Salinity of the Modern Mahakam Delta, East Kalimantan

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Introduction

As one of the most prolific basins in Indonesia, Kutai Basin has been well explored. A lot of research has been run and millions of dollars has been spent in order to have a better understanding of the basin setting. One of the key aspects to understand the Kutai basin is to fully understand the Modern Mahakam Delta, including its sedimentary source, depositional energy, reservoir behaviour and some other important aspects.

The salinity study of modern Mahakam was performed as part of the regional study to understand the modern delta better. The Mahakam river waters were sampled during the LSU (Louisiana State University) Mahakam Delta Study in 1994, whilst the project itself was funded by VICO Indonesia, UNOCAL and TOTAL Indonesie .

The salinity measurement was done on the sampling sites for both surface and bottom channel water. From the respective sample sites, salinity values (with the approximate iso-salinity contours) are shown in the Figure 1 and Figure 2

Physical Setting of Mahakam

The Modern Mahakam Delta was formed since 5,000 years BP, with 50-70 m total sediment accumulated on top of Holocene and late Pleistocene deltaic deposits (Allen et al. 1979). These sediments were deposited under conditions of combination of two major energies, moderate tides and fluvial with lack of flood, while wave energy is very low.

The morphology of the modern Mahakam delta is a fan-shaped lobate morphology. On delta plain, fluvial distributary channels radiating out from the head pass as long as 42 km with 300 – 600 metres wide. These distributary channels mainly go to the northern and southern part of the fan. The southern part is the most active one while the northern part is less active. Channel abandonment also happen in northern part of the fan and currently changing into tidal channel. The depth of the distributary channels varies from 5 metres up to 17 metres. On the centre part of the delta, the tidal channels dominate the morphology. These tidal channels have lengths of 20-25 km, around 1 – 2.5 km width, and at 2-5 metres depth on the down stream. Some tidal channels can go as narrow as 10 metres width and around 20's metres depth at up-stream.

Survey Result

More than a hundred of water samples have been taken during the project, the samples were taken from surface and bottom from all part of the Mahakam delta, starting from proximal to dital portion of the delta. Geomorphologically the samples were taken from upper delta plain, lower delta plain including distributary channels, tidal

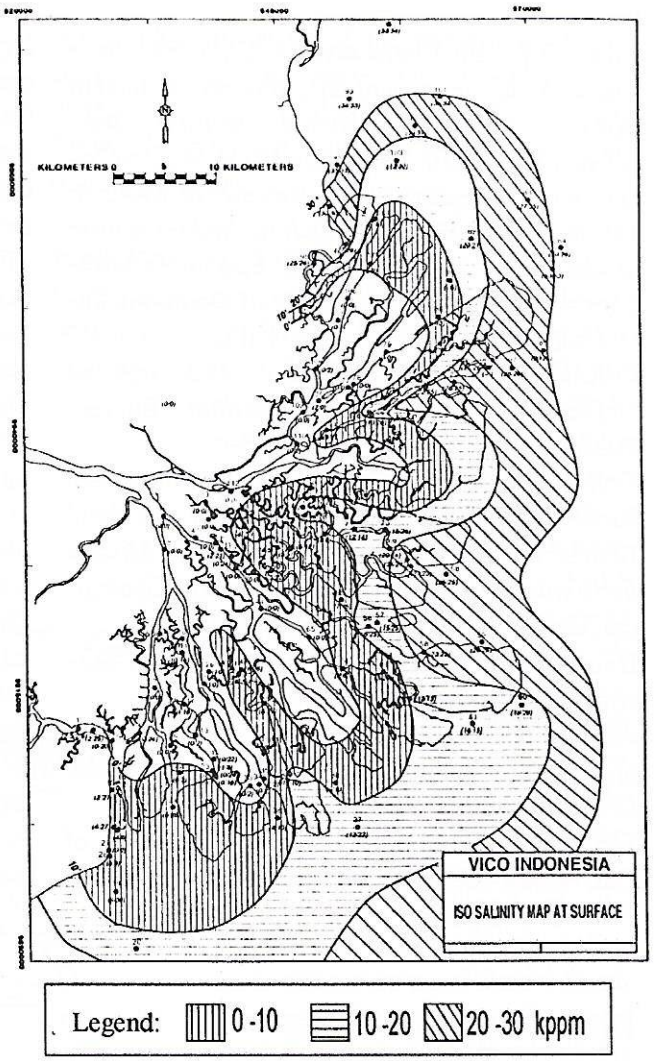


Fig. 1. Mahakam Delta iso salinity map at surface See

channels and river mouth also pro-delta or very shallow marine. The samples were taken at daylight ranging from 7.30 until 16.30 and therefore the tide condition varied, high tide in the morning, low tide at mid day, and on the afternoon back again to the high tide.

On surface, fresh waters (0 ppm Salinity) reach as far as lower delta plain or around 30 km from the head-pass on distributary channels, both in southern and northern parts of the Mahakam delta. On centre part of the delta, where tidal channels dominate the morphology, fresh water only reacheas 10-km distance from head-pass. In contrast, in the tidal channels, the salinity fluctuates (mix between fresh water and sea water) and varies between 1 kppm up to 20 kppm depending upon the distance from distributary channel as well as from the sea. In other words, the wider the interdistributary marsh the higher salinity variation is, and the further tidal channels penetrates, the lower the salinity is.

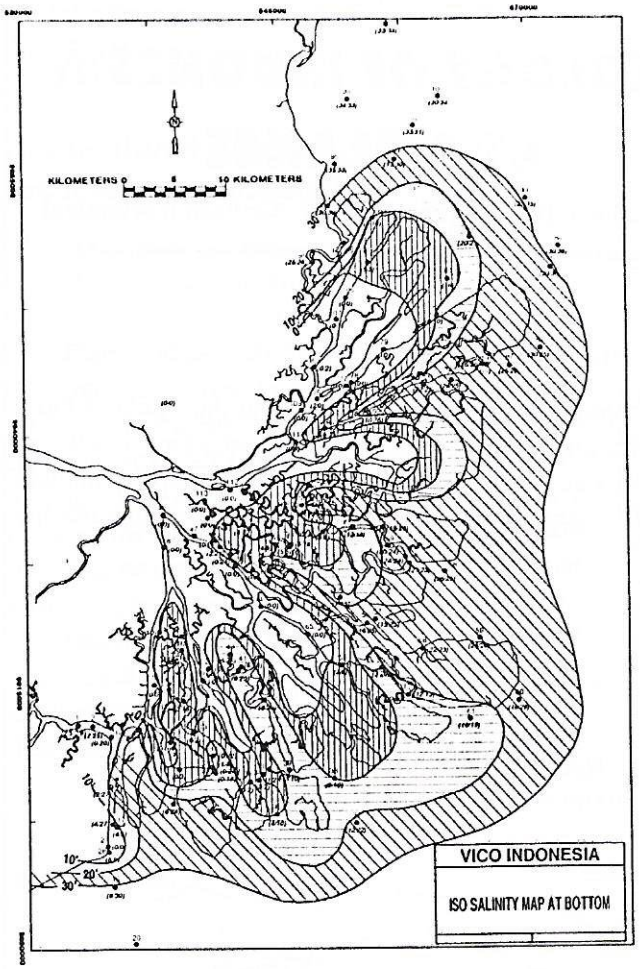


Fig. 2. Mahakam Delta iso salinity map at bottom. See Fig. 1 for legend.

From the bottom samples, it is indicated that fresh water might intrude downstream as far as 26 km from head pass at the southern part of delta, at northern part of the delta, the fresh water goes for 30 km.

On tidal channels, at the same sampling point bottom samples mostly have higher salinity compare to surface samples. In a few cases, they have similar value especially when tidal channels are connected with the distributary channel.

In the southern part of delta where distributary channel is very active, fresh water floats above saline water for about 4-6 km. Whilst in the northern part this case does not obviously exist as shown by 0 ppm salinity contour line for both surface and bottom fall at the same position. In the centre part where tide acts as dominant energy, fresh water discharge still exists and mixed with sea-water down until 25 km (20,000 ppm contour) from the head pass.

Comparison of salinity value at surface and bottom yields that salinity at surface always lower or at least the same compared to the bottom one, simply because of density differentiation. However, it seems salinity has major role in controlling the water density compared to the sediment suspension within water.

On one of abandoned distributary channel where currently becoming tidal channel with very narrow tidal channel connection to the distributary channel, the salinity values are the same as the other tidal channel.

Application

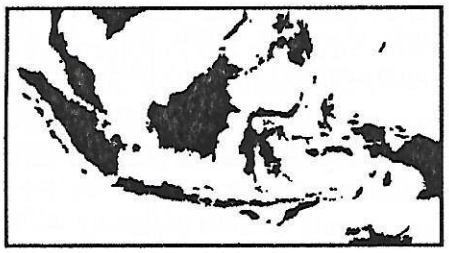
The application of modern Mahakam delta salinity study will be used as one of sedimentary environment indicator for the ancient rock, especially the Middle to Upper Miocene successions in Kutai Basin. The salinity model from the modern example also can be utilized to understand salinity enrichment in ancient system, especially for petrophysical parameters determination (*Surachmat et al, in prep.).*

The other application of deltaic salinity model is for diagenesis study. It is observed that diagenetic processes in onshore Kutai Basin, especially secondary porosity enhancement, were significant factors in reservoir quality with up to 70% of total porosity being attributed to dissolution of unstable grains during diagenesis. Since the reservoir quality depends on depositional fa-

cies, the distributary channels in general will have greater porosity than the distributary mouth bars since they might have been exposed to meteoric waters shortly after deposition and therefore are prone to considerable secondary porosity enhancement. The other consideration is the pH variation within the various reservoir facies which might lead to slightly different diagenetic processes.

Conclusion

- Upper delta plain and most of the lower delta plain distributary channels have zero salinity values. Only the last 10 km of lower delta plain has mixed water with salinity varies between 0-10 kppm.
- On the tidal channels, the water is more saline compared to the distributary channels. It varies between 0-25 kppm.
- During high tide and probably also during neap tide, fresh water floats above the more-saline water.
- Salinity also provides greater role in water density compared to sedimentary solution.
- On the abandoned channels, the salinity value is about the same as on the tidal channels.



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