SOME ASPECTS OF MIXING PROCESSES OF THE VELLAR ESTUARY

Abstract

The hourly sequence of changes in salinity during a complete tidal cycle at one station has been studied. These changes are discussed in relation to mixing processes and the amplitude and duration of the tides in the estuary.

Jacob and Rangarajan (1959) explained the seasonal cycles of hydrological events in the Vellar estuary. Recently, Dyer and Ramamoorthy (1969) discussed salinity and water circulation in the Vellar estuary, which is a typical bar-built estuary and is a salt wedge at high river discharge and well stratified at low river discharge.

The study of the mixing processes in the estuary shows that two periods can be recognised, (1) the drought period and, (2) the monsoon period. During the drought period (May to July) neritic waters occupy almost the entire estuary and during the monsoon period (October and November) the estuary is completely scoured out by freshwater. Transitional stages occur between these two periods.

The present study reports observations on the hourly salinity changes for about 12 hours during a semidiurnal tidal cycle from 08.00 hrs to 20.00 hrs opposite the Biological Station, about 1.2 km from the mouth during a premonsoon period. Three stations (A, B & C) were chosen for study along the cross-section of the estuary at this place. Samples were taken at the surface and at different depths. The tidal range differed slightly at the three stations being 91.4 cm at A, 84 cm at B and 96.5 cm at C. The changes in the surface and bottom salinity values during a flood tide and ebb tide, at station C are discussed below :

Flood tide—Surface : During flood tide the overall change of salinity in the surface water was 24.53‰. The salinity increased from a minimum of 8.87‰, at 14.00 hrs to a maximum of 33.40‰ at 20.00 hrs. The mean rate of change of salinity per hour was 4.09‰ and 0.68‰ per minute (Table 1).

This rise, however, was not uniform all the time. During the first hour there was a deviation of +1.72‰ from the mean, and during the succeeding three hours the deviations from the mean were +3.61‰, —2.96‰ and +2.16‰ respectively. During the 5th hour there was a marked positive deviation of +9.41‰ from the mean rate of increase (Table 1). The surface-bottom salinity difference—which was present hitherto—disappeared during the 5th hour indicating that there was complete mixing of the waters.

Flood tide—Bottom : The overall change of salinity at the bottom was 12.07‰. Salinity increased from a minimum of 21.13‰ at 15 hrs to a maximum of 33.20‰ at 20.00 hrs. The mean rate of change per hour was 2.12‰ and 0.04‰ per minute. During the first hour there was a deviation of —1.47‰ from the mean, and during next two hours no change was noticed. During the fourth hour, the deviation was —1.47‰ from the mean but during the 5th hour there was a marked deviation of +7.60‰ from the mean rate of increase (Table 1).

Ebb tide—Surface : The overall change of salinity at the surface during ebb tide was 18.11‰. The salinity decreased from a maximum of 26.98‰ at 09.00 hrs to a minimum of 8.87‰ at 14.00 hrs. The mean rate of change per hour was 3.72‰ and 0.06‰ per min. (Table 1).

Ebb tide—Bottom : At the bottom the changes in salinity during ebb tide were less marked. The overall change of salinity was 5.73‰. The salinity decreased from a maximum of 27.09‰ at 09.00 hrs to 20.16‰ at 12.00 hrs. The mean rate of change per hour was 2.31‰ and 0.03‰ per min. (Table 1).

During ebb tide for the first three hours, for surface and bottom there was positive deviation from the mean. At the surface at the fourth hour there was a deviation of —1.77‰, for 5th hour +0.42‰ and for sixth hour —3.56‰. At the bottom there was deviation of —0.70‰ for 4th hour, —2.15‰ for 5th hour, and —2.15‰ for 6th hour. (Table 1).

The low density freshwater in the surface layers normally prevents the vertical

TABLE 1. *Hourly changes in salinity at Station C*

Hour	Flood tide						Ebb tide					
	Surface			*Bottom*			*Surface*			*Bottom*		
	Hourly change of salinity	Mean rate of change per hour	Deviation from mean	Hourly change of salinity	Mean rate of change per hour	Deviation from mean	Hourly change of salinity	Mean rate of change per hour	Deviation from mean	Hourly change of salinity	Mean rate of change per hour	Deviation from mean
1	5.81‰		+1.72‰	0.65‰		—1.47‰	4.23‰		+0.50‰	5.00‰		+2.69‰
2	0.48‰		—3.61‰	0.00		0.00	5.80‰		+2.08‰	4.52‰		+2.21‰
3	1.13‰	4.09‰	—2.96‰	0.00	2.12‰	0.00	6.05‰	3.72‰	+2.33‰	2.42‰	2.31‰	+0.11‰
4	1.93‰		—2.16‰	0.65‰		—1.47‰	1.95‰		—1.77‰	1.61‰		—0.70‰
5	13.50‰		+9.41‰	9.72‰		+7.60‰	4.69‰		+0.42‰	0.16‰		—2.15‰
6	1.67‰		—2.42‰	1.70‰		—0.42‰	0.16‰		—3.56‰	0.16‰		—2.15‰

mixing which might be responsible for the existence of stratified water in the estuary during the first four hours (Table 2).

TABLE 2. *Bottom-surface difference in salinity at Station C*

Hour	*Flood tide*	*Ebb tide*
1	6.45‰	0.40‰
2	5.97‰	1.41‰
3	4.85‰	5.04‰
4	3.55‰	8.07‰
5	0.23‰	12.90‰
6	0.20‰	12.91‰

During the fifth hour at Station A, the salinity was 29.00‰ for the surface and 28.90‰ for the bottom and for station B, 31.50‰ and 31.27‰ respectively. Both stations A and B also showed a similar pattern of mixing during the fifth hour as at Station C, during flood tide. At all stations the increase in salinity with tidal rise was not uniform but varied continuously. When the tide receded, the pattern of decreasing salinity was different at stations A and B, depending on the intensity.

On account of the extreme variations in salinity and the varying degree of tidal influence in different seasons a fixed zonation concept is difficult to fit into this estuary where conditions are so labile.

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