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Chromophoric Dissolved Organic Matter (CDOM) as an Indicator for Studying Carbon Cycle in the Northern Bay of Bengal

Mini Review

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The dissolved organic matter (DOM) is one of the largest pools of organic carbon in aquatic environments. In the coastal, estuarine and riverine waters, the DOM is dominated by dissolved soil organic matter and anthropogenic inputs [1,2]. The Chromophoric dissolved organic matter (CDOM) is operationally defined as that component of the total DOM of the hydrosphere that absorbs light over a broad range of UV (UV-A: 315 to 400 nm; UV-B: 280 to 315) and Visible region (400 - 750 nm). The CDOM is optically measurable. It contributes significantly to the global carbon cycle. The CDOM of terrestrial origin to the coastal sea is mainly from breakdown of terrestrial plants, human activities such as logging, agriculture, effluent, discharge, and wetland drainage and detritus transported through fresh water and estuarine systems [3]. In the coastal and estuarine systems, where CDOM is higher than in offshore regions, it is therefore particularly important to identify the sources and sinks of CDOM in order to gain an understanding of the biogeochemical processes or carbon cycle in which CDOM is involved either or indirectly [4].

To look upon or consider in a specified way, School of Oceanographic Studies, Jadavpur University (SOS, JU) has undertaken many research activities to portray and understand the CDOM dynamics of the northern Bay of Bengal (nBoB). The first observation about the range and magnitude of CDOM (namely a_{CDOM} (440)) was accomplished by means of SOS, JU in the nBoB.

The study was carried out in the shallow continental shelf waters off the Hugli Estuary to offshore transition zone situated in the nBoB. This estuarine zone is mainly drained by the freshwater flow regulated by the Farakka Barrage situated 286 km upstream from the mouth of the estuary [5]. There are several other localized river distributaries like the rivers Muriganga, Saptamukhi, Thakuran, Matla, Gosaba and Bidya. This estuary is known to be a 'well-mixed' estuary which experiences a semidiurnal tide of meso-macrotidal nature (2.5–7 m) and the mean current velocities vary between 117 and 108 cm s^{-1} during low and high tide respectively [6].

For CDOM absorption, the seawater samples were stored in amber coloured glass bottles for four hours to equilibrate to room temperature. The samples were filtered through the 47 mm Whatman GF/F filter to remove the coarse particles. The filtered seawater samples were again filtered through 47 mm Nuclepore membrane filter (pore size: 0.2 mm) to remove the fine particles. The absorption of CDOM was scanned in the range from 300 to 750 nm using 10 cm path-length cuvette with UV-VIS spectrophotometer (Shimadzu UV-Visible 1600 double-beam). Milli-Q water was used as a reference. The measured absorbance data were normalized to zero at 600 nm due to temperature-dependent artefacts [7] observed between 650 nm and

750 nm. A blank (Milli-Q water versus Milli-Q water) was subtracted from each wavelength of the spectrum. The CDOM absorbance was then multiplied by 2.303 to convert from log10 to loge and by 10 to convert to a 1 m path length [8].

The study area encompasses a typical freshwater-seawater mixing regions of the world. Das et al. (2016) [9], Das et al. (2017a) [10] and Das et al. (2017b) [11] studied the CDOM variability in the northern Bay of Bengal at nine distant stations, between October, 2014 and January 2016. The a_{CDOM} (440) varied between 0.1002 m^{-1} and 0.6631 m^{-1} during the entire study period. Seasonal mean a_{CDOM} (440) exhibited a marked difference in magnitudes in the three seasons (one-way ANOVA: $F = 11.77$, $p < 0.05$). It was as low as 0.1200±0.0327 m^{-1} during the pre-monsoon, which increased to 0.3064±0.1595 m^{-1} in the monsoon season and in the post-monsoon it was 0.1621±0.0790 m^{-1}. While analysing the spatial distribution higher values of a_{CDOM} (440) were observed near the confluence and a gradual decrease towards the offshore was observed. While inspecting the monthly Hugli River discharge vs. a_{CDOM} (440) time series indicated that a significant positive relationship might exist between the two parameters at inshore stations ($R^2 = 0.81$, $p < 0.05$), whereas, in the offshore station the relationship was not significant. Correlation between rainfall and a_{CDOM} (440) time series data also showed the same trend as observed in the case of discharge vs. a_{CDOM} (440). Significant positive correlation between rainfall and a_{CDOM} (440) was observed at the inshore station ($R^2 = 0.63$; $p < 0.05$), however, at the offshore station it was not significant.

In the Vishakhapatnam coast situated on the east coast of Bay of Bengal, Pandi, et al. [12]observed a_{CDOM}(440) magnitudes ranging from 0.120 m^{-1} to 0.252 m^{-1}, whereas in the present study a_{CDOM} (440) ranged between 0.1002 m^{-1} and 0.6631 m^{-1}. Hence it can be seen that the highest a_{CDOM} (440) magnitudes observed in the present study was much higher than the highest magnitudes observed by Pandi, et al. [12]. This might be attributed to the vicinity of the present study area to Hugli Estuary, whereas, the study area of Pandi, et al. (2014) [12] is far away from the Hugli mouth and it does not experience any significant perennial river flow. Present results also portrayed that near shore stations showed comparatively higher magnitudes of CDOM compared to the offshore stations. This might be attributed to the obvious fact that riverine dominance was found much higher in the near shore stations and it steadily dissipated towards the offshore stations. The findings of Das et al. 2016, Das et al. 2017a and Das et al. 2017b [9-11] along with the observations of Pandi, et al. (2014) [12] also indicated significant evidence of allochthonous character of CDOM in the Bay of Bengal.

Overall, it can be inferred that the near shore to offshore transition zone in the nBoB portrayed significant spatial distribution of CDOM value. Thus it also an indication of higher anthropogenic input from the Hugli estuary in term of organic carbon. Thus increased the chance to generate cardon-dioxide (CO_2) by decaying these organic materials in the same study zone. By this way, CDOM measurement is also significant now a day for studying carbon cycle.

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