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Review
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THE CENTRESPREAD
IS IT 'RIP CONGRESS' IN GOA?

KONKNNI DAIZ
KONKNNI BHAS AMCHEM DAIZ ANI TICH AMCHI OSMITAI

Fish in troubled waters

Sound is critical for communication between all living creatures. While soft chatter indicates happy atmosphere, loud noise levels signify signs of disturbance. SHASHWAT GUPTA RAY reports on two different studies related to sounds observed underwater off Goa shores and their implications on marine life, especially the fish, which are critical for the people of Goa. While the first study deals with the issue of marine sound pollution caused by human activities, the other establishes a direct link between variations in sound emitted by fish and temperature change underwater

While harmful impact of noise pollution on land is well documented, however very little is known to the common people about the impact of marine noise pollution caused by human activities.

Now, a study has been done by researchers at BITS Pilani, Goa campus in which noise levels were recorded from under water off Goa coast. The study found high anthropogenic noise levels under water caused by human activities like movement of ships, tourism activities, and construction activities viz building of bridge amongst others. This is going to have long-term impact on the fish availability in Goa.

The research was carried out by Commodore (retd) K Laxmi Narasimha Chary in pursuit of his PhD degree, under the supervision of Dr (Prof) Mukund K Deshmukh and Dr (Prof) Nitin Sharma at the Department of Electrical and Electronics Engineering of BITS, Pilani K K Birla Goa Campus, is the first ever attempt to develop a comprehensive marine soundscape at the marine site near the coast of Goa.

"The marine site is characterised in terms of measured values of the existing noise levels and corresponding frequencies, and also their variation over time of the day, time of month, time of the season, and time of the year. I have undertaken the study as part of my PhD thesis to develop underwater soundscape in shallow tropical coastal waters near Grande Island biodiversity site," Commodore Chary told Herald.

There were many challenges encountered while taking the underwater measurements of sound levels as part of the study.

"Main was monsoon weather. No underwater measurements could be undertaken during May to October due to rough seas and the instruments getting damaged. This is the first underwater soundscape developed based on long term measurements in Indian waters," the Indian Navy veteran officer said.

This will be useful to monitor the human made underwater noise pollution in marine environment that is increasing and threatening marine life. Noise radiated by ships, fishing and tourist boats can be monitored and noise control regulations can be implemented near Grande island to protect marine life.

"Goa coastline provides livelihood to fishermen communities, and it should be ensured that fish species are not threatened by underwater noise pollution. Marine ecosystem in estuaries also needs to be protected from underwater noise pollution. Noise maps are required to be generated for bio diverse zones to monitor underwater noise pollution," he said.

A marine soundscape is essentially a comprehensive representation of existing sound (or noise) levels in an underwater environment. Study of soundscapes is an emerging field of research that attempts to provide important baseline information on environmental conditions and also biological composition of the underwater environment.

The measurements have been carried out at the site using three distinct innovative methods. The measurement site is located close to Grade Island Archipelago near the coast of Goa, about 16 km west of the Dabolim International Airport.

"The measurements have been recorded over a long period, spanning many years. It is found that the measured noise is mostly a low frequency noise ranging from near zero to 10 kHz, which confirms the presence of the diverse biophonic sources, including variety of fish, snapping shrimps, dolphins, near the site," said Dr Deshmukh, who was the research guide for the study.

It may be noted that the Grande Island Archipelago is globally recognized as the biodiverse site. Also, the existence of higher levels of noise in the range 10 Hz to 10 kHz is recorded at the site, which confirms that the noise levels due to anthropogenic sources such as shipping and boat traffic and off-shore constructions, etc, are regularly contributing to the soundscape at the site.

"The trends in the measured noise levels at the site clearly show that the noise levels due to anthropogenic sources are increasing over the period of measurement and these may interfere with the frequencies used by the aquatic species for their livelihood. It is well known that the consistent excessive noise levels may be fatal to the aquatic ecosystem as these hamper communication between the marine animals and, in the long run, may be a major threat to the existence of a bio diverse marine site near the Grande Island Archipelago," the senior faculty said.

In may be noted that in contrast to environmental regulatory practices in the advanced countries such as the USA, Europe, New Zealand and Australia, the inclusion of underwater noise in Environment Impact Assessment in India, is of recent origin.

"There is urgent need to measure underwater noise levels and establish baseline soundscapes for the site. To this end, there is scope for developing appropriate measurement schemes using the available technologies and appropriate formats of soundscapes for standardization.

"Also, there is wide scope for developing Artificial Intelligence-based computer models for prediction of noise levels over short and long terms, using the data generated through extensive measurements. The present research emphasizes need to continue efforts in this direction," he said.

Scientist-Emeritus at National Institute of Oceanography Bishwajit Chakraborty, an authority on marine soundscape, said behaviour of the fish gets affected due to noise created by human activities.

"Due to the constant noise pollution, the communication system fails and their ears get affected. Their otolith bone sare getting adversely affected, degrading the hearing system of the fish. The impact is already seen on ground. For example, off Goa coast, you find that fish are coming up at night and going down in the daytime. This is affecting their breeding due to the noise as they are unable to hear each other mating calls," Dr Chakraborty said.

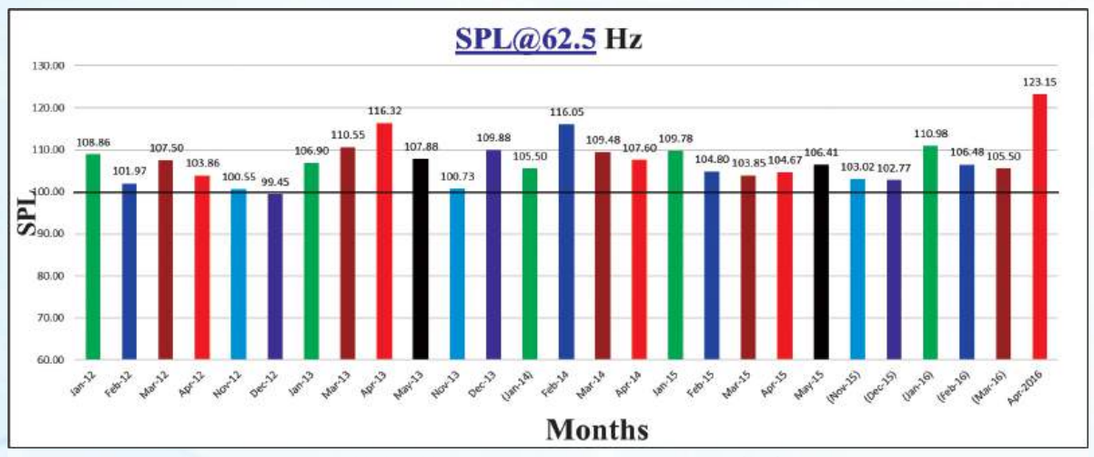
This according to him, will result in the fish species moving out of their current location in search of more peaceful environment, which will result in unavailability of fish that are found now.

"Moreover, Fish are important members of aquatic ecosystems and indicators of water quality..A healthy aquatic ecosystem contains a good balance of producers (like algae and aquatic plants), consumers (like zooplankton and invertebrates), and predators (like fish)"Dr Chakraborty said.

Director of NIO Sunil Kumar Singh said there are different kinds of fish that are found underwater which produce different kinds of sounds to communicate with each other.

"Their sound frequency is very low. The source level and frequency of the signals generated by human activities is very harmful for their biology. Their daily activity is affected since noise pollution acts as a barrier in their communication process. This will also affect the fish productivity," Dr Singh said.

International Quite Ocean Experiment (IQOE) is an international program of research, observation, and modelling to characterize ocean sound field to promote understanding of sound on marine life initiated from 2016 through the funding from the Sloan Foundation to SCOR (Scientific Committee on Ocean Research).Dr Chakraborty represented India in the IQOE founding committee (2016-2018).



During the period of measurement from 2012 to 2014, variation of sound pressure level (SPL)is shown with the months in a year. It can be seen from the figure that the SPL exceeded average value of 100 decibel on multiple locations indicating high level of noise pollution underwater caused by human activities.

QUOTE ROOM



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– Commodore (retd) K Laxmi Narasimha Chary, *Indian Navy veteran*



"The trends in the measured noise levels at the site clearly show that the noise levels due to anthropogenic sources are increasing over the period of measurement and these may interfere with the frequencies used by the aquatic species for their livelihood

- Dr (Prof) Mukund K Deshmukh, *Department of Electrical and Electronics Engineering of BITS, Pilani Goa*



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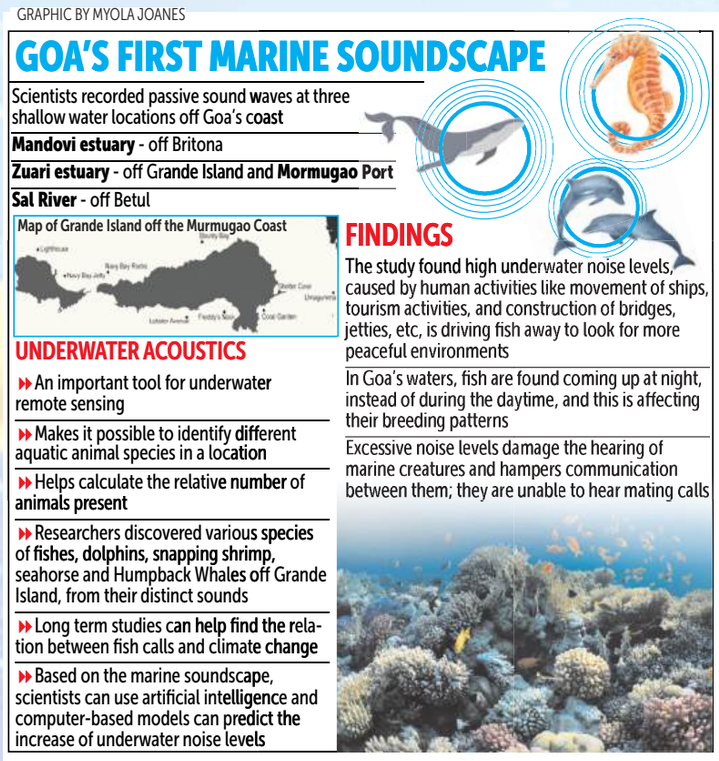
- Dr Bishwajit Chakraborty, *Scientist-Emeritus, NIO Goa*



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- Dr (Prof) Sunil Kumar Singh, *Director NIO*

GRAPHIC BY MYOLA JOANES



Variation in fish sound linked to temperature change in water: NIO study

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While the impact of temperature change on land is easily ascertained by various indicators like behavioural pattern of living beings, very little is known about the same when it comes to the situation underwater.

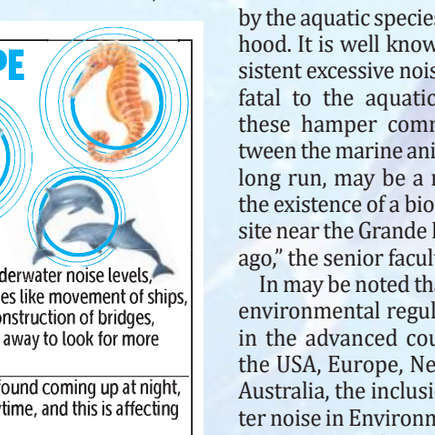
Now, a study by National Institute of Oceanography (NIO) Goa, has found that variation in fish sound is directly linked to temperature change happening underwater.

The team of scientists at NIO led by CSIR-Emeritus Scientist The underwater sound intensity and dominant frequency caused by fish calls fluctuates as water temperatures change, and the pulse repetition rate decreased when the water temperature increases conducted study of passive sound waves generated by marine species underwater in three shallow water sites in Goa - Off Britona in Mandovi estuary, In Grande Island in Zuari estuary, off Mormugao Port and Sal River off Betul.

The findings have been published in the Journal of the Acoustical Society of America. The study is titled Characterizing three shallow-water locations off Goa, India, using passive acoustic data.

"We had few notable observations in our analyses. Off Britona in Mandovi estuary, correlation coefficient of 88-67% is observed between the Sound Pressure Level (SPL) of Toadfish sound with respect to the temperature. In Grande Island in Zuari estuary, maximum correlation coefficient of 80% is observed between the SPL of Tiger Perch, whereas in Sal River off Betul, correlation coefficient of 84% is observed between the SPL of background sounds with respect to the wind speed," said Bishwajit Chakraborty, Scientist Emeritus at NIO and an authority on marine or hydro-acoustics.

This means that underwater sound intensity and dominant frequency caused by fish calls increases as water temperatures rises,



Dr Bishwajit Chakraborty explains his study

"The underwater sound intensity and dominant frequency caused by fish calls fluctuates as water temperatures rises, and the pulse repetition rate decreased when the water temperature increases

– Bishwajit Chakraborty, *Scientist-Emeritus NIO*

and the pulse repetition rate decreases when the water temperature increases.

"When wind becomes dominant, SPL is related to wind. SPL consists of fish sound as well as geophony from wind. That time fish sound SPL becomes insignificant compared to wind. Therefore, relationship shows SPL versus wind dominant," the senior scientist said.

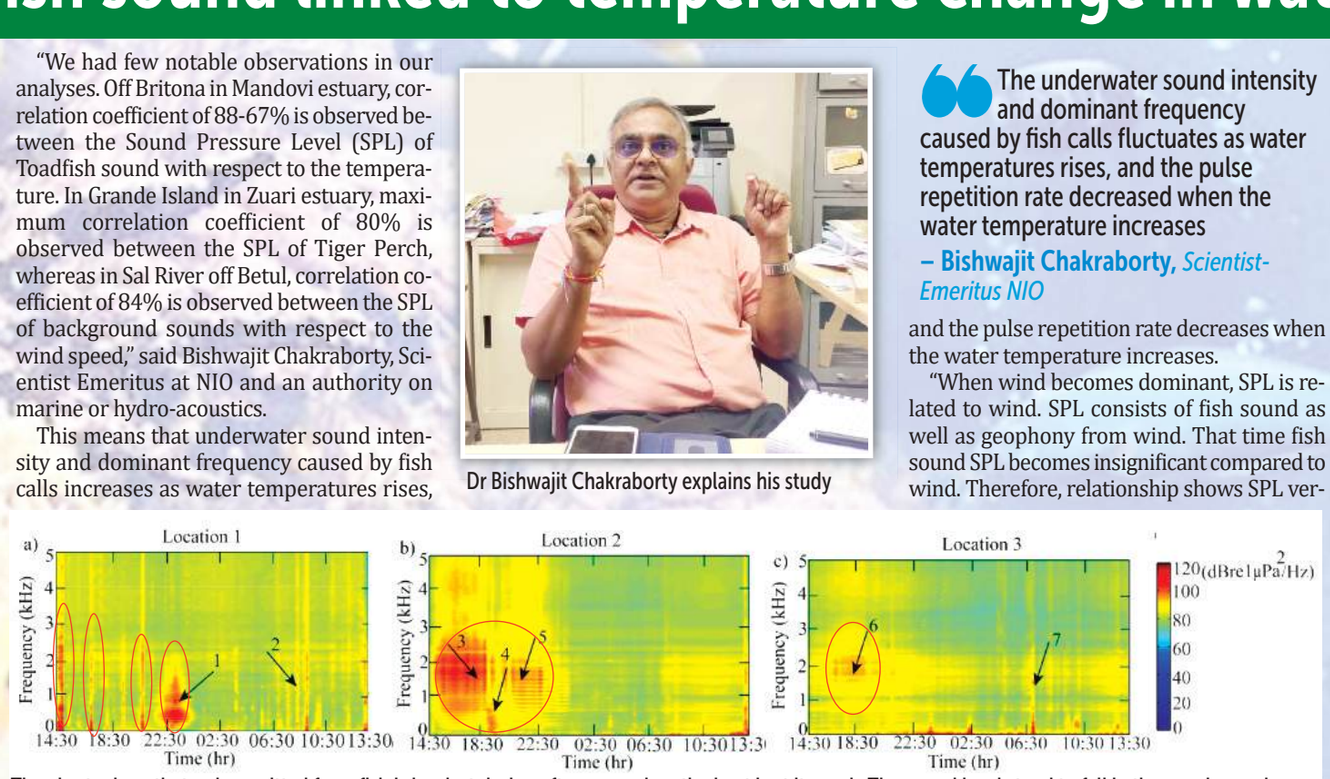
"The study results suggested that passive acoustics is a vital tool for understanding the biological components in relation to the environmental conditions," added Chakraborty, who is the lead author of the study.

Underwater acoustics is the science of sound waves in the water that has become an essential tool for underwater remote sensing.

"We have also analysed data of Seahorse feeding click non-linearity using the Artificial Intelligence method, which was published in Journal of Acoustical Society America (American Institute of Physics).Further, we discovered the Humpback whale (Megaptera novaeangliae) sound from Grande Island and published it in the Bioacoustics journal," Dr Chakraborty said. By analysing passive acoustic recordings, it is possible to discriminate and identify different animal species and to calculate the relative number of animals present within the measurement range.

Currently CSIR-NIO is busy in acquisition and analyses of passive acoustic data along with the other ancillary systems to carry out multi-parameter studies.

"However, long term passive acoustic data acquisition is needed to relate among fish sound and climate," he said.



The charts show that noise emitted from fish is loudest during afternoon when the heat is at its peak. The sound levels tend to fall in the evening and night, when the temperature cools down.