RELATING THE KBDI WITH SEA WATER INTRUSION TO FARM LAND

Kyaw Sann Oo [*a], Van Ngoc An [a], Wataru Takeuchi [a], Sein Lin [b] and Zaw Win [c]
[a]Institute of Industrial Science, University of Tokyo
Ce 509, 4-6-1 Komaba, Meguro-ku, Tokyo 153-8505 Japan;
[b]Department of Meteorology and Hydrology, Yangon, Myanmar
[c]Myanmar Hydrology Study Group, No.8 Aungdama Yeiktha st.,12 Block, Hlaing Tsp., Yangon, Myanmar
[*]E-mail: ksoo@iis.u-tokyo.ac.jp

KEY WORDS: KBDI, Sea water intrusion, salinity, agriculture

ABSTRACT: Myanmar is one of agricultural countries in the south-east Asia region. As the major agricultural product is rice which covers about 60% of the country's total cultivated land area. The climate is cooler in the northern mountainous area and warmer in the south with monthly mean maximum temperatures from 24.1°C to 38.2°C in May, and monthly mean minimum temperatures from 2.3°C to 20.8°C in December. The biggest productive area in the country is Ayeyarwaddy delta because of it has large region of fertile deltaic alluvial soil and abundant monsoon rainfall. However Ayeyarwaddy is the biggest rice production area; it productivity is lower than upper Myanmar. Some researchers are concluded that the water management could be the factor of less productivity. As cropping calendar in the country, the main rice is sown in rainy season (from the end of May through November) and the summer rice is sown in dry summer season. While main rice is cultivated by rain fed, the summer rice is by irrigated water. Most of the irrigated water is acquired from tributaries of Ayeyarwaddy River. Thus, the major problem occur the agricultural productivity for the lack of rainfall drainage and salt water intrusion into delta due to tidal effects in the dry season. Gradually increment of temperature in the summer season increases the salinity in the delta area and thus the salinity could affect the irrigated cultivation in the delta area. Measuring the salinity for the whole delta is time consuming for every year. Once we could be related the satellite born daily KBDI with the salinity of the sea water, it might be very useful for the monitoring the salinity in the delta area and it could be a supporting factor to increase rice cultivation productivity in the region. Thus, the study will find the relationship of satellite born daily KBDI with the irrigated agriculture productivity in the delta area causes by sea water intrusion to the farm lands. The study will map the margin line of KBDI values changes. The margin line will be used to conduct field survey for salinity. Finally the in-situ field survey data will be used in the process of finding relationship. The result will be relationship between the KBDI values and salinity. The expected result will be salinity map to monitoring sea water intrusion in the delta area.

1. INTRODUCTION

The Ayeyarwaddy River is the longest river in Myanmar. It drains from the northern most snow cap Himalaya mountain range (the peak of Hkakabo Razi) to the southern Ayeyarwaddy delta and drains to the Bay of Bengal. The richness of fertile alluvial soil at this delta area is providing a wide farmland and contributing to the nation as the biggest rice pot. In tradition, the whole country practice in rain fed cultivation (monsoon crop) in rainy season.
Summer crop (irrigated crop) is introduced in late 1970s to fulfill the need for the increasing of population and to increase the peasant income. Though the delta owns the fertile soil, the productivity is somehow less that upstream region. A survey reported that the important of irrigation and better water management in the delta region needed to improve to increase productivity of delta region (Naing, T. A. A., et al., 2008). Another reason might be the water quality which feed to the farmland. The rain water might be fallen with the same quality in the same river basin and hence the mean factor of decreasing rice productivity might be the salinity intrusion and the water quality of irrigated water in downstream delta region. In-situ salinity survey in the deltaic estuaries is conducted in yearly basis since 1998 (unpublished data, Zaw Win, 2006). The calculated 1 p.p.t isohalides are spatially compared from 1998-2006 (figure 1).

On the other hand, the daily KBDI (Keeth-Byram drought index) database is publishing at webgms server of Institute of Industrial Science, the University of Tokyo (http://webgms.iis.u-tokyo.ac.jp/KBDI/) (Takeuchi, W., et al., 2010). The doughtiness index KBDI can be monitored areas of agricultural and climatological drought in 10km grid size on a daily basis. The KBDI represents both LST and precipitation anomaly and well capture a drought offset date. Thus, KBDI can be applied for a future prediction if we incorporate a weather forecast result including LST and precipitation. Once relationship between KBDI and the sea saline water intrusion isohelides could define, the satellite based KBDI could be used to monitor the saline water intrusion to farmland. It could be very useful for crop disaster by climatological drought.

One of the main factors to increase crop productivity is the national authority must have a monitoring strategy on dynamic of sea water intrusion to the estuaries in summer season. Thus, the objective of the study is finding the relationship between the satellite based drought index (KBDI) and the in-situ salinity measurement.

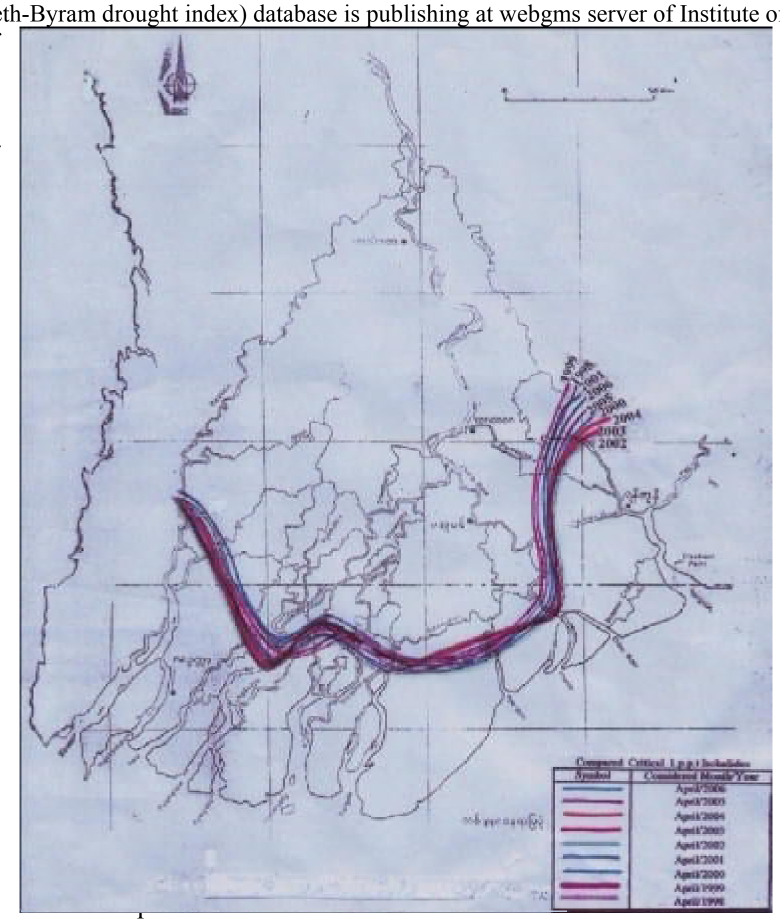

Figure 1. Compared 1 p.p.t critical isohalides line(1998-2006).

2. METHODOLOGY

Though overall methodology is presented in the figure (figure 2), result in this paper is up to the part of the geospatial integration comparison between the KBDI and in-situ salinity measurement data.

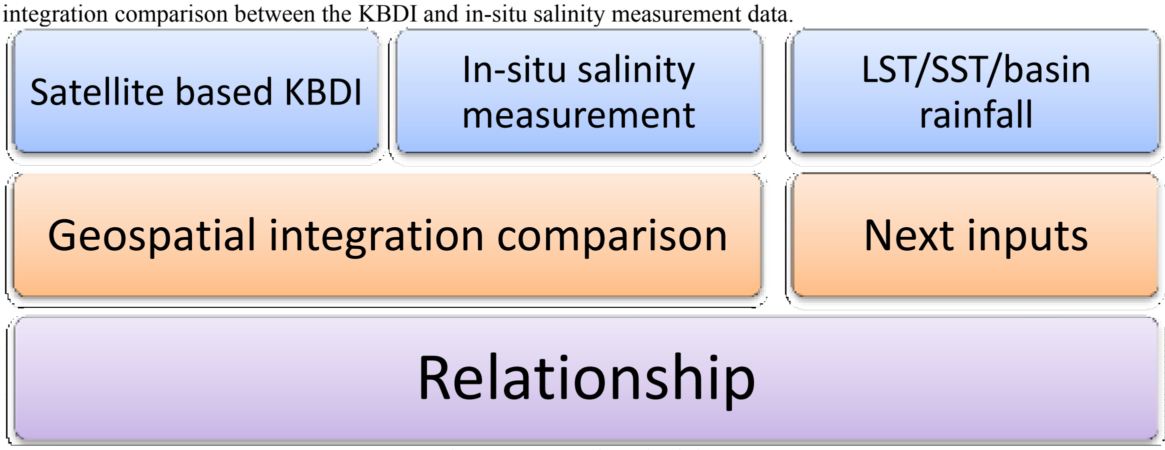

Figure 2. Overall methodology.

2.1 Satellite based KBDI

Satellite based KBDI (W. Takeuchi, et al., 2010) is generated from rainfall and land surface temperature where the rainfall derived from global satellite mapping of precipitation (GSMaP) (K. Okamoto, et al., 2005, T. Kubota, et al., 2007, K. Aonashi, et al., 2009, T. Ushio, et al., 2009) and the land surface temperature derived from MTSAT (K. Oyoshi, et al., 2008, W. Takeuchi, et al., 2012).

English unit equation from Keetch and Byram (1968)

$$\mathrm{dQ} = \frac{[800 - Q][0.968^{(0.0486\,T)} - 0.830]d\tau}{1 + 10.88^{(-0.0441\,R)}} + 10^{-3}$$

English unit equation from Keetch and Byram (1968) corrected in Martin E. Alexander (1990)

$$\mathrm{dQ} = \frac{[800 - Q]\left[0.968^{(0.0486\,T)} - 8.30\right]d\tau}{1 + 10.88^{(-0.0441\,R)}} + 10^{-3}$$

SI unit equation from Crane (1982)

$$\mathrm{dQ} = \frac{[203.2 - Q]\left[0.968^{(0.0875\,T + 1.5552)} - 8.30\right]d\tau}{1 + 10.88^{(-0.001736\,R)}} + 10^{-3}$$

The generated KBDI is presented in the figure with township boundary (figure 3).

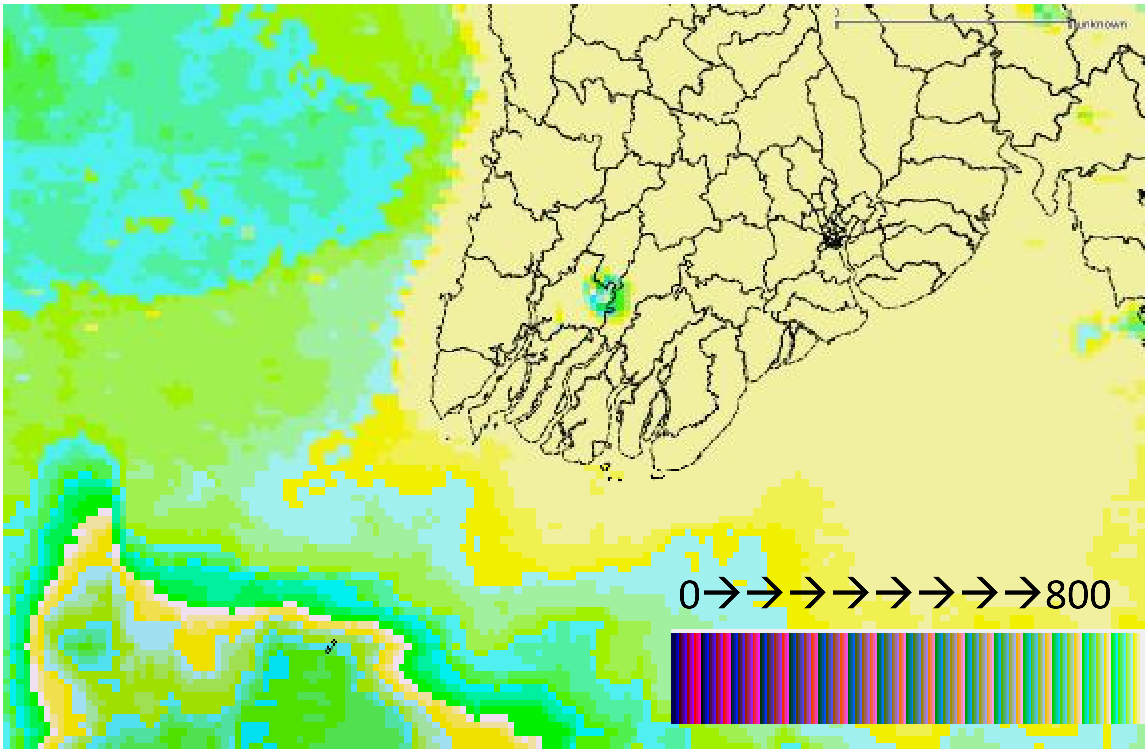

Figure 3. The satellite based KBDI with township boundary.

2.2 Existing salinity in-situ survey

Two rivers namely Ywe (red color line in figure 4) and Pyamalaw (blue color line in figure 4) at Labutta District are selected at Ayeyarwady delta to study the saline front penetration during dry season. These two rivers are selected because of the distribution of high fresh water flow from main Ayeyarwady during low flow period. The pattern of flow is significant at these two rivers as shown in figure attached. The saline front movement can be measured during high spring tide at least two times a month for four months (Jan – Apr) along the rivers with propelled local boats. The measurements are to be carried out at the center of the river at 3 levels (surface, middle and bottom). The boat should be driving along with the high tide and measurements must be carried out one kilometer apart. Comparative saline front lines can be drawn with the other years. A conventional type salinometer YSI Co. Ltd, USA model 33 SCT (salinity, conductivity and temperature) was being utilized for many years.

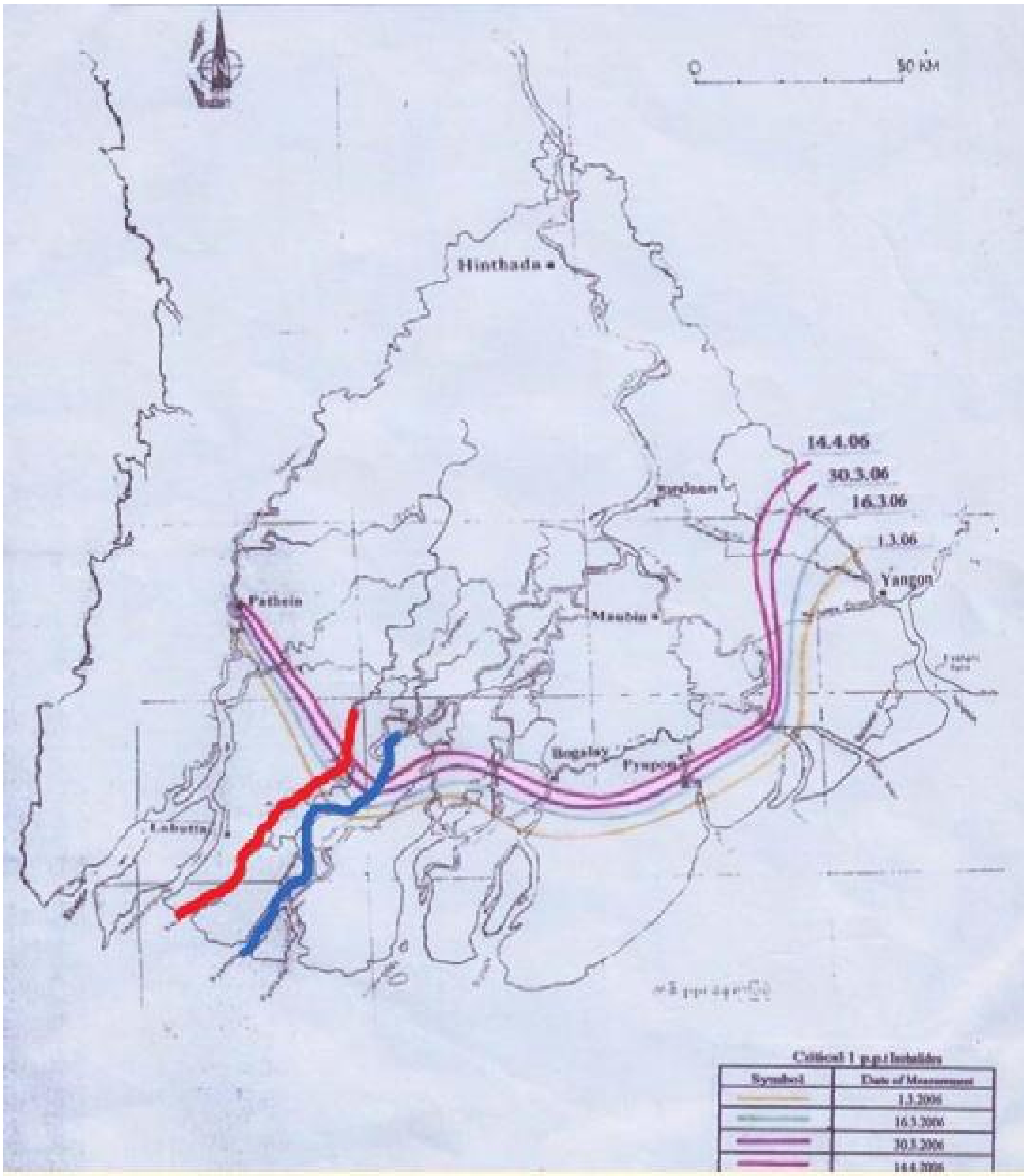

Figure 4. year-wide spatially intruded critical salinity limits in the Ayeyarwaddy Delta (2006).

2.3 Applying geospatial technology

The paper maps are overlay to the ©Google Earth and digitized the 1 p.p.t isohalides lines for available years (1998 to 2006).

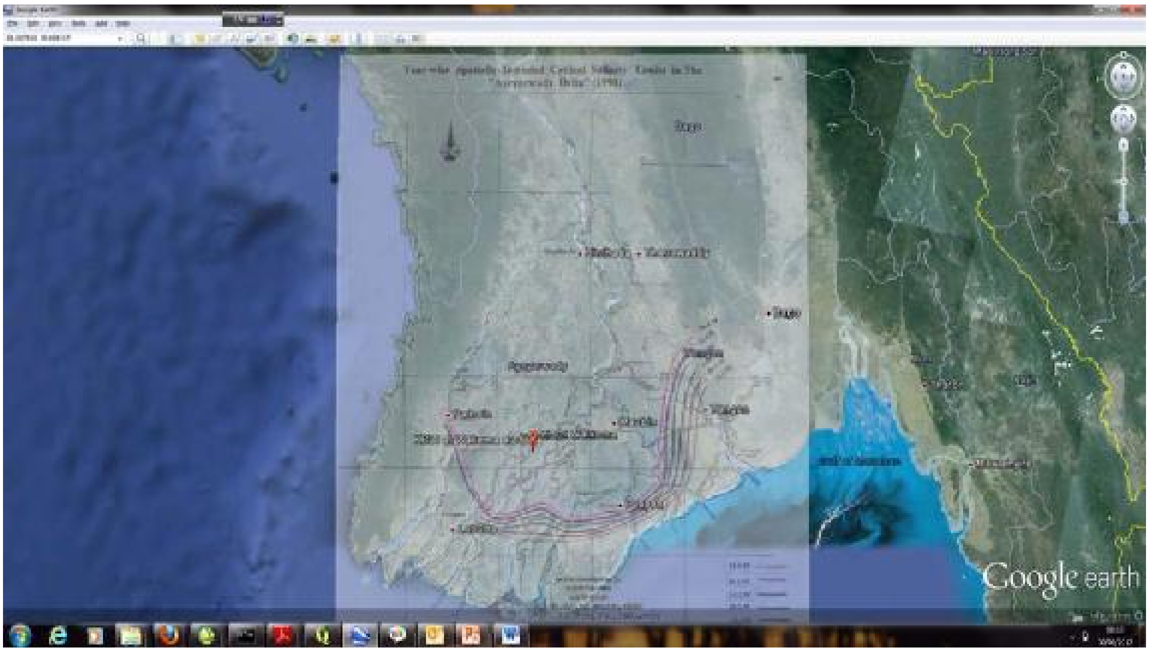

Figure 5. The digitalized geospatial records.

3. FINDING RELATIONSHIP AND RESULT

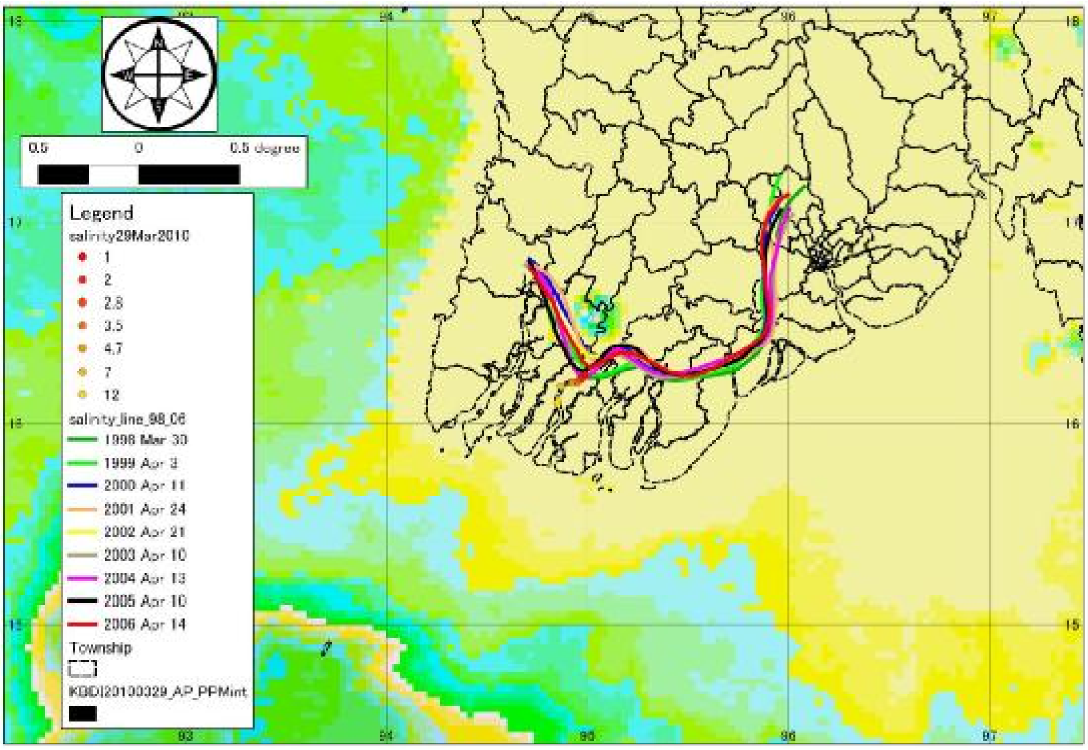

Figure 6. The digitalized 1 p.p.t isohalides on the KBDI map of 2010-Mar-29.

Up to now we could not find a big relationship between the KBDI and in-situ measurement data because of the lack of update in-situ field survey data. Moreover, it might be a good idea to compare other satellite based SST (sea surface temperature) and LST (land surface temperature) once the high resolution satellite data are available for SST and LST maps.

4. DISCUSSION

The trend of the dry season flow of the Ayeyarwady is declining due to many reasons such as climate change, deforestation, sedimentation because of the extraction of gold and jade. Water quality is being deteriorating due to the content of heavy materials. The salinity of the creeks those flow into the farm lands at upstream of Labutta (Ywe river) and upstream of Kanbe (Pyamalaw river) should be measured. Previously, the water in the creek is fresh and tidal irrigation could be carried out successfully. In 2010 (lowest water level at Pyay in 40 years) many farm lands were damaged due to high penetration of saline water. Nowadays a lot of farmers are demanding to provide embankment equipped with flap gates on the creeks.

5. CONCLUSION AND FUTURE WORKS

The variation region should be considered as salinity dynamic farmland region (figure 7). The peasant must follow the alternative cropping guide line from the authority for keeping their good income by farming. Thus, it is very important that to survey on salinity intrusion in the delta area to define the salinity dynamic region.

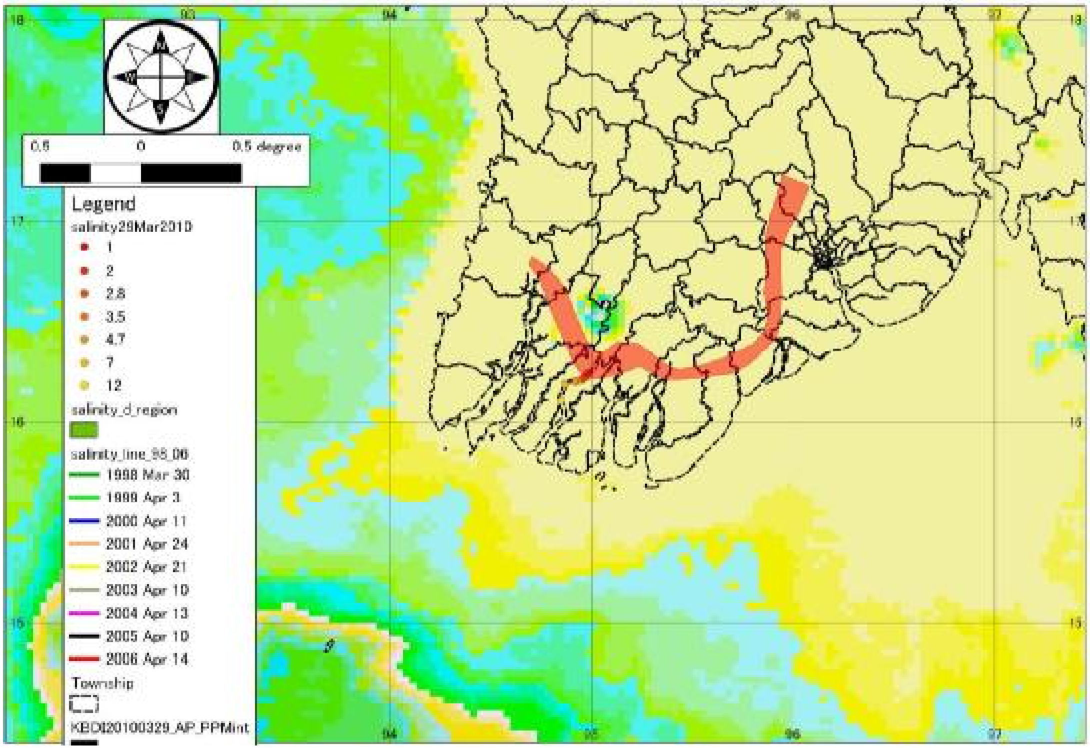

Figure 7. Salinity dynamic region (SDR) of Ayeyarwaddy delta.

The salinity surveyor suggested that the rice is growth well on the salinity of less than or equal to 1 p.p.t. Thus when the salinity is more than 1 p.p.t, the farmland in the salinity dynamic region must be replace with other crops which resistant in the saline water.

On the other hands, because of the ice meltdown from Himalaya through Ayeyawaddy River push the salinity out in the convergent region of SDR. Thus, the curve may represent the river's meltdown icy water flow to predict the climate changes.

To going to monitoring and prediction level of the SDR, the following points are draw as future works.

1) we should have up-to-date daily in-situ measurement data to compare with daily satellite measurement especially for the dry season (Jan-Apr are mentioned)
2) it is need to model the ice meltdown icy water flow to delta through estuaries
3) the tidal dynamic in estuaries model might be integrated

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