

# Field measurement of fluid mud layer in dredged navigation channel at river mouth

Nakagawa Yasuyuki<sup>1</sup>, Takumi Shinozawa<sup>2</sup>, Yuji Matsumoto<sup>3</sup> and Michiyuki Watanabe<sup>3</sup>

<sup>1</sup> Coastal and Estuarine Sediment Dynamics Research Group,  
Port and Airport Research Institute, Nagase 3-1-1, Yokosuka, 239-0826, Japan  
E-mail: [y\\_nakagawa@ipc.pari.go.jp](mailto:y_nakagawa@ipc.pari.go.jp)

<sup>2</sup> National Institute for Land and Infrastructure Management, Ministry of Land and Infrastructure,  
Transport and Tourism, Nagase 3-1-1, Yokosuka, 239-0826, Japan

<sup>3</sup> Niigata Port and Airport Office, Hokuriku Regional Development Bureau, Ministry of Land,  
Infrastructure, Transport and Tourism, Irihune-cho 4-3778, Chuo-ku, Niigata, 951-8011, Japan

## Introduction

Many ports and harbours in the world have been suffering from channel siltation which are crucial topics for the safety navigation of ships (e.g. PIANC, 2008). Mechanisms of the siltation depend on the sediment transport processes around navigation channels governed by several factors, such as sediment types, force conditions (waves and current) and sediment discharge through the river. A better understanding of the process is essential for selecting an effective countermeasure and minimizing siltation.

The aim of this study is to elucidate the siltation process in a navigation channel which is dredged in a river mouth area. This abstract describes results of field survey at a navigation channel under a flood condition with highly turbid water discharge and shows measured fluid mud layers in the dredged channel.

## Study site and field measurements

The study site is in the Port of Niigata, which is one of the biggest ports located in the west coast of the Japanese main island (Fig. 1) and the port has been developed around the mouth of the Shinano river, which is the longest one with the total length of 367km in Japan. The channel of the port has been suffering from the siltation by the discharged sediment through the river and maintenance dredging is required around 800,000m<sup>3</sup> annually to keep the depth of -5.5 to -11m in the navigation channel and harbour basin.

The field measurement was conducted along the channel, including acoustic sounding, *in-situ* mud density measurement with a tuning fork type densimeter and taking sediment core samples by Scuba-divers. The bathymetry of the site along the channel is shown in Fig. 2 with the data of multi frequency acoustic survey. The downstream area from the Stn.B are deepened by artificial dredging. The surveys were carried out in the summer of 2013 and the several data were taken just under a flood condition with relatively higher turbid water discharge from the upper tributary.

## Results and discussions

Measured vertical profiles of salinity and SSC (calibrated from OBS measurements) at Stn.A and Stn.B are shown in Fig. 3. At the upstream points of Stn. A, only fresh water with high turbidity outflow was observed throughout the entire depth. In the dredged downstream area, clear interface can be seen around the depth of 3m from the water surface between the turbid fresh water in the upper and the less turbid sea water in the deeper layer. Another key point in the measured profile at Stn. B is the rapid increase of SSC near the bed. The concentration at the near bottom layer is extremely high such that the optical sensor is saturated. In this near bottom layer at Stn.B, high concentrated mud layer with the bulk density of around 1,200kg/m<sup>3</sup> appears, according to *in-situ* density measurement as shown in Fig. 4. This high concentration layer does not appear consistently according to the previous field test during the normal discharge rate condition. It is conceivable that the near bed high concentrated layer could be formed by fluid mud transport from the upstream which is often observed on shelves off river delta (e.g. Fan *et al.*, 2004).

## Conclusions

We conducted several field surveys in order to elucidate the siltation mechanism in the navigation channel located at the mouth of the Shinano River. The survey successfully captured the formation of high concentrated mud layer in the deeper dredged channel under the river flood condition with high turbid water discharge. We will also discuss, in the presentation, sediment properties such as particle size and water content obtained from analyses of sediment core samples comparing with the multi frequency soundings and the *in-situ* measured density data.

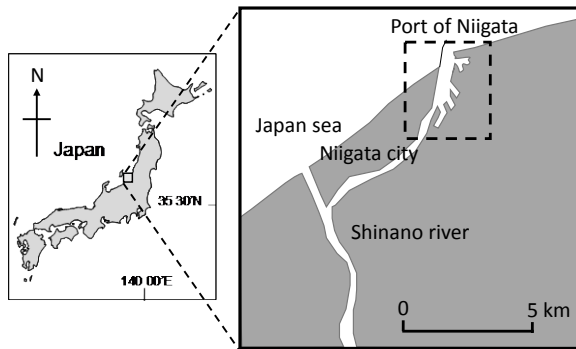


Fig. 1. The location of Port of Niigata (indicated in the dotted box).

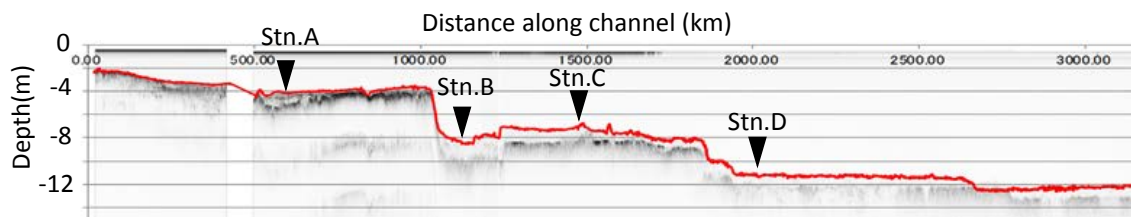


Fig. 2. Bathymetry and sub-bottom data along the channel. The triangles indicate the locations for *in-situ* measurements and core samplings.

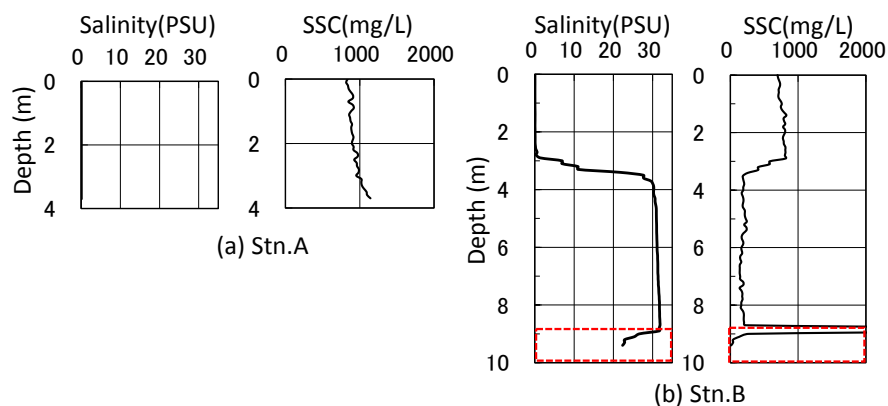


Fig. 3. Measured vertical profiles of Salinity and SSC at Stn.A and B. Salinity at Stn.A and near surface at Stn.B shows almost zero of fresh water. The rapid increase of SSC near the bed at Stn.B indicates saturation of optical turbidity sensor.

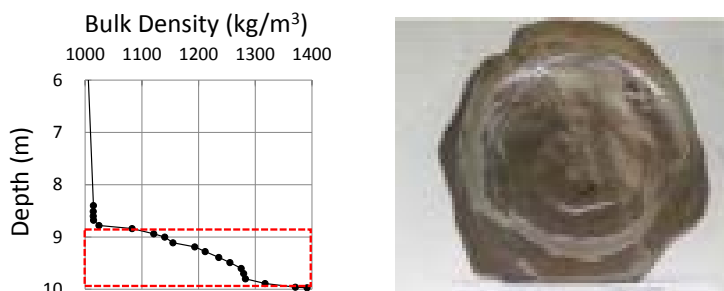


Fig. 4. Measured vertical profile of bulk density at Stn.B (left) and picture of bottom sediment sample taken from the station (right). The dotted line in the density data shows the same layer near the bottom as in Fig. 3 (b) indicating fluid mud layer with the density of around  $1,200\text{kg/m}^3$ .

## References

- PIANC. 2008. Minimizing harbour siltation. The World Association for Waterborne Transport Infrastructures, Report 102. 75p.
- Fan S. *et al.* 2004. River flooding, storm resuspension, and event stratigraphy on the northern California shelf: observations compared with simulations. *Marine Geology* 201:17-41.