Evolution of coastal sea surface salinity in Trincomalee and Dondra evaluated using sea water samples collected by local fishermen between 2013-2015.

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Abstract

East Indian Coastal Current (EICC) is a seasonal western boundary current, which flows along the east coast of Indian subcontinent. EICC carries freshwater, discharged at northern Bay of Bengal to Arabian Sea. NARA initiated a weekly sea water sample collection program at Trincomalee (TR) and Dondra (DO) in November 2013. Two local people were trained to collect sea water samples at a knee depth and samples were analyzed using Autosal. This program is an extension of sea water sample collection being conducted at eight locations by CSIR-NIO, India, since 2006.

Winter freshening of coastal waters, an indication of EICC set on, is observed at the beginning of October and Mid September at TR and DO respectively. In all three years, peak freshening is recorded in November. However, freshening at TR in November 2014 is dramatic, salinity has decreased from its averaged salinity of 32.1 to 17.9 PSU. Such a strong freshening is not recorded neither in November 2013 nor in 2015. Quality controlled data by Tukey fences method yielded the salinity decrease at TR in November 2014 as 26.1 PSU. Nagapattinam too reported a similar drop in salinity but a with phase lag of two weeks. However, Rameshwaram and Colachal did not record such a strong salinity drop. The salinity had decrease from 32.79 to 29.08 PSU, at DO, the salinity drop is weaker than that of TR, indicating mixing of EICC with the high saline water masses.

This study concludes, that during the winter, EICC flows along the Indian sub continent and continue along the southern coast of Sri Lanka. It further revels that the EICC does not branch out to flow via the Palk Strait into Gulf of Mannar. Thus, it is recommended to establish monitoring locations at north and north-west coasts of Sri Lanka

Keywords: East Indian coastal current, salinity.

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Introduction

Sri Lanka is located at the Northern Indian Ocean (IO), between two semi-enclosed water bodies, the Bay of Bengal (BoB) and Arabian Sea (AS). IO is exposed to semiannual wind reversals called as monsoons. During May to September strong southwesterly winds (Southwest Monsoon/SWM) blows across the IO and during November to March, dry northeasterly winds blows (Northeast Monsoon/(NEM). During NEM, East Indian Coastal Current (EICC), which carries accumulated freshwater in the Northern BoB, flows along the east of Indian and Sri Lanka turns at the southern end of Sri Lanka to enter into AS, making its peak speed in November (Schott and McCreary, 2001). EICC is a western boundary current which participate to water mass transport between AS and BoB (Durand *et.al.* 2007). The EICC, fresh water tongue causes seasonal fluctuations of Sea Surface Salinity (SSS) along its passage. So, by

enumerating the SSS, along the coast of India and Sri Lanka, the seasonal flow pattern of the EICC shall be traced. Besides, another important question seeks an answer is whether the EICC bifurcates at Pedro Bank, at the junction between India and Sri Lanka to flow into Gulf of Mannar via Palk Strait.

Council of Scientific and Industrial Research's National Institute of Oceanography (CSIR-NIO, Goa) India commenced a novel in situ coastal SSS observation in 2006 to study the evolution of salinity along the coast. Eight locations along the east and south Indian coast; Paradeep, Visakhapatnam, Perupalem, Chennai, Nagapattinam, Rameshwaram, Tiruchandur, and Colachal, were weekly occupied repeatedly. Local fishermen collected water sample at a depth of knee, the sample were analyzed used laboratory AutoSal.

National Aquatic Resources Research and Development Agency (NARA) has commenced similar program in November 2013 at Trincomalee (TR) and Dondra (DO), added another location in January 2014 at Induruwa, which is later shifted to Beruwala. The discussion of this paper is limited to the time series data of first two locations.

Materials and Methods

Fisherman at the respective coastal village collected a sea water sample per a week in a 100 mL plastic bottle at a depth of knee from TR and DO and stored at a shadow place. Water samples were not collected on the day of rain to avoid contamination of sea water. Sample collection at an additional location is commenced at Induruwa, but later the location was shifted to Beruwala, where the samples were collected by the NARA staff at the Ocean Observation Center, Beruwala.

Samples were analyzed using AutoSal (Guildline 8400B) at NARA, Sri Lanka and NIO, India laboratory. AutoSal gives the Conductivity ratio (Conductivity of the sample/ Conductivity of standard sea water) readings from the AutoSal were converted in to salinity values by a MATLAB computer program.

Time series data are quality controlled by Tukey Fences method (Tukey, 1977) to remove outlier data. Both raw and QC data analyzed using a MATLAB program. Five day mean ocean surface current data are obtained by the Ocean Surface Current Analyses-Real time (OSCAR, available at http://www.oscar.noaa.gov/datadisplay/) and the three hourly rain data are obtained from Tropical Rainfall Monitoring Mission up to January 2015, because the service was terminated then after due to collapse of the mission. (TRMM available at http://giovanni.sci.gsfc.nasa.gov/giovanni/). Wind data at 10 m level for the total period were downloaded by European Center for Median Range Weather Forecast (ECMRWF available at http://apps.ecmwf.int/datasets/data/). All these data are processed and averaged for the time collocation.

Results and Discussion

During the period from November 2013 to November 2015, total of 144 coastal SSS data are collected at TR. The minimum and maximum salinity value are 17.97 and 34.76 PSU, recorded in November 2014 and August 2015, respectively (Fig. 1). The three year average salinity at TR is 32.07 PSU.

SSS data reveals freshening of coastal waters in November at TR, the freshening is observed in all three years; 2013, 2014 and 2015. The average salinity for November was 28.14 PSU. Nagapattinam, which lies further north of TR also recorded similar freshening event, an average salinity of 23 PSU, however, the freshening at Nagapattinam preceded by more than a month. It clearly reveals that the freshening is associated with EICC, which originates at the northern Bay of Bengal, flows southward along the east coast of Indian subcontinent to reach Nagapattinam and TR in September and November respectively.

A very strong freshening of coastal water up to 17.97 psu is recorded in November 2014, quality control of data to remove local effects, normalized the minimum SSS value at 26.1 PSU, almost similar to the magnitude of freshening as of 2013 and 2015. The OSCAR data reveals that during the month of November 2014, ocean surface currents were directed southward, which nullify the possibility of Mahaweli River water reaching the sampling site, which lies north of the river mouth. Thus, the surface runoff could be the reason for the strong freshening recoded during November 2014 at TR.

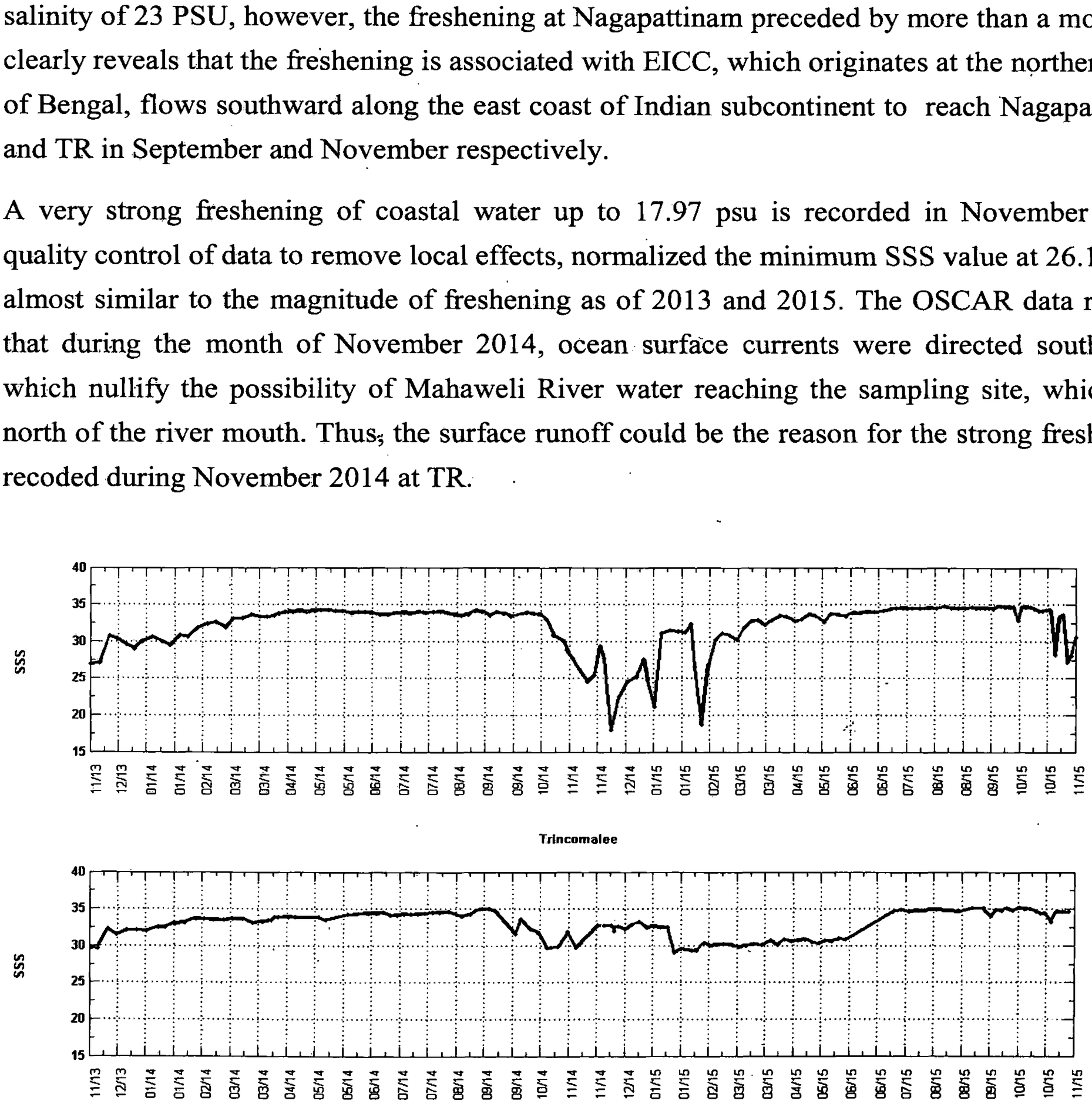

Fig.1: Coastal sea surface salinity evolution with time in Trincomalee and Dondra.

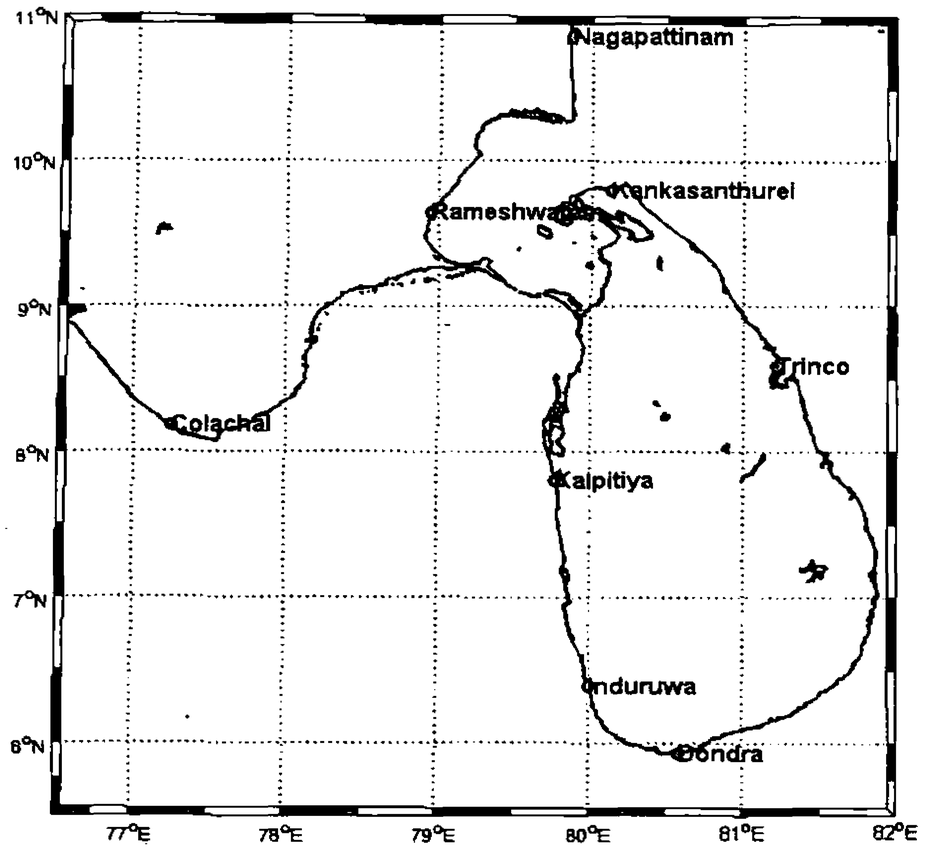

Fig. 2: Sampling locations of Sri Lanka and their adjacent location in India. Proposed two sites are indicated (Kankasanthurei and Kalpitiya).

However, SSS data at Rameshwaram does not show strong freshening in November as of TR and Nagapattinam. The average salinity for the November is 31.42 PSU at Rameshwaram, which lies within the Palk Strait. It indicates that EICC, which flows along the east coast of India and Sri Lanka does not bifurcate at Pedro Bank to flow into Gulf of Mannar via Palk Strait.

In DO, during the period from November 2013 to November 2015, total of 115 salinity observation are recorded, the two year average salinity is 32.79 psu. Minimum and maximum salinity values of 29.08 and 35.20 PSU are recorded in January 2015 and October 2015 respectively (Fig. 1). DO time series shows an extended period of freshening event (up to 29 psu) from September, 2014 to June, 2015, which is specific to the site and not observed at any other station This phenomena could not be explained due to the lack of longer period of data and limited sampling stations.

Conclusion

EICC causes freshening along the east of Indian subcontinent, the maximum freshening occurs in November. Observations at Rameshwaram indicates that EICC does not bifurcate at Pedro Bank to enter into Gulf of Mannar via Palk Strait. However, it is necessary to establish another station at Northern Sri Lanka to confirm no flow through Palk Strait. The path of EICC beyond Dondra is not established, another station at Northwestern coast would facilitate to trace the path of EICC beyond Dondra.

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