THE EXPECTED UPSURGE IN THE INDO-ISRAEL DEFENCE COOPERATION

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CHALLENGES OF EFFECTIVE UNDERWATER DOMAIN AWARENESS IN THE INDIAN OCEAN REGION

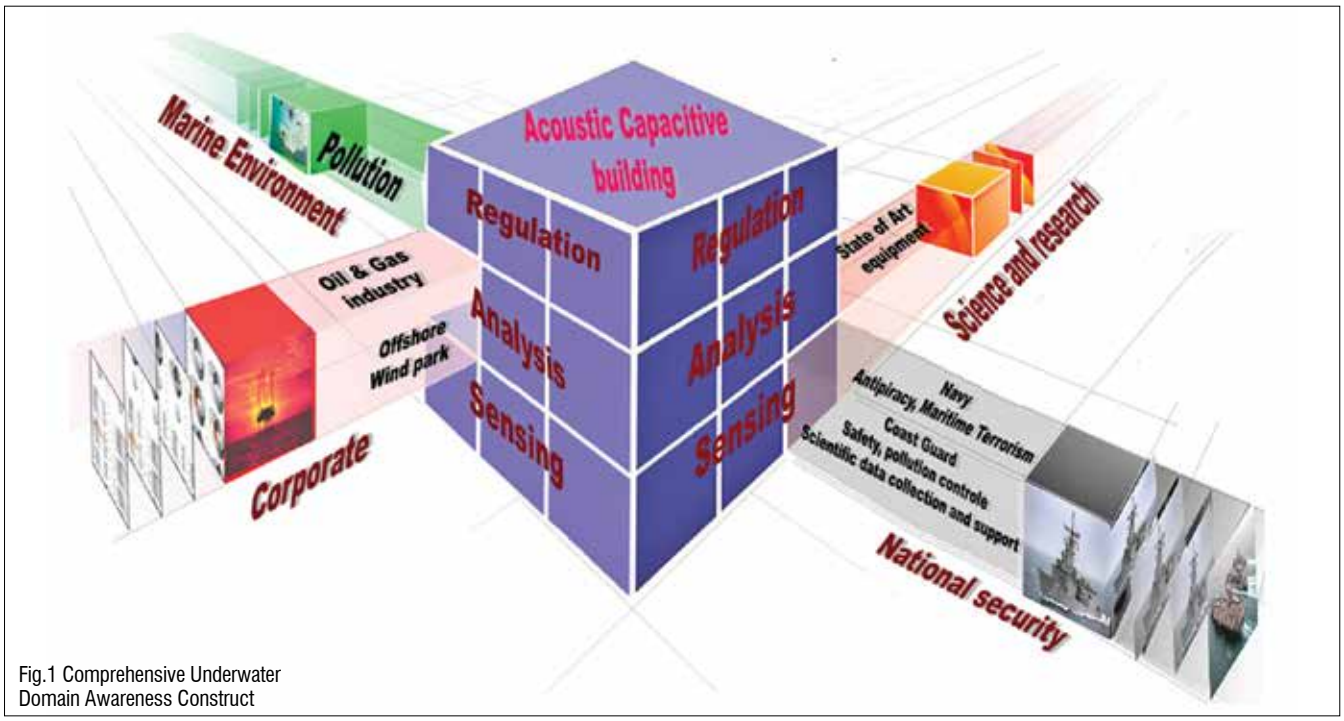

Fig.1 Comprehensive Underwater Domain Awareness Construct

Enhanced UDA will bring more clarity on the regulatory aspects and may aid maintenance of good order at sea, writes **DR. (CDR) ARNAB DAS**

"The development of blue economy can serve as a growth catalyst in realising the vision to become a $10 trillion economy by 2032"

Niti Ayog in its blog dated February 14, 2017

India and the government is making massive economic, political and diplomatic endeavor to be a formidable global power and the maritime potential has received the much-deserved impetus now. Maritime capacity and capability building is being given significant priority with massive project allocations and policy support. The underwater component of the maritime space does contain much of the wealth and also poses a significant threat from a security and defence standpoint. The oceans regulate the environment and are the origin of most of the natural disasters. The present understanding of what is there or going on in the vast undersea domain is minuscule. The concept of Underwater Domain Awareness (UDA) like the Maritime Domain Awareness (MDA) is a structured attempt to generate real-time situational awareness of the undersea space. The four stakeholders namely the national security apparatus, components of the blue economy, regulators of environment and disaster management authorities and the science and technology providers do have specific requirements and outlook towards the UDA concept. However, the basic acoustic capability which is the core requirement for an effective UDA construct remains a cause of concern. The entire UDA construct is presented in *Fig-1*.

The acoustic capability involves effective sensors and also the vehicles or platforms that can facilitate reach of these sensors to every nook and corner of the vast undersea space. These platforms could be ships, submarines, Remotely Operated Vehicles (ROVs), Autonomous Underwater Vehicles (AUVs), Underwater Gilders (UG), static and mobile observatories, underwater sensor networks and much more. Each of these will have their specific advantages and limitations, but we will require near an infinite number of all types of vehicles or platforms to be able to map the entire underwater space in the Indian Ocean Region (IOR). The alternative is to evolve a network that has the capability to collect data from all kinds of seagoing platforms and integrate into a system that can present the larger picture for UDA. All possible sources of information need to be gathered and analyzed to construct the broad UDA framework. Thus, the requirement is threefold – sensors, their platforms and also a network that can gather inputs from conventional and unconventional sources.

The challenges of realizing effective

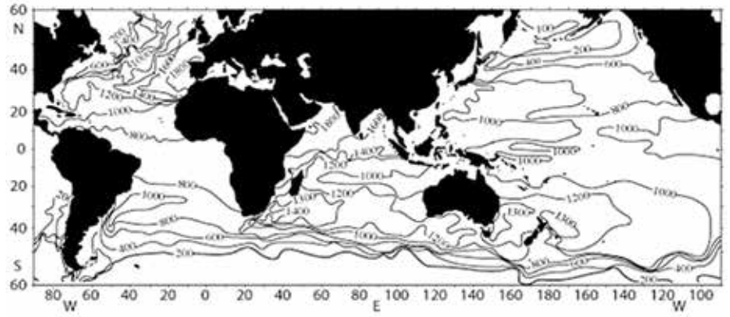

Fig 2: Sound Axis Variability (*Source: DOSITS*)

UDA in the IOR comprises of multiple dimensions, ranging from technology, infrastructure, regulatory, strategic, etc. The entire acoustic capability limitation originates from our continental outlook since independence. Maritime consciousness has eluded us in every facet of nation building.

The technology gap emanates from the acoustic sensor itself. The western manufacturers continue to monopolize the supply and since the larger underwater applications remained in the military domain, the dual use technology tag ensured high cost. The sanctions and import restrictions always discouraged widespread use of such devices for academic and non-military research. The indigenous efforts in developing acoustic sensors have been too little too late and could not match the quality standards even for low-end requirements. The vehicles to carry the sensors are again a gray area. The indigenous efforts to design and develop autonomous and unmanned underwater platforms have been lackadaisical. A primary reason could be that many attempts at design and development of such vehicles has been without the precise application. These attempts have been to develop a general purpose vehicle. However, it is important to appreciate that precise application determined the entire payload and based on that one needs to finalize power requirements, control and navigation, sensors, etc. Such attempts only get us a technology demonstrator and do not go any further to make a deployable system in the real sea. Any deployment in the undersea domain requires sea legs and other than the Indian Navy (IN) and the Indian Coast Guard (ICG), there is hardly any agency under the government or otherwise, that can reach the length and width of the IOR. The overhyped security concerns also block any private efforts to undertake undersea acoustic surveys or development of AUV/UUVs. It may also be admitted that indigenous private sector wants firm orders before they invest in R&D to develop underwater systems of any kind. The government wants them to prove their capabilities before big orders can be placed. The chicken and the egg story continues.

The tropical littoral waters in the IOR have a significant impact on the sonar performance. The definition of littoral waters attains a new dimension in the IOR due to underwater medium characteristics. As per the hypsometric definition of shallow water, widely used during the Cold War period, the extent of the continental shelf with 200 m depth was considered to be the threshold of deep waters. The entire evolution of sonar technology during the Cold War era was in the deep waters of the temperate region. The sound velocity profile of the temperate region allowed access to the sound axis (with minimum sound speed) within the 200 m depth. The depth of sound axis varies from 50 m near the poles to 2,000 m near the equator. Thus, from an acoustic perspective, the IOR always behaves like littoral waters even up to 2000 m depth causing severe degradation to sound propagation due to the multipath phenomenon. The sound axis facilitates sonar signal propagation with minimal interaction with the surface and the bottom. The multiple interactions with the boundaries (surface and the bottom) in the tropical region ensure that the sonar signal gets corrupted due to the surface and bottom fluctuations. Also, the rich bio-diversity and the characteristic boundary properties in the tropical region further complicate matters. *Fig-2* and *Fig-3*, presents the sound axis variability and biodiversity across the globe. Detailed oceanographic studies with channel modeling and ambient noise mapping in the IOR can minimize medium impact. Such field experiments in the vast IOR will entail massive resource deployment in terms of hardware and software. Such investments are not possible by individual stakeholders.

Integrating multiple stakeholders always raises the security concerns and many times ambitious proposals get blocked. The government with its limited resources cannot build the acoustic capabilities just for the national security requirement. The post-liberalized India is a different reality and it has only fragmented the stakeholders in the maritime domain. The components of the blue economy are trying to import technologies and undertake acoustic surveys, however, beyond a point, their efforts get blocked citing national security concerns. The participation of academic and research institutes in field studies is near zero. No university, in this country runs a comprehensive underwater technology curriculum that can generate a human resource for the emerging underwater technology industry. Acoustic aspects of underwater signal processing are taught only in IIT Delhi that has no access to the sea. Even after four decades of research and academic efforts, the group has not grown and probably when the present set of experts retire the capability will be gone with them. The concept of academic institutes taking on underwater research does not work for real-world problem-solving. We need independent research institutes that have clear mandates and sustain themselves on soft funding and not get spoiled by unquestioned government support. These institutes should have strong collaboration with academic institutes to produce state-of-the-art technology and capable human resource. Overstretched faculties in our academic institutes are left with no energy to undertake meaningful research beyond their academic load.

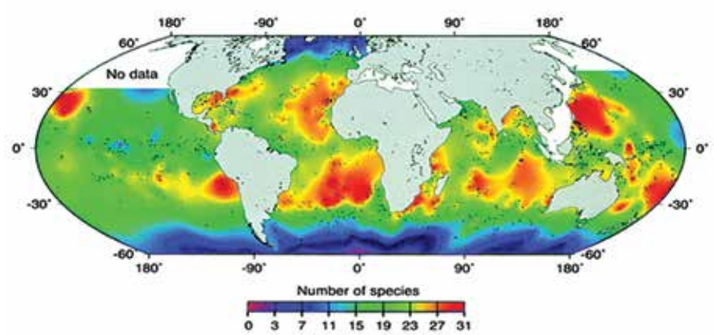

Fig 3: Phytoplankton diversity which is directly related to the biodiversity and biological density of the region (*Source: Nature Journal*)

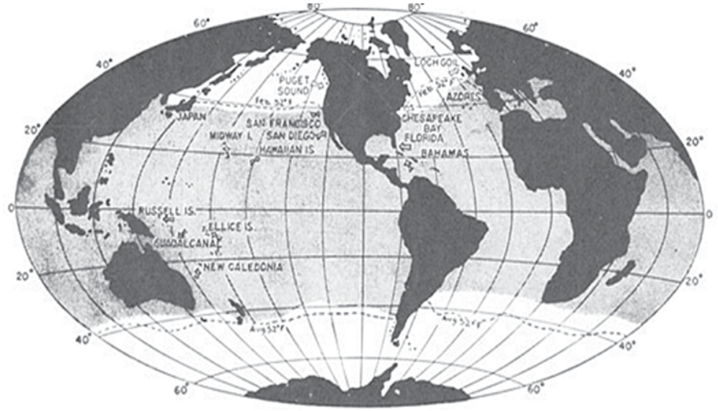

Fig 4: Snapping Shrimp density (*Source: Naval sonar document*)

The combination of real experimental validation with simulation and modeling is the only way forward. The US Scripps Research Institute undertook Snapping Shrimp mapping and their acoustic characterization globally in 1946, when even transducer technology was still evolving. The US launched their first nuclear submarine in the year 1952. These two developments do have a connection and many years later in late 1980's, when the first INS Chakra was operationally deployed, it was sitting on a Snapping Shrimp bed and the entire sonar screen got blanked. The Captain had to resort to blast transmission to get out of the situation, which any naval commander knows is suicidal in an operational deployment. The tropical warm waters are a known habitat for these highly noisy creatures and the IOR is in the middle of it. *Fig-4*, presents the Snapping Shrimp habitat globally.

The above discussion brings to fore the requirement of pooling of resources by the stakeholders to undertake massive efforts to generate acoustic surveys in the IOR. The horizontal construct of *Fig-1*, indicates diverse requirements of UDA for the four stakeholders (represented by the four faces of the cube), however the acoustic capacity will remain the core capability. The sensed data will mean different things to different stakeholders. The biological signals from marine species like Snapping Shrimps are noise for naval sonar operators. However the same signal is the desired signal for marine biologists studying the marine acoustic habitat. Sonar transmissions are big sources of acoustic habitat degradation for the marine mammals leading to frequent stranding. The undersea soundscape has many components of sound that interact with each other and also get modified by the medium conditions. Precise qualitative and quantitative understanding of the entire soundscape could give us a good sense of the developments in the undersea realm and facilitate effective UDA. The stakeholders need to invest and ensure the indigenous development of sensors, vehicles, acoustic analysis with field experimental validation, even material research to develop material that withstands long term deployments in the corrosive sea conditions and much more.

Now once we ensure good sensing and analysis capabilities to derive clean data that is not corrupted by medium fluctuations and filtered from undesired noise from other sources, we can move up the vertical construct to derive a meaningful interpretation of the collected data. Tactical and strategic conclusions can be drawn from the processing of such data over a sustained period of time. Any regulatory framework will require precise understanding of the present situation and how each stakeholder is interacting with the undersea domain. The multiple debates like national security vs. development, conservation vs. growth, national security vs. environment and many more will continue to hijack the effective governance and policy formulation in the absence of UDA. The IOR is poorly regulated for each of the stakeholders and that is causing extra-regional powers with enhanced access to exploit the resources in the region and also plunder the environment. It is a vicious cycle, the absence of regulations evades good order and peace in the region and that encourages military build-up at the cost of development. Poor development ensures least regards for the environment and so investments for technology and sustainable growth gets no priority.

The IOR nations are still struggling with basic needs for their citizens and have failed to come out of this vicious cycle. The political instability and economic developing nation status have prevented considered and comprehensive view of the entire maritime domain awareness aspect. Diplomatically extra-regional powers from the west and the east have managed to exploit the chaos and formed alliances to encourage more chaos. The economic and political pressures to go seaward is only increasing and the blue economic push in the absence of UDA and sound regulatory framework could mean disaster in the IOR. There seems to be no clarity on the finer aspects of regulatory requirements for each of the stakeholders. Enhanced UDA will bring more clarity on the regulatory aspects and may aid maintenance of good order at sea.

A leadership role by India with its geostrategic location in the region is called for to bring together all the nations under a comprehensive UDA framework that will lead to sound regulatory formulations in all the aspects of the undersea domain. Enhanced acoustic capacity can be leveraged diplomatically to bring these nations under one umbrella and realize our vision of 2032 as envisaged by the Niti Ayog. This will substantially minimize the relevance of the extra-regional powers that are here to encourage the chaos for their vested interest.

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