# SALINITY DISTRIBUTION IN NATORI RIVER ESTUARY AFTER TSUNAMI

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## 1. INTRODUCTION

Estuaries are the transition between two distinct water bodies; a river and sea (Savenije, 2005). Estuaries also serve as important connections for many anadromous (ocean dwelling but spawning in estuaries and rivers) and catadromous (freshwater dwelling but spawning in seawater) species. Estuaries support many important ecosystem functions: biogeochemical cycling and movement of nutrients, purification of water, mitigation of floods, maintenance of biodiversity, biological production (nursery grounds for several commercial fish and crustacean species) etc. An estimate of the economic value of these ecosystem functions (goods and services) indicated that estuaries are among the most valuable ecosystems in the world (Meire et al., 2005), and make these areas vulnerable to natural disasters such as storm and tsunami (UNEP, 2006).

Natori River estuary is located in Sendai Bay. During Tohoku Pacific Tsunami 2011, this area was most severely hit by tsunami. According to Tomiyama et. al (2007), Natori River estuary became a nursery ground for the juvenile of the stone flounder *Platichthys bicoloratus* fish, a commercially important flat fish in the coastal water of Japan. Tsunami will affect the fishery production in estuary. On the other hand, previous study about Indian Ocean Tsunami December 2004 impact assessment found out that tsunami period seems to support an increased migration of fish into Coachin estuary in India (Laluraj et.al., 2007).

Salinity is one ecological factor and influencing the type organism that lives in body of water. Considering the ecology value of Natori River estuary as nursery ground, this present study investigated the salinity distribution in estuary. The main objective of the study was to find out the average salinity, length of salinity intrusion and relation between salinity and chlorophyll-a in Natori River estuary.

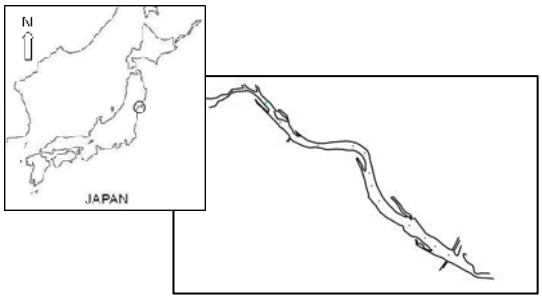


**Figure 1. Study area, Natori River Estuary**

## 2. METHODOLOGY

The site investigation was carried out at Natori River estuary (from 38°10'48.40"N and 140°57'19.13"E to 38°12'26.96"N and 140°54'10.00"E) in November 28th, 2011 (Figure.1). Water quality parameters were measured using water temperature and salinity depth instrument (RINKO Profiler). The distance between the zero kilometers of measurement was located around 735 meter from river mouth. Every 0.5 kilometer, the salinity in the river was measured until 6 kilometer to the upstream.

Time of measurement was set up in two times; 10.00-12.00, and 13.00-15.00, to find out the salinity condition for different tidal condition.

## 3. RESULT AND DISCUSSION

From tide prediction for Shiogama-Minatobashi port (http://www1.kaiho.mlit.go.jp) on November 28th 2011, from 10.00 to 12.00 was low tide and from 13.00 to 15.00 was high tide. Water level was taken from www1.river.go.jp for observation station No. 302021282206010 at downstream of Natori River. During measurement water level was tend to be low and similar if the tidal fluctuation omitted (Table 1).

**Table 1. Tidal level and water level during measurement**

| Time | 8.00 | 9.00 | 10.00 | 11.00 | 12.00 | 13.00 | 14.00 | 15.00 |
|---|---|---|---|---|---|---|---|---|
| Tidal level (m) | 1.29 | 1.16 | 1.04 | 0.98 | 1.02 | 1.15 | 1.33 | 1.62 |
| Water level (m) | 0.80 | 0.71 | 0.63 | 0.50 | 0.58 | 0.69 | 0.82 | 1.06 |

### Horizontal distribution

There were 13 points of measurement from 0 km to 6 km from river mouth. Water quality could be define according to the salinity; saline water; if the salinity in range of 30-50 psu, which usually refer as sea water; brackish water, if the salinity in range of 0.5-30 psu and usually could be found in estuary, brackish lake, mangrove swamps; and fresh water if the salinity lower than 0.5 psu, and type of river, lake, ponds water (UNESCO, 1981)

The average of salinity for each measuring point was shown on Figure 4. Salinity in river mouth during low tide is 23.82 psu (brackish water), but in kilometer 1.0 from river mouth the salinity is reach 30.67 psu (saline water). Location of zero kilometers is near to the canal. The water flow from the canal should probably influence the salinity of water.

During high tide, salinity in river mouth is reach 32.25 psu (saline water) and from Figure 2, we could see that the salinity become lower in upstream direction. From kilometers 0.5 to 5.0, the water salinity is categorized as brackish water, which means that the boundary of Natori river estuary is around 5.7 kilometer from river mouth in upstream direction.

### Vertical distribution

Vertical distribution was arranged to find out the difference of salinity within the depth and pattern of salinity intrusion.

Since the salinity from 0 to 2.5 kilometer was more than 30.00 psu, during high tide and low tide, we try to analyze the pattern of vertical distribution in this section.

*Keywords*: estuary, salinity
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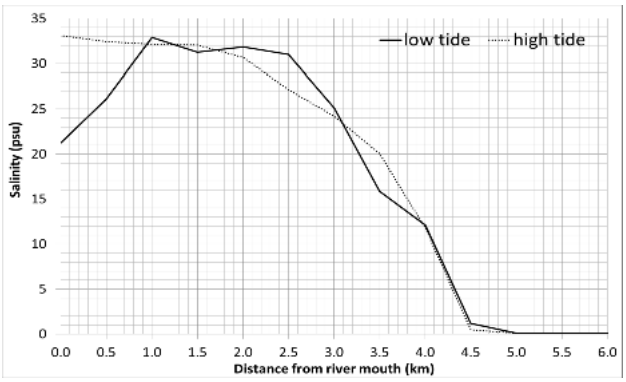


**Figure 2. Horizontal distribution of salinity**

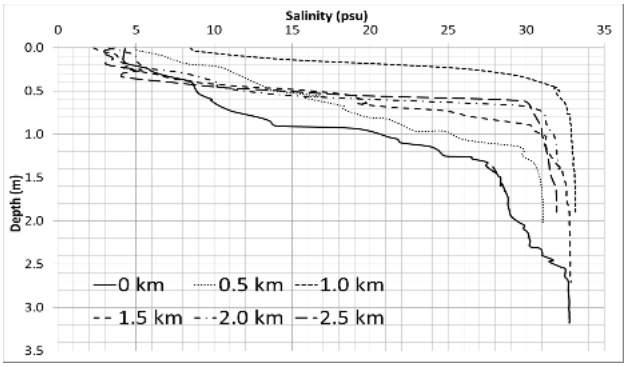


**Figure 3. Vertical distribution of salinity between 0 to 2.5 km from river mouth during low tide**

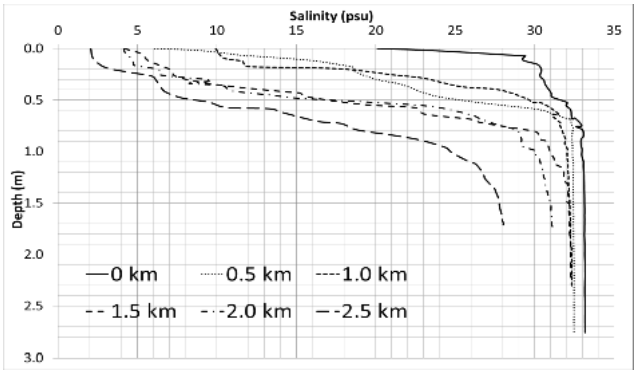


**Figure 4. Vertical distribution of salinity between 0 to 2.5 km from river mouth during high tide**

Comparing to water level during the measuring, the average of water level during low tide and high tide are 0.57 m and 0.76 m, respectively, which mean that the difference of water discharge not significant, the pattern of salinity intrusion is similar with partially mixed type, according to Savenije (2005). The partially mixed type occurred when fresh water discharge similar with tidal flow. The salinity intrusion in Natori River can be longer that 5.7 kilometer upstream during summer and winter when the fresh water discharge is small.

**Relation between salinity and chlorophyll-a**

Chlorophyll-a is used to indicate the state of fertilization of water body. All species of phytoplankton use chlorophyll-a as the main input for photosynthesis. The relation between salinity and chlorophyll-a in Natori River estuary shows in Figure 5.

As we can see, the chlorophyll-a value are very varied. The high concentration of chlorophyll-a occurred when salinity in range of 10 to 25 psu. The value of chlorophyll-a reach 2.5 µg/l. Between 25 to 33 psu, the value of chlorophyll-a was tend to be low.

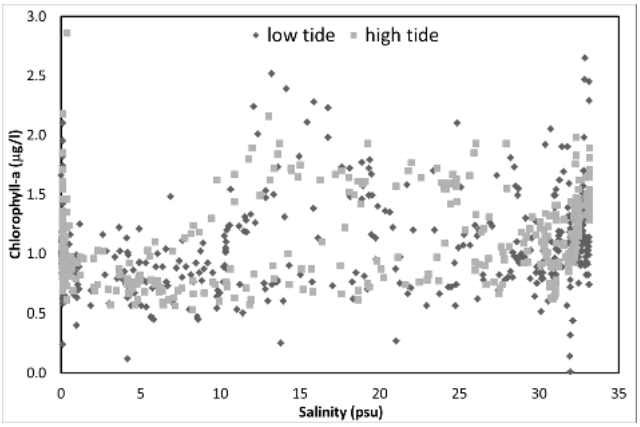


**Figure 5. Relation of salinity and chlorophyll-a**

## 4. CONCLUSION

Measurement of salinity in Natori River shows that the salinity is very varied from river mouth to 6 kilometer upstream. The high salinity (>30 psu) can be found in 0 to 2.5 km. It is indicated that this area had already intrude by sea water. The brackish water (0.5 psu -30 psu) can be found from point 2.5 to 5 kilometer. The type of salinity intrusion was tend to be partially mix. During low water level, the intrusion couldbe more than 5.0 km. Considering the chlorophyll-a, high value could be found in the range of 10 to 25 psu or between 2.5 to 5 kilometer from river mouth. The biological activity, such as fish migration, became an interesting aspect to examine.

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