An Autonomous Real Time Passive Acoustic Monitoring system to investigate the Ocean Environment.

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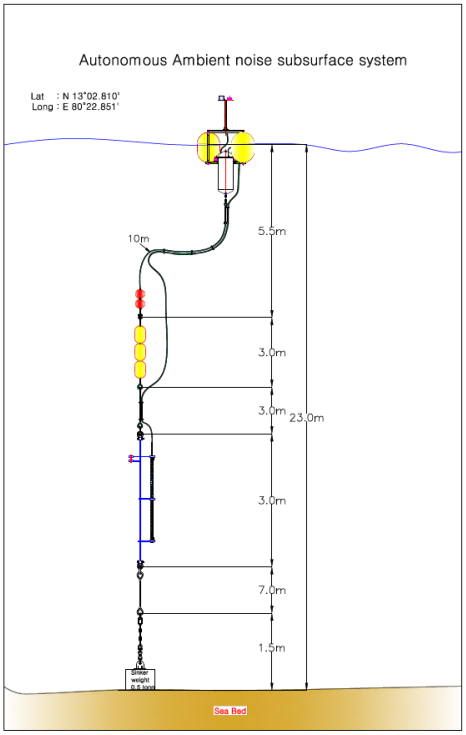
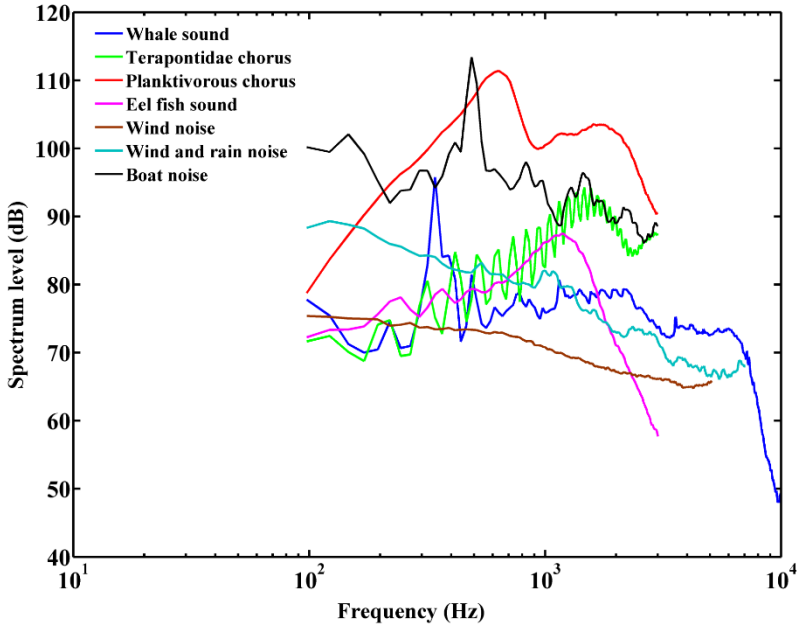
The background noise prevailing in the ocean is caused by geophonic, biophonic and anthropogenic sources and continuous monitoring the ocean ambient noise, it is possible to estimate the ocean environmental parameters such as wind, rain, ocean depth, type of sea bed, sub bottom, seismic activities, marine species and the man made activities such as shipping, pile driving and other offshore activities. Also, since most of the technologies for underwater applications use active sonars, estimation of prevailing noise in the region of interest is very crucial for successful operation of the acoustic system. Keeping these in view, the Ocean Acoustics team of National Institute of Ocean Technology developed an autonomous passive acoustic monitoring system for time series measurements of ocean ambient noise over long term and deployed / operated at many shallow water locations off the Indian coast successfully. The system consists of a vertical linear array of hydrophones, data acquisition system, battery pack, acoustic pinger and subsurface floats which are connected through a mooring line and deployed at the required ocean depth.



- No. of hydrophones – 21
- Freq – 100 Hz to 20 kHz
- Spacing - 7.5cm
- Data acquired every 1 hours
- Sampling frequency – 100 kHz

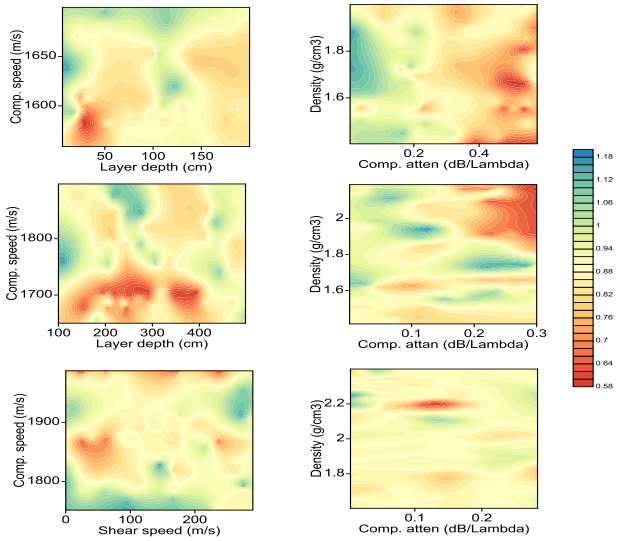
The time series data obtained in shallow waters off Cochin, Goa, Vizag, Chennai and Cuddalore were analysed and noise due to wind, rain, fish and mammals , shipping other anthropogenic activities were identified. The soundscape studies off Cochin is shown below.



The vessel noise at the shallow water sites have been identified and noise levels have been analysed.

Also the array data has been used for seabed characterization using geo acoustic inversion technique.

Estimation of seabed geoacoustic parameters such as compressional/shear speed, compressional/shear attenuation, density and layer depths carried out. Inversion attempted for 2 sites with soft bottom (absorptive) and hard bottom (reflective).

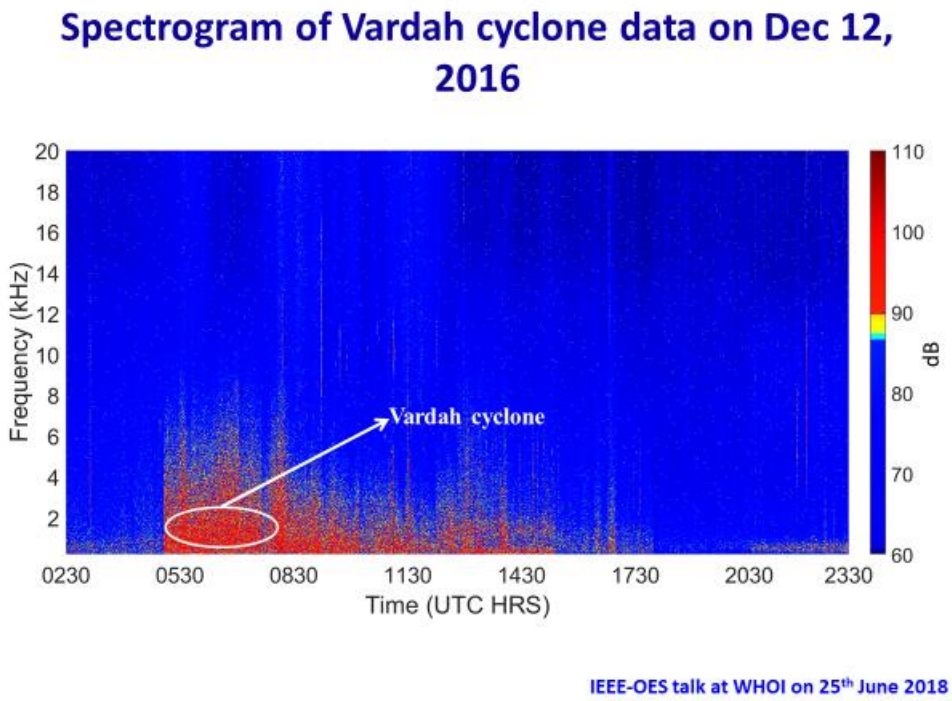


The coherence based inversion gives reasonable estimate for silty site, aided by absorbing nature of the seabed. Silty site: Surficial layer of silty and clay with higher organic content, Silty/sandy substrata. Sandy site: Surficial layer of high fine sand content. Substrata of well sorted medium to fine sand.

Further , real time transmission of processed data was achieved by incorporating different communication modems such as RF, Wi-Fi and INSAT and all were tested and operated successfully in the field.

Sl. No.	**Type of communication**	**Range**	**Requirements**	**Field**	**Remarks**
1	WIFI	≤ 2 km	Receiver station required at shore.	Off Chennai	Data can be transmitted from surface buoy to shore.
2	RF	≤ 15 km	Receiver station required at shore.	Off Goa	Data can be transmitted from surface buoy to shore.
3	GPRS	GSM tower range	No receiver station required at shore.	Off Chennai	Data can be accessed directly from FTP server of NIOT.
4	INSAT	-	-	Off Chennai	Limitations in data size

The system withstood cyclonic events such as Jal and Vardhah and recorded data. The Vardah Cyclone crossed the coast of Chennai on Dec 12, 2016 the autonomous system operated in shallow waters off Chennai recorded the data during cyclone.



Subsequently, the development of Vector sensor Array(VSA) has been taken up since vector sensors can provide underwater source localization precisely since acoustic particle velocity is also measured along with acoustic pressure . VSA enables accurate estimation of Direction of Arrival and Range form the source, with very less number of elements in the array.

The highlights of the autonomous system, data analysis techniques, soundscape studies carried out in various shallow water regions along the Indian coast and challenges faced in Passive Acoustic Monitoring are preented. Also the development of autonomous system using vector sensor array is described which will be used in future deployments.