in the ISPS Code, such as key shipboard operations, and possible threats and weaknesses, including human factors.[42]

Under special measures to enhance maritime security vis-à-vis the security of ships and port facilities, all ships must be provided with a Ship Security Alert System (SSAS)[43] , which, at the very basic level, would include onboard security equipment such as (inter alia) metal detectors for checking persons boarding the vessel. The SSAS is meant to alert the designated authority of the ship's Flag State whenever the security of the ship is under threat. Every Indian shipping company is obligated to provide each ship that it is operating with a SSAS.[44]

Every ship is subjected to prescribed control measures and compliance.[45] Thus, every ship subject to the ISPS Code is subject to verification to ensure that the security system and the associated security equipment of the ship are fully compliant with the requirements stipulated in Chapter XI-2 of SOLAS, Part A of the ISPS Code, and the approved SSP. The concerned administrative authority is required to carry out this verification and an International Ship Security Certificate (ISSC) or Interim International Ship Security Certificate.[46] Is to be issued, for a period not exceeding five years, by the Directorate General of Shipping (DGS).[47] While the authority to issue an IS may be delegated — the issuance of ISSC, Ship Security Certificate (SSC) and the Continuous Synopsis Record (CSR) to Indian ships has, for example, been delegated to the concerned Registrars of Shipping[48] — the responsibility *per se* cannot and so, responsibility in respect of all Indian-flagged vessels remains vested solely in the Government of India.

Port Security

Plans must also be developed to ensure the application of measures designed to protect the port facility itself, as also the ships, persons, cargo, cargo transport units, and ship-stores, located within the port facility, from the risks of a security incident.[49] In compliance with the provisions of the ISPS Code,[50] a Port Facility Security Assessment (PFSA) is required to be to be carried out by designated officers of the Indian Register of Shipping (IRS), taking into account inputs from national security agencies, with each PFSA being approved by the DGS.[51] A Port Facility Security Plan (PFSP) is then developed and maintained by Port Facility Security Officers (PFSO), on the basis of the PFSA, and every such PFSP must make provisions for all three security levels.[52] The ISPS Code sets out the requirements of the PFSPs,[53] which may be combined-with or made part of the overall port-security plans.[54] Obviously, PFSPs must be protected from nauthorized access or disclosure. [55] The Government of India may also allow a given PFSP to cover more than one port facility if the government feels that the operator, location, operations, equipment and design of the port facilities are similar.[56]

To act as a security consultative body that remains involved in the continuous development and implementation of PFSPs, the DGS has formed committees, each comprising the PFSO of the port concerned, along with suitable representatives drawn from the Customs Department, the Narcotics Control Bureau (NCB), Central Intelligence Agencies (principally the IB), State Intelligence Agencies, the Central Industrial Security Force (CISF), the local police, the Immigration Department, the Indian Navy, the Indian Coast Guard, and any other concerned agency of the state or central government, as deemed appropriate by the Chairman or CEO of the concerned port.[57]

It is, of course, quite obvious that with such an enhancement in security measures and restricted right of entry, Indian ports would be better able to handle vessel-clearance processes, while improving inter-agency and inter-departmental cooperation, and paving the way to a sharp reduction in port- or ship-related crimes. Nevertheless, the implementation of the ISPS Code needs a significant number of security assessments and plans to be approved, and this, in turn, requires coordination between public and private sectors and different government- as well as intergovernmental organisations, which itself leads to a number of challenges such as delays in obtaining clearance for ships and overcrowding at port entry-points. Such delays need to be minimised through proper regulations.

Ship-Safety Aspects of the ISPS Code

The International Ship Management Code (ISMC) for the safe operation of ships and for pollution- prevention, and the ISPS Code are interrelated. The IMO and Chapter IX of SOLAS have developed certain standards and procedures for the safe operation of ships, as also for the prevention of pollution.[58] A maritime navigation safety communications system, the Automatic Identification System (AIS), has been mandated by the IMO for all cargo ships of 300 gross tonnage and upwards that are on international voyages, cargo ships of 500 gross tonnage and upwards that are not on international voyages, and all passenger ships irrespective of size.[59] In India, however, fitment of AIS is compulsory on all vessels more than 15 NT.[60] The AIS automatically transmits vessel information, including identity, type, position, course, speed, navigational status, and other safety-related information, and this information is capable of being received by other ships and shore stations both, via line-of site radio communications as well as via satellite (the latter is known as space-based AIS).[61] In addition, the Ship Identification Number has to be permanently marked in a visible place,[62] and the CSR has to be carried on board.[63] In compliance with extant regulations, the Shipping Corporation of India (SCI) has introduced its safety management system by setting up an International Safety Management (ISM) cell, which has developed, documented and structured certain norms and practices to be followed.[64]

Although the implementation of both Codes sometimes leads to a dilemma as to which is more important to uphold, both safety and security are equally critical within the maritime sector. Acts of piracy and other forms of maritime crime make ships insecure. Consequently, in case of a conflict between safety and security, safety prevails over security.[65]

Scope of ISPS Code

The MS Act, in relation to the ISPS Code, applies to ships engaged in the international carriage, including passenger ships and high-speed passenger craft; cargo ships, including high-speed craft of 500 gross tonnes and above; as also to mobile offshore units[66] and ports facilities serving such ships.[67] The Government of India may also extend the application of this provision to ports that are only occasionally required to serve ships on international voyages.[68] Warships, naval auxiliaries, and other ships owned or operated-by the Government of India for non-commercial service are excluded.[69] It is apparent that the MS Act does not apply to fishing vessels, cargo ships less than 500 tonnes, high-speed container vessels built prior to July 2001, and vessels not employed for international voyages. In the infamous terror attack in Mumbai in November of 2008, the terrorists travelled from Pakistan to Mumbai by boat, hijacked an Indian fishing trawler on the way, and landed in Mumbai in an inflatable dinghy.[70]

This clearly indicates that the maritime security of India must include each and every apparent threat. Yet, the MS Act narrows its scope to specified vessels or ships. Threats involving containerised cargo and bulk shipments are also not covered, despite their being well-recognised globally.[71] The ISPS Code largely deals with how risks to maritime sector can be prevented and curtailed but does not cover the aftereffects of major security incidents. Fortunately, India has not, thus far, experienced a major incident involving merchant ships or a port, yet it would be prudent to fill this lacuna by proper procedures and laws. India would also be well advised to look at areas like the security of ships, which is not an aspect that is expressly covered under the ISPS Code.

It is, of course, undeniable that India has implemented the basic principles of the ISPS Code by enhancing security measures through national legislation. However, the requisite checks and control mechanisms in respect of the ISPS Code are scattered in the MS Act, and rules and regulations are promulgated through DGS circulars. To fill this gap the Indian Ports Bill, 2021, was introduced by Ministry of Ports, Shipping and Waterways.[72] Chapter IX (Sections 44-61) of this bill will provide a comprehensive mechanism that provides more transparency to all maritime stakeholders for implementing their obligations under the ISPS Code.

ENDNOTES

1. 1184 UNTS 2, [1983] ATS 29, 14 ILM 959. Also see: Centre for international Law, Download, https://cil.nus.edu.sg/databasecil/1974-international-convention- for-the-safety-of-life-at-sea/.

2. IMO, "Maritime Security," https://www.imo.org/en/OurWork/Security/Pages/SOLAS-XI-2%20ISPS%20Code.aspx.

3. ISPS Code, Part A, Mandatory requirements regarding the provisions of chapter XI-2 of the Annex to the International convention for the Safety of life At Sea, 1974, as amended https://www.classnk.or.jp/hp/pdf/activities/statutory/isps/code/ISPS_CodeA.pdf.

4. Ibid, , Part B, Guidance regarding the provisions of chapter XI-2 of the Annex to the International Convention for the Safety of Life at Sea, 1974 as amended and part A of this Code, https://www.classnk.or.jp/hp/pdf/activities/statutory/isps/code/ISPS_CodeB.pdf.

5. Supra note, 2.

6. IMO, "Status of Conventions," accessed on March 28, 2022, p 17 https://wwwcdn.imo.org/localresources/en/About/Conventions/StatusOfConventions/Status%20-%202022.pdf.

7. Ministry of Law and Justice, Legislative Department, https://legislative.gov.in/sites/default/files/A1958-44.pdf.

8. Maritime security of India includes a range of measures employed by those in the maritime industry to address terrorism, sabotage, stowaways, illegal migrants, asylum seekers, piracy, armed robbery, seizure or pilferage; and any other hostile act or influence which threatens the security in the maritime transport sector. Merchant Shipping Act, 1958 as amended in 2004, (Ms Act) Section 44A.

9. Security level" means the qualification of the degree of risk associated with the threat or an unlawful act against a ship, or against a port facility or any other area connected therewith. Ibid, Section 344 K (g).

10. "Company" means the owner of the ship who, or any organisation which has assumed the responsibility of operation of the ship from the owner of such ship and who or which has agreed to take over all the duties and responsibilities imposed by the International Safety Management Code; Ibid, Section 344 K (a).

11. "Port facility" means any location or area including anchorages or waiting berths or approaches from seaward and determined by the Central Government or the designated authority, as the case may be, where interface between ships or a ship and a port takes place; Ibid, Section 344 K (e).

12. A port facility in India shall comply with all the requirements contained in Chapter IBO of the Merchant Shipping Act, 1958 (44 of 1958) or the rules made there under so far as they are not inconsistent with the provisions of this Act. Indian Ports Act, 1908, Section 68 D.

13. MS Act, Section 344 T.

14. IMO, SOLAS XI-2 and the ISPS Code, https://www.imo.org/en/OurWork/Security/Pages/SOLAS-XI- 2%20ISPS%20Code.aspx.

15. Designated Authority means the organization(s) or the administration(s) identified, within the Contracting Government, as responsible for ensuring the implementation of the provisions of this chapter pertaining to port facility security and ship/port interface, from the point of view of the port facility. Chapter XI-2, Special measures to enhance Maritime Security, Regulation 1.11 https://www.classnk.or.jp/hp/pdf/activities/statutory/isps/code/SOLAS-XI-2-e.pdf Also under Section 344 K (c) of MS Act, "designated authority" means such authority as the Central Government may, by notification in the Official Gazette.

16. ISPS Code, Part A, Section 15.2.

17. In accordance with the Ministry of Shipping Directive No. SR-20013/2/2003-AG dated 4th July 2003, ISPS Circular: NT/ISPS/PFSP/02/2004, https://www.dgshipping.gov.in › Shipping Notices.

18. MS Act, Section 344 Q.

19. According to SOLAS Chapter, IX-1, Regulation 5 all passenger and cargo ships of 500 gross tonnages and above must have a continuous synopsis record on the board. The CSR is a procedure in the onboard record of the history of the ship with respect to the information recorded therein.

20. ISPS Code Part A, Section 6-12.

21. Ibid, Section 14-16.

22. Ibid, Section 4.
23. Ibid, Sections 7.1 and 14.1.
24. Ibid, Sections 4.1 and 4.2.
25. Ibid, Sections 7.2 and 14.2.
26. Ibid, Section 7.3 and 14.3.
27. Ibid, Section 7.4 and 14.4.
28. Ibid, Section 4.2.
29. Ibid, Section 7.5.
30. Ibid, Part B, Section 4.
31. Security Level as on 31 December 2018, https://www.dgshipping.gov.in/writereaddata/ShippingNotices//ShippingNotices/201904260432028982272securityl evellistntbr.pdf.
32. ISPS Code, Part A, Section 2.1.4.
33. Ibid, Section 9.1.
34. Ibid, Section 9.4.
35. Ibid, Section 9.7.
36. Ibid, Section 9.1.1.
37. Ibid, Section 9.2.1.
38. Ibid, Part B, Section 1.9.
39. Ibid, Section 8.
40. Ibid, Section 8.
41. Ibid, Part A, Section 8.2.
42. Ibid, Section 8.4.
43. SOLAS XI-2, Regulation 6.1.
44. MS Act, Section 344 R.
45. Ibid, Section 344 S.
46. MS Act, Section 344 Q.
47. ISPS Code, Part A, Section. 19.3.1.
48 DGS, Shipping Notices, M S Notice No. 1 S of 2014, Para 1, https://www.dgshipping.gov.in/writereaddata/ShippingNotices/201409031235566323114note15_2014_nt.pdf.

49. ISPS Code, Part A, Section. 2.1.5.
50. Ibid, Section 15.
51. DGS Circular, "ISPS and Maritime Security", ISPS Circular NT/ISPS/PFSP/02/2004, Para 2, https://www.dgshipping.gov.in/Content/DGSCirculars.aspx?branchid=24.
52. ISPS Code, Part A, Section 16.1.
53. Ibid, Section 16.3.
54. Ibid, Section 16.5.
55. Ibid, Section 16.8.
56. Ibid, Section 16.9.
57. DGS Circular No. 04 of 2022, https://www.dgshipping.gov.in/.
58. Resolution A.788 (19) of the IMO, https://wwwcdn.imo.org/localresources/en/KnowledgeCentre/IndexofIMOResolutions/AssemblyDocumen ts/A.788(19).pdf.
59. SOLAS Chapter V, Regulation 9.
60. DGS Circular No. NT/ISPS/2/2013 dated 14 May 2013. NT (net tonnage) is a method of calculation for how much cargo-space a ship has. https://www.dgshipping.gov.in/writereaddata/ShippingNotices/201307221135218544921M20.pdf.
61. Guidelines for the onboard operational use of shipborne \AIS, https://wwwcdn.imo.org/localresources/en/KnowledgeCentre/IndexofIMOResolutions/AssemblyDocuments/A.917(22).pdf.
62. Ibid, Regulation 3.
63. Ibid, Regulation 5.
64. The Shipping Corporation of India Ltd., ISM Cell, https://www.shipindia.com/ism/ismpage/index.
65. Safety4Sea, "Security Measures: A Brief Review of ISPS Code Implementation," https://safety4sea.com/cm- security-measures-a-brief-review-of-isps-code-implementation/.
66. Merchant Shipping Act, 1958 as amended in 2004 (MS Act) Section 344J para 1(a).
67. Ibid, Para 1(b).
68. Ibid.
69. Ibid, Para (2).
70. Nana Kwabena Boakye-Boampong, "The ISPS code: An Effective or Defective Maritime Security Tool?" https://www.linkedin.com/pulse/international-ship-port-facility-security-isps-code-effective-boakye.

71. Maritime Transport Committee, Organization for Economic Co-operation and Development (OECD), July 2004, https://www.oecd.org/newsroom/4375896.pdf.

72. Ministry of Ports, Shipping and Waterways website, https://shipmin.gov.in/sites/default/files/Indianportbill2021.pdf.

About the Author:

Dr Bhanu Krishna Kiran Ravella is an independent researcher in public international maritime law and security. He earned an MSc in Strategic Studies from the S Rajarathnam School of International Studies, Nanayang Technological University, Singapore; an MPhil in international law and a PhD in international maritime law from the Jawaharlal Nehru University, New Delhi; he holds a diploma in Ocean laws and Policy from the Rhodes Academy, Greece; and is a Master of Law from Sri Venkateswara University, Tirupathi. He may be contacted at kiran.ravella@gmail.com

Note

This article was first published on the website of National Maritime Foundation on 9 June 2022

Industry 4.0 in the Shipping Industry: Challenges and Preparedness – The Prevailing Scenario

Namita Barthwal and Commander (Dr) Nitin Agarwala

The rapid and inexorable rise in the 1990s of the internet, networking, and digital communication, which, in aggregate, represents 'cyberspace', has produced startling and indelible changes in almost all aspects of modern life. The accelerated growth of cyberspace has given birth to a new industrial revolution, often called the 'Fourth Industrial Revolution'. In this revolution, which is an ongoing one, the industry is experiencing a distinct movement towards digitalisation,[1] automation and data-exchange, in both, the secondary[2] and the tertiary sectors.[3] In the continuing effort to create a holistic and better-connected ecosystem, this phase in the industrial landscape, which focuses intensely on interconnectivity, machine learning, and real-time data, has resulted in a sharp enhancement in productivity and has been branded 'Industry 4.0'. In recent times, the concept of Industry 4.0 has been deployed in the global shipping industry, too, and has led to the development of an ecosystem that is increasingly being defined by the Internet of Things (IoT), for the shipping industry to manage navigation and operations, through computers.

Industry 4.0, is, of course, not without significant challenges of its own. Today, cybercriminals are embezzling users of virtual space (cyberspace). Their targets range from individuals to companies. In this scenario, the shipping industry has become an especially attractive target for cybercriminals, largely because it moves goods of large monetary value from and to ports, through shipping. Unfortunately, this industry is also amongst the least prepared to guard itself against cyber transgressions. In 2017, a major cyber-attack on AP Møller-Maersk, the world's largest container shipping company, using the *NotPetya* virus, served to dramatically (and quite catastrophically) highlight the severe vulnerabilities of the shipping industry in this digital world. These vulnerabilities are now a major area of concern, thereby necessitating the need-for and the consequent growth-of the 'maritime cybersecurity' market.

According to predictions by *Cybersecurity Ventures*, a leading source of cybersecurity facts, figures and statistics, global spending on cybersecurity products and services is likely to exceed US$ 1 trillion, cumulatively, during the period from 2017 to 2021.[4] This growth is a direct outcome of rising cyber-crimes and the increases in frequency and level of sophistication of cyber-attacks on the shipping industry. This has made the shipping industry a very significant consumer of cybersecurity products so as to be able to safeguard its IoT-dominated ecosystem. These products include guidance, sensors, controls, command and communication systems, and their hydra-headed linkages to coastal infrastructure.

This article offers an empirical overview of: (a) the digital revolution in the shipping industry; (b) the cyberspace challenges in the shipping industry; (c) the level of preparedness of the shipping industry to handle prevailing and future cyber-threats, and (d) the role of the cybersecurity market in providing solutions to these cyber-threats.

The Digital Revolution in the Shipping Industry

As industries revolutionise themselves through Industry 4.0 by using technologies such as machine-to-machine communication, cognitive computing, Radio Frequency Identification (RFID), IoT, robotics, cloud computing, mobile technologies, etc., computing, data-storage, connectivity and production-efficiency improved by leaps and bounds, resulting in a spurt in the growth of the world economy. Taking careful note of the fact that this growth was being achieved through the increasingly ubiquitous use of technology, the global shipping industry — which is the lifeblood of the global economy and is manifested in the 50,000 ships that are at sea or in ports at any given moment of time (see Figure 1), moving about 90 per cent of world-trade by volume, and, in the process, generating an estimated annual income of over half trillion USD in freight rates[5] — felt the need to replicate this technology-driven growth. Hence, Industry 4.0 was embraced by the shipping industry to improve its value-chain and its management, in an effort to enhance profits and reduce overheads by improving efficiency.

This effort drove the shipping industry to promote sophisticated developments in areas such as connectivity, maintenance and safety, etc., through digitalisation. Today, the shipping industry uses digitalisation for connectivity — to get real-time information about a ship's performance at sea; for maintenance — to enable remote diagnostics of the machinery of ships at sea; and, for safety — to ensure the shore-based monitoring of gas-emissions and cargo temperatures of its seagoing assets, so as to decrease the operational cost and risk of failure due to negligence.

Although digitalisation in the shipping industry is still in an embryonic phase, it has already become hugely popular. This popularity has led to an exponential creation of data that is supported efficiently by hardware (computing power) and 'Cloud'-

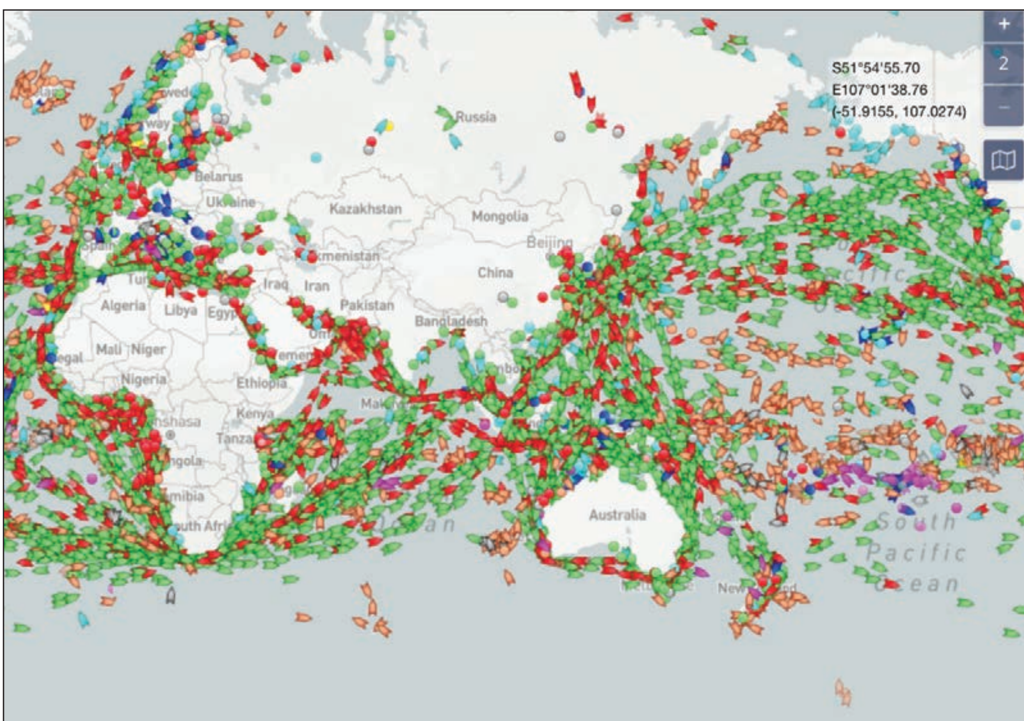


Figure 1: Vessels at sea and in port
Source: www.marinetraffic.com

based data-storage solutions (on-site storage). Another area where digitalisation is being implemented in the shipping industry (even though it is still in a nascent stage) is in cargo shipment using blockchain technology. A 'blockchain' is basically a way to store, share, and verify information, using a 'ledger'. The stored information in the blockchain exists as a shared, secured, decentralised, and encrypted 'public ledger', which inherently resists any modification and is easily verifiable. This, therefore, enhances cybersecurity, resulting in the blockchain process becoming a platform of trust and value in industries that have adopted this technology. The introduction of blockchain technology in the shipping industry has the potential to cut administrative and operational risks for shipowners, charters and brokers,[6] as it ensures greater transparency, enhances security, improves traceability, increases efficiency and speed of transactions, and reduces costs. In January of 2018, AP Moller-Maersk (Maersk) and IBM jointly announced the launch of 'TradeLens'[7] — an internet-based platform intended to apply blockchain technology to the global supply chain. In August of that same year, in a follow-up of their January announcement, the two partner companies also announced that 94 organisations were actively involved or had agreed to participate in the TradeLens platform, built on open standards.[8] In the first year of its use alone, the time of shipments in the United States has been reduced by 60 per cent.

As it stands, overall digital transformations, as part of Industry 4.0, are in progress for the betterment of the shipping industry. However, at the same time, it is essential to acknowledge the challenges associated with this technological development. To understand the challenges faced by the shipping industry due to the growth of cyberspace, it is instructive to look at prevailing cyber-threats.

Cyberspace Challenges in the Shipping Industry

In the shipping industry, cyber-dependence has spawned unprecedented threats from unknown sources that are difficult, if not impossible, to identify. Cyber-threats in the shipping domain may be divided into two categories – targeted and untargeted.[9] *Targeted* attacks are where a company or a ship's systems and data are, indeed, the intended targets. Targeted attacks include the use of brute force, denial-of-services, spear-phishing, subverting the supply chain, port-scanning, etc.[10] On the other hand, *Untargeted* attacks are those where a company or a ship's systems and data are merely one of many potential targets. These untargeted threats include, *inter alia*, malware attacks, phishing, water-holing, and, scanning. In addition, cyber-threats in the shipping industry may be 'intentional' or 'unintentional'. *Intentional* cyber-threats are those where the cyber breach comes from intentional malicious actions, while *unintentional* cyber-threats are those where the breach is a result of negligence or ignorance. It is essential that the shipping industry identifies the predominant cyber threats before looking at means to address them.

With digitalisation, even piracy has gone high-tech. Today, cargo ships, oil tankers, and super yachts are facing an increasing threat from cyber-attackers[11] who can cause service-disruption, system-downtime, financial loss, cargo-theft, loss of contracts, and, reputational-damage. These cyber-attackers are able to attack critical systems of a target-ship, such as the propulsion, machinery, and navigation systems. They can threaten or actually cause ecological disasters such as oil spills by actions such as the opening of remotely-controlled or automated discharge valves,[12] or, causing groundings or collisions through the malicious manipulation of GPS signals and receivers. Malicious manipulation of positional, heading and speed data can cause a ship to change direction, making it susceptible to piratical attacks. Likewise, shipborne radars can be jammed, making the ship blind to its surroundings. Any attack of this nature can lead to disruption and collision of ships in busy shipping lanes[13] and can severely harm the shipping industry, the energy industry, and also the marine environment.

A maritime cybersecurity survey, conducted in 2018 by the 'The Baltic and International Maritime Council' (BIMCO), Fairplay, and ABS Advanced Solutions,[14] provides some idea of the nature of cyberthreats experienced by the maritime industry. These threats include phishing, malware, spear phishing, the threat to credentials, ransomware, theft of data, man-in-middle application-level attacks, breach of procedure, known vulnerability-exploitation, brute force, network-protocol attack, manipulation of data, loss of operational control, and, honeytraps. The study revealed that: (a) of these threats, phishing and malware are the *major cyber challenge*, (b) the shipping sector is the *major target*, (c) 'theft of credentials' was the *major* *reason* for cyberattacks, which increased significantly from 2 per cent in 2017 to 28 per cent in 2018, and, (d) the *major result* of these attacks was loss of corporate data, lowering of performance of IT system and financial loss.

In recent years, the shipping industry has faced many cyber-attacks. The most significant and an extremely high-profile incident was that the attack on AP Møller-Maersk,[15] on 27 June 2017, when a malware called 'NotPetya'[16] destroyed almost the entire AP Møller-Maersk computer network. 'NotPetya' was a 'ransomware' that came through software used by companies to file their tax returns. After hijacking the company's network, the attackers, based in Ukraine,[17] demanded a payment of US$ 300 worth of bitcoins (~US$ 16,88,926) to decrypt the important files from the Maersk database. The company refused to pay the ransom and tried to resolve the problem on its own. Since the ransomware attack was a severe one, it corrupted the Maersk's network extensively, preventing the company's IT experts from recovering the data. In the end, instead of recovering the data, the company chose to reinstall over 4,000 servers, 45,000 computers, and 2,500 applications. The resulting loss to Maersk is estimated to have been between 250 million and 300 million US Dollars.

In January of 2018, after the cyber-attack, AP Møller-Maersk's Chairman, Jim Hagemann Snabe, accepted that *"we were basically average when it comes to cybersecurity, like many companies, and this was a wake-up call."*[18] At nearly the same time, on 24 July 2018, the Chinese shipping and logistics company, the China Ocean Shipping (Group) Company (COSCO), too, became a victim of a ransomware attack. The attack was not severe, but it alarmed the shipping sector.[19] Other large shipping companies that have faced cyber-attacks include the BW Group[20] and the Clarksons.[21] These cyber-attacks on big and powerful shipping houses bring into question the level of preparedness of the shipping industry for cyber-attacks.

Level of preparedness to tackle cyber-threats

Several reports and surveys indicate that the *maritime industry* is ill-equipped to deal with cyber threats. The Global Maritime Issues Monitor,[22] in its report of 2018, brings out that cyber-attacks and data-theft are among the top issues impacting the maritime industry, while the preparedness to tackle these specific cyber-threats is the poorest. Similarly, in 2017, in order to diagnose the lack of preparedness of the *shipping industry* in tackling prevailing cyber threats, the Jones Walker LLP[23] conducted a maritime cybersecurity survey of the US maritime industry. The report revealed that the US maritime industry had a false sense of preparedness. While 69 per cent of the respondents believed that the industry was ready to handle devastating cyber-attacks, only 36 per cent believed that their own company was prepared. Highlighting the insignificant level of preparedness to deal with cyber-threats in the maritime sector, the survey brought out that, *"Hackers are modern day pirates who have the ability to sink maritime industry sectors that are unprepared for what's coming at them."*[24]

When talking about preparedness of the *crew* to protect a ship from cyber-attacks, the lack of preparedness is starkly visible. In the Crew Connectivity Survey 2015[25] (conducted by Futurenautics), it was found that only 12 per cent of crew members had received any form of cyber training. In addition, only 43 per cent of crew members had any knowledge of cyber hygiene provided by their company for personal web-browsing. Unsurprisingly, 43 per cent of the survey participants revealed that they had sailed on vessels that had become infected with a virus or malware. Even now, these figures have not changed by much.

While there certainly is a distinct lack of preparedness of the shipping industry and the crew to tackle cyber-attacks, much of the blame must be attributed to the lack of a regulatory framework for cyber security in the shipping industry. Although the International Maritime Organisation (IMO), in 2017, amended its two general security-management codes — the International Ship and Port Facility Security (ISPS) Code and the International Safety Management (ISM) Code to explicitly include cybersecurity and how the maritime industry should undertake cyber risks management processes, these amendments will come into force only by 01 January 2021. These slow developments in maritime cybersecurity regulation have left the shipping industry to face the brunt of repeated cyber-attacks.[26]

The slow development notwithstanding, in 2018, a group of the world's largest shipping associations, which included BIMCO, the International Union of Marine Insurance (IUMI), the International Association of Independent Tanker

Owners (INTERTANKO), the International Association of Dry Cargo Shipowners (INTERCARGO), the Oil Companies International Marine Forum (OCIMF), the World Shipping Council, and, the International Chamber of Shipping, collaborated to jointly prepare and release a manual titled, *"Guidelines on Cyber Security Onboard Ships"*. This manual is aimed at improving a ship's safety management system, risk assessments for operational technology, and, in addition, offers guidance for identifying and tackling on-board cyber security threats arising from the external supply chain. The guidelines also set-out the cyber risk-management approach and exhorts the IMO to stay engaged throughout the process so as to ensure that the protection, and contingency- and response-planning, are balanced in relation to the threats, vulnerabilities, risk-exposure and consequences of a potential cyber accident.[27]

Despite realising the accelerated dangers of the cyberspace, cyber risk-management in the maritime industry is moving at a painfully slow pace. This has forced the owners of the shipping companies to engage with cyber-security providers to minimise the losses arising from cyber incidents. This has, in turn, led to the emergence of the maritime cybersecurity market.

The Cybersecurity Market

In order to achieve requisite cyber protection, the shipping industry relies heavily on external parties such as technology consultancies, security experts, and software suppliers. These external parties sell cybersecurity products to shipping companies and enhance the security of their Information technology (IT), Operational technology (OT) and navigation systems. It is essential to mention that the cyber-industry is not currently investing in the shipping industry directly, due to the lack of consciousness about cyber threats in the industry. Further, the industry and its IT infrastructure is obsolete and do not adhere to the latest IT standards.

Over the years, several cybersecurity companies and consultants have emerged, specifically to address the cyber challenges of the shipping industry and to provide solutions to develop a secure digital environment. Some of these key firms are:

(a) The 'MTI Network', which trains shipping industry employees to recognise cyber-attacks and implement policies on computer hardware usage, particularly the use of USB memory sticks.[28]

(b) Marlink, which has provided a facility called Cyber Guard that enables Marlink customers to protect, detect and resolve any cyber-threat through a holistic combination of network resilience and redundancy, dedicated maritime cyber-security technology and maritime security experts.[29]

(c) The Seawall Scan, an open source firewall, helps the industry to test ship systems to detect security weaknesses.[30]

(d) Other cybersecurity firms, such as the Cydome, the CyberSail, the Hudson's Cyber Risk Management, the Solace Global, and the Gard, are dedicated to provide cybersecurity services to the shipping industry.

Recommendations to Improve Cybersecurity in the Shipping Industry

Although it is believed that in the shipping industry, cyber security has to be expensive and supported by external parties, this is not true. Simple measures that are inexpensive and safe can be put in place to provide a secure cyber-environment. These measures include actions such as regularly and frequently updating systems, configuring network features, testing security features, and, training users to operate the systems optimally.

Further, it is an accepted fact most shipowners do not have a comprehensive knowledge of cyber risks. There is, therefore, a clear need to improve this situation. Towards this end, four key steps have been recommended by Max J. Bobys, Vice President of the Hudson's Cyber Risk Management. These are:

(a) To develop cyber-loss scenarios that could impact the business and determine their exposure values. Since smaller scale scenarios cover site-specific instances, such as how a vessel or an office might be impacted, the need is to have a broader thinking to characterise how a multi-vessel / site attack might impact the overall business.

(b) To review and test existing insurance policies against the loss scenarios.

(c) To perform a top-down, cybersecurity capability maturity-model based evaluation. This is considered essential since cyber risk needs to be continuously and proactively managed as an organisational risk.

(d) To sustain cyber risk management resources. This can be achieved by ensuring that personnel are trained, insurance policies are updated to support incident reporting and recovery, and, to maintain budgets to support a range of technical and non-technical cybersecurity investments.

Conclusion

A majority of the world's trade is moving by sea, along the International Shipping Lanes (ISL). Statistics by the United Nation Conference on Trade and Development (UNCTAD) shows that international seaborne trade gathered considerable momentum in 2017, with volumes expanding by 4.0 per cent. It is expected that this trend will continue over the coming years. Simultaneously, ships, ports, and mobile offshore units, are becoming increasingly connected and reliant on software-dependent systems. In this scheme of things, the shipping industry is clearly a vulnerable target for cyber-attackers. Hence, it is essential for the shipping industry to develop a protected IoT ecosystem and the ability to recognise the risks associated with the cyber domain, including technologies such as radars, sensors, and drones. It is essential to understand that if digitalisation were to continue without proper security measures, it could have severe repercussions on both, the shipping industry and the world economy. It is hence vital to maintain the integrity and resilience of cyber-physical systems through a holistic approach.

This article has sought to provide an overview of the lack of consciousness, awareness and protection mechanisms against cyber-attacks within the shipping industry. At the moment, the preparedness of the shipping industry to deal with cyber threats is unacceptably low. Currently, the internal mechanisms of the industry are slow in framing cyber risk management policies, while those policies that have been adopted by the IMO are still to come in force. Consequently, there is no available and usable framework to deal with the vulnerabilities associated with Industry 4.0.

As digitalisation facilitates an efficient business environment, a gain in the value chain, and serious damage to the business if adequate precautions are not taken, it is necessary that adequate steps are taken by the shipping industry to increase opportunities and decrease risks associated with Industry 4.0, through qualitative management.

Although technology-consultants are supporting the shipping industry in tackling this demand for cyber-security, the need of the hour is to train personnel and ensure upgradation of the IT infrastructure aboard ships, so as to have better involvement of the cyber industry in developing and ensuring a robust cyber-system for the shipping industry. However, until that is done the shipping industry must persist with inhouse measures that would provide for the requisite degree of cyber-security.

ENDNOTES

1. The *digitisation* and *digitalisation* are different terms that are mistakenly used as synonyms. *Digitisation* means taking analogue information and encoding it into binary format (using *zeroes* and *ones*), so that computer could store, process and transmit such information, whereas *digitalisation* is an ambiguous term, which means a way in which many social domains are structured or restructured around digital communication and media infrastructure.

2. The secondary sector encompasses manufacturing — the making, building, and assembling of finished products.

3. The tertiary sector provides services to consumers and businesses and includes retailers, transportation and entertainment companies, banks, and healthcare providers.

4. Steve Morgan, Cybersecurity Market Report, 2018; retrieved on 18 April 2019 from https://cybersecurityventures.com/cybersecurity-market-report/.

5. Shipping and World Trade, data by International Chamber of Shipping (ICS); retrieved on 18 April 2019 from http://www.ics-shipping.org/shipping-facts/shipping-and-world-trade.

6. Alexander Farnsworth, "BlockChain- The case for digitalising shipping", Wartsila, 2 January, 2019; retrieved on 18 April 2019 from https://www.wartsila.com/twentyfour7/innovation/blockchain-the-case-for-digitalising-shipping.

7. Is an open and neutral industry platform underpinned by Blockchain technology, supported by major industry players? See, *for example*, https://www.tradelens.com/.

8. IBM Newsroom: "Maersk and IBM Introduce TradeLens Blockchain Shipping Solution", Copenhagen, Denmark, and ARMONK, NY, 09 Aug 2018, from https://newsroom.ibm.com/2018-08-09-Maersk-and-IBM-Introduce-TradeLens-Blockchain-Shipping-Solution.

9. Sotiria Lagouvardou, *Maritime Cyber Security: concepts, problems and models,* Thesis, DTU Management Engineering: 2018, pp. 44-48; retrieved on 18 April 2019 from http://orbit.dtu.dk/files/156025857/Lagouvardou_MScThesis_FINAL.pdf.

10. Ibid, p. 44.

11. Luke Graham, "The new face of piracy: cybercrime is threatening the shipping industry", City A.M, 26 November, 2018; retrieved on 18 April 2019 from http://www.cityam.com/269633/new-face-piracy-cyber-crime-threatening-shipping-industry.

12. Luke Graham, "The new face of piracy: cybercrime is threatening the shipping industry", City A.M, 26 November, 2018; retrieved on 18 April 2019 from http://www.cityam.com/269633/new-face-piracy-cyber-crime-threatening-shipping-industry.

13. In 2016, 280 South Korean vessels returned to the port after experiencing problems with their navigation systems. The South Korean government blamed North Korea behind the disruption, but was unable to obtain evidence for the accusation. See, *for example*, Jonathan Saul, "Cyber threats prompt return of radio for ship navigation", Reuters, 7 August, 2017; retrieved on 18 April 2019 from https://www.reuters.com/article/us-shipping-gps-cyber/cyber-threats-prompt-return-of-radio-for-ship-navigation-idUSKBN1AN0HT.

14. IHS Markit, *2018 Maritime Cyber Security Results*, Results Overview; retrieved on 18 April 2019 from http://www.nepia.com/media/977540/Fairplay-and-BIMCO-Maritime-Cyber-Security-survey-2018.pdf.

15. A Danish maritime business conglomerate, operating in more than 120 countries; provide services in 300 ports around the world and nearly 800 vessels. The company represents one-fifth of the entire world's shipping capacity.

16. A malware that aims to encrypt the hard drive of infected computers and does not require human intervention to spread itself.

17. Andy Greenberg, "The untold story of NotPetya, the most devastating cyberattack in the history", Wired, 22 August, 2018; retrieved on 18 April 2019 from https://www.wired.com/story/notpetya-cyberattack-ukraine-russia-code-crashed-the-world/.

18. Catalin Cimpanu, "Maersk Reinstalled 45,000 PCs and 4,000 Servers to Recover From NotPetya Attack", Bleepingcomputer, 25 January, 2018; retrieved on 18 April 2019 from https://www.bleepingcomputer.com/news/security/maersk-reinstalled-45-000-pcs-and-4-000-servers-to-recover-from-notpetya-attack/.

19. "COSCO Shipping Lines Falls Victim to Cyber Attack", World Maritime News, 25 July, 2018; retrieved on 18 April 2019 from https://worldmaritimenews.com/archives/257665/cosco-shipping-lines-falls-victim-to-cyber-attack/.

20. Jamey Bergman, "Tanker group says it faced cyber-attack in July", Maritime Digitalisation and Communications, 17 October, 2017; retrieved on 18 April 2019 from https://www.marinemec.com/news/view,tanker-group-says-it-faced-cyber-attack-in-july_49564.htm.

21. Notice of cybersecurity incident, CLARKSON PLC, 29 November 2017; retrieved on 18 April 2019 from https://www.clarksons.com/media/1129201/notice_of_cyber_security_incident.pdf.

22. Global Maritime Issues Monitor, 2018, MARSH and IUMI; retrieved on 18 April 2019 from https://www.globalmaritimeforum.org/content/2018/10/Global-Maritime-Issues-Monitor-2018.pdf.

23. Jones Walker LLP 2018 Maritime Cybersecurity Survey; retrieved on 18 April 2019 from https://sites-communications.joneswalker.com/38/1033/uploads/2018-jones-walker-llp-maritime-cybersecurity-white-paper.pdf?intIaContactId=8590524490&intExternalSystemId=1&strExternalSystemType=Interaction%205.6.

24. Hellenic Shipping News Worldwide article "Maritime Cybersecurity Survey Indicates Industry is Unprepared for Risks"; retrieved on 18 April 2019 from https://www.hellenicshippingnews.com/maritime-cybersecurity-survey-indicates-industry-is-unprepared-for-risks/.

25. Lean Kinthaert, "8 Experts Weigh In on Cybersecurity in Shipping & Maritime", KNet365, 9 April 2017; retrieved on 24 April 2019, https://knect365.com/shipping/article/56554e0a-1356-42ac-88cd-564a389bcd1e/cybersecurity-shipping-maritime.

26. Forbes Vivian Louis, 2018, "The Global Maritime Industry Remains Unprepared for Future Cybersecurity Challenges", Future Direction International, 21 August 2018; retrieved on 18 April 2019, http://www.futuredirections.org.au/wp-content/uploads/2018/08/Global-Maritime-Industry-Remains-Unprepared-for-Future-Cybersecurity-Challenges.pdf.

27. The Guidelines on Cyber Security Onboard Ships, Version 3; retrieved on 18 April 2019 https://iumi.com/uploads/2018-Cyber_Security_Guidelines.pdf.

28. MTI Network article "Taking Cyber Security seriously" Retrieved on 18 April 2019 https://www.mtinetwork.com/taking-maritime-cyber-security-seriously/.

29. "Cyber Security in the Maritime Industry", 20 November 2018, Maritime Digitalisation & Communication; retrieved on 18 April 2019 https://www.marinemec.com/news/view,cyber-security-in-the-maritime-industry_55948.htm.

30. Seawall cybersecurity protection package presentation; retrieved on 18 April 2019 https://docs.wixstatic.com/ugd/90f4b3_ef08ea2b9f7f4d288eca48289f70c744.pdf.

About the Author

Namita Barthwal was a Research Intern at the National Maritime Foundation. She can be contacted at namita.barthwal@gmail.com

Commander (Dr) Nitin Agarwala was a Research Fellow at the National Maritime Foundation. He can be contacted at nitindu@yahoo.com

Note

This article was first published on the website of National Maritime Foundation on 24 July 2020

India's Endeavour to Reboot Shipping Industry: Rationale and Implications

Rajesh Soami

The Indian economy has been growing at a rapid pace since the country initiated economic reforms in 1991. The country's GDP has doubled in the last decade[1] alone and multiplied almost ten times since '91. Earlier this year, the World Bank, in its global economic prospect report, said that India is expected to grow at the fastest pace among all major economies[2] in coming years. Buoyed by healthy current figures and future predictions, Prime Minister Modi has talked of targeting double-digit growth for the country[3]. The growing economy has meant growing trade. Figures for the country show exemplary growth in trade in the previous decades. In the financial year 2017-2018 alone, Indian trade grew 16.32 per cent from 660.2 to 769.9 billion dollars[4]. The bulk of this trade is carried through the maritime route. According to government data, 90 per cent of the country's trade by volume, and 70 per cent by value, is carried on ships[5]. This has led to increased activity of merchant ships in ports in and around the country. Unfortunately for Delhi, the flag-bearing merchant fleet of the country has failed to keep pace with growing trade[6]. Consequentially, it is the foreign shipping companies which have reaped the benefits of India's growth story.

At the same time, foreign ports around India, Colombo, Dubai and Singapore have also benefited from Indian trade. Larger ships are loaded and offloaded at these ports. Containers are shipped to or from smaller ports in India. New Delhi is now trying to bring back this traffic directly into India by investing in the development of large ports in the country. But the ports alone are unlikely to change the transportation habits of the larger shipping companies. The Indian government has therefore decided to give incentives to these companies by relaxing old laws and changing its shipping policies.

The smaller merchant shipping industry in India is protesting against these policy decisions pertaining to the sector. These new policies, promulgated in the last couple of months, seek to remove advantages that the local industry receives in favour of free competition between Indian and foreign-flagged vessels. Indian ship owners have threatened to flag out[7] if these new policies are implemented. In case the government fails to satisfy the Indian companies and the threat is indeed carried out, it would mean the end of the country's merchant fleet. This could have grave implications for the country, both in strategic and economic terms.

At the heart of the dispute lies the nature of business operated by the shipping sector. As transport vessels, ships pay the bulk of taxes in the countries in which they carry the flag. In return, they receive favourable treatment in the territory of the native country to support their business. This favourable treatment could be in many forms. Laws and regulations to support domestic shipping have been the norm in the sector for ages.

Change in Laws

Till recently, cabotage laws used to be the most common means of supporting the home-based shipping industry. What exactly are cabotage laws? Cabotage may have come from the French word 'caboter' meaning 'to coast', or the Spanish word 'cabo', which means 'cape'. Either way, cabotage has everything to do with shipping in the coastal regions of a country. The first cabotage laws were introduced by the Portuguese in the early 16th century to protect their coast from foreign ships. Other countries followed soon after. Cabotage laws place various restrictions on ships of other countries to travel in the territorial waters of a country. Initially designed to protect the coast, cabotage laws became a powerful tool to support the indigenous shipping industry as shipbuilding, and naval warfare grew in relevance in succeeding centuries.

These laws could range from very restrictive to extremely open. The Japanese and the Americans have some of the most stringent laws. Article 3 of the Ships Act in Japan prohibits foreign ships from traversing Japanese territorial waters for trade between the country's ports. Similarly, Section 27 of the Merchant Marine Act in the US, commonly known as the Jones Act, dictates that ships traversing American territorial waters, from one port to another, must be country-flagged and also majorly crewed by their nationals. Till recently, India had similar provisions in the law. Section 407 of the Merchant Shipping Act allowed for only Indian ships or Indian-owned ships to be granted a license to indulge in coastal trading in the country[8]. On the other hand, lesser or non-sea-faring states have either relaxed cabotage laws or no such restrictions in place.

There is an ongoing debate[9] in many countries about the protectionist nature of cabotage laws and if they must be done away with. Some countries have chosen to relax their cabotage laws in favour of freer trade. Loosening the cabotage regulations provides incentives to merchant ships to use the country's ports. Increased traffic into and from ports leads to a larger collection of port charges by the country. This often offsets the economic disadvantages which countries may accrue when moving away from discriminatory laws supporting their shipping industry. The Philippines[10], China[11], and Canada[12] have relaxed their cabotage laws to varying degrees. The same enthusiasm, though, is missing from other traditional seafaring nations like Japan and the US, which have stuck to centuries-old laws.

India has now decided to follow the Philippines and China in loosening the cabotage regulations. For long, international shipping giants had lobbied the government for such a step. Initially, the government relaxed rules for the transhipment of containers[13] from one port to another. This allowed the transportation companies to move empty containers from one port to another using the territorial waters of India. That was in 2016. Now in 2018, New Delhi has decided to do away with the requirement of licenses[14] to carry agriculture, horticulture, fisheries and animal husbandry products. The government has also removed restrictions[15] on carrying fertilisers. This means that the domestic shipping industry will have to compete with foreign shippers, even in Indian territorial waters, to carry Indian products. Needless to say, this has not gone down well with Indian shipping companies.

The government is also in the process of reviewing another pillar that supports Indian shippers. According to media reports, the government has informed the shipping industry of its intention to scrap the 'right of first refusal' provision available to national carriers[16]. Under this provision, Indian shipping companies have the choice of matching the lowest bid of any foreign company and thereby picking up tenders from Indian state-owned companies that require transportation services.

Shipping Industry's Arguments

The Indian shipping industry has vigorously protested against these new regulations. They claim that the new regulations, if enforced, will wipe out the Indian merchant fleet by making them economically uncompetitive.

Shipping companies, with Indian-flagged ships, argue that they pay their taxes in full to the government. Besides, they also contribute by hiring Indian nationals to man their ships, which is mandatory by the country's law. Moreover, the shipbuilding industry catering to the requirements of these companies also contributes to the manufacturing industry in India and indirectly to the economy. None of this applies to foreign shippers. It is only fair, then, that Indian companies get concessions from the government for their activities. After all, cabotage laws are the general norm in the industry, they argue. Most of the developed or developing countries have one or the other form of cabotage laws supporting their own shipping companies. Why, then, should India become the vanguard of cabotage law relaxations, damaging the economic viability of its own shipping industry?

These arguments are not without basis. Many international shipping companies register their ships at either tax havens or where the taxes are sufficiently low to be negligible. For example, Panama, the Marshall Islands and the Bahamas have an extremely large number of registered ships, although the volume of trade in these countries is extremely low. Similarly, many other countries also have lower taxes when compared to India. Countries like Greece proactively encourage their shipping companies. They also tax foreign ships in almost equal measure to ensure fair competition. Indian shipping companies argue that in the prevailing situation, they would be unable to compete successfully without help from the government.

Anil Devli, the President of the Indian National Shipowners Association (INSA), recently, in a passionate argument[17], said that if the apathy towards the Indian merchant fleet continues, the country could end up with East India Company on its horizons again. East India Company of Great Britain had initially colonised India before the British government directly took over governance in the middle of the 19th century.

Government's View

The government of India has very little consideration for such dramatisations as Devli's. For nearly half a century, the government, fed by Marxist historians and economists, equated capitalism with imperialism. Consequently, they pursued socialist policies and protected indigenous companies from international competition. In this, they were lobbied for by the industries themselves, not unlike the shipping industry today. This served India poorly. The now infamous license-raj, turned Indian companies inefficient and burdened the taxpayers. Only after the International Monetary Fund (IMF) forced the country to open up its economy in 1991, did India eventually see some meaningful economic growth. Free trade, globalisation and liberalisation are seen as drivers of growth now and not threats. Protectionism is considered regressive, and there are few takers for it.

Specifically, in the shipping industry, the government sees less and less logic in continuing with rigid cabotage laws. As previously stated, the Indian economy and, therefore, its trade has shown remarkable growth in the last two decades. The merchant fleet, though, has failed to catch up. The sector has continued to report stunted growth despite the country allowing a hundred per cent foreign direct investment (FDI) in the shipbuilding industry. As a result, there are simply not enough Indian-flagged ships in the Ocean to cater to increasing demand. Even with rigid cabotage laws, Indian-flagged bottoms never manage to carry more than 40 per cent of the trade in any of the products. The bulk of the transport continues to be carried by foreign ships.

Secondly, strict cabotage laws, among other factors, have led to the growth of transhipment ports around India. In fact, Colombo has emerged as a major hub for large ships to offload their India-bound cargoes. Smaller ships could then ferry these cargoes to various Indian ports. Almost 50 per cent of the transhipment containers being loaded or offloaded in the Colombo port are either destined for India or originate from here[18]. This causes losses to New Delhi in two ways. Indian ports do not receive sufficient traffic to become financially profitable as foreign-flagged ships prefer Sri Lanka to India. As a result, Indian ports end up losing millions of dollars in port charges. Also, trading through foreign ports increases turnaround time as well as cost for Indian products, making them expensive in the international market in the long run.

To bring this trade back to India, shipping ministry's flagship project, Sagarmala, envisages the construction and upgradation of ports along both of the Indian seaboards. Presently, India is heavily dependent on its road and rail infrastructure for its transportation needs, even within India. More than 90 per cent of transport is carried over these means, despite maritime trade offering the benefit of relatively lower transportation, operation and logistics costs[19]. New Delhi now seeks to end its criminal underutilisation of the country's long coastline.

The plan is to move transportation from land to sea. The international Container Transhipment Terminal (ICTT) at Vallarpadam, functional since 2004, has been showing healthy signs of growth in the last couple of years[20]. At the same time, India is also moving ahead with developing other ports in the country, including Vizhinjam, close to Vallarpadam itself. Another six mega ports have already been cleared by the ministry of shipping for development in the future[21]. The ports being built or upgraded under the Sagarmala Programme will need traffic. Relaxing of Cabotage laws is therefore in line with the future plans of the government in the sector.

Security and Strategic Aspects

After the attack on Mumbai in 2008 by jihadi terrorists, India woke up to the perils of not properly manning its coastline. Since then, the government has been working to upgrade its security along the entire coast of the country[22]. Phase one of this plan has been completed with the establishment of a chain of 46 coastal surveillance radars and electro-optic sensors. Phase 2 proposes installation of another 38 additional radars and four mobile surveillance stations as well as two vessel traffic management systems (VTMS)[23]. Even with the best of technologies though, it could prove difficult to defend a long coastline from subversion.

As stated before, cabotage laws were initially put in place to secure the coastline from foreign ships. The argument supporting these laws continues to be relevant. Allowing foreign ships, with foreign crews on them, to move close to the Indian coast is a security challenge for the agencies manning the coastline. India remains a major target of international terrorists. To defend against such threats, more than a hundred coastal police posts have been set up since the 2008 attack. The patrolling capacity of the agencies has also been increased, both through increased manpower as well as through the acquisition of boats and planes / choppers. Nevertheless, subversion and infiltration from foreign ships close to the coast will now be a new threat.

Secondly, the concerns of the Indian shipping industry are also real. The lack of economic viability of Indian bottoms will kill the industry. Eventually, all of the Indian trade will have to be carried by foreign-flagged vessels. This could be detrimental in more ways than one. During sanctions on Iran, New Delhi has already seen international insurance companies refusing[24] to support the shipment of oil from the country. Without a national merchant shipping capability of its own, the country could end up in hot waters when its interests collide with those of other powerful adversaries in future. Considering that oil is the lifeline of the Indian economy, the country could be endangering its much-vaunted `strategic autonomy` by crippling its merchant shipping industry.

Also, the merchant fleet forms the auxiliary support system for the Navy during any conflict. India's ability to arm and supply troops and weapon systems will be severely hindered without a large number of functional merchant ships, which could be called upon in times of need. India aims to have a blue water navy, capable of power projection in the Indian Ocean and also perhaps in the South China Sea. Without a successful shipping industry, this could remain a pipe dream.

But the government is willing to accept such risks in view of the larger dangers associated with geopolitics. China, along with its pseudo-alliance with Pakistan, already encircles India on its land borders. With its increasing financial muscle, it could also pose a naval challenge in the Indian Ocean in future. This would complete the encirclement of India. China has been investing heavily in ports all over the Indian Ocean, which could help it in this endeavour.

Beijing has taken over the strategically located Hambantota port on a ninety-nine-year lease[25] after Sri Lanka expressed its inability to pay back loans received from Beijing by the previous government. India, till now, has been unable to convince its neighbours, all of whom are in need of foreign investment, to stay away from opaque Chinese funding. Now the financial problems faced by Sri Lanka[26] have become a warning for other countries willing to jump onto the Chinese rollercoaster. India could use its better geographic advantage to buttress this point.

By making its own ports more lucrative for foreign shippers, India could pull away substantial traffic from Sri Lankan ports. India is the largest economy in the Indian Ocean region, and most of the trade flows from the country. It could use this as leverage in a strategic sense, the same way Beijing is attempting to use its newfound economic muscle to lure countries into its orbit. Undercutting Chinese financial investments in Sri Lanka while promoting its own ports is a win-win situation for New Delhi.

Conclusion

Relaxation of cabotage laws has taken place in a number of countries, including the Philippines, China and Malaysia. The argument that freer trade will increase the volumes, thereby countering the damage to the merchant fleets of these countries, has many supporters. India does not want to be late on this new economic trend as it was on the liberalisation and globalisation processes. China opened up its economy a decade before India and earned itself a massive lead in economic prowess. Free trade is the order of the day. Protectionism is passé.

The Government of India seems to have made up its mind. Despite furious protests[27] from the shipping industry, the government has refused to review its decisions[28]. Both the geopolitical equation with China as well as the economic rationale seems to have convinced the government about the relaxation of cabotage laws. According to all indications, the government might be considering loosening the rules further to increase shipping via Indian ports. The success of the Sagarmala programme depends on this.

It is, therefore, unlikely that the demand of the shipping industry to reinstate the cabotage laws in toto will be successful. That is not to say that their concerns are unfounded. The relaxation of cabotage laws is bound to hurt the tax-paying merchant fleet of India. But perhaps, the shipping industry needs to recalibrate its approach to the whole issue.

Rather than seeking the rollback of the recent decisions, the industry will do well to demand a fair playing ground. Healthy economic competition is what globalisation and liberalisation are all about. If government-imposed restrictions and taxes are unfairly disadvantageous to the Indian shipping industry, removal of these is what will even the grounds again. Later, if the Indian merchant fleet proves itself to be efficient, it can demand financial support from the government and other institutions to increase the quantity and size of its ships.

As to how far such an approach will succeed is difficult to guess. Governments all over the world are resistant to decreasing their income by reducing or removing taxes, unless there is a strong rationale for it. Strategic and economic arguments may succeed in convincing the government to bite the bullet. Clearly, similar considerations have forced the government to relax the cabotage laws in the first place.

ENDNOTES

1. "India Replaces France As World'S 6Th Biggest Economy". *Https://Www.Livemint.Com/*, 2018. https://www.livemint.com/Politics/xHmKR9JBEzahuw38wtA5SL/India–replaces–France–as–worlds–6thbiggest–economy.html. (accessed August 20, 2018).
2. World Bank. *Global Economic Prospects, June 2018*. World bank, 2018. http://www.worldbank.org/en/publication/global–economic– (accessed August 26, 2018).
3. Times of India. "PM Seeks Double-Digit GDP Growth, Raising India's Share In World Trade", 2018. https://timesofindia.indiatimes.com/business/india–business/pm–seeks–

double–digit–gdp–growthraising–indias–share–in–world–trade/articleshow/64694389.cms. (accessed August 14, 2018).

4. Government of India, Ministry of Commerce and Industry. http://commerce-app.gov.in/eidb/default.asp.

5. Government of India, Ministry of Shipping. *Ministry Of Shipping 2017- Year Of Consolidation*, 2018. http://pib.nic.in/PressReleaseIframePage.aspx?PRID=1513281. (accessed August 14, 2018.

6. Ibid.

7. Manoj, P. "Indian Ship Owners Threaten To Flag Out If Cabotage Is Eased And Rofr Removed". *The Hindu*, March 30, 2018.

8. Section 407, Merchant Shipping Act, 1958.

9. Isidore, Chris, and Madison Park. "Puerto Rico Crisis: What The Jones Act Controversy Is All About". *Cnnmoney*, 2018. https://money.cnn.com/2017/09/27/news/economy/jones–act–puertorico/index.html. (accessed August 14, 2018).

10. "Philippines Repeal Cabotage Law". *The Maritime Executive*, 2018. https://www.maritimecom/article/philippines–repeal–cabotage–law#gs.EoHOwT0. (accessed August 22, 2018).

11. Chen, Celia. "China'S Easing Of Cabotage Rules Deals Serious Blow To Hong Kong Ports Industry, Say Experts". *South China Morning Post*, 2016. https://www.scmp.com/business/global–economy/article/2049041/chinas–easing–cabotage–rules–deals–serious–blow–hong–kong. (accessed August 21, 2018).

12. "Could Free Trade End Canada's Cabotage Laws?". *The Maritime Executive*, 2018. https://www.maritime–com/article/could–free–trade–end–canadas–cabotagelaws#gs.U8mKdSA. (accessed August 14, 2018).

13. Government of India, Ministry of Shipping. *Cabotage Restrictions Relaxed For Container Transshipment Ports*, 2018. http://pib.nic.in/newsite/PrintRelease.aspx?relid=138099. (accessed August 15, 2018).

14. Government of India, Ministry of Shipping. *Relaxation Under Section 407 Of The Merchant Shipping Act, 1958, For Coastal Movement Of Agriculture, Horticulture, Fisheries And Animal Husbandry Commodities.*, 2018. http://www.dgshipping.gov.in/writereaddata/ShippingNotices/201805230234105484282GeneralOrder No02of2018_sd.pdf. (accessed August 20, 2018).

15. Government of India, Ministry of Shipping. *Relaxation Under Section 407 Of The Merchant Shipping Act. L958, For Coastal Movement Of Fertilizers*, 2018. http://www.dgshipping.gov.in/writereaddata/ShippingNotices/201807030530443256146GeneralOrder3 of2018_Ministry.pdf. (accessed August 21, 2018).

16. Thomas, Tanya. “Shipping Firms Look To Register Abroad If Govt Scraps Benefits”, 2018. https://www.livemint.com/Companies/nGqd27UUSgpJV3mBxPuecP/Shipping–firms–look–to–registerabroad–if–govt–scraps–benefi.html. (accessed August 21, 2018).

17. Vivekanand International Foundation. *Session 2 – Conference On Assessing India'S Connectivity With Its Neighborhood*. Video, 2018. https://www.youtube.com/watch?v=Ar5tTkZ7EoI. (accessed August 21, 2018).

18. “Better Infrastructure Leads To Dip In India Foreign Transshipment”. *Com*, 2018. https://www.joc.com/port–news/asian–ports/better–infrastructure–pushes–india–foreign–transshipmentlower_20180131.html.(accessed August 21, 2018).

19. Bhaskar, RN. “How A Robust Water Transportation Can Help India Drastically Cut Its Freight Costs”. *Com*, 2016. https://www.firstpost.com/business/how–a–robust–water–transportation–can–helpindia–drastically–cut–its–freight–costs–3116440.html. (accessed August 21, 2018).

20. Martin, K. A. “Vallarpadam Traffic At Record High”. *The Hindu*, May 03, 2016.

21. Acharyya, Kangkan. “India To Get Six New Mega Ports Under Ministry Of Shipping's Sagarmala Project”. *Com*, 2016. https://www.firstpost.com/india/india–to–get–six–new–mega–ports–underministry–of–shippings–sagarmala–project–3082626.html. (accessed August 21, 2018).

22. Das, Shaswati. “Govt Moves To Strengthen Security Along Coastline”. *Com*, 2017. https://www.livemint.com/Politics/ZiD6LX38qRHt1TZIe5ZQZJ/Bid-to-strengthen-securityinfrastructure-across-coastal-sta.html. (accessed August 21, 2018).

23. Peri, Dinakar. “More Radars To Beef Up Coastal Surveillance”. *The Hindu*, February 21, 2017.

24. Dutta, Sanjay. “Iran Oil Puts Refineries On Slippery Ground With Insurance Companies.” *The Times Of India*, July 26, 2018.

25. The Hindu. “Sri Lanka Formally Hands Over Hambantota Port On 99-Year Lease To China”, December 9, 2017.

26. Shepard, Wade. “Sri Lanka's Debt Crisis Is So Bad The Government Doesn't Even Know How Much Money It Owes”. *Com*, 2016. https://www.forbes.com/sites/wadeshepard/2016/09/30/srilankas–debt–crisis–is–so–bad–the–government–doesnt–even–know–how–much–money–itowes/#5721614d4608. (accessed August 21, 2018).

27. Bhaskar, R. N. “Troubled Waters? Who Owns The Right Of Way On India'S Coasts?”. *Moneycontrol.Com*, 2018. https://www.moneycontrol.com/news/business/troubled–waters–who–ownsthe–right–of–way–on–indias–coasts–2739121.html. (accessed August 14, 2018).

28. Manoj, P. "Shipping Ministry Says It Won'T Review Rules On New Cabotage Law". *Https://Www.Livemint.Com/* , 2018. https://www.livemint.com/Politics/7AgP8KjiWK8XgZzLJGdkIO/Shipping–ministry–says–it–wontreview–rules–on–new–cabotage.html. (accessed August 18, 2018).

About the Author

Rajesh Soami was an Associate Fellow at National Maritime Foundation, New Delhi. The views expressed in the article are his own and do not reflect the position of the NMF. He can be reached at rajesh96_isg@jnu.ac.in

Note

This article was first published on the website of National Maritime Foundation on 12 March 2019

Assessing the Shipping Industry's Contribution to Greenhouse Gas Emissions

Dr Pushp Bajaj, Dr Sameer Guduru, Akshay Honmane, and Priyanka Choudhury

The impacts of climate change are now affecting the way of life for billions of people in almost every part of the planet. Future projections, derived from the latest climate models, suggest that the global average temperature could rise by as much as 5.6 °C above pre-industrial levels if the carbon dioxide (CO2) concentration in the atmosphere is doubled (this is commonly known as 'Equilibrium Climate Sensitivity').[1] The consequences of such a large temperature rise will be catastrophic for human civilisations. In 2015, over 190 countries signed the Paris Agreement[2] and agreed to halt global warming at a threshold well below 2 °C, aiming, in fact, for a threshold of 1.5 °C, in order to avoid the worst effects of climate change. In 2018, the United Nations (UN) Intergovernmental Panel on Climate Change (IPCC), in its Special Report on Global Warming of 1.5 °C, stated that in order to limit global warming below 1.5 °C, global human-caused carbon emissions must decline to around half of their 2010 levels by 2030, and reach net zero by 2050.[3] This poses a Herculean challenge, which requires nothing short of urgent and transformative action in all sectors of all economies around the world. This transition is currently being led by the energy sector, through the growth of renewable energy sources, such as solar and wind, owing to recent advances in their efficiency and accessibility. However, other, equally-critical sectors of the global economy still require innovative solutions to reduce their carbon emissions. According to 2019 data, 98 per cent of the global transportation sector still runs on fossil fuels.[4] In this context, this article will assess the contribution of the global shipping industry, which forms the backbone of international trade, to global greenhouse-gas emissions. The article highlights some of the key issues and challenges associated with the quantification and classification of shipping emissions. It concludes by discussing solutions and mitigation strategies to decarbonise the shipping sector while managing the increasing trade volumes in the future.

Quantifying Shipping Emissions

The shipping sector accounts for around 90 per cent of global trade and is the most carbon-efficient mode of transportation for goods.[5] However, in terms of absolute numbers, it is one of the largest carbon-emitting sectors, accounting for 2-3 per cent of global greenhouse gas (GHG) emissions. If it were a country, it would be the sixth largest GHG emitter in the world, placed between Japan (which is in the fifth position) and Germany (which is in the seventh position). It is estimated that global shipping currently emits 90000 tonnes / hr or 25 tonnes / sec of CO2. It is important to note that GHG emissions from ships are not restricted to the duration of their voyage but also occur while they are berthed alongside or are at anchor in or off seaports and harbours. Moreover, since ships have long lifetimes, spanning two to three decades, these emissions are committed-for for many years in the future.[6] In 2015, carbon emissions from global shipping, including domestic shipping, international shipping, and fishing, were estimated to be 932 million tonnes (see Figure 1).[7] International shipping alone contributed around 812 million tonnes which are 282 million tonnes higher when compared to emissions from international aviation.[8]

Official data maintained by the UN's International Maritime Organisation (IMO) since 2007 show a reduction in CO2 emissions between 2008 and 2009, followed by a plateau (see Figure 1). The sudden dip in emissions in 2009 could be attributed to the slowdown in trade caused by the global financial crisis (GFC) of 2008.[9] A similar kink can be seen in the activity of the global aviation sector during the same time period, immediately after the GFC. Similarly, with the reduction of maritime activity during the era of the Covid-19 global pandemic, carbon emissions are likely to plummet from previously estimated values in a 'business as usual' (BAU) scenario.[10] The plateau in emissions since 2009, despite consistent growth in seaborne

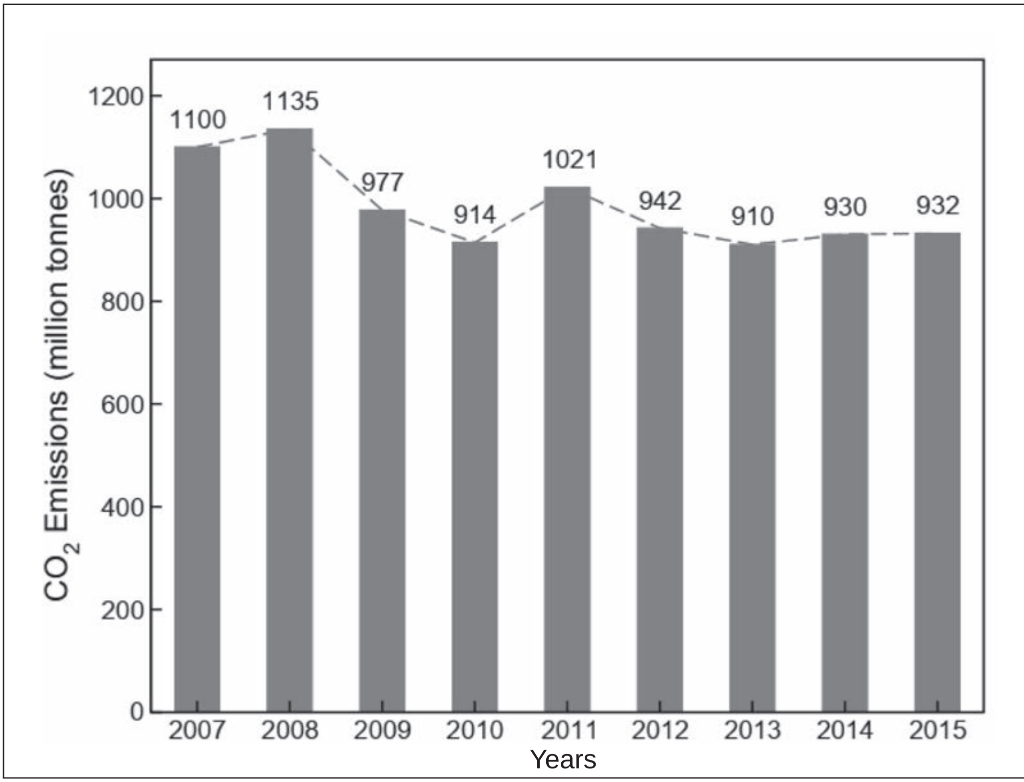


Figure 1: Carbon Dioxide (CO2) Einissions from Global Shipping (including International Shipping, Domestic Shipping, and Fishing) over the period 2007-2015.
Source: Created by Dr Pushp Bajaj with data from the "Third IMO GHG Study 2014" by IMO (http-//www.imo.org/en/OurWork/Environtnent/PallutionPrevention/AirPollution/Pages/Greenhouse-Gas-Studies-2014.aspx) for 2007-2013, and the "Greenhouse GAS Emissions from Global Shippirkg, 2013-2015" report by The international Council on Clean Transportation (1CCT) (https://theicct.org/Publications/GHG-emissions-global-shipping-2013-2015) for 2013-2015

trade, could be explained by the stricter energy efficiency standards imposed by the IMO and the ensuing technological advances in the design of the main engines of merchant ships, leading to a decrease in 'emissions intensity'.

According to the projections made by the IMO, in its "*Third IMO GHG Study 2014*"[11], by the year 2050, carbon emissions from global shipping are likely to increase by 50-250 per cent, under business-as-usual scenarios, relative to 2012 levels. The large range of predictions is representative of the uncertainties in future oil demand, the fuel-efficiency of ships, and the rate of growth of international trade. Clearly, the shipping industry is a major contributor to global GHG emissions and will continue to contribute more and more in the future. Hence, the shipping sector will play a vital role in achieving the global warming targets established in the 2015 Paris Agreement. It is important to remember that the Paris Agreement was signed by 'countries' and not 'private companies'. The question that then arises is: what role can / should individual nations play in addressing carbon emissions from shipping, which is inherently a complex, interconnected, international sector? In this regard, the complexities and challenges involved in attributing carbon emissions to individual countries, and the various technological and operational solutions that can be adopted to reduce these emissions, are deliberated-upon in the succeeding paragraphs.

Challenges in Classifying Shipping Emissions

The shipping industry is quite unique in the way its operations are conducted. For instance, it is common for a cargo ship to be owned by one country, fly the flag of a second country, carry cargo belonging to a third country, and be manned by a crew from a fourth country. Naturally, this complicates the monitoring and country-wise attribution of GHG emissions from a given ship during a given trip. Present mechanisms do not involve any country-specific data-collection of the emissions that could then be included in the total carbon emissions of individual countries. Understandably, the international nature of the shipping industry demands an international regulatory body. The IMO, in this case, is the principal authority under the aegis of the UN responsible for the daunting tasks of recording, classifying, and regulating global shipping emissions.

Currently, there are two data-collection mechanisms for shipping emissions. The first is the European Union (EU) MRV regulation, which stands for Monitoring, Reporting and Verification of CO2 emissions from maritime transport. Acknowledging the lack of an international agreement regarding international maritime carbon emissions at the time, the European Parliament passed a resolution on 25 April 2015 to set up the MRV system for CO_2 emissions from maritime transport.[12] The MRV entered into force in 2015, and requires all ships equal to or larger than 5000 gross tonnes (GT) that intend to enter EU ports to report their fuel-consumption data, which is then used to calculate CO_2 emissions.[13] According to the EU, 55 per cent of the ships entering into European waters were above 5000 GT and accounted for around 90 per cent of the maritime emissions in 2015.[14]

The second mechanism is the IMO's Data Collection System (DCS), which derives its legitimacy from the International Convention on Prevention of Pollution from Shipping (MARPOL) provisions that came into force on 01 March 2018. As is the case with the EU MRV, the IMO DCS applies to ships of 5000 GT and above.[15] However, unlike the EU MRV regulation, which only applies to ships entering EU ports, the IMO DCS applies to all ships entering ports worldwide ports, worldwide. Another distinction is that while the EU MRV data is publicly available, the IMO DCS data is kept confidential and is unavailable in the open domain. Nonetheless, it is mandatory for ships to submit their fuel-oil consumption-data to the IMO as per the amendments made in 2016 to Annex VI of MARPOL. Moreover, as per a new regulation, the data on shipping emissions collected by the IMO is made available to all countries that have ratified the updated MARPOL Annex VI, albeit, under conditions of anonymity, and strictly for the purposes of internal analysis.[16] Due to the diverse nature of the stakeholders and the presence of two different regulatory mechanisms, ship operators, have to maintain two separate records for the ship's fuel consumption, which is an additional administrative burden.

The present classifications of the shipping emissions are primarily based on ship-type and/or flag-state. In its 2017 report on "*Greenhouse Gas Emissions from Global Shipping, 2013-2015*",[17] the International Council on Clean Transportation provides a decomposition of CO_2 emissions by ship type (see Figure 2).

Container ships, bulk carriers, and oil tankers account for 23, 19, and 13 per cent of the emissions, respectively, amounting to a total of 55 per cent.[18] Clearly, how these three ship types are regulated in the future, will determine a large part of the total shipping CO_2 emissions. Annex VI of MARPOL explicitly sets limits on emissions of sulphur oxide, nitrogen oxide, and ozone-depleting substances from the

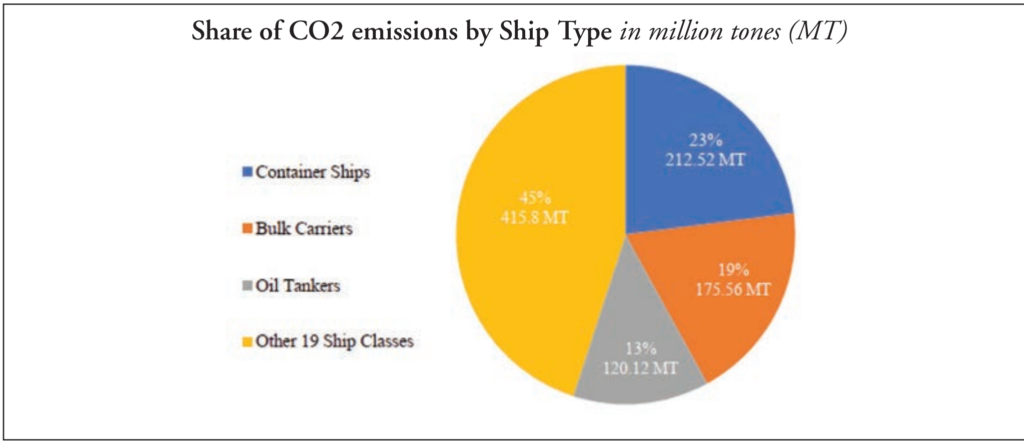


Figure 2: Share of CO2 emissions by Ship Type
Source: Image adopted from Figure ES-2 of "Greenhouse Gas Emissions from Global Shipping, 2013-2015" by The International Council on Clean Transportation (ICCT), https://theiccet.org/sites/default/files/publications/Global-shipping-GHG-emissions-2013-2015_ICCT-Report_17102017

ships. However, it does not explicitly mention CO2.[19] In order to address this issue, and a new Chapter 4 was later added to the MARPOL Annex VI, with two regulatory mechanisms, viz., the Energy Efficiency Design Index (EEDI) and the Ship Energy Efficiency Management Plan (SEEMP), to specifically target CO2 emissions. These mechanisms seek to reduce the 'carbon factor', i.e. the amount of CO2 generated per unit mass of fuel used.[20]

The second commonly used classification of shipping emissions is by flag-state, where just six nations, Panama, China, Liberia, Marshall Islands, Singapore, and Malta (all of which, except for Singapore, have 'open registries' wherein ships fly 'Flags of Convenience') constitute about 53 per cent of the total CO2 emissions (see Figure 3).

The current legal framework, under the 'Flag of Convenience' (FOC) provision, allows ships to register under the flag of any country 'of convenience'. Very often, shipping companies register their vessels in another country to avoid the stricter regulations and higher financial costs that prevail in the country where the ship has been built, or the country of origin of the owners of the shipping company

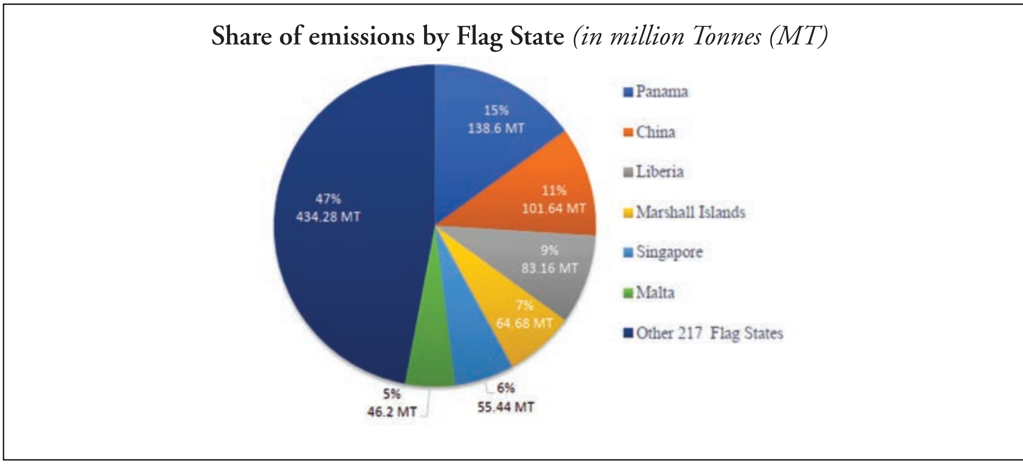


Figure 3: Share of CO2 Emissions by Flag State
Source: Image adopted from Figure ES-2 of "Greenhouse Gas Emissions from Global Shipping, 2013-2015" by International Council of Transportation (ICCT).
https://theicct.org/sites/default/files/publications/Globa-shipping-GHG-emissions-2013-2015_ICCT-Report 1712017.pdf

concerned.[21] Countries such as Panama, Marshall Islands and Liberia make attractive contenders for FOC as they maintain an open registry.[22] The flexible registration and ability to hire cheap foreign labour has resulted in Panama acquiring the largest shipping fleet in the world. It has around 7,100 vessels registered under its flag.[23] This may seem irrelevant to the present discussion until one realises that according to international maritime law, it is the flag state that bears responsibility for the ship's emissions and for compliance with energy efficiency regulations.

Article 94 of the United Nations Convention on the Law of the Sea (UNCLOS), while defining the duties of a flag-state, stipulates that, *"each State is required to conform to generally accepted international regulations, procedures and practices and to take any steps which may be necessary to secure their observance*".[24] It implicitly assigns flag-states with overall responsibility for enforcing and implementing international maritime regulations. As mentioned above, barring China, the majority of the vessels are registered in smaller, less-developed nations such as Panama, Liberia, and the Marshall Islands. These nations have neither the financial nor the technological capacity to implement any meaningful solutions to mitigate the rising carbon emissions from ships. Therefore, a flag-state-based classification hides the true identity of the shipowners and stakeholders, and puts the onus on less-equipped nations.

On the other hand, an analysis of annual maritime trade statistics paints a very different picture. Figure 4 depicts the distribution of global seaborne trade in 2018 in terms of goods loaded and unloaded.

Clearly, Asia accounts for the largest amount of trade by a big margin, followed by Europe. Further, looking at individual countries, Figure 5 shows the distribution of the world's top 20 exporters and importers of containerised cargo (which forms a majority of maritime trade) based on 2014 data.

China undoubtedly leads the world's exports by a huge margin, followed by the USA, South Korea and Japan. India ranks ninth on the list. In terms of imports,

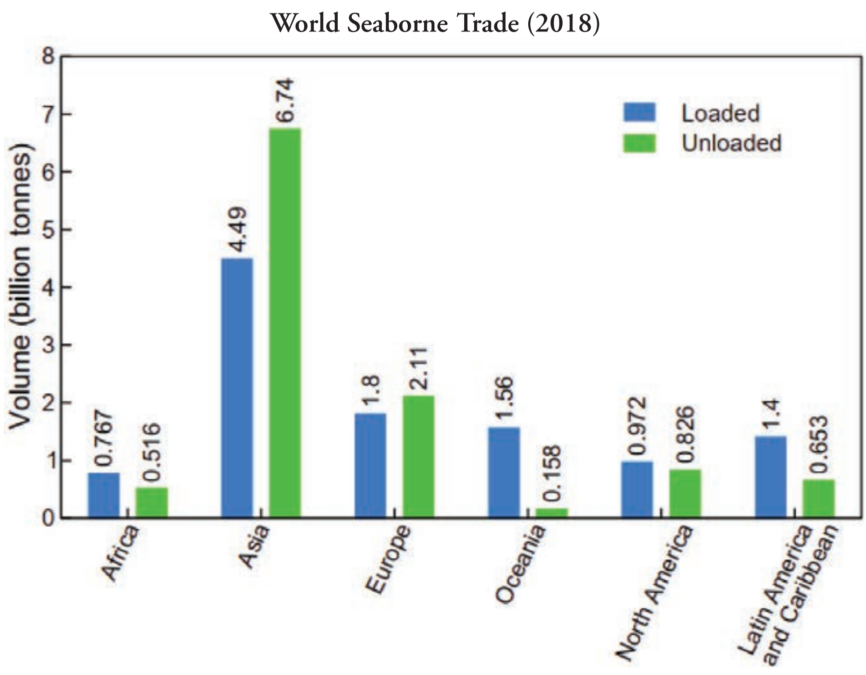


Figure 4: World Seaborne Trade based on 2018 data.
Source: Created by Dr. Pushp Bajaj with data from "World Seaborne Trade", by Development Statistics and Information Branch, UNCTAD
https://stats.unctad.org/handbook/MaritimeTransport/World SeaborneTrade.htm;

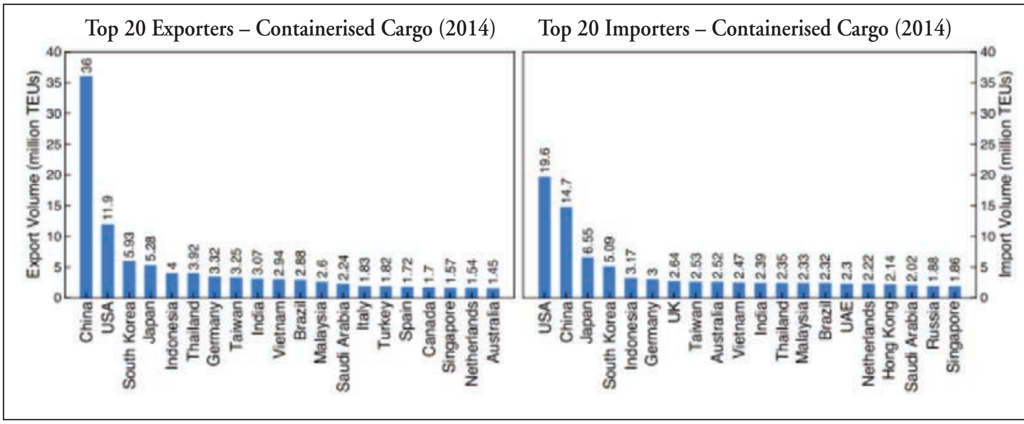


Figure 5: Tope 20 Exporters (left) and Importers (right) of Containerized Cargo based on 2014 data.
Source: Created by Dr. Pushp Bajaj with data from Trade Statistics, World Shipping Council. http:/www.worldshipping.org/about-the-industry/globa-trade/trade-statistics

the USA is the world's largest importer of containerised cargo, followed by China, Japan, and South Korea. Now, while China does rank second in the list of 'flag-state' countries, other major maritime trading powers, notably the USA, Japan, and South Korea, are not among the top six. Also noteworthy is that, Panama, Liberia, Marshall Islands, and Malta, which have large numbers of vessels registered under their flag, do not make it to the list of top exporters and importers.

This highlights the imbalance between vessels registered in a given nation and the amount of maritime trade undertaken by the same nation. Such an unequal distribution gives a distorted picture of the countries accountable for carbon emissions. Therefore, the classification of shipping emissions must go beyond flag-states to a more equitable system that is truly representative of each country's stakes in the global shipping industry. This is crucial for the planning and efficacy of international efforts to reduce GHG emissions from shipping. The Paris Climate Agreement requires each member nation to declare their Nationally Determined Contributions (NDCs) to reduce GHG emissions. Remarkably, shipping emissions are currently not addressed in any nation's NDCs.[25] Member States must take responsibility for their share of carbon emissions caused due by the intensity of their respective maritime trade. While the industry resolves these administrative and legal challenges, it must simultaneously devise strategies and adopt technologies to mitigate GHG emissions from shipping.

Current Mitigation Strategies and Path Ahead

In April of 2018, the International Maritime Organization (IMO), through its Marine Environment Protection Committee (MEPC), unveiled the "*Initial IMO Strategy on Reduction of GHG Emissions from Ships*".[26] It is encouraging to note that the governments of all 100-plus nations that are members of the IMO agreed to an ambitious target of reducing annual shipping emissions by at least 50 per cent by 2050 relative to 2008 levels. The MEPC, on its part, has highlighted measures such as stricter energy efficiency standards, and increased investment in clean energy technologies and alternative fuels, through cooperation between public and private stakeholders. Considering the sustained growth in international seaborne trade and the lack of low-carbon fuel alternatives at the moment, the 50 per cent reduction target does, indeed, seem ambitious. However, it is important to note that the latest climate-change projections of the UN Intergovernmental Panel on Climate Change (IPCC) show that in order to stay below 1.5 degrees Celsius of global warming, global carbon emissions must go down to net-zero by 2050. Therefore, barring a dramatic increase in carbon sink capacity to offset the emissions, the IMO's proposed 50 per cent reduction target by 2050 might well be ambitious, but it is, in and of itself, still not enough to meet the UN IPCC climate goals. Arguably, more ambitious measures could be included in the next revision of the strategy, which is due in 2023.

Improving Energy Efficiency

Even prior to the GHG reduction strategy of 2018, the IMO had taken measures to address GHG emissions from ships. In 2011, two important energy efficiency measures were introduced: the Energy Efficiency Design Index (EEDI), and, the Ship Energy Efficiency Management Plan (SEEMP).[27] Both these were further emphasised and increased in scope in the 2018 GHG reduction strategy. The EEDI mandates every new ship put into operation after 01 January 2013 to follow a strict energy efficiency level (in terms of grams of carbon dioxide / capacity-mile), depending on the ship type and size, as defined by the MEPC. Additionally, the reference efficiency standard was set to be tightened incrementally every five years. The SEEMP, on the other hand, provides operational guidelines to improve the efficiency of both, new and existing ships. As per this regulation, each ship must devise, disseminate and execute its own SEEMP, based on the specific ship-type. This individual-ship plan needs to include, *inter alia*, guidelines for speed optimisation, trim and draught optimisation, just-in-time arrivals at ports, etc. While improved energy-efficiency standards and regulations are necessary and will help in reducing shipping emissions to some extent, the fact remains that without economically viable and readily accessible 'clean' alternatives to fossil fuels, we cannot hope to achieve the UN IMO target.

In this regard, several options are being explored by engine manufacturers, scientists, and experts. While the road-transportation sector has quite successfully incorporated electric vehicles, including cars and even trucks, a similar transition to electric-vessels in shipping remains an outstanding challenge.

Onshore Power Supply

Carbon emission from ships is not restricted to the period during which the ship is actually sailing (on passage). Even while ships are berthed alongside on jetties, quays and wharves in ports, they contribute to the overall pollution in coastal cities. Auxiliary engines continue to run so as to drive motors to power cargo loading and unloading as well as to sustain day-to-day activities on board, as also to cater for mandatory safety-lighting, and a large variety of pumps. The 61st meeting of the MEPC, which was held in 2010, focussed upon ways and means of reducing greenhouse gas emissions from ships in ports and harbours.[28] The delegates identified "On-shore Power Supply" (OPS) or "Cold Ironing" as a viable measure to improve air-quality in ports and port cities by reducing carbon dioxide emissions by ships alongside. This involves replacing onboard generated power from diesel auxiliary engines with electricity supplied by the port.[29]

Ancillary Battery Storage

Currently, batteries and hybrid technologies are being used only for small ships and over short voyages. We are yet to develop large enough batteries at low enough costs that can be used in large cargo ships on longer passages. In addition to these limitations in storage-capacity there are other technical, environmental, and safety challenges involved in creating batteries for large ships. Manufacturing batteries of the size required for ships would require large amounts of Rare Earths (within the Periodic Table, these comprise the fifteen lanthanides, as well as scandium and yttrium), and critical raw materials such as nickel and cobalt that are already in very short supply. Conventional lithium-ion batteries pose a safety threat as well, in case of malfunction or degradation, the battery could heat up rapidly (known as 'thermal runaway') and ultimately result in an explosion. Such batteries also have a large environmental impact due to the notoriously difficult processes involved in their recycling. Although the energy-storage industry is evolving rapidly, new, more efficient, and safer battery technologies will be critical for the transition of the shipping industry away from fossil fuels.[30]

Alternative Fuels

Insofar as alternative fuels are concerned, biofuels are already being used as a transitionary low- carbon-alternative to oil. In the long term, zero-carbon fuels will be required to completely decarbonise the shipping sector. In this context, liquid hydrogen (or compressed gas) offers a promising solution due to its high calorific value and zero carbon-content. There are, however, significant challenges associated with commercially-viable production and storage, since hydrogen exists as a liquid only at very low temperatures and very high pressures, and is highly flammable. This issue could potentially be solved by using a precursor (such as ammonia) instead, which may be relatively easier and safer to store and could then be converted to hydrogen at the time of operation. As is the case with battery technologies, vigorous research is being carried out around the world to determine viable solutions to these challenges.

Of course, merely developing a low-carbon fuel will not solve the problem entirely. It will only be the first, albeit critical, step towards large-scale decarbonising of the maritime trade network. The accessibility and scalability of the fuel will determine its practical efficacy. Appropriate infrastructure to store and use the fuel on new and existing ships, and the infrastructure to store and supply that fuel at international and smaller, national ports will have to be established accordingly. Similarly, if the battery storage problem is solved for larger ships and the industry decides to add a certain number of electric ships to existing fleets, then appropriate 'charging stations' will have to be installed at ports worldwide. These 'charging stations' must themselves be powered by renewable sources of energy in order to make the ships truly 'carbon-free'.

Implementing the measures mentioned above will require large-scale and long-term cooperation — not only between nations but also between the public and private sectors. Developed nations that have the financial and infrastructural wherewithal to innovate and explore zero-carbon technologies must take the lead. In this context, capital investments from the private sector will play a critical role. In an encouraging effort last year, a group of international banks committed to integrate climate change considerations into loan agreements to shipping companies with the idea of incentivising projects that aim to reduce carbon emissions.[31] It must be also ensured, through appropriate mechanisms developed by the IMO, that such technologies are then made accessible to developing and least developed countries.

ENDNOTES

1. Mark D Zelinka et al, "Causes of Higher Climate Sensitivity in CMIP6 Models", *Geophysical Research Letters* 47, No 1, (2020). https://agupubs.onlinelibrary.wiley.com/doi/full/10.1029/2019GL085782.

2. "The Paris Agreement", *United Nations Framework Convention for Climate Change (UNFCCC)*. https://unfccc.int/process-and-meetings/the-paris-agreement/the-paris-agreement.

3. Myles R. Allen et al, "Summary for Policymakers", in Global Warming of 1.5°C. An IPCC Special Report on the impacts of global warming of 1.5°C above pre-industrial levels and related global greenhouse gas emission pathways, in the context of strengthening the global

response to the threat of climate change, sustainable development, and efforts to eradicate poverty, eds. V. Masson-Delmotte et al., (Geneva: World Meteorological Organisation, 2018). https://www.ipcc.ch/sr15/chapter/spm/.

4. "International Energy Outlook 2019," *US Energy Information Administration (EIA)*, (assessed 10 August 2020). https://www.eia.gov/outlooks/aeo/data/browser/#/?id=49-IEO2019&cases=Reference.

5. "IMO Profile - Overview", *International Maritime Organization (IMO)*. https://business.un.org/en/entities/13.

6. Simon Bullock et al, "Shipping and the Paris climate agreement: a focus on committed emission", *BMC Energy* 2, No (2020). https://bmcenergy.biomedcentral.com/articles/10.1186/s42500-020-00015-2.

7. Naya Olmer et al, *Greenhouse Gas Emissions from Global Shipping, 2013 - 2015*, International Council on Clean Transportation, (Washington DC: 2017). https://theicct.org/sites/default/files/publications/Global-shipping-GHG-emissions-2013-2015_ICCT-Report_17102017_vF.pdf.

8. "International Shipping," *Climate Action Tracker*, last modified June 25, 2020. https://climateactiontracker.org/sectors/shipping/.

9. Kalgora, Bomboma and Christian Tshibuyi, "The Financial and Economic Crisis, Its Impacts on the Shipping Industry, Lesson to Learn: The Container Ships Market Analysis," *Open Journal of Social Sciences* 04 (January 2016): 38 – 44. https://www.scirp.org/journal/PaperInformation.aspx?PaperID=62786.

10. Ibid.

11. Third IMO GHG Study 2014 - Executive Summary and Final Report, (London: International Maritime Organisation (IMO), (2015). http://www.imo.org/en/OurWork/Environment/PollutionPrevention/AirPollution/Documents/Third%20Greenhou se%20Gas%20Study/GHG3%20Executive%20Summary%20and%20Report.pdf.

12. European Union, "Regulation (EU) 2015/757 of the European Parliament and Council", Journal of the European Union, (19 May 2015): 55-56. https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32015R0757&from=EN.

13. "European Union MRV Regulation", International Chamber of Shipping (ICS). https://www.ics-shipping.org/docs/default-source/resources/ics-guidance-on-eu-mrv.pdf?sfvrsn=10.

14. Ibid.

15. “Data Collection System for Fuel Oil Consumption of Ships”, International Maritime Organisation (IMO). http://www.imo.org/en/OurWork/Environment/PollutionPrevention/AirPollution/Pages/Data-Collection-System.aspx.

16. Ibid.

17. Third IMO GHG Study 2014 - Executive Summary and Final Report, IMO.

18. Naya Olmer et al, Greenhouse Gas Emissions from Global Shipping, 2013 – 2015.

19. “International Convention for the Prevention of Pollution from Ships (MARPOL)”, *International Maritime Organisation (IMO).* http://www.imo.org/en/About/Conventions/ListOfConventions/Pages/International-Convention-for-the-Prevention-of-Pollution-from-Ships-(MARPOL).aspx.

20. *IMO Train the Trainer (TTT) Course on Energy Efficient Ship Operation,* (London: International Maritime Organisation, January 2016), 19. http://www.imo.org/en/OurWork/Environment/PollutionPrevention/AirPollution/Documents/Air%20pollution/M 2%20EE%20regulations%20and%20guidelines%20final.pdf.

21. *Shipping, World Trade and the Reduction of CO2 Emissions*, (London: International Chamber of Shipping, 2014). https://www.ics-shipping.org/docs/default-source/resources/policy-tools/shipping-world-trade-and-the-reduction-of-co2-emissionsEE36BCFD2279.pdf?sfvrsn=20.

22. “Why so many shipowners find Panama’s flag convenient”, *BBC*, 05 August 2014. https://www.bbc.com/news/world-latin-america-28558480.

23. Marianna Parraga and Elida Moreno, “Panama to withdraw flags from more vessels that violate sanctions”, *Reuters*, 13 July, 2019. https://in.reuters.com/article/mideast-iran-tanker-panama-exclusive/exclusive-panama-to-withdraw-flags-from-more-vessels-that-violate-sanctions-idINKCN1U72E9.

24. “United Nations Convention on the Law of the Sea”, *United Nations*, 55-56. https://www.un.org/depts/los/convention_agreements/texts/unclos/unclos_e.pdf.

25. Andrew Murphy, “Planes and ships can’t escape Paris climate commitments”, *Transport and Environment*, May 4 2018. https://www.transportenvironment.org/newsroom/blog/planes-and-ships-cant-escape-paris-climate-commitments.

26. “Note by the International Maritime Organisation to the UNFCCC Talanoa Dialogue”, *International Maritime Organisation(IMO).* https://unfccc.int/sites/default/files/resource/250_IMO%20submission_Talanoa%20Dialogue_April%202018. pdf.

27. “Energy Efficiency Measures”, *International Maritime Organisation (IMO).* http://www.

imo.org/en/OurWork/Environment/PollutionPrevention/AirPollution/Pages/Technical-and-Operational-Measures.aspx.

28. "Marine Environment Protection Committee (MEPC) 61st session: 27 September to 1 October 2010", *International Maritime Organisation (IMO)*. http://www.imo.org/en/MediaCentre/MeetingSummaries/MEPC/Pages/MEPC-61st-Session.aspx.

29. MEPC 1/Circ 794, "On-Shore Power Supply", *International Maritime Organisation (IMO)*, 09 October 2012. http://www.imo.org/en/OurWork/Environment/PollutionPrevention/AirPollution/Documents/Circ.794.pdf.

30. Daniel Oberhaus, "Want Electric Ships? Build a Better Battery", *Wired*, 19 March 2020. https://www.wired.com/story/want-electric-ships-build-a-better-battery/.

31. Michael Parker and Johannah Christensen, "Banks Launch Green Charter to Help Shipping Reduce its Carbon Footprint", *World Economic Forum*, 18 June 2019. https://www.weforum.org/agenda/2019/06/how-banks-are-leading-shippings-green-transition.

About the Authors

Dr Pushp Bajaj is a Research Fellow at the NMF. His current research focusses upon the impact of climate-change upon India's holistic maritime security. He may be contacted at climatechange2.nmf@gmail.com

Dr Sameer Guduru was an Associate Fellow at the National Maritime Foundation

Mr Akshay Honmane and Ms Priyanka Choudhury have done their internships (Summer 2020 [Extended]) at the National Maritime Foundation. They can be contacted at akshayhonmane.ah21@gmail.com and priyanka.choudhury13@gmail.com, respectively

Note

This article was first published on the website of National Maritime Foundation on 24 August 2020

Introducing Climate Resilience as the Fifth Pillar of the SAGARMALA Programme

Dr Pushp Bajaj, Dr Saurabh Thakur, and Dr Chime Youdon

This article seeks to highlight the glaring gap between the planned activities within SAGARMALA and the long-term climate-change-induced threats facing coastal regions in India. It first discusses some of the more prominent impacts of climate change on India's coastal infrastructure and highlights the likelihood of their continuing to amplify and accelerate in the near-term future. It thereafter advocates the introduction of a new 'fifth' pillar upon which SAGARMALA must rest — one that is centred upon building 'climate resilience'. The paper provides an outline of contemporary global and national initiatives being taken by other countries to better adapt their ports to the impacts of climate change. Finally, it seeks to contextualise the criticality of climate-resilient and sustainable port infrastructure to India's ongoing endeavour to transition from a 'Brown Economy' to a 'Blue Economy'.

Snapshot Overview of SAGARMALA

India's maritime sector, in general, and maritime trade, in particular, play critical roles in the economic development of the country. Around 95 per cent of India's annual merchandise trade (by volume) is carried through the sea. Of course, this fact is not lost on the central government, which has, especially in recent years, put in place a whole slew of measures to enhance the capacity of the maritime sector. Most notably, in 2015, the Government of India (GoI) launched the SAGARMALA programme, a nationwide multi-decadal 'port-led development' plan for India. SAGARMALA focuses upon the country's 7,516 km long coastline, 14,500 km of potentially navigable waterways, and the broader maritime sector. SAGARMALA aims to double the capacity of Indian ports by 2025, ensure "last-mile connectivity" where ports will be connected to the nearest highway and railway line, and, establish Coastal Economic Zones (CEZs). Indeed, the stated vision of SAGARMALA is to "reduce logistics cost[s] for both domestic and EXIM cargo with minimal infrastructure investment".[1] The four principal pillars of this megaproject are: (1) port modernisation, (2) port connectivity, (3) port-led industrialisation, and (4) coastal-community development. Although the first three pillars and the thrust-lines along which they are developed are sharply focussed upon ports, and the follow-through mechanisms accordingly seek to improve efficiency and productivity, and although SAGARMALA is coherent with India's endeavour to transition to a 'Blue Economy',[2] there is little or no evidence of the existence of a critical 'fifth pillar', namely, 'resilience', especially resilience in the face of 'climate change'.

Thus, while the government is moving ahead at full speed to execute its plans for coastal development, manifestations of climate change, such as sea-level rise; tropical revolving storms (cyclones) that are more frequent, and more ferocious, but whose path is less predictable; and associated storm-surges, are all threatening India's vast and densely populated coastline.

Climate Change Impacts on India's Coastal Infrastructure

Sea Level Rise and Extreme Weather Events in the Indian Ocean: Driven by climate change, sea-level rise in the North Indian Ocean was recorded to be between 1.06 to 1.75 mm per year during the 1874-2004 period.[3] The average rate of rise has since accelerated to 3.3 mm per year since 1993, which is comparable to the current rate of global mean sea-level (GMSL) rise. However, there could be significant differences at the local-level, and it is these local-level variations that pose a very significant threat to the country's coastal infrastructure. Some of the major ports in India are experiencing a higher rate of sea-level rise than the average rate. For instance, between the years 1948 and 2013, the sea level at Diamond Harbour in Kolkata has risen at a rate of around 4.6 mm a year.

Similarly, between the years 1970 and 2013, Haldia port has experienced a sea-level rise of 2.93 mm a year.[4] The Bay of Bengal as a whole is experiencing a much faster sea-level rise than the broader North Indian Ocean and the Global Mean Sea Level (GMSL). Superimposed upon this acceleration in sea-level rise, are extreme weather events such as abnormally high tides, floods, storm surges, etc., associated with tropical revolving storms that are becoming more frequent, more intense, and, at the same time, less predictable. Combined together, accelerations in local sea level, powerful cyclonic storms, abnormally large tidal ranges, and, storm surges, could result in a series of devastating impacts in the near-term future.

The Vulnerability of India's Port Infrastructure

In the wake of increasingly frequent and intense extreme weather events, any substantial damage caused to critical coastal infrastructure, such as ports, could easily lead to a complete system-breakdown in several Indian coastal cities that are at high risk from climate-change-driven disasters. The World Bank has estimated that the adverse impacts of extreme weather events, under a worst-case scenario, could cost India about 2.8 per cent of its GDP by 2050.[5]

The year 2019 witnessed as many as eight cyclonic storms in a single year — the highest since 1976 — of which six were recorded as 'very severe' cyclones, each of which affected millions of coastal residents.[6] Last year (2020), the catastrophic 'Extremely Severe Cyclonic Storm' (Cyclone Amphan) ravaged the state of West Bengal in the month of May. It caused widespread damage to the region amidst the coronavirus pandemic, the economic losses in the region were estimated at around US$ 13.2 billion.[7] The event also caused severe disruptions in the port supply-chains and logistics of the Kolkata Port Trust (KoPT), which had to suspend cargo operations and railway operations, while the Central Permit Office had to be kept shut for more than 24 hours so as to prevent further damage to the port's infrastructure. Similarly, the port authorities at Visakhapatnam, Gangavaram, Sandheads, Dhamra, Paradip Port Trust and Gopalpur Port had to take precautionary measures, wherein all cargo-handling operations and all of the inbound and outbound movements of vessels were suspended.[8] Despite adopting all precautionary measures, port-infrastructure at Haldia, Budge Budge and Kukrahati suffered significant damage.[9] Several port services remained disrupted even after the cyclone. For instance, damage to the roads caused significant hindrances to the movement of trucks to the port, vital internet services remained unavailable, and consequent supply-chain disruptions posed large delays in the provision of essential services.

Ports are critical nodes in the supply chain of public services as well as private sector goods for urban agglomerations in their vicinity. There are a number of cases of severe climate-induced damage and disruption to ports around the world, which India — and the executive structures of SAGARMALA — need to learn lessons from. Several of these cases are from countries that are generally considered to be 'advanced' in port operations and yet illustrate a striking lack of resilience. For instance, in 2005, Hurricane Katrina made landfall at Hallandale Beach, Florida, USA, causing major devastation at the port of New Orleans, which was a critical node for the export of crops like wheat, corn, and soybeans.[10] Similarly, the port of Hong Kong suffered an estimated loss of US$ 627 million per day in 2018 when Typhoon Mangkhut shut down its nine terminals for two days.[11] Given the concentration of population, assets, and services associated with ports, the consequences are non-linear, and quantifying the loss in socio-economic terms remains challenging. Moreover, the risk of cascading disasters is also high, because the ports and shipping sector is integrated-with and interdependent-upon other sectors. Where India is concerned, it is sobering to reflect upon the fact that even well before the acceleration in the various manifestations of climate change that have already been mentioned, extreme weather events — despite their far lower frequency and intensity at the time — nevertheless had large-scale adverse effects, particularly upon states located on India's eastern coast. As a case in point, a 2011 study found that between the years 1823 and 1900, tropical revolving cyclones and storm surges were a key reason for the decline of ports in Odisha.[12] Unless resilience is an intrinsic and central element of contemporary port development — especially that envisaged via SAGARMALA, — how much greater might be the decline over the foreseeable future, wherein the frequency and ferocity of these types of extreme-weather events are going to be so much higher?

Future Projection

By 2100, steric sea level *("Steric sea level is the variation of the ocean volume due to density changes (expansion and contraction of water masses), through ocean salinity* *(halosteric) and ocean temperature (thermostatic) variations")* [13] in the North Indian Ocean is estimated to "rise by about 300 mm relative to the average over 1986-2005 under the RCP 4.5 [mid-range] scenario, with the corresponding projection for the GMSL projected at 180 mm".[14] It would certainly be worse under the 'business-as-usual', high emissions scenario. There are also some inherent uncertainties associated with the melting of the Greenland and Antarctic ice sheets and glaciers, which are notoriously difficult to predict. This notwithstanding, actual observations made over recent decades suggest that climate change is moving much faster and farther than had been predicted in model-based projections. Therefore, it would be wise to prepare for the worst-case sea-level-rise scenarios. Even a marginal increase in the sea level in the Indian Ocean would be enough to threaten millions of livelihoods and billions of dollars' worth of infrastructure. According to one estimate, the population in Low-Elevation Coastal Zones (LECZ) in India is projected to grow to over 120 million by 2030 and 216 million by 2050.[15]

Incorporating Resilience into SAGARMALA.

The government of India released its big picture document on SAGARMALA in 2016, with a key emphasis on capacity building, as highlighted in its subtitle, "Ports to Prosperity".[16] The document envisioned the concept of *"port-led development"* as a 'game changer' that would reduce the costs of logistics through the creation of Coastal Economic Zones (CEZs), create efficient multimodal connectivity, and, further, provide employment opportunities to communities in adjoining areas.

The SAGARMALA initiative does envisage a roadmap for the growing needs of the nation, but it does not address the question of uncertainty that may arise due to scenarios such as rising sea-levels, or the non-feasibility of fossil-fuel-based economic models in the coming decades. In the maritime domain, the value of resilience can be understood in various ways, but the basic idea is centred upon tackling this uncertainty and ensuring the critical functionality of ports under both normal and extraordinary circumstances. Long-term sustainability of ports is not only critical from an infrastructure resilience point of view, but also from a business accountability perspective. As these environmental threats grow in both scale and frequency, the emphasis on accounting for their impact on business and transparency will grow.

Therefore, sustainability-reporting of ports will prove to be critical for stakeholder-engagement.[17] Climate Resilience, therefore, is not merely an adaptive strategy against the vagaries of climate but offers a unique perspective on investment in the future of ports. Thus, the importance of the proposed 'fifth' pillar of SAGARMALA lies in its focus on the bigger picture of resilience that avoids the trap of short-term policy-making.

On an increasingly global basis, the maritime sector is recognising the importance of the long-term sustainability of ports and is responding to the threats of climate change. A study conducted on the port of Rotterdam, Netherlands, found that the impact of flooding was to cause a rise of nearly 86 per cent in trading-costs — *excluding* the damage to the infrastructure itself. The Rotterdam City authorities thereafter invested time, effort and money in developing an integrated approach, which was evident from its adoption of Rotterdam Climate Proof (2008) and the Rotterdam Climate Change Adaptation Strategy (2013),[18] both of which focus on enhancing resilience by strengthening port infrastructure against storm surges and sea level rise. Likewise, the Port of San Diego (California) designed the 'Climate Mitigation and Adaptation Plan', wherein multiple stakeholders, including nearby communities, were involved in sharing responsibilities to protect critical utilities during emergencies.[19]

In the aftermath of COVID-19, the European Sea Ports Organization (ESPO) has released its climate-change adaptation strategy for European ports, which recognises ports as critical infrastructure. It pledges to invest in climate-proofing and the mainstreaming of climate-change adaptation in EU legislation.[20] Many global organisations have also taken cognisance of the climate-resilience aspect of maritime trade and transport. The World Association for Waterborne Transport Infrastructure (PIANC) has set up a special task group that focuses upon the resilience of transport systems, both in maritime and inland waterborne spheres.[21] Likewise, the International Finance Corporation (IFC) initiated a number of case studies and projects, as part of its own 'Climate Risk Series', to understand climate risks and their potential impact on seaborne trade.[22.] The United Nations Conference on Trade and Development (UNCTAD), too, has focussed upon climate-change impacts and challenges in port-adaptation as part of its ongoing focus on sustainable transport.

It is important for the SAGARMALA initiative to take a similarly long-term view of port-led development — one which prioritises a risk-based approach to present and future climate-change impacts. The mainstreaming of climate resilience in port-led development models has both strategic and economic benefits. However, port-planning in India currently favours short-term economic benefits instead of resilience and long-term sustainability, which probably remain low priorities because of the high costs for first movers and lack of data-driven analysis of climate risks. Therefore, the government led initiatives such as SAGARMALA, which can absorb the first mover risks, are critical for paving the path for private investors.

Way Forward

The big-picture objectives of the SAGARMALA programme for port-led economic development, are highly commendable and very promising. However, the success of this ambitious programme, the economies of India's coastal states, and, in fact, the fate of India's Blue Economy, rely heavily upon the long-term stability and security of the port-infrastructure over multiple decades. In view of this, there is an urgent need for government authorities at the centre-, state-, and district-levels to pay focused attention to ensuring the resilience of port-infrastructure against the growing impacts of disasters such as floods, cyclones, and storm surges, compounded by sea-level rise and hotter ocean temperatures, all of which are being exacerbated by man-made (anthropogenic) climate change.

Climate resilience is critical for safeguarding the long-term investments that need to be made in ports. As the threat of climate change intensifies, it will become a key decision-making criterion in the minds of potential investors. The wide range of uncertainties associated with the impacts of climate change, both in terms of the magnitude and the timeframe, make it simultaneously difficult and essential to plan for all possible scenarios. Moreover, the local impacts could vary widely as well, depending on a number of natural factors such as geography, topography, and atmospheric and ocean conditions, as also human-controlled factors such as population density, construction practices, urban planning and management, etc. The solutions, therefore, would have to take into account the uncertainties and the local-level challenges or constraints.

In this context, the National Maritime Foundation has recently initiated a long-term research endeavour to study the impacts of climate change on coastal infrastructure security vis-a-vis the threats to port infrastructure, including the support infrastructure and critical supply chains. The study will develop a resilience-centred policy framework comprising guidelines and tools to incorporate climate resilience during the planning stages of coastal development projects. One of the main focus areas of the study will be to create a generic framework for an efficient top-down approach, where the national-level policy would guide, support, and encourage sustainability and resilience in the development initiatives at the state- and district-level.

Additionally, in order to highlight the local-level challenges, a number of case studies will be conducted on some of India's key coastal urban agglomerations — the cities of Visakhapatnam, Kolkata, Mumbai, and Chennai, to name just a few — which are expected to see the greatest increase in infrastructure development activity and are the most vulnerable to extreme weather events. The framework so created will be applied and tested via these case studies in order to create a comprehensive set of policy recommendations relevant to a number of ministries and local authorities of the Government of India.

ENDNOTES

1. Ministry of Shipping, Government of India, SAGARMALA National perspective Plan, April 2016, http://sagarmala.gov.in/sites/default/files/5457695312te1.pdf.
2. The Blue Economy is defined by the World Bank as *"sustainable use of ocean resources for economic growth, improved livelihood and jobs and ocean ecosystem health."*, https://www.worldbank.org/en/news/infographic/2017/06/06/blue-economy.
3. R Krishnan, J Sanjay, G Chellappan et al, *Assessment of Climate Change over the Indian Region*, A Report of the Ministry of Earth Sciences, Government of India, Pune: Springer, 2020.
4. G Seetharaman, "Coastal Concerns: Rising Sea Levels Will Inundate Coastal Areas Sooner than Projected", Economic Times, 10 Nov 2019, https://economictimes.indiatimes.com/news/politics-and-nation/coastal-concerns-rising-sea-levels-will-inundate-coastal-areas-sooner-than-projected-/articleshow/71985765.cms.

5. Business Line Staff, "Climate Change can cost India 2.8% of GDP by 2050", *Business Line*, 28 June, 2018, https://www.thehindubusinessline.com/economy/climate-change-can-cost-india-28-of-gdp-by-2050-world-bank/article24282307.ece.
6. Kunal Kambli, "Throwback to a Stormy Year: A Look at the 8 North Indian Ocean Cyclones of 2019", *India News,* 03 Jan 2020, https://weather.com/en-IN/india/news/news/2020-01-03-stormy-year-8-north-indian-ocean-cyclones-2019.
7. Vedika Sud and Prema Rajaram, "Cyclone Amphan Caused an Estimated $13.2 Billion in Damage in India's West Bengal: Government Source", CNN, 22 May 2020, https://edition.cnn.com/2020/05/22/weather/cyclone-amphan-damage-intl-hnk/index.html.
8. "Kolkata Port Takes Precautions against Severe Cyclonic Storm Amphan", Maritime Gateway, http://www.maritimegateway.com/kolkata-port-takes-precautions-severe-cyclonic-storm-amphan/.
9. Jayanta Gupta, "Cyclone Amphan: Situation Returning to Normal at Kolkata and Ports", Times of India, 22 May 2020, https://timesofindia.indiatimes.com/city/kolkata/cyclone-amphan-situation-returning-to-normal-at-kolkata-and-haldia-ports/articleshow/75899875.cms.
10. Austin H Becker, Michele Acciaro, Regina Asariotis, Edgard Cabrera, Laurent Cretegny, Philippe Crist, Miguel Esteban, et al. "A Note on Climate Change Adaptation for Seaports: a Challenge for Global Ports, a Challenge for Global Society", Climatic Change 120, No 4, 2013, 683-695.
11. Yoon Kim and Lindsay Ross, "Ports: An Industry Guide to Enhancing Resilience", Resilience Primer, Four Twenty Seven Inc. and Resilience Shift, UK, March, 2019, ttps://www.resilienceshift.org/wp-content/uploads/2019/10/RP-Ports_Final_Pages.pdf.
12. Tripati Sila, and AS Unnikrishnan, "Role of Cyclones and Other Factors in the Decline of the Ports of Northern Orissa", Current Science, 2011, 305-312.
13. Andrea Storto et al, Paper for the 5th International Conference on Reanalysis, Copernicus Marine Service, https://climate.copernicus.eu/sites/default/files/repository/Events/ICR5/Posters/36_S4_Storto.pdf.
14. R Krishnan, J Sanjay, G Chellappan et al, "Assessment of Climate Change over the Indian Region", Report of the Ministry of Earth Sciences, Government of India, Pune: Springer, 2020.
15. B Neumann, AT Vafeidis, J Zimmermann , RJ Nicholls, "Future Coastal Population Growth and Exposure to Sea-Level Rise and Coastal Flooding - A Global Assessment", *PLoS ONE,* Vol 10, 3 (2015), e0118571, https://doi.org/10.1371/journal.pone.0118571.
16. Ministry of Shipping, "SAGARMALA: The Big Picture", September 2016 http://sagarmala.gov.in/sites/default/files/Sagarmala_the_Big_Picture.pdf.
17. Rüdiger Hahn, and Michael Kühnen, Determinants of Sustainability Reporting: A Review of Results, Trends, Theory, and Opportunities in an Expanding Field of Research", Journal of Cleaner Production, Vol 59, 2013, 5-21.

18. Rotterdam Climate Initiative, "Rotterdam Climate Change Adaptation Strategy", City of Rotterdam 70, 2013.

19. C Hooven, J Hirsch, M White, D Daugherty, L Moran Messner, and D Kim, "Port of San Diego Climate Mitigation and Adaptation Plan", in *Ad Hoc Expert Meeting on Climate Change Impacts and Adaptation: A Challenge for Global Ports*, reproduced by the United Nations Conference on Trade and Development, Geneva, Switzerland, https://unctad. org/sections/wcmu/docs/AHM2011_2_22_Hooven_en.pdf, 2011.

20. "Climate Change Adaptation Position Paper." 03 September, 2020, ESPO, https://www.espo.be/views/climate-change-adaptation-position-paper.

21. "Resilience of the Maritime and Inland Waterborne Transport System (MIWTS)", PIANC Resilience TG 193, https://www.pianc.org/uploads/files/EnviCom/ToR/ToR-EnviCom-193.pdf.

22. "Account for Climate Risk", International Finance Corporation, World Bank Group

About the Authors

Dr Pushp Bajaj is a Research Fellow at the National Maritime Foundation. He heads the Blue Economy and Climate Change Cluster at NMF. He may be contacted at climatechange2.nmf@gmail.com

Dr Saurabh Thakur was an Associate Fellow and a 'Vice Admiral KK Nayyar' Fellow at the National Maritime Foundation. During his tenure at NMF he was engaged in a set of major studies related to resilience-assessments of urban agglomerates in the face of climate change and the various facets of India's Blue Economy

Dr Chime Youdon is an Associate Fellow and a 'Vice Admiral KK Nayyar' Fellow at the National Maritime Foundation. She is deeply engaged in a set of major studies related to resilience-assessments of urban agglomerates in the face of climate change and is concentrating upon the city of Mumbai. She may be contacted at climatechange1.nmf@gmail.com

Note

This article was first published on the website of National Maritime Foundation on 31 January 2021

Climate Change Implications for Holistic Maritime Security in the Indian Ocean Region

Dr Pushp Bajaj

The scientific consensus built over the past few decades unequivocally states that climate change is real, and it is occurring at an accelerating rate. It is being caused primarily by human activities, and we are already experiencing its impacts all across the planet.

Following a relentlessly rising trend, the global average temperature in 2020 was recorded at about 1.2° C above the pre-industrial period, taken as the 1850-1900 average, primarily due to the increasing concentration of greenhouse gases in the atmosphere. Even though this may seem like a small number, at the planetary scale, this temperature rise corresponds to an incredible amount of energy that has been absorbed by the land, ocean, and the atmosphere. From the growing number of extreme heat days to more erratic rainfall patterns to more intense tropical storms to melting glaciers and polar ice resulting in sea level rise, the signs of our changing climate are ubiquitous.

The traditionally calm Arabian Sea witnessed four major cyclones in a row in the last four years. Cyclone *Tauktae,* in May of this year, made landfall in the state of Gujarat as an Extremely Severe Cyclonic Storm with a sustained wind speed of over 180 km/h. While Gujarat was hit the worst, *Tauktae* caused significant damages estimated at over Rs 15,000 crore to the states of Kerala, Karnataka, Goa, and Maharashtra as well. Over 169 Indians lost their lives due to the cyclone, making *Tauktae* one of the deadliest cyclones to have originated from the Arabian Sea.

Originating in the Bay of Bengal, Cyclone *Amphan*, in 2020, caused major damages, estimated at over Rs 1.02 lakh crore, because of the loss of residential, commercial, and municipal infrastructure in the state of West Bengal alone.[1] Soon after that, in June 2020, the west coast of India also witnessed cyclone *Nisarga*, its strongest tropical cyclone since 1981.[2]

The rising trend of powerful cyclones in the Indian Ocean is a direct consequence of the rising sea surface temperature, which is providing favourable conditions for the rapid intensification of cyclonic storms. Of course, this trend will continue to get worse unless drastic measures are taken to mitigate global carbon emissions and arrest ocean warming.[3]

The warming of the Indian Ocean is also the leading contributing factor to sea level rise (SLR) in the region due to the thermal expansion of water in addition to other sources of sea level rise such as the melting of mountain glaciers and the polar ice caps in Greenland and Antarctica. The Indian Ocean, the Bay of Bengal in particular, is experiencing a much faster rate of sea level rise than the global average.[4]

SLR is practically irreversible through natural processes on timescales of hundreds of thousands of years. Moreover, the latest science suggests that there are a number of 'tipping points' in the cryosphere which, when crossed, would commit us to multiple metres of global SLR over a period of decades to centuries to millennia. There is no certain way to determine where these tipping points lie in terms of the level of global warming. In the 2021, Working Group I contribution to the Sixth Assessment Report, entitled "Climate Change 2021: The Physical Science Basis",[5] the United Nations' (UN) Intergovernmental Panel on Climate Change (IPCC) projected that the global mean sea level (GMSL) rise could be in the range of 0.63–1.01 m by 2100, relative to 1995-2014 levels, if no mitigation action is taken (scenario referred to as 'Shared Socio-Economic Pathway 5-8.5' or SSP5-8.5), derived from climate models-based projections. In the most optimistic scenario, where all nations take immediate and drastic measures to slash down global greenhouse gas emissions (referred to as RCP2.6), the potential sea-level rise could be brought down to around 0.28-0.55 m, relative to 1995-2014 levels.

Every fraction of a metre of rise in sea level, compounded by the increase in the probability of extreme sea-level events, such as high tides, storm surges, and cyclones, poses a direct threat to the critical infrastructure and the population of all the littoral states in the Indian Ocean Region (IOR).[6]

While it is true that most of the major changes in sea level have historically occurred over timescales of several centuries to millennia, there are also recorded instances of naturally occurring rapid changes in sea level in our planet's history. Considering the exponentially accelerating rate of climatic changes that we are experiencing now, we must not discount the possibility of abrupt changes in sea level, which would, of course, have significant repercussions for all coastal nations in the IOR and the world. This was also acknowledged in the 2021 IPCC report, which stated, *"global mean sea level rise above the likely range – approaching 2 m by 2100 and 5 m by 2150 … cannot be ruled out due to deep uncertainty in ice sheet processes."*

Rising ocean temperature is also causing a series of knock-on physical, chemical, and biological changes in the ocean.[7] We know that the ability of the ocean to store dissolved oxygen decreases with increasing temperature, this is being actively observed in the expansion of the dead zones in the ocean. In this context, tropical regions, including the Indian Ocean are particularly susceptible to low-oxygen conditions compared to higher latitudes. As the name 'dead zone' suggests, these areas of the ocean are devoid of complex marine life because of the extremely low dissolved oxygen content.

Most marine species, all the way from the microscopic plankton to the apex predators, are highly sensitive to temperature changes.[8] In recent decades, scientists have recorded many physiological, behavioural and distributional changes in fish populations in response to rising temperatures.[9] The changing geographical distribution of fish is having and will continue to have significant impacts on the fisheries sector and the local fisherfolk communities. Taken together with other human stressors like overfishing, IUU fishing, industrial effluent pollution, and plastic pollution, these changes spell peril for marine life.

Climate change is already causing major socio-economic disruptions to all nations worldwide. However, as one would expect, the magnitude of the impacts varies widely across countries due to their widely different national circumstances. Developing and least developed nations in the region are the most vulnerable and experiencing the worst impacts mainly due to their limited financial and technological capacity to manage and adapt to the rapidly changing conditions. The same countries have also contributed the least to causing the problem, as evidenced by their marginal cumulative carbon emissions through recent decades.

The Small Island Developing States (SIDS) in the IOR are at the frontlines of climate change. Several impacts of climate change, such as extreme heat and droughts, intensifying cyclonic storms, and sea level rise, in particular, pose an imminent existential threat to these nations. Most of the SIDS in the region fall under the low-income category, in fact, a large part of their national GDP comes from international tourism, which would be adversely affected by the impacts of climate change including loss of marine biodiversity and frequent bouts of extreme weather events. Due to limited economic resources, these nations cannot deal with these impacts and, therefore, rely on the regional powers for support.

Growing food and water scarcity as a consequence of the complex web of climate change impacts is emerging as perhaps the most dangerous destabilising factor in the region. The arid regions in West Asia and North Africa are getting progressively drier due to climate change, which is converting once fertile lands into deserts. According to some estimates, desertification in Africa is occurring at a rate of as much as 20,000 hectares per year. This is contributing to further destabilisation of the already turbulent region and creating opportunities for malevolent actors to take advantage and infiltrate and expand their operations.[10]

It should surprise no one that these long-term impacts of climate change are forcing and will continue to force many people to leave their native homes and move to more hospitable regions or in search of better opportunities. This is, of course, not a new phenomenon. Throughout history, all species, including humans, have, at some point or the other, undergone displacement due to environmental changes. However, the expected scale of migration in the coming decades due to climate change will likely be unparalleled in human history.

We are seeing both internal and external migration, that is, from one area to another within a country and across international boundaries from one country to another. It is not always straightforward to unambiguously identify a certain displacement of a group of people to have been caused by climate change because climate change often acts as the last straw by exacerbating existing problems to a tipping point. Moreover, there is no globally recognised definition of climate refugees or climate migration yet, which makes it harder to put in place appropriate response mechanisms. Climate-change-induced internal and external migration is already happening in almost all parts of the world, albeit at different scales. Since this issue cuts through international boundaries, it can only be addressed through proactive and concerted efforts at the regional and global levels, otherwise, it may transform into the one of the greatest humanitarian crises of our generation.

There is a need to utilise the existing regional and sub-regional frameworks such as the Indo-Pacific Oceans Initiative, the QUAD security dialogue, the Indian Ocean Rim Association, the Indian Ocean Naval Symposium, the Indian Ocean Commission, BIMSTEC and ASEAN, and prioritise climate change mitigation and adaptation as the action points. Several of these frameworks already include an environment or ecology component, however, the necessary urgency and emphasis are completely lacking at the moment. Moreover, the inter-relations between the environment and climate change components and the other facets of cooperation such as maritime trade and connectivity, security, technology and innovation, etc. need to be appreciated and addressed in these forums.

Enhancing the resilience of critical infrastructure, both physical and social infrastructure, against the adverse impacts of climate change must take priority to minimise the expected socio-economic losses in the near future. Retrofitting, relocating, and redesigning our infrastructure would be a herculean task which would take several years to decades. Therefore, we must start preparing now, in order to be ready for the storms of the future.[11] It is important that we adopt a dynamic approach and account for the low-probability but high-risk scenarios of abrupt changes. In this context, the major powers in the region must support the most vulnerable and least equipped nations through capacity building and capability enhancement.

Of course, mitigation is the best form of adaptation. Rapid and significant cuts in global carbon emissions must take top priority in order to avoid some of the worst-case scenarios. The findings of the most recent Sixth Assessment Report of the United Nations' Intergovernmental Panel on Climate Change indicate that we may have already missed our chance to limit global warming below 2 degrees Celsius. This conclusion should not become the cause for inaction and defeat, rather it should serve as a wake-up call that we are entering into dangerous territory. The international community must work together to prevent every fraction of a degree of future warming because the impacts scale exponentially with every degree of warming.

Clearly, climate change poses significant threats to the maritime domain, however, pursuing a sustainable, regional Blue Economy offers a promising way to mitigate climate change and climate-proof the maritime sector while simultaneously generating a myriad of opportunities for economic growth.

For instance, the vast oceanic space provides significant opportunities to harness clean, renewable energy. Through greater academic research and technological evolution, ocean-based renewable energy resources could become cost-effective alternatives to fossil fuels and contribute to our efforts to reduce global carbon emissions. Ocean renewable energy resources also provide alternatives to the more prevalent land-based solar and wind energy installations, which is critical for the already densely populated, land-scarce countries in South Asia and South-East Asia in particular. Ocean based renewable energy is already being utilised very efficiently by many countries in Europe, which implies that there are opportunities to learn from our neighbours in the region and simultaneously strengthen our geopolitical relations.

ENDNOTES

1. Shiv Sahay Singh, "Bengal Pegs Cyclone Amphan Damage at Rs 1.02 Lakh Crore", *The Hindu*, 7 June 2020. https://www.thehindu.com/news/national/other-states/bengal-pegs-cyclone-amphan-damage-at-102-lakh-crore/article31771039.ece.
2. Surendra P Gangan and Tanushree Venkatraman, "Cyclone Nisarga: Crops on 8,000 Hectares Destroyed in Maharashtra", *Hindustan Times*, 5 June 2020. https://www.hindustantimes.com/cities/cyclone-nisarga-crops-on-8-000-hectares-destroyed-in-maharashtra/story-4jdtSeYlDRXvn7tt3wbQdO.html.
3. Thomas Knutson et al, "Tropical Cyclones and Climate Change Assessment: Part II: Projected Response to Anthropogenic Warming", *Bulletin of the American Meteorological Society* 101, No 3, E303-E322 (2020). https://journals.ametsoc.org/bams/article/101/3/E303/345043/Tropical-Cyclones-and-Climate-Change-Assessment.
4. R Krishnan et al, *Assessment of Climate Change Over the Indian Region* (New Delhi: Ministry of Earth Sciences, Government of India, 2020). https://www.springer.com/gp/book/9789811543265.

5. "Summary for Policymakers", in Climate Change 2021: The Physical Science Basis. Contribution of Working Group 1 to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change, eds V. Masson-Delmotte et al, (Cambridge University Press, In Press, 2021).
6. Michael Oppenheimer et al, Sea Level Rise and Implications for Low-Lying Islands, Coasts and Communities , in IPCC Special Report on the Ocean and the Cryosphere in a Changing Climate, eds Hans-Otto Pörtner et al, (In Press, 2019), https://www.ipcc.ch/srocc/chapter/chapter-4-sea-level-rise-and-implications-for-low-lying-islands-coasts-and-communities/.
7. Nathaniel L Bindoff et al, "Changing Ocean, Marine Ecosystems, and Dependent Communities", in IPCC Special Report on the Ocean and the Cryosphere in a Changing Climate, eds Hans-Otto Pörtner et al, (In Press, 2019). https://www.ipcc.ch/srocc/chapter/chapter-5/.
8. Malin L Pinsky, "Greater Vulnerability of Warming of Marine versus Terrestrial Ectotherms", Nature 569 (2019), 108-111, https://www.nature.com/articles/s41586-019-1132-4.
9. Hans O Pörtner and Julian Gutt, Impacts of Climate Variability and Change on (Marine) Animals: Physiological Underpinnings and Evolutionary Consequences, Integrative and Comparative Biology 56, No 1 (2016), 31-44. https://academic.oup.com/icb/article/56/1/31/2363254.
10. Caitlin E. Werrell and Francesco Femia, Climate Change Raises Conflict Concerns, *UNESCO Courier*, 2018, 2. https://en.unesco.org/courier/2018-2/climate-change-raises-conflict-concerns.
11. Dr Pushp Bajaj, "Climate Risks to India's Holistic Maritime Security —Part 2: Intensifying Extreme Weather", National Maritime Foundation Website, 23 July 2020, https://maritimeindia.org/climate-risks-to-indias-holistic-maritime-security-part-2/.

About the Author

Dr Pushp Bajaj is a Research Fellow and the Head of the Blue Economy and Climate Change Cluster at the NMF. His current research focuses upon the impacts of climate change on India's holistic maritime and naval security. He may be contacted at climatechange2.nmf@gmail.com

Note

This article was first published on the website of National Maritime Foundation on 30 December 2021

Cyber Security

Artificial Intelligence and Machine Learning for the Indian Navy

Commander Subhash Dutta (Retd.)

Artificial Intelligence (AI) — and its attendant term, 'Machine Learning' (ML) — is described as the capability of a computer system to perform tasks that normally require human intelligence, such as visual perception, speech recognition and decision-making. Almost all AI / ML examples in commercial as well as military use today rely on data stores that drive deep learning and natural language processing.[1]

The defining feature of an AI / ML system is its ability to learn and solve problems. There has been a gradual change in our understanding of what exactly constitutes AI. While advancements in computer hardware and more efficient software have led to the development of AI systems, hitherto computer-resource-intensive tasks, such as optical character recognition (OCR), are now considered a routine technology and, hence, no longer included in any contemporary discussion of AI / ML.

Modern AI / ML techniques are gaining rapid acceptance in almost all fields in which intellectual tasks are involved. Amongst these are autonomous vehicles, medical diagnoses, solving complex mathematical theorems, playing strategy-based games (Chess or Go, for example), web search-engines, etc. Adapting AI / ML in the defence forces has been pursued by almost all advanced nations. Most of this is in the realm of surveillance and autonomous vehicles.

Commander Amrut Godbole, in his absorbing paper titled, "AI & Machine Learning for the Indian Navy",[2] has put forth four usable cases for the adoption of AI and ML for the Indian Navy:

(a) Inventory Management.

(b) Training.

(c) Prescriptive Maintenance.

(d) Security and Surveillance

Adoption of AI and ML in the Indian Navy

Contrary to popular movie lore, AI can never replace humans; rather, it augments our abilities and makes us better at what we do. AI algorithms learn differently than humans; therefore, they look at things differently. They can see relationships and patterns that often escape us. There are, of course, limitations to what can be accomplished by AI. The principle limitation being 'data'. AI learns from the data presented to the algorithm and the mathematical model it is built on. It, therefore, follows that any inaccuracies in the data will be reflected in the results. The other limitation to AI is its single purpose – an algorithm designed to play chess can never detect financial fraud. These systems are very specialised and focused on what they can achieve, and this is far from how humans behave.

Of the four use cases proposed by Cdr Godbole, this author opines that two have been incorrectly identified. 'Inventory management' and 'training' utilise systems and technologies that would not readily benefit from the adoption of AI or ML technologies.

Inventory Management

a) In our desire to attribute AI / ML to anything and everything, we end-up creating systems that were efficient, to begin with, and gain precious little by having AI / ML models strapped onto them. Inventory-management is one such system. The problems associated with the present inventory-management system, as outlined in the paper by Commander Godbole, have little to do with the technology behind the system *per se*. Organisations and industries (automobile-manufacturing, with its large supply chains and multiple processes, immediately comes to mind) have been using these traditional systems with great efficiency. The drawbacks of the present system used by the Indian Navy stem more from the processes rather than the technology driving it. An AI / ML-based system, with the existing infirmities of data processing and labelling, would certainly not address the lacunae as brought out by the CAG report quoted in the paper by Commander Godbole.

b) An inventory-management system has a flat, structured database at its heart, with queries either built-in or generated 'on the fly' to solve the problem of providing the product (spares, in this instance) when needed and where needed. The strength of an AI / ML system is its ability to parse large, unstructured data and detect patterns. The mathematical model or the algorithm is then trained to detect variations in this data by feeding it labelled parameters. An inventory-management system, on the other hand, deals with a very specifically structured database. A measure of its effectiveness is the 'just-in-time availability' of the stores. An accurate prediction model can be developed around the existing system by carefully considering the variables associated with it. These would include consumption patterns, supply chains, types of stores needed and the, available capacity, etc.

c) What is needed to correct the weaknesses in the present system is a process of feedback on consumption patterns, correct labelling, regular weeding out of redundant stores and stock verification. An AI / ML-based system cannot address these issues, as they are largely human-process-based ones. Cdr Godbole's prescription for the adoption of AI models for the inventory management may not address what are essentially systemic-problems in the process itself.

Training

a) Commander Godbole correctly summarises the basic dilemma that the Personnel Branch of the Indian Navy — or for that matter, any other defence force — faces. That is, what should be the primary focus — manning ships with good officers and men so that the Fleet is at its peak efficiency, or to send the best available human-resources to training establishments so that future generations of personnel become better? His panacea for this and the other problems associated with crew efficiency is to incorporate AI and ML in training as well.

b) The solutions proposed include the use of Virtual / Augmented / Mixed Reality. These technologies provide a near-realistic environment in the absence of actual systems on which to train. While being resource intensive in terms of computing power, these are not AI / ML-driven technologies. The investment that the Navy would make for the development of AI / ML-based training can be better spent on IT-based training systems. The other lacunae of the present training system, too, are more of an administrative nature rather than a technological one.

The other two 'use-cases', namely, maintenance, and, security and surveillance, are much more amenable to adoption by AI / ML technologies. Both rely on large amounts of unstructured data with multiple parameters. The Indian Navy has been maintaining its platforms for quite some time now as well as conducting diverse operations. Therefore, the data required for building a robust mathematical model for these use cases exists with the Navy.

Prescriptive Maintenance

a) Commander Godbole correctly brings out the need for data for the development of a robust AI / ML model. However, if a fault is to be found, it lies in the architecture proposed. It is proposed that the analytics would be performed on systems that would be a combination of platform-based as well as a shore-based cloud infrastructure.

b) The AI / ML model is trained on the parameters extracted from the data. This is a computer-resource-intensive activity and would necessarily have to be an offshore infrastructure. Once the model is developed, it is ported to the decision system that would take in the current parameters and, based on the model and give its decision. An analogy can be derived from the modern AI / ML-based antimalware-based systems. The ML model, once trained with enough data, is transferred to the computer system as an update. The file size of this update is generally around 1 Gb and is well within the capability of most PCs available today.

c) It is felt that this architecture will suffice the needs of both, ship-based operators as well as shore-based maintenance planners.

Security and Surveillance

a) At the present point in time, perimeter-security of naval units is an overwhelmingly manual process. The paper discusses various technologies that can be incorporated to develop a technical alternative to the present system. These include trip wires, facial and feature recognition cameras and underwater autonomous systems for surveillance and security.

b) While such systems are certainly technically advanced as compared to the present manual system, the development of AI / ML technologies along with these systems could vastly improve the outcomes desired. Facial-recognition systems and the associated AI / ML model would map an individual's normal entry and exit points. Any deviation or abnormal behaviour would be detected by the AI / ML technology and appropriate alarms raised. This is just one illustration of the benefit that would accrue towards a more robust security system by the adoption of AI / ML technologies.

Additional AI / ML 'Use-Cases' for the Navy

Apart from the use-cases proposed by Commander Godbole, it is felt that the maximum advantage of adopting AI / ML would be derived in the area of Maritime Domain Awareness (MDA) and autonomous vehicles (on surveillance as well as offensive missions). While the Indian Navy operates many automated systems, these are markedly different from autonomous systems. An automated system processes an input to produce the desired output, and if the input is the same, the results will always be the same. Autonomous systems, on the other hand, deal with a set of inputs to make a guess on the best possible course of action depending on the inputs. Given the same input, autonomous systems may not necessarily produce the exact same outcome every time; rather, such systems will produce a range of behaviour-patterns.

MDA is a near-ideal candidate for the adoption of AI / ML models. The inputs are diverse and numerous, the environment affects the presence or absence of other units, and there are a variety of sensors that provide information. The inputs could come from shore, ship or space-based sensors, various ship tracking and monitoring systems (AIS, VMS, LRIT, to name three), and open-source information.[3] AI / ML algorithms could then fuse this data to present a single coherent picture of the area of interest. The benefits that could accrue from this adoption could be in the form of enhanced visibility of activities of units at sea, determining patterns of deployment, the determination of risks arising from anomalous behaviour of ships, particularly small craft, and so forth.

The Indian Navy is quite correct in pursuing this path in the development of the TRIGUN software suite, to enhance Maritime Domain Awareness with Artificial Intelligence.[4] It is understood that the development of this system would progress in incremental stages, with full operationalisation being planned for 2024.

Unmanned vehicles are another strong contender for the adoption of AI / ML technology. These could be by way of Unmanned Underwater Vehicles (UUV) or Unmanned Surface Vehicles (USVs).[5] These systems generally have a man-in-the-loop to make decisions for navigation or targeting.

In the case of autonomous vessels, their ability to execute tasks without human intervention is enhanced using AI / ML algorithms to accept inputs from the environment and from its own sensors, and take decisions involving either locomotion or weapon use or both.[6] Such AI / ML systems further shorten the time taken for the commander to decide on a course of action that would be unimaginable were this process were to be undertaken manually.

Lethal Autonomous Weapon Systems (LAWS) constitute yet another class of autonomous vehicles that utilise an onboard sensor suite coupled with AI / ML algorithms to detect targets and employ their onboard weapon systems to engage a target without human intervention.[7] The US Navy and DARPA's *Sea Hunter*, which was launched in April of 2016, is an example of this type of vessel. Designed as an Anti-Submarine Warfare Continuous Trail Unmanned Vehicle (ACTUV), the *Sea Hunter* can travel the oceans for months at a time with no onboard crew, searching for enemy submarines and reporting their location and findings to remotely-located human operators.8 Other nations developing similar systems include Russia, Israel, China and the UK.[9]

Conclusion

Advances in computing hardware and efficient programming-languages have enabled the development of a range of technologies that have contributed immensely to our professional activities as well as leisure ones. Systems leveraging AI / ML have grown in scope to offer a richer experience to almost all our Internet engagements. Traditionally, the defence industry has been at the forefront of innovation, and the private sector has utilised these technologies for commercial use. In the IT domain, however, the defence sector, particularly the Indian defence sector, is playing catch-up with private entities. Machine Learning and Artificial Intelligence play an increasing part in our lives today. We need to harness these technologies to defence systems as well, albeit with due care that we do not end-up overplaying or exaggerating their application.

ENDNOTES

1. *Wikipedia*, s.v. Artificial intelligence, last modified 24 April 2020, 02:37, https://en.wikipedia.org/wiki/Artificial_intelligence.
2. Cdr Amrut Godbole, "AI & Machine Learning for the Indian Navy", *Gateway House*, 23 Apr 2020. https://www.gatewayhouse.in/ai-machine-learning-indian-navy.

3. Vijay Sakhuja, "Artificial Intelligence and Maritime Domain Awareness", *Society for Study of Peace and Conflict*, 11 Jun 2018. https://sspconline.org/index.php/opinion/artificial-intelligence-maritime-domain-awareness-vijay-sakhuja-110618.

4. Mayank Singh, "New system with AI to boost maritime security", *The New Indian Express*, 09 Feb 2020. https://www.newindianexpress.com/thesundaystandard/2020/feb/09/new-system-with-ai-to-boost-maritime-security-2100873.html.

5. Tuneer Mukherjee, "Securing the maritime commons: The role of artificial intelligence in naval operations", *Observer Research Foundation*, 16 Jul 2018. https://www.orfonline.org/research/42497-a-i-in-naval-operations-exploring-possibilities-debating-ethics/.

6. Dr Vincent Boulanin and Maaike Verbruggen, "Mapping the Development of Autonomy in Weapon Systems", *SIPRI*, Nov 2017. https://www.sipri.org/publications/2017/other-publications/mapping-development-autonomy-weapon-systems.

7. Wikipedia, s.v. "Lethal autonomous weapon , last modified 12 Apr 2020, 23:08, https://en.wikipedia.org/wiki/Lethal_autonomous_weapon.

8. Michael T. Klare, "Autonomous Weapons Systems and the Laws of War", Arms Control Association, Mar 2019. https://www.armscontrol.org/act/2019-03/features/autonomous-weapons-systems-laws-war.

9. Wikipedia, s.v. "Lethal autonomous weapon", last modified 12 Apr 2020, 23:08, https://en.wikipedia.org/wiki/Lethal_autonomous_weapon.

About the Author

Commander Subhash Dutta is a former Indian Naval Officer and Adjunct Fellow at the National Maritime Foundation. He can be contacted at subhashdutta.nmf@gmail.com

Note

This article was first published on the website of National Maritime Foundation on 3 May 2020

Applying the Principles of War to the Cyber Security Domain

Commander Subhash Dutta (Retd)

Anyone who has spent a significant period of time within the Information Security (InfoSec) industry would recognise the industry's felt need to reinvent itself at regular intervals. The author has always found this to be a rather defeatist approach as the impression that it creates is that InfoSec professionals are in a constant tail-chase while the attackers always have the upper hand. However, a dispassionate assessment of security technologies and their core functions would lead one to realise that nothing really has changed. The attackers have always been after data / information that can be monetised, and the defenders have always been trying to prevent this and protect the sought-after data / information.

While the technologies underpinning IT-infrastructure have advanced rapidly over the last few years, the underlying feature — the ability to rapidly process and consume information — has remained the same. After their initial attempts to attack information systems, the focus of attackers has always been the information rather than the systems that create, store, or process this data. Therefore, it stands to reason that while our defensive tools and processes may change to keep up with newer systems or technologies, the basic principles must remain the same.

This article is a consequence of numerous discussions with professionals chartered with keeping their IT infrastructure and users safe — these professionals typically bear the designation Chief Information Security Officers (CISOs) —– regarding specific threats. From the earlier generations of "rootkits" — hidden malware[1] that incorporates a number of tools, ranging from programmes that allow hackers to steal passwords to modules that make it easy for them to steal credit card or online banking information or enable them to subvert or disable security software and track the keys that are tapped on a keyword in order to steal personal information)[2] — the industry transitioned to "Advanced Persistent Threats" (APTs) — *"in which an unauthorised user gains access to a system or network and remains there for an extended period of time without being detected"*[3] — and now the conversation of CISOs is peppered with a generous sprinkling of ransomware.[4] If one were to consider the basic functioning of these classes of malware, one would find that there are remarkable similarities among them. The California-based American multinational technology conglomerate, Cisco Systems, Inc, commonly known simply as "Cisco", defines an APT as "*processes (that) require a high degree of covertness over a long period of time*".[5] This is markedly similar in capability to a rootkit, which hides the existence of malware by hooking and altering the 'requests made to' and the 'responses received from' a remote server's "Application Programming Interface" (API), which is *"the part of the server that receives requests and sends responses"*.[6]

However, if one were to tell them that instead of chasing threats, which will be constantly evolving, CISOs must focus on their risks (where is their critical data, who has access to it, and where is it moving), one would probably get a politely thoughtful stare, and then the conversation would rapidly change back to "but what can your product do against ransomware?"

Needed: A Shift in Thinking so as to Simplify Security

So, what is required to change the mindset? The first and foremost need is to uncomplicate security. This is not very hard to do, but it has never received the focus that it deserves. InfoSec professionals the world over, find themselves drowning in a veritable deluge of information — something that is commonly referred to as "information overload. As a consequence, they suffer greatly from "alert-fatigue". Triaging incidents to take on the most dangerous threat considering the criticality of the system being attacked, is virtually impossible when facing up to 900 million events per day[7] (something that most Security Operation Centres face).

IT administrators and InfoSec professionals are in a daily battle against attackers who are constantly on the lookout for lowhanging fruit. The most common adage in the InfoSec community is that while the security professional must ensure that every single door and window is secured, the attacker has to find just one tiny crack or hole. Thus, it is not a question of "whether" but rather, of "when" an organisation would be successfully attacked and lose data.

If at least a modicum of succour is to be provided to these beleaguered InfoSec professionals, the best way would be to reduce the number of dashboards / consoles that they need to monitor. A single "endpoint security solution"[8] that provides advanced protection against threats emanating from outside while also preventing the movement of data to an unauthorised entity would cover several different and discrete (independent) security products that are currently in use — for example, anti-malware, patch management, Data Leakage Prevention (DLP), device-hardening, host-based firewall / Intrusion Detection / Protection System (IDS / IPS), application control, etc.

Adapting the "Principles of War" to InfoSec.

The second most important factor is to fight this menace much as a nation would fight a war. Nation-states have been fighting wars for centuries and have distilled from the experience they have gained at such a high cost — in terms of the human lives lost and the property and infrastructure destroyed — some basic principles that lead to victory and whose neglect pretty much assures defeat. Renowned strategic thinkers, such as Sun Tzu[9], Chanakya[10], Machiavelli[11], Clausewitz[12], amongst several others, have outlined these principles — "Principles of War" as they are termed — that have successfully stood the test of time. Even though there are some variations that cater to individual national peculiarities and the military doctrines that flow from these individual circumstances, there is, nevertheless, a very remarkable degree of commonality that stretches across both, time and space.

The British enunciated ten Principles of War after their experience within the Great War (a.k.a. the First World War) that were the outflow of the remarkable work done by the British general and military theorist, JFC Fuller.[13] With only some minor variations, these principles have been adopted by the contemporary

British armed forces, as also by those of most Commonwealth States. The current Principles of War stipulated in the UK Defence Doctrine[14], which have also been adopted (or slightly adapted) by the North Atlantic Treaty Organisation (NATO) in its *"Principles of Allied Joint and Multinational Operations"*[15] are:

(1) Selection and maintenance of the aim (adapted by NATO as *"Unity of Effort" and "Definition of Objectives"*)

(2) Maintenance of morale

(3) Offensive action (adapted by NATO as *"Offensive Spirit"* and *"Initiative"*)

(4) Security

(5) Surprise

(6) Concentration of force

(7) Economy of effort

(8) Flexibility (adapted by NATO as *"Freedom of Action"*)

(9) Cooperation (adapted by NATO as a "characteristic" rather than a "principle", and described as *"Multinationality"*)

(10) Sustainability (adapted by NATO as a "characteristic" rather than a "principle", and described as *"Perseverance"*)

Particularly germane to this article is the one striking variation that NATO's listing incorporates (as compared to the UK's list) — probably as a result of the former's long experience in dealing with its quarrelsome and often fractious constituent members. This is the principle of *"Simplicity"*. Indeed, the central underlying message of this entire article is precisely this — a plea for "Simplicity". That having been said, it is not merely possible, but would be hugely beneficial to use these principles (drawn from the UK's Defence Doctrine) to the domain of Information Security and to thereafter devise strategies and tactics in conformity with these principles.

Selection and Maintenance of Aim: This is the first and preeminent principle and guides all subsequent actions within any organisation, military or civilian. Organisations must have a singular and unambiguous aim — the protection of critical data to ensure continuation of business operations. This must be communicated clearly to the InfoSec team. Decisions taken in pursuance of this principle will, thereafter, govern all other actions.

Maintenance of Morale: Security professionals are confronted by a deluge of information comprising an incredibly high frequency of threat- and attack-alerts, which causes an information-overload at individual and institutional levels, resulting in "alert fatigue". All too often, the actions that InfoSec personnel take to protect the assets of their organisations go unnoticed and hence unrecognised. This leads to a lowering of morale, which, when coupled with alert-fatigue, makes for quite a deadly cocktail. It is of utmost importance that InfoSec personnel are perceived as frontline "warriors" and acknowledged as such, and that their efforts are publicly rewarded. While monetary rewards do provide some satisfaction, peer recognition and regular feedbacks have been known to produce far better results. Simultaneously, reposing trust in security partners will provide additional gains.

Offensive Action: A series of activities that enable these InfoSec "warriors" to seize the initiative, gain an upper hand, and maintain momentum over attackers ensures will, taken in aggregate, almost invariably ensure the protection of the security of an organisations' critical data. Allocation of resources in terms of talented personnel and appropriate security systems is essential. It is equally critical for InfoSec team leaders to be empowered to take actions to fend off attacks with minimal requirement to process approvals through a convoluted chain of command. On the other hand, while the people on the ground will always demand more manpower and resources, it is the higher "C-level" authorities or CxOs[16] as they are also known, who must retain a clear idea of the strategic picture and it is they who must frame long-term priorities in terms of the allocation of human and material resources. To do so wisely, they must be crystal clear about the criticality of individual systems and be able to identify those that need higher protection and, therefore, require a more generous allocation of resources. If these critical systems fail (which is why they are known as "critical" systems in the first place!), everything else will collapse.

Security: The application of this principle must always ensure that one's "base"', or "home turf" or "parent company" is secure. This then provides for an operating environment that gives freedom of action, when and where required, to achieve objectives. On the other hand, most security controls are considered an inconvenience and internal users frequently attempt to circumvent them, thereby achieving apparently impressive but potentially disastrous and artificially high speeds in terms of operational processes. Management must, therefore, repeatedly send out a clear and unambiguous message that the security controls in place do not imply any mistrust in the employees, but rather, seek to provide a safe and secure environment within which these very employees can be productive. Even if this means biting the bullet from time to time, InfoSec teams must be empowered to take urgent protective action when required.

Surprise: From an attacker's perspective, surprise is a desirable consequence of sowing confusion and inducing panic amongst defenders by deliberately or incidentally introducing the unexpected. Obviously, InfoSec professionals must guard against being surprised by attackers. To preclude surprise attacks from being effective, the most important ingredient in the armoury of the InfoSec team is up-to-date and comprehensive "intelligence". The "Who" component is important, but significantly less so than being able to predict the "What" component, so that the always-unknown nature of the "When" component does not throw the defenders completely out of gear. The enormous value of knowing just what is out there is quite akin to the value conferred, within the maritime space, to a defender who possesses a high degree of "Maritime Domain Awareness" (MDA). While it is critical to know what to look for, this itself depends upon how thoroughly one is aware of just "what" is out there. Thus, threat- and malware intelligence is essential for the development of a picture that provides a holistic view of the hostile environment. Any blurring or blindness of such a view enables attackers to retain the element of surprise and, hence, initiative. If intelligence — it cannot be stressed enough that a prerequisite of "specific" intelligence is "general" intelligence — is missing or inadequate, the best that an InfoSec team can be expected to do once the organisation has been allowed to be taken by surprise, is to be reactive one with a general lack of direction. This is a situation that is not only disastrous in the short run, but is also deeply frustrating in the long run.

Concentration of Force: In military terms, this involves decisively applying superior fighting power (physical, intellectual, and moral) to realise intended effects, when and where required. For InfoSec warriors, it is essential that they do not spread themselves too thin and attempt to do everything simultaneously. Meticulous planning is required by the CISO to analyse the critical components that would require his or her prioritised attention, align personnel to these established priorities, and equip them with the requisite tools with which to fight both, localised outbreaks and more general attacks.

Economy of Effort: This principle invokes the judicious exploitation of resources to achieve the objective. Activities pursuant to this principle flow from the previous one on “Concentration of Force”. The InfoSec team of a CISO who attempts to do everything will very probably end up doing nothing. Resources will always be in short supply, security systems may not be optimally configured, personnel may lack training, or the time available to respond and recover may not be adequate. InfoSec leaders will never have an option other than to prioritise. Prioritisation certainly leads to economy of effort but the decision as to what to prioritise and when to do so, must be based upon a continuous and dynamic evaluation of possible threats — as revealed by past attacks that have been dealt with elsewhere (or else-when) through preventive deterrent means, or preventive approaches, or curative actions. CISOs must be trained to plan for contingencies and ensure that process delays are ironed out, and resources are not only available to meet a given requirement but can be switched smoothly should a higher-priority threat be identified.

Flexibility: As just outlined above, the principle of “flexibility” connotes the ability to change rapidly but smoothly to meet new circumstances. Attackers may not always follow a set pattern; they will often look for targets of opportunity, and a vulnerable internet-facing resource might invite their unwelcome attention. The only real way to attain “flexibility” is through well-rehearsed drills and simulations. Of course, “flexibility” also requires that greater autonomy be accorded to personnel who need to act quickly to mitigate an emergent threat that carries a greater risk of compromise of information. Resilient business operations during an ongoing attack will only be possible if responses are not rigid, but instead, agility and adaptability are incorporated in security operations.

Cooperation*:* Surprisingly, many organisations do not follow a structured and carefully implemented method of team-building, and the development of multiple levels of team leadership. Trust-deficits are a particularly ubiquitous flaw in far too many organisations. This is especially the case with start-ups, whose leadership assumes that by some divine method of osmosis, their own skills (especially skills that stood them in good stead in some past position or endeavour) will automatically result in a well-bonded team in which internal processes of cooperation and collaboration teamwork can be taken to be a given. This lack of managerial commitment and the concomitant investment of time, effort, and, most important of all, persistence, is the single biggest reason that so many InfoSec teams (and organisational management structures as a whole) do poorly. Cooperation is not just about being nice to one another. It also implies the sharing of dangers, burdens, risks, and opportunities in every aspect. It is this shared responsibility in terms of both, success and failure, that creates the sore of bonding that HR set-ups enunciate but seldom achieve. It is essential that the HR structure as well as the departmental organisations responsible for corporate communications and legal aspects be in complete sync with the InfoSec team. The flow of information between these various departments must be seamless and systems should be in place to exchange this information. Once again, this requires committed rehearsals — what the military calls "drills". A telling example of the risks of inadequate attention having been paid to the principle of cooperation is that of an employee who has left the organisation, but whose accesses to obscure repositories remain and are open to abuse.

Sustainability: Just as nations and militaries emphasise "sustenance" to ensure the ability to fight and preserve freedom of action, so must organisations enable their InfoSec teams by providing them with adequate and well-drilled resources to fight off determined attackers. Investments in training and upgrading the skills of InfoSec warriors will pay handsome dividends when a serious attacker is encountered. This will also ensure that committed and capable resources remain with the organisation for a longer period — a feature that is in great demand in an industry with high horizontal mobility of personnel and consequent high rates of attrition within a given company or organisation.

Conclusion

Early malware activities were largely nuisance attacks, such as defacing or putting graffiti on an organisation's webpage. Present day malware attacks have become full blown cyber offences involving determined sophisticated attacks on critical infrastructures and sophisticated crimes. Not surprisingly an underground ecosystem has emerged to support the full malware lifecycle, which includes development, deployment, operations, and monetisation. This ecosystem has spawned a number of actors who specialise in key parts of the malware lifecycle, and, by providing their services to others, they obtain their share of the ill-gotten financial gains and rewards. Unfortunately for those charged with assuring information security, such specialisations markedly improve the quality of malware. For example, a contemporary attacker can hire the best exploitation-researcher to write that part of the malware responsible for remotely compromising a vulnerable computer. A wider example is that of the progression of ransomware. It started off as simple data encryption, with payment of ransom being required for the decryption key. Organisations adapted to this by ensuring proper backups of critical data, rebuilt their systems, and then refused to pay ransom. The attackers then changed tack and exfiltrated data prior to encrypting it and now demanded a ransom to prevent the data from being exposed publicly. Organisations now protected themselves with ensuring that protective measures — such as encrypting data — were rigorously enforced while also opting for cyber risk-insurance. The attackers then again shifted their tactics and started informing clients and users whose data had been exposed that they would name and shame the compromised individuals and / or organisations!

An InfoSec organisation must be agile, and must be able to keep up with the continuously evolving techniques, tactics, and procedures of attackers, by building a robust data comprising intelligence of threats and malware. Organisations, too, must do their part by supporting their InfoSec warriors by way of the provision of resources, capability, and technical advancement. Overall, there must be a concerted effort at reducing the complexity of security operations so as to reduce the degree of alert fatigue currently being faced in information-security operations.

ENDNOTES:

1. Malware is a *"portmanteau"*, a word coined from the combination of the words malicious and software, commonly used within the InfoSec community.

2. Dan Rafter, "What is a rootkit? And How to Stop Them", NortonLifeLock Inc https://us.norton.com/internetsecurity-malware-what-is-a-rootkit-and-how-to-stop-them.html.

3. Nate Lord, "What is an Advanced Persistent Threat? APT Definition", 11 September 2018, https://digitalguardian.com/blog/what-advanced-persistent-threat-apt-definition.

4. Josh Fruhlinger, "Ransomware Explained: How it Works and How to Remove it", CSO Online, 19 Jun 2020. https://www.csoonline.com/article/3236183/what-is-ransomware-how-it-works-and-how-to-remove-it.html.

5. "What Is the Difference: Viruses, Worms, Trojans, and Bots?", Cisco, 14 June 2018, https://tools.cisco.com/security/center/resources/virus_differences#APT.

6. Petr Gazarov, "What is an API", FreeCodeCamp, 19 Dec 2019, https://www.freecodecamp.org/news/what-is-an-api-in-english-please-b880a3214a82/.

7. This is a representative figure. Sequretek IT Solutions SOC ingests around 800 million events per day from almost 3500 devices spread across its more than 60 clients.

8. https://sequretek.com/wp-content/uploads/2018/10/EDPR_Datasheet.pdf.

9. Joshua Mark, "Sun-Tzu", World History Encyclopaedia, 09 Jul 2020. https://www.worldhistory.org/Sun-Tzu/.

10. *Wikipedia*, s.v. "Chanakya", last modified 28 Feb 2021, 07:32, https://en.wikipedia.org/wiki/Chanakya.

11. Cary Nederman, Niccolò Machiavelli", Stanford Encyclopaedia of Philosophy, 28 May 2019. https://plato.stanford.edu/entries/machiavelli/.

12. Jordan Lindell, "Clausewitz: War, Peace and Politics", E-International Relations, 26 Nov 2009. https://www.e-ir.info/2009/11/26/clausewitz-war-peace-and-politics/.

13. *Wikipedia*, s.v. JFC Fuller, last modified 15 Mar 2021, 16:58, https://en.wikipedia.org/wiki/J._F._C._Fuller.

14. UK Ministry of Defence, "UK Defence Doctrine, Annex 2A", Nov 2014, https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/389755/20141208-JDP_0_01_Ed_5_UK_Defence_Doctrine.pdf.

15. Allied Joint Doctrine (AJP-01), Edition E Version 1, February 2017, 1-13, https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/905877/20200728-doctrine_nato_allied_joint_doctrine_ajp_01.pdf.

16. In a commercial organisation such as a registered company, senior executives charged with ensuring that the company stays true to its pre-set plans and policies, are often given titles that beginning with the letter "C", standing for "Chief" and ending with the letter "O" for "Officer." Examples are "Chief Executive Officer" (CEO), "Chief Financial Officer" (CFO), "Chief Information-Security Officer" (CISO), etc. These are frequently collectively known as "C-Suite" or "C-level" executives. Given the proliferation of these titles, they are collectively referred to as "CxOs".

17. Kevin Savage et al, "The Evolution of Ransomware", *Florida State University*, 06 Aug 2015. https://its.fsu.edu/sites/g/files/imported/storage/images/information-security-and-privacy-office/the-evolution-of-ransomware.pdf.

About the Author

Commander Subhash Dutta is a former Indian Naval Officer and an Adjunct Fellow at the National Maritime Foundation. He can be contacted at subhashdutta.nmf@gmail.com

Note

This article was first published on the website of National Maritime Foundation on 04 May 2021

Cyber Operations Associated with the Ukraine-Russia Conflict: An Open-Source Assessment

Commander Subhash Dutta (Retd)

Russia's invasion of Ukraine on 24 Feb 2022 was preceded by warnings from the US, UK, and others, of an impending attack by the Russian forces massed along Ukraine's eastern and northern borders. These warnings were unprecedented in that they were explicit and were asserted to be the results of analysed intelligence operations. However, if these warnings were meant to deter Russia from carrying out its stated plans, then they failed quite abjectly.

With the extent of offensive cyber capability available to Russia,[1] it was expected that this would be a major contributor to the outcome of the war, over and above the kinetic ones being undertaken by Russia.[2] It was also assumed that any offensive cyber operation involving the deployment of destructive malware would spill over to other countries and organisations as had been observed in the behaviour of malware such as Stuxnet[3] and NotPetya[4], the latter being assessed to have originated in Russia and targeting Ukraine. These experiences led to the intuitive belief that in a hyper-connected society, it would be naïve to expect that offensive cyber operations would remain confined solely to their intended targets. Yet, this is precisely what appears to have happened thus far. While there is extensive evidence of offensive cyber operations being carried out by both sides in the present conflict, there is little evidence, as yet, of any spillover of these in areas beyond the conflict zone.

While the dissemination of propaganda through a variety of media is very much an aspect of Information Warfare as a whole, this paper will focus on cyber aspects and will attempt to collate and analyse existing open-source information available on the use of cyber capability, by both, Russia, and Ukraine.

Russian Cyber Operations

Russia has long held the view that the Internet poses a danger to the sovereignty of the nation. Particularly, the open exchange of information that renders borders obsolete has been considered an anathema to Russian thinkers.[5] This view is, of course, divergent from the basic concept of the Internet, which was envisaged to enable the unfettered exchange of information. It is this very spread of information which Russia perceives as posing a threat to its society as well as the State, and consequently, the exercise of sovereignty over the resultant 'national internet', is a key security concern of the Russian Stare.

This sort of understanding of cyberspace and the unacceptability of the risk of its unfettered use, has manifested itself in Russia attempting to disconnect from the rest of world. Regulations on the Internet in Russia described publicly as the Sovereign Internet Law,[6] which was passed by the Russian parliament in November of 2019, permits, among other aspects, the Russian Government to partition Russia from the rest of the Internet. In tests running over a month from 15 Jun 2021, Russia did, indeed, disconnect its Internet infrastructure from the rest of world.[7] While the results of this disconnect are still not clear, it certainly does confirm Russian intentions to control online discourse.

As is the case with most countries, Russia, too, acknowledges the importance of information operations to steer the narrative among its adversaries. Comments by its former Chief of General Staff and other senior officials to the Russian Parliament in February of 2017[8] indicates a firm belief that victory obtained through information operations is, at present, seen to be even more important than that resulting from the use of traditional weapons, especially if the former significantly degrades the enemy's morale, discrediting its leadership, and undermining its military and economic potential.

In the opinion of this author, it is this feeling of isolation and a narrative of victimisation by the West that has driven Russia to develop extensive offensive cyber capabilities that routinely target its presumed enemies. Of course, most countries with advanced cyber capability are also believed to possess these capabilities. Russia, however, is among very few countries that are known to actively encourage non-governmental entities to carry out cyber-attacks against other private organisations. Most malware known to be authored by Russian attack groups do have the capability to determine the location of the impacted systems and leave them alone if they happen to be Russian.

Some known Russian entities involved in cyber operations during the current conflict and in the past include the following[9]:

The Russian Federal Security Service (FSB): The successor to KGB, the FSB is known to have conducted cyber operations against energy companies in the West. Attack groups associated with FSB have been named Berserk Bear, Crouching Yeti, Dragonfly, and Energetic Bear, by global security organisations[10].

Russian Foreign Intelligence Service (SVR):[11] The SVR is known to operate an Advanced Persistent Threat (APT) group, known variously as APT29, COZY BEAR, CozyDuke, Dark Halo, Nobelium, etc. The known targets of this group include critical infrastructure organisations. Their most well-known attack was one that used the SolarWinds Orion software to infiltrate a large number of US organisations.[12]

Russian General Staff Main Intelligence Directorate. The GRU's 85th Main Special Service Centre has operated an APT group that targets governmental organisations, research institutes, and critical infrastructure organisations. The group is known as Unit 26165 and by security organisations as APT28, Fancy Bear, Strontium, Group 74, etc.[13]

GRU's Main Centre of Special Technologies: GTsST, or Unit 74455, is an APT group that has operated since at least 2009 and has targeted a variety of critical infrastructure organisations, including those in the Energy, Transportation Systems, and Financial Services Sectors. The group is also known as Sandworm, Iron Viking, BlackEnergy, and Voodoo Bear. The primary distinguishing characteristic of the group is its use of techniques aimed at causing disruptive or destructive effects at targeted organisations using Distributed Denial of Service (DDoS) attacks, or wiper malware.[14] Some of the more prominent destructive attacks attributed to this group include the cyberattack against Ukrainian energy-distribution companies in December of 2015[15] and the destructive NotPetya attack of June, 2017.[16]

Apart from these State organisations involved in offensive cyber operations, there are other Russia-based groups that either operate with official patronage or are tolerated by the authorities. These Russia-aligned cybercrime groups pose a threat to critical infrastructure organisations primarily through their deployment of ransomware through which cyber actors remove victim access to data (usually via encryption), potentially causing significant disruption to operations, and conducting DDoS attacks against websites. The more prominent of these groups include:

The Gamaredon Group:[17] This group has been active since 2013 at least and has targeted individuals believed by them to be involved with the Ukrainian government in one capacity or another. The group uses Russian web-hosts to distribute their malware. In November 2021, the Security Service of Ukraine made a public announcement that attributed Gamaredon to the Federal Security Service of the Russian Federation (FSB).[18]

Venomous Bear:[19] Also known as the Turla Group, Venomous Bear has historically targeted governments aligned with the North Atlantic Treaty Organization (NATO), defence contractors, and other organisations of intelligence value. Venomous Bear is known for its unique use of hijacked satellite internet connections for command and control (C^2). It is also known for the hijacking of other non-Russian State-sponsored APT actor infrastructure.

Conti Ransomware Group:[20] Conti is amongst the most professional of the organised crime-groups and it possesses dedicated subgroups akin to departments in a traditional business. Just a day after the Russian invasion of Ukraine, the Conti Ransomware Group announced its support of the Russian government, on their website,[21] although this support was toned down subsequently.

Destructive Cyber Attacks Targeting Ukraine During the Current Conflict: Although large scale cyber-attacks against countries and organisations assisting Ukraine have not yet materialised, there has been no dearth of these operations against Ukrainian organisations and systems. Destructive cyber-attacks have the capacity to render systems inoperable. Wiper malware[22] is the weapon of choice here. Russia is reported to have used these attacks since the beginning of the current conflict.[23]

These attacks are chronologically tabulated below:

S. No.	Date/Time Period	Attack Description	Attribution
1	13 Jan 2022	WhisperGate malware esigned to wipe the contents of hard disks of Ukrainian Foreign Ministry, as also some IT organisations.[24]	Initially attributed by Microsoft to nation-state threat actor designated DEV-0586. Later attributed to GRU's Main Centre of Special Technologies (aka Sandworm)
2	Early Feb	DDoS attack against Ukrainian banking and defence websites.[25]	Russian Main Intelligence Directorate (GRU)
3	23 Feb 2022	Hermetic Wiper (similar to Whisper Gate). Targets the Ukrainian government's IT, energy, and financial sectors.[26]	Sandworm group
4	24 Feb 2022	Isaac Wiper carried out similar actions to Hermetic Wiper and Whisper Gate, but bearing no resemblance to either. Its targets are Ukrainian organisations that were not affected by earlier attacks.[27]	No specific attribution, however, the composition of the malware and targets attacked point to the involvement of Russian agencies.
5	14 Mar 2022	CaddyWiper is another wiper malware that bears no relations to earlier wipers[28].	No specific attribution, however, the composition of the malware and targets within Ukraine point to the involvement of Russian agencies.
6	12 Apr 2022	Industroyer2, a sophisticated malware framework designed to cause an impact to the working processes of Industrial Control Systems (ICS), specifically components used in electrical substation. An earlier version was launched against Ukrainian power grid in December of 2016[29]	Sandworm group

Attack on Viasat Satellite Internet Communications: To coincide with the commencement of the Russian attack on Ukraine on 24 Feb 2022, a deliberate cyber-attack caused disruption of Viasat's KA-SAT satellite broadband service in Europe.[30] The attack, which rendered almost 30,000 modems physically inoperable,[31] impacted not only users in Ukraine but also much of Europe, including wind turbines operated by German energy company Enercon.

Social-Engineering-Based Attacks: Social engineering attacks[32] have been used in the majority of successful data breaches and penetrations. This high success rate is due to a simple fact – these attacks target human behaviour and not IT systems. The purpose of these attacks is to gain usernames and passwords associated with critical systems. Attackers are no longer hacking into systems. They are logging in. Given this high rate of success, it is widely presumed that almost all attacks in the current conflict originated with a social-engineering-based attack. For instance:

- During the initial stage of the current conflict, Ukraine accused the Belarusian State-sponsored hacking group UNC1151 of attempting to hack the email accounts of its military personnel in a mass phishing attack.[33] Once the attackers infiltrated the email accounts of at least some military personnel, they leveraged the compromised address books to send more malicious emails.

- The threat actor APT28, attributed to Russia's GRU, has engaged in a credential phishing campaign, targeting users of the popular Ukrainian media company UKRNet[34].

- Mustang Panda,[35] a China-based threat actor, has been targeting European entities with lures related to the Ukrainian invasion. This is a departure from this group's normal targets based in Southeast Asia. The compromise chain includes decoy documents that are frequently updated and relate to events in Europe and the war in Ukraine.

- Google has reported[36] multiple DDoS attacks against the Ukrainian Ministries of Foreign Affairs and Internal Affairs, as well as against services such as Liveuamap, which are designed to help people find information.

- The Russian APT, Gamaredon, was found spreading the LoadEdge backdoor among Ukrainian organisations.[37] The backdoor allows Gamaredon to thereafter install surveillance software and other malware onto infected systems.

Ukrainian Cyber Operations

While there is widespread information about Russian cyber attacks targeting Ukrainian organisations, there is relatively little news about the outcomes of any cyber-attacks targeting Russian assets. There are two reasons for this. The first is the extensive coverage given by Ukraine, which has been amplified by Western governments and media outlets that are at odds with Russia. The second has been the success achieved by Ukraine in fending-off Russian cyberattacks, publicly claiming this success, and hence gaining an upper edge in the ongoing psychological warfare.

Ukraine has very effectively leveraged the outrage expressed by several Western countries, highlighting attacks on civilian infrastructure, and emphasising the humanitarian crises generated by the exodus of Ukrainian refugees. There are obvious comparisons with other conflicts and their coverage in the Western media. However, the information warfare aspects are heavily in favour of Ukraine precisely because of a near total clampdown on news inside Russia and therefore, lack of any credible inputs regarding the success or otherwise of Ukrainian offensive cyber operations. What little is known of these attempts have come to us from the individuals or groups that are involved in this effort.

As far as cyber-attacks go, there appears to be an ongoing 'crowd-sourced'[38] supplementary effort from Ukraine. The official Ukrainian government efforts are focused on defence of their networks. However, this has not stopped them from reaching out to the hacker community in carrying out offensive operations against Russia.[39]

Some of the other notable efforts aiding Ukraine on the cyber front include the following:

- **Ukraine's IT Army**: Ukraine's deputy prime minister and minister for digital transformation, Mykhailo Fedorov, announced the creation of a volunteer cyber army, the IT Army.[40] The IT Army has functioned by posting important targets to a Telegram channel, while individuals or groups use the details provided to launch attacks against the specified targets. The IT Army targeted the websites of several Russian banks[41], the Russian power grid and railway system, and has launched widespread DDoS attacks[42] against other targets of strategic importance.
- **Anonymous**: A decentralised group of hacktivists, Anonymous, "declared war" against the Russian State on 01 March 2022, and the group claims to have disabled sites run by Russia's State-owned media.[43] Anonymous appears to have targeted pro-Russia media outlets several times over the past few weeks. It also claimed to have hacked several major Russian broadcasters,[44] including State-run television channels.
- **Belarusian Cyber Partisans**: The Belarusian Cyber Partisans, a group that launched cyberattacks in January on Belarusian train systems in protest against Russian troop deployments in the country,[45] appears to be continuing its campaign. The attacks took down websites used to purchase tickets and may have encrypted data on switching and routing systems, although the scale and severity of the attacks beyond website-takedowns[46] remains unclear.
- **RURansom Wiper**: The emergence of the RURansom wiper on 01 Mar 2022, represents one of the first uses of a wiper by pro-Ukrainian hacktivists, and may portend a new phase in the ongoing cyber campaign against Russia. Despite its name, RURansom functions as a wiper, and offers victims no opportunity to pay to have their systems decrypted. The malware appears to check victim-systems for a Russian IP address, and if it doesn't find one, the malware halts execution. The malware creators also appear to be actively releasing new versions of the wiper, and it may grow far more potent over time.[47]

Support from Security Organisations: Microsoft[48] and the Slovakia-based ESET[49] have been proactively providing support to the Ukrainian organisations that have been attacked. For instance:

- Microsoft security teams have worked closely with Ukrainian government officials and cybersecurity staff at government organisations and private enterprises to identify and remediate threat activity against Ukrainian networks. Microsoft has also reported on Russia-aligned threat groups that were pre-positioning for conflict as early as March 2021, when threat actors that had sporadically targeted Ukraine in the past started to conduct more actions against organisations inside or allied with Ukraine. Microsoft has also announced the suspension of all new sales of products and services in Russia.

- ESET security researchers have been at the forefront of analysing the destructive wiper malware targeting Ukrainian institutions. The company continues to provide technical support to Ukrainian organisations that come under cyber-attack and has offered a free upgrade to higher versions of their products. ESET has also stopped sales of its products and services in Russia and Belarus.

Implications of Cyber Operations on the Rest of the World

Both players in the current conflict have used the digital media to propagate their own view of the ongoing conflict. The Western media has largely sided with the Ukrainian projection of it being the innocent victim of an unjust conflict inflicted by Russia. While official Ukrainian efforts have been focused on defending their own networks, they have, nevertheless, actively encouraged private efforts aimed at offensive actions against Russian organisations. In the opinion of many experts, Russia's formidable offensive cyber-capability has not been unleashed to the extent that was expected[50].

Even though the spill-over effect of offensive cyber-attacks[51] has not yet been observed, it remains a significant risk, because past experience has been that malware variants do not remain restricted to their intended targets. Stuxnet, WannaCry, and NotPetya, all spread well beyond the original targets. As a case in point, NotPetya, a malware designed to target Ukrainian organisations, caused damage worth US$ 300 million to Maersk, a shipping company based in Denmark.[52] Given that the US and EU have banded together in support of Ukraine, the scope of a broadening of the cyberwar can hardly be ruled out and present large-scale cyber-skirmishes could well become global due to the spill-over effect.

Ukraine's crowd-sourced cyber army encompasses the entire spectrum of cyber capabilities. On one end there are established cyber-security companies such as Microsoft and ESET, and on the other, there is a loose collective of hackers whose skills may not quite be up to the mark. It is understood that many so-called "script kiddies"[53] have also answered the call and joined-up. Script kiddies have at their disposal a large number of effective, easily downloadable programs capable of breaching computers and networks. The danger in using this amorphous group of hacktivists is that because they tend to run hacking tools without fully understanding how they work, they might accidentally damage unintended targets or prompt counterattacks by technologically superior nation-state hackers.

While there have been more than a hundred cyber-attacks in Ukraine since Russia's invasion, in most cases, their effect has been psychological. As such, according to a number of experts, these will not decide the outcome of the war.[54] In this hybrid war, with its mix of cyber and conventional weapons, it has been made amply clear that offensive cyber operations can at best be used in a supporting role and ultimately, it still remains "boots on the ground" that will win the battle.[55]

The dilemma of using cyber weapons to disrupt enemy facilities that rely on information technology is that this will also blind the attacker who then loses the ability to monitor the enemy. Due to its low capital investment, cyber warfare is normally the preferred option of a nation that does not possess advanced conventional weaponry, and by corollary, it is most effective against an adversary that has advanced information technology components enabling the various functions of the country. However, a technologically advanced nation would also be expected to possess a robust IT defence. Therefore, the effect of cyber warfare can never be decisively predicted while planning offensive operations.

The most effective component of information warfare in the present campaign by both sides has been in the use of media to spread information, and at times, disinformation. Obfuscation is one of the oldest tactics in a conflict when actors in a war flood a civilian population with misleading information. Its effect is largely psychological, but nevertheless effective. With its rapid dissemination of information regarding the Ukrainian version of events, stories of atrocities committed by Russian soldiers and almost daily briefings to world leaders and assemblies by the President himself, Ukraine presently has the upper hand.[56]

Conclusion

Russia's invasion of Ukraine has been a hybrid war from the start; a mix of conventional military strategy – traditional "boots on the ground" – and a slightly more unconventional, digital or cyberwar. There is enough evidence that the preparations for deploying cyber weapons against Ukraine began well before the start of the actual operations in February 2022. There have been repeated attacks using destructive malware on Ukrainian critical infrastructure that have been attributed to Russian entities. Almost all of these attacks have been thwarted by the Ukrainians, aided by US and EU based cyber security companies, who have helped in the detection and containment of these attacks.

In the present conflict, Ukraine, too, has used offensive cyber operations against targets in Russia, although this effort is largely the result of private citizens rather than a government-driven one. The effects of these efforts are not readily apparent due to the present paucity of information emanating from Russia.

While cyber warfare has been with us for some time now and although most technically advanced nations do possess offensive cyber capability, its use is still limited in effecting the overall outcome of a conflict. These limitations notwithstanding, psychological aspects of information warfare do affect civilian morale especially in times of tension and this aspect has been effectively used by both sides in the present conflict, albeit with Ukraine having won the battle for sympathy across much of the world.

ENDNOTES

1. Julia Voo et al, "National Cyber Power Index 2020", Belfer Centre for Science and International Affairs, Sep 20202. https://www.belfercenter.org/publication/national-cyber-power-index-2020.

2. Colin Demarest, "Blue, Yellow and Gray Zone: The Cyber Factor in Ukraine", C4ISRNET, 14 Mar 2022. https://www.c4isrnet.com/cyber/2022/03/14/blue-yellow-and-gray-zone-the-cyber-factor-in-ukraine/.

3. Wikipedia, s.v. "Stuxnet", last modified 24 Apr 2022, 12:56, https://en.wikipedia.org/wiki/Stuxnet.

4. Wikipedia, s.v. "Petya and NotPetya", last modified 17 Apr 2022, 20:42, https://en.wikipedia.org/wiki/Petya_and_NotPetya.

5. Press release, "Russian Federation Armed Forces' Information Space Activities Concept", Ministry of Defence of the Russian Federation, 22 Dec 2011. https://eng.mil.ru/en/science/publications/more.htm?id=10845074@cmsArticle.

6. Alena Epifanova, "Deciphering Russia's Sovereign Internet Law", DGAP, 16 Jan 2020. https://dgap.org/en/research/publications/deciphering-russias-sovereign-internet-law.

7. Alexander Marrow, "Russia Disconnects from Internet in Tests as it Bolsters Security – RBC Daily", 22 Jul 2021. https://www.reuters.com/technology/russia-disconnected-global-internet-tests-rbc-daily-2021-07-22/.

8. Press release, "Shoigu Spoke About the Tasks of the Information Operations Troops", RIA Novosti, 22 Feb 2017. https://ria-ru.translate.goog/20170222/1488617708.html?_x_tr_sl=auto&_x_tr_tl=en&_x_tr_hl=en&_x_tr_pto=wapp.

9. CISA Alert AA22-110A, "Russian State-Sponsored and Criminal Cyber Threats to Critical Infrastructure", Cybersecurity and Infrastructure Security Agency, 20 Apr 2022. https://www.cisa.gov/uscert/ncas/alerts/aa22-110a.

10. "MITRE ATT&CK Framework Groups", MITRE, 12 Oct 2021. https://attack.mitre.org/versions/v10/groups/G0035/.

11. MITRE ATT&CK Framework Groups, "APT29" MITRE, 16 Oct 2021. https://attack.mitre.org/versions/v10/groups/G0016/.

12. Press release, "Russia: UK Exposes Russian Involvement in SolarWinds Cyber Compromise", UK Foreign, Commonwealth & Development Office, 15 Apr 2021. https://www.gov.uk/government/news/russia-uk-exposes-russian-involvement-in-solarwinds-cyber-compromise.

13. Wikipedia, s.v. “Fancy Bear”, last modified 19 Apr 2022, 12:03, https://en.wikipedia.org/wiki/Fancy_Bear.

14. MITRE ATT&CK Framework Groups, “Sandworm Team”, MITRE, 14 Apr 2022. https://attack.mitre.org/groups/G0034/.

15. Kim Zetter, “Inside the Cunning, Unprecedented Hack of Ukraine’s Power Grid”, Wired, 03 Mar 2016. https://www.wired.com/2016/03/inside-cunning-unprecedented-hack-ukraines-power-grid/.

16. Press release, “Russian Military ‘Almost Certainly’ Responsible for Destructive 2017 Cyber Attack”, UK National Cyber Security Centre, 14 Feb 2018. https://www.ncsc.gov.uk/news/russian-military-almost-certainly-responsible-destructive-2017-cyber-attack.

17. Anthony Kasza and Dominik Reichel, “The Gamaredon Group Toolset Evolution”, Unit 42 Paloalto Threat Research, 27 Feb 2017. https://unit42.paloaltonetworks.com/unit-42-title-gamaredon-group-toolset-evolution/.

18. Press release, “SSU Identifies FSB Hackers Responsible for Over 5000 Cyber-attacks against Ukraine”, Security Service of Ukraine, 04 Nov 21. https://ssu.gov.ua/en/novyny/sbu-vstanovyla-khakeriv-fsb-yaki-zdiisnyly-ponad-5-tys-kiberatak-na-derzhavni-orhany-ukrainy.

19. MITRE ATT&CK Framework Groups, “Turla” MITRE, 27 Aug 2021. https://attack.mitre.org/versions/v10/groups/G0010/.

20. Mitre ATT&CK Framework Software, “Conti”, MITRE, 21 Jun 2021. https://attack.mitre.org/versions/v10/software/S0575/.

21. Trend Micro Research, “Cyberattacks are Prominent in the Russia-Ukraine Conflict”, Trend Micro, 03 Mar 2022. https://www.trendmicro.com/en_us/research/22/c/cyberattacks-are-prominent-in-the-russia-ukraine-conflict.html.

22. Wikipedia s.v. “Wiper (malware)”, last modified 03 Apr 2022, 16:25, https://en.wikipedia.org/wiki/Wiper_(malware).

23. Kyle Fendorf and Jessie Miller, “Tracking Cyber Operations and Actors in the Russia-Ukraine War”, Council on Foreign Relations, 24 Mar 2022. https://www.cfr.org/blog/tracking-cyber-operations-and-actors-russia-ukraine-war.

24. Blog post, “Destructive Malware Targeting Ukrainian Organizations”, Microsoft Threat Intelligence Center, 15 Jan 2022. https://www.microsoft.com/security/blog/2022/01/15/destructive-malware-targeting-ukrainian-organizations/.

25. Press release, “UK Assesses Russian Involvement in Cyber-attacks on Ukraine” UK Foreign, Commonwealth & Development Office, 18 Feb 2022. https://www.gov.uk/government”/

news/uk-assess-russian-involvement-in-cyber-attacks-on-ukraine.

26. Juan Andrés Guerrero-Saade, “HermeticWiper New Destructive Malware Used In Cyber Attacks on Ukraine”, Sentinal Labs, 23 Feb 2022. https://www.sentinelone.com/labs/hermetic-wiper-ukraine-under-attack/.

27. Press release, “Ukraine Hit by Destructive Attacks Before and During the Russian Invasion with HermeticWiper and IsaacWiper”, ESET Research, 01 Mar 2022. https://www.eset.com/int/about/newsroom/press-releases/research/eset-research-ukraine-hit-by-destructive-attacks-before-and-during-the-russian-invasion-with-hermet/.

28. Michael Dereviashkin, “New Analysis: The CaddyWiper Malware Attacking Ukraine”, Morphisec blog post, 05 Apr 2022. https://blog.morphisec.com/caddywiper-analysis-new-malware-attacking-ukraine.

29. Patrick Howell O’Neill, “Russian Hackers Tried to Bring Down Ukraine’s Power Grid to Help the Invasion”, MIT Technology Review, 12 Apr 2022. https://www.technologyreview.com/2022/04/12/1049586/russian-hackers-tried-to-bring-down-ukraines-power-grid-to-help-the-invasion/.

30. Raphael Satter, “Satellite Outage Caused ‘Huge Loss in Communications’ at War’s Outset -Ukrainian Official”, Reuters news report, 15 Mar 2022. https://www.reuters.com/world/satellite-outage-caused-huge-loss-communications-wars-outset-ukrainian-official-2022-03-15/.

31. Press release, “KA-SAT Network Cyber Attack Overview”, Viasat, 30 Mar 2022. https://www.viasat.com/about/newsroom/blog/ka-sat-network-cyber-attack-overview/.

32. Wikipedia s.v. “Social engineering (security)”, last modified 28 Apr 22, 12:30, https://en.wikipedia.org/wiki/Social_engineering_(security).

33. Catalin Cimpanu, “Ukraine says Belarusian Hackers are Targeting its Military Personnel”, The Record, 25 Feb 2022. https://therecord.media/ukraine-says-belarusian-hackers-are-targeting-its-military-personnel/.

34. Elizabeth Montalbano, “Russian APTs Furiously Phish Ukraine”, Threat Post, 09 Mar 2022. https://threatpost.com/russian-apts-phishing-ukraine-google/178819/.

35. Mitre ATT&CK Framework Groups, “Mustang Panda”, MITRE, 11 Apr 2022. https://attack.mitre.org/groups/G0129/.

36. Shane Huntley, “An Update on the Threat Landscape”, Google Threat Analysis Group, 07 Mar 2022. https://blog.google/threat-analysis-group/update-threat-landscape-ukraine/.

37. Charlie Osborne, “Ukraine Warns of Invisimole Attacks Tied to State-Sponsored Russian

Hackers", ZD Net, 21 Mar 2022. https://www.zdnet.com/article/ukraine-warns-of-invisimole-attacks-tied-to-state-sponsored-russian-hackers/.

38. Wikipedia s.v. "Crowdsourcing", last modified 30 Apr 22, 12:14, https://en.wikipedia.org/wiki/Crowdsourcing.

39. Joel Schectman et al, "Ukrainian Cyber Resistance Group Targets Russian Power Grid, Railways" Reuters, 02 Mar 2022. https://www.reuters.com/technology/ukrainian-cyber-resistance-group-targets-russian-power-grid-railways-2022-03-01/.

40. Matt Burgess, "Ukraine's Volunteer 'IT Army' Is Hacking in Uncharted Territory", Wired, 27 Feb 2022. https://www.wired.com/story/ukraine-it-army-russia-war-cyberattacks-ddos/.

41. Thomas Brewster, "Moscow Exchange, Sberbank Websites Knocked Offline—Was Ukraine's Cyber Army Responsible?", Forbes, 28 Feb 2022. https://www.forbes.com/sites/thomasbrewster/2022/02/28/moscow-exchange-and-sberbank-websites-knocked-offline-was-ukraines-cyber-army-responsible/.

42. Sergiu Gatlan, "Russia Shares List of 17,000 IPs Allegedly DDoSing Russian Orgs", Bleeping Computer, 05 Mar 2022. https://www.bleepingcomputer.com/news/security/russia-shares-list-of-17-000-ips-allegedly-ddosing-russian-orgs/.

43. Chris Morris, "Hacker Collective Anonymous Declares War on Russia", Fortune, 01 Mar 2022. https://fortune.com/2022/03/01/anonymous-declares-cyber-war-on-russia/.

44. Carmela Chirinos, "Anonymous Claims it Hacked into Russian TVs and Showed the True Devastation of Putin's Ukraine Invasion", Fortune, 08 Mar 2022. https://fortune.com/2022/03/07/anonymous-claims-hack-of-russian-tvs-showing-putins-ukraine-invasion/.

45. Peter Dickson, "Cyber Partisans Target Russian Army in Belarus Amid Ukraine War Fears", Atlantic Council, 26 Jan 2022. https://www.atlanticcouncil.org/blogs/belarusalert/cyber-partisans-target-russian-army-in-belarus-amid-ukraine-war-fears/.

46. Ryan Gallagher, "Belarus Hackers Allegedly Disrupted Trains to Thwart Russia", Bloomberg, 28 Feb 2022. https://www.bloomberg.com/news/articles/2022-02-27/belarus-hackers-allegedly-disrupted-trains-to-thwart-russia.

47. Jaromir Horejsi and Cedric Pernet, "New RURansom Wiper Targets Russia", Trend Micro, 08 Mar 2022. https://www.trendmicro.com/en_us/research/22/c/new-ruransom-wiper-targets-russia.html.

48. Brad Smith, "Digital Technology and the War in Ukraine", Blog post by Microsoft President, 28 Feb 2022. https://blogs.microsoft.com/on-the-issues/2022/02/28/ukraine-russia-digital-war-cyberattacks/.

49. Press Release, “UA Crisis – ESET Response Centre”, ESET, 08 Mar 2022. https://www.eset.com/int/ua-crisis/.

50. Sean Lyngaas, “Russia’s Cyber Offensive Against Ukraine has been Limited so far”, CNN, 12 Mar 2022. https://edition.cnn.com/2022/03/12/europe/russia-ukraine-war-cyber-attacks/index.html.

51. K V Kurmanath, “Russia-Ukraine War Could Spill Over to Cyber Space”, The Hindu Business Line, 25 Feb 2022. https://www.thehindubusinessline.com/info-tech/russia-ukraine-war-could-spill-over-to-cyber-space/article65084334.ece.

52. Adam Bannister, “When the Screens went Black”, Portswigger, 09 Dec 2019. https://portswigger.net/daily-swig/when-the-screens-went-black-how-notpetya-taught-maersk-to-rely-on-resilience-not-luck-to-mitigate-future-cyber-attacks.

53. Nancy R Mead et al, “Security Quality Requirements Engineering (SQUARE) Methodology”, Carnegie Mellon University, Nov 2005: 56, https://doi.org/10.1184/R1/6583673.v1.

54. Stuart Madnick, “What Russia’s Ongoing Cyberattacks in Ukraine Suggest About the Future of Cyber Warfare”, Harvard Business Review, 07 Mar 2022. https://hbr.org/2022/03/what-russias-ongoing-cyberattacks-in-ukraine-suggest-about-the-future-of-cyber-warfare.

55. Doron Tamir, “Cyberattacks Don’t Win Wars”, Defense News, 13 Apr 2022. https://www.defensenews.com/opinion/commentary/2022/04/13/cyberattacks-dont-win-wars/.

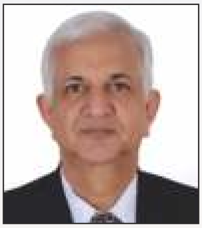
56. Sara Brown, “In Russia-Ukraine War, Social Media Stokes Ingenuity, Disinformation”, MIT Sloan School, 06 Apr 2022. https://mitsloan.mit.edu/ideas-made-to-matter/russia-ukraine-war-social-media-stokes-ingenuity-disinformation.

About the Author

Commander Subhash Dutta is a former Indian Naval Officer and Adjunct Fellow at the National Maritime Foundation. He can be contacted at subhashdutta.nmf@gmail.com

Note

This article was previously published on Website of National maritime Foundation on 10 May 2022



Vice Admiral Pradeep Chauhan, AVSM & Bar, VSM, is an alumnus of the National Defence Academy, the Defence Services Staff College, the Naval War College, and the National Defence College, with BSc, MSc and MPhil degrees under his belt. He is currently the Director-General of the National Maritime Foundation, New Delhi. The NMF is India's foremost resource centre for the development and advocacy of strategies for the promotion and protection of India's maritime interests. The admiral retired on 30 November 2013 after an illustrious four-decade-long career in the Executive Branch of the Indian Navy. His sea-going service incorporated as many as four Command Tenures, culminating in his command of the aircraft carrier, the *Viraat*.

Commodore Debesh Lahiri is an alumnus of the Naval Engineering Course (NEC), Naval Engineering College, INS Shivaji, Lonavala and College of Defence Management (CDM), Secunderabad. He was commissioned into the Indian Navy on 25 November 1988. He is a Marine Engineer by profession and has completed his Master's (MTech) from Indian Institute of Technology (IIT), Chennai. He has completed a World Bank programme on Alternate Dispute Resolution-Arbitration, Conciliation and Mediation. He was the Deputy Naval Attaché at the Embassy of India, Moscow, and has been at the helm of two Naval ship Repair Yards, at Port Blair and Karwar respectively. He has a wide experience at sea, having been Engineer Officer on steam, diesel, and gas-turbine propelled ships.

Raghvendra Kumar is an Associate Fellow at the National Maritime Foundation (NMF). He has done his BA and MA from Kirori Mal College, and MPhil from the Department of African Studies, University of Delhi. He is currently pursuing his PhD on the topic *China's Engagement with the Island States of Africa in the Western Indian Ocean Region: Implications for India* from the same institution. At the NMF, his primary research focuses on the Maritime Geostrategies of the East African Coastal and Island States, and the challenges to maritime security in the Western Indian Ocean Region. Before joining the NMF, he taught at the Department of Political Science, Maharaja Agrasen College, University of Delhi. He is also the co-author of the book *Oceanic Strategy: India and Other Powers in the Indian Ocean* published by Routledge, India (Forthcoming, January 2023).

Rs. 600.00

ISBN 978-81-959791-0-3

9 788195 979103

National Maritime Foundation

Varuna Complex, Airport Road,
NH-8, New Delhi-110 010