THE DEVELOPMENT OF PORONG ESTUARY

By :

Undang Hernawan[1]

ABSTRACT

Coastal zone is an area of interaction between the land and the sea. Coastal dynamic is influenced by many factors, such as sedimentation and current. Development of an area in the coastal zone such as estuary is also influenced by suck factors.

Development of porong estuary is analyzed by interpretation of Image data, i.e. Landsat TM data that acquired in July, 29th 1975, August, 17th 1994, August, 17th 2000, May, 19th 2002 and Quickbird imagery that acquired in April, 25th 2008. Field survey has been done on April 2008.

Based on data interpretation, there are accretion and abrasion in this area. The accretion in the southern part of Porong estuary between 1975 – 2008 is about 33.15 km or about 3.15 km/ year equivalent to 1,492.29 Ha. The abrasion area in the northern part of Porong estuary in 33 years since 1975 till 2008 is around 0.5 km or aproximately 15.15 m/year equivalent to 222.45 Ha of wide or 6.802 Ha/year.

Development of Porong delta, especially in the southern part of Porong estuary, is caused by change of pattern and main stream of Porong River from the noth to the south. This river delivered large volume of sediments and precipated at this area without or minor influence from the sea. Porong delta is a fluvial delta.

Coastal characteristic is mangrove, muddy sediment and locally is sand sediment. Land use in this area is fish pond and mangrove.

Key words: Porong estuary, Satellite imagery

SARI

Pantai/pesisir merupakan wilayah antara daratan dan lautan yang masih dipengaruhi oleh keduanya. Dinamika pantai akan dipengaruhi oleh faktor-faktor dari daratan seperti sedimentasi dan faktor dari lautan seperti arus. Demikian halnya perkembangan suatu daerah di pesisir, seperti daerah muara, dipengaruhi oleh daratan dan lautan.

Perkembangan muara Porong dianalisis berdasarkan interpretasi citra satelit, yaitu Landsat hasil perekaman 29 Juli 1975, 17 Agustus 1994, 17 Agustus 2004, 19 Mei 2002 dan citra Quickbird perekaman 25 April 2008. Survey lapangan dilaksanakan pada bulan April 2008.

Berdasarkan interpretasi citra, ditemukan daerah akresi dan abrasi pada daerah penelitian. Daerah akresi ditemukan di bagian selatan daerah penelitian yaitu sekitar 33.15 km selama

1. Marine Geological Institute, Ministry of Energy and Mineral Resources, Bandung, Indonesia

1975–2008 atau sekitar 3.15 km/tahun dengan luasan sekitar 1,492.29 Ha. Daerah abrasi umumnya terdapat di muara Kali Porong sebelah utara, yaitu sejauh 0.5 km selama 33 tahun atau kira-kira 15.15 m/tahun dengan luasan 222.45 Ha atau sekitar 6.802 Ha/tahun.

Perkembangan muara dan delta Porong, terutama di muara sebelah selatan, diperkirakan karena adanya perubahan arah utama Sungai Porong, yang berubah dari arah utara kea rah selatan. Aliran sungai ini membawa banyak sedimen dan diendapkan pada daerah ini, karena tiada atau kurangnya pengaruh dari laut. Delta Porong termasuk kawasan delta fluvial.

Karakteristik daerah pantai umumnya berlumpur dengan setempat berupa pasir. Penggunaan lahan pada daerah ini umumnya berupa tambak dan mangrove.

Kata Kunci : Delta Porong, citra Satelit

INTRODUCTION

The term "coastal zone" means the coastal waters (including the lands therein and thereunder) and the adjacent shore lands (including the waters therein and thereunder), strongly influenced by each and in proximity to the coastlines of the several coastal region, and includes islands, transitional and intertidal areas, salt marshes, wetlands, and beaches.(http://mapping2.../glossary.html).
Coastal dynamic is influenced by many factors from land and sea, such as sedimentation and current. Human activities in the land/upper coast still can influence to coastal dynamic, such as transporting suspended material to the coast and it is precipated as sedimentation (Dahuri et al, 2004).

Remote sensing technology is an accurate technology which record the earth continuously, real time, and up to date, so relatively accurate for describing real condition on the earth and capable to detect environmental changes on long-term trends. One of remote sensing data is Landsat Thematic Mapper (TM) for middle resolution and Quickbird imagery for high resolution. The use of remote sensing data has many benefits, i.e. remote sensing data can record wide area in same time and generate data periodically, so we can know development of region.

The location of study area is in Porong Region, and it is included in Sidoarjo District in the north part and in the south part is Pasuruan District.

METHOD

The material for this study is Landsat TM imagery that acquired in July, 29th 1975, August, 17th 1994, August, 17th 2000, May, 19th 2002 and Quickbird imagery that acquired in April, 25th 2008. Field survey has done on April 2008.

The method is comparison between multi-temporal imagery that shows environmental changes. The processing software for imagery is Erdas Imagine and software for interpretation of imagery and GIS format is MapInfo.

The first step in this study is geometric correction to geographically and customized all images. Geometric correction is a procedure to remove deviation that marks sense geometric distortion, so geographically, image have equals position at the earth. The base image that utilize for geometric correction is Quickbird imagery, and then Landsat TM that acquired in 2002 and second base imagery for other Landsat TM correction.

RESULTS AND ANALYSIS

Geology

Morphology of Porong region is lowland and relatively flat. The altitude is between 0 – 25 m asl and occupied by extensive alluvium

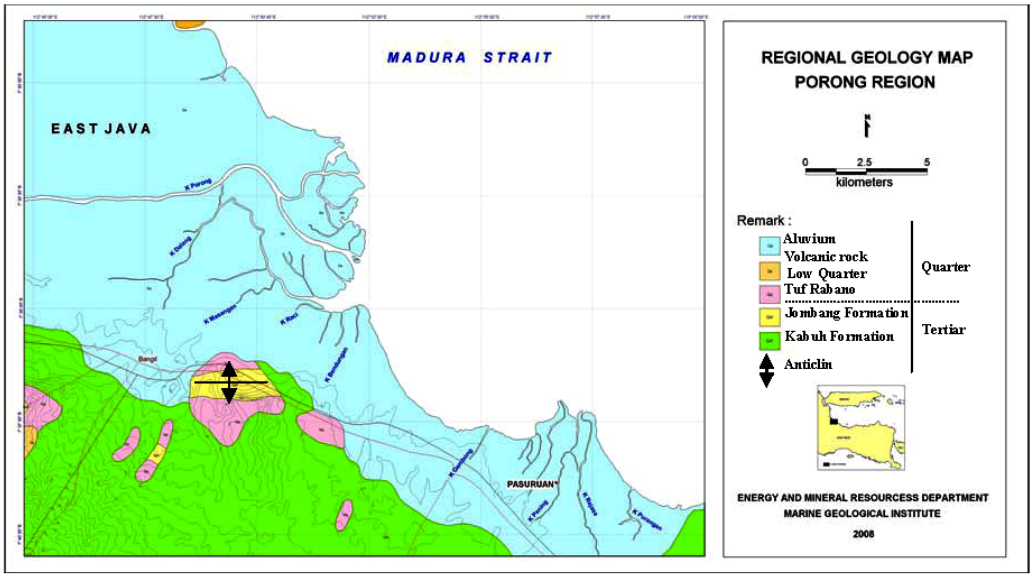


Figure 1. Map of regional geology in Porong and its surrounding (Source: Santosa dan Suwarti, 1992)

sediment. The river has flow patterns, braided, anastomic and scrawl of constant temporal and periodical characters. The main river is Porong, Rabano and Rejasa. The larger part in this area constitutes fishponds.

Generally, geological condition of Porong is alluvium, which consisted of gravel, sand, clay that constitutes alluvial sediment and beach sediment. Outspread of alluvial sediment is along Porong River, Alo R and Rejasa R. Outspread of beach sediment is along Madura strait coast, consisted of sand, locally a lot of mollusc or shell and coral. (Santosa and Suwarni, 1992)

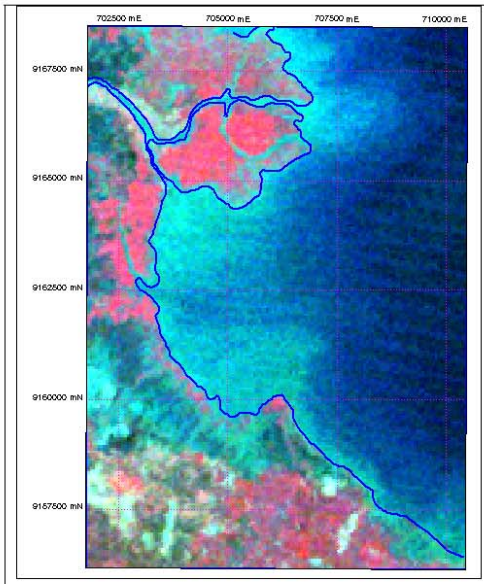
Porong Estuary Development

The change of coastal line interpretated based on satellite imagery. Figure 2 shows images which are used in this study in interpretation of coastal line in all and every images (a) landsat TM image 1975 (b) landsat TM image 1994 (c) landsat TM image 1994 (d) landsat TM image 2000 (e) Quickbird image 2008 and (f) all interpretation of coastal line.

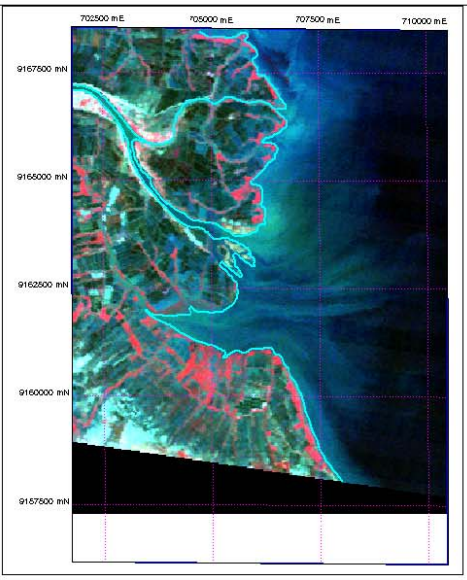
Generally, the results of interpretation show depelopment of porong estuary, abration and accretion area, development and changing of main stream of Porong River.

Based on teh images, the pattern of Porong river is estimated had changed its main river crude. In 1974 main stream of Porong River is to the north and a river that toward south is stated at branch of Porong River. In 1995 – 2008 main stream of Porong River and its branch changed to the opposite; main stream of Porong become to the south and and the river that go to the north become a branch.

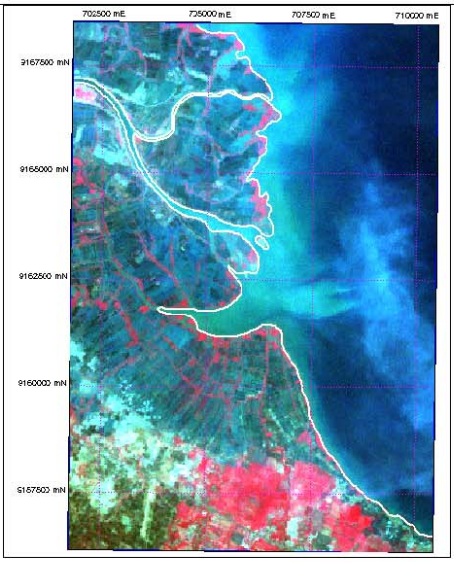
This Changing of rivers streaming direction is presumed constitutes the root cause shoreline change and formation new delta at Porong estuary. Porong estuary region those are on southern based on image data 1975 just originally constitute ramifications of Porong River, but based on image data 1994 this river branch has changed as main stream


702500 mE
705000 mE
707500 mE
710000 mE
9167500 mN
9165000 mN
9162500 mN
9160000 mN
9157500 mN

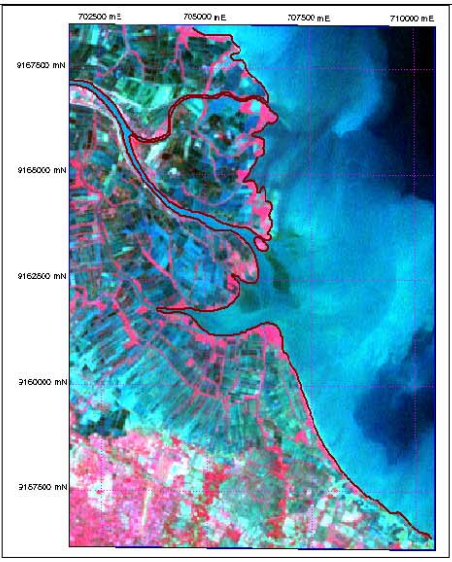
(a)


702500 mE
705000 mE
707500 mE
710000 mE
9167500 mN
9165000 mN
9162500 mN
9160000 mN
9157500 mN

(b)


702500 mE
705000 mE
707500 mE
710000 mE
9167500 mN
9165000 mN
9162500 mN
9160000 mN
9157500 mN

(c)


702500 mE
705000 mE
707500 mE
710000 mE
9167500 mN
9165000 mN
9162500 mN
9160000 mN
9157500 mN

(d)

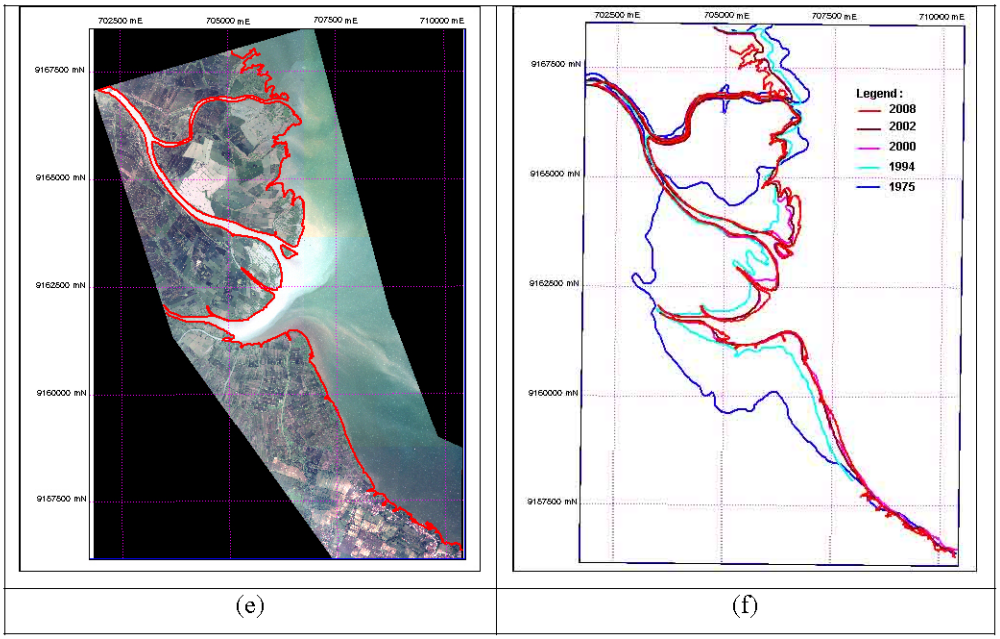


Figure 2. Image of (a) Landsat 1975, (b) Landsat 1994 (c) Landsat 2000, (d) Landsat 2002 (e) Quickbird 2008 and (f) Interpretation of all coastal line

of Porong River. This condition has got the significant impact to sedimentation that precipated by Porong River in the estuary, so the southern region has become an active sedimentation region. Different condition has experienced by Porong estuary those are on the northern. Porong estuary region at northern that originally becomes main place of sedimentation from indigenous Porong River has change as contrability and tending as region which most erosion / abrasion.

Tabel 1. Area of Porong estuaries changes

No.	Class of changes	Area (Ha)	Area (Ha/year)
1	Accretion :		
	1975 – 1994	1,124.97	59,21
	1994 – 2000	280,36	46,73
	2000 – 2002	43,636	21,82
	2002 – 2008	72,991	12,17
	1975 – 2008	1.492,29	45,22
2	Abrasion :		
	1975 – 1994	109,643	5,77
	1994 – 2000	65,211	10,87
	2000 – 2002	66,82	33,41
	2002 – 2008	29,479	4,913
	1975 – 2008	224,45	6,802

Table 1. shows change of Porong estuaries based on image interpretation between 1975 - 2008.

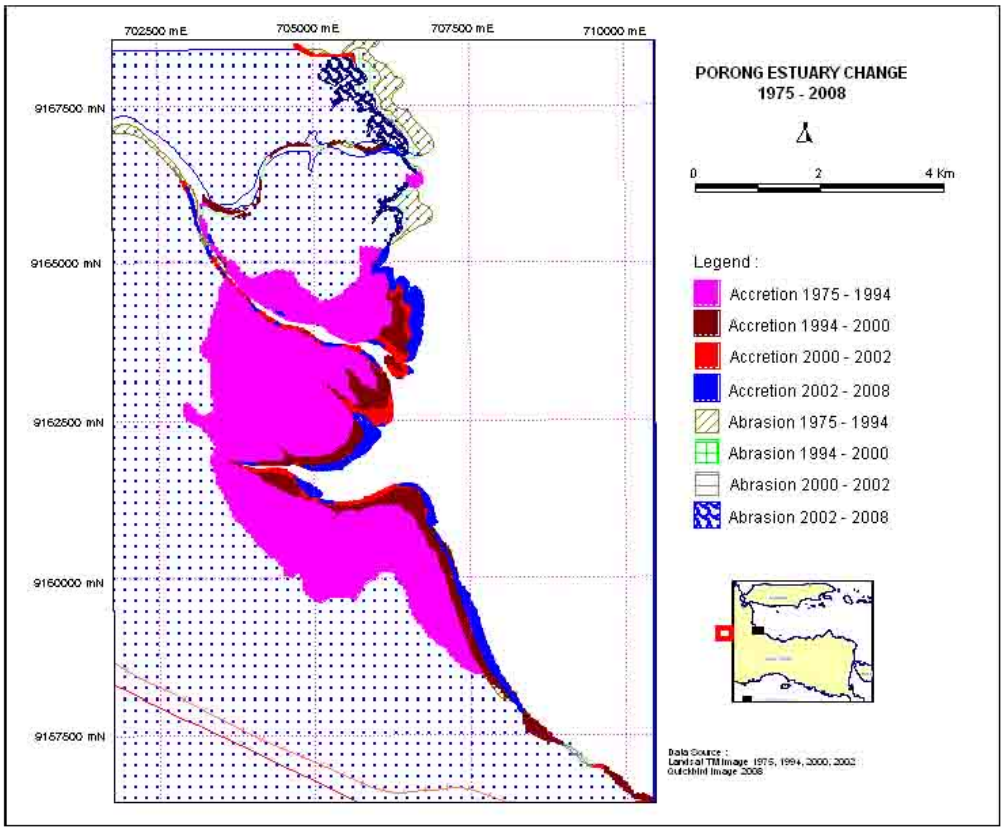


Figure 3. Coastal line change and development of Porong estuaries and its surrounding

Generally, Changing of Porong estuary show accretion area greater than abrasion and it is reaches 1.492,29 Ha. Changing shoreline (accretion) at Porong River estuary that took place between 1975 – 2008 up to 3,15 km in his far. This matter approximately average changing Porong's River estuary increases around 95,46 meters per year. Greatest increase that really influent to Porong River delta developing happens on 19 years among 1975 – 1994 which is as extensive sedimentation i.e. 1.124,97 Ha or about 59,21 Ha/years with distance approximately as far as 2,75 km or about 145 m/year. Coastal line changing on 14 next year among 1994 – 2008 as far as 0.4 km or 285,71 m/ year or as wide as 280,36 Ha or about 46,73 Ha/year.

This development scheme show that the most significant factor that influent changing of Porong estuary is sedimentation carried out by Porong River. Changing of Porong River stream from the northern in the previous time to the southern gave significant influence to developing of Porong estuary, especially on early period and initial delta formation. This condition show that Porong River stream that take in sediment in large quantities perpetual moving and most precipates at this region, so sizable sediment input overshot ability of current and wave in sediment transport

process, so causes velocity of delta developing.

Its diference with the southern part of Porong river mouth which continously sedimentation and acretion is occured where as in the northern of Porong river tend to occur the coastal abrassion. Abration in the northern of branch of Porong River among 33 years since 1975 till 2008 is around 0.5 km or aproximately 15.15 m/year with 222.45 Ha of wide or 6.802 Ha/year.

Figure 4. show general pattern of acretion an abrasion in Porong estuary region and its surrounding.

Generally, development of Porong estuary and coastal dynamic at Porong area show abrasion area is found in the north of study area exacly in the mouth of Porong River and a small area in the southern part of study area. Wide accretion area is found in the southern part of Porong estuary that is main stream of Porong river and its surrounding. Accretion area is found also in a small area in the northern of Porong river mouth

Porong delta is occurred in the southern part of Porong River with large river volume along the year and just a minor influence from the sea like current and wave. Porong River takes large volume of sediment from upstream continuously along the year and precipated at the mouth of river, so the mouth is go forward and form a delta

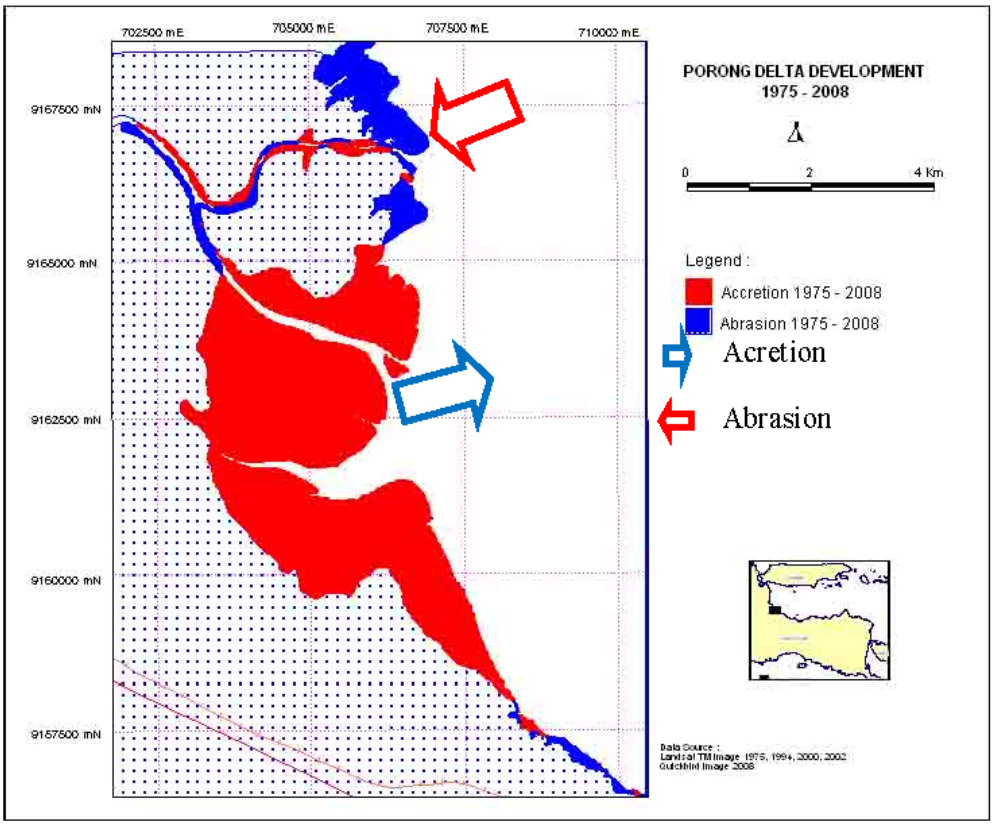


Figure 4. General direction of acreation - abrassion of Porong and its surrounding among 1975 - 2008

Based on the pattern and condition of delta form, the delta Porong is a fluvial delta. This fluvial delta is formed by river process without or minor influence from wave or tide (Kamal, 2008).

There is five reasons that affecting to delta form, i.e:

- Large volume of river sediment
- The coast is shielded and experiences low rate of tide
- Sea water at the estuary must shallow
- There is no high velocity current that is adrift correct angular with river confluence
- There in no big sand bars along river flow

(http://www.sabah.edu.my/mrc030.wcdd/sungai.html#deltamuara)

Large sediment input, condition of Porong estuary that flat and gets hollow form on river estuary particularly that avoiding from big oceanic influence take in delta formation impact especially on early period that experiences fast development.

On year 1975, Porong delta stills as an embryo of a delta. The increase delta occured extremely since 1975 until year 1994 especially when the main stream of Porong river is change from the north to the south, so sedimentation input goes to downstream at the southern part as a new main Porong estuary. Large volume of sedimentation in the upstream, i.e. Malang city and along drainage basin since marks sense farm uncovering activity and its reducing vegetation along river begets wall or river bank can easily erosion so adding total sediment input that took by river flow and it is precipated at estuary region.

Coastal characteristic around Porong estuary is relatively flat in it relief, its geology constitutes alluvium where the shoreline is marked by mud sediment, clay, silt and locally is featured too by sand sediment. Vegetation in general constitutes mangrove plant that spread around Porong River estuary.

Coastal land use and land in Porong estuary and delta region is fishpond. Coastal land use for settlement is just found in a small area in the southern of study area. Mangrove vegetation stays along shoreline and at causeway of fishpond. Analysis of different image show mangrove forest always gets ahead motion toward the sea follow sedimentation extension at this area. Mean while, increasing of Porong delta is not accompanied with significant mangrove increasing, because mangrove forest development is reconverted again by local society by hews that Mangrove to extend their fishpond area.

Figure 5 shows coastal characteristic and landuse around Porong delta and its surrounding, i.e. as flat area, muddy, with mongrove forest. Behind this region is fish ponds.

CONCLUSION

There is development of Porong estuary such as accretion and abrasion that took place in both of Porong estuary, in the southern and northern part. The accretion in the southern part of Porong estuary among 1975 – 2008 is about 33.15 km or about 3.15 km/year as far as 1,492.29 Ha. The abrasion area in the northern part of Porong estuary in 33 years since 1975 till 2008 is around 0.5 km or aproximately 15.15 m/year with 222.45 Ha area or 6.802 Ha/year.

Development of Porong delta, especially in the southern part of Porong estuary, is estimated caused by change of pattern and main stream of Porong River, that is change from the noth to the south. This river take large volume of sediment. Porong delta is a fluvial delta.

Coastal characteristic is mangrove, muddy sediment and locally is sand sediment. Landuse change is fish pond and mangrove.

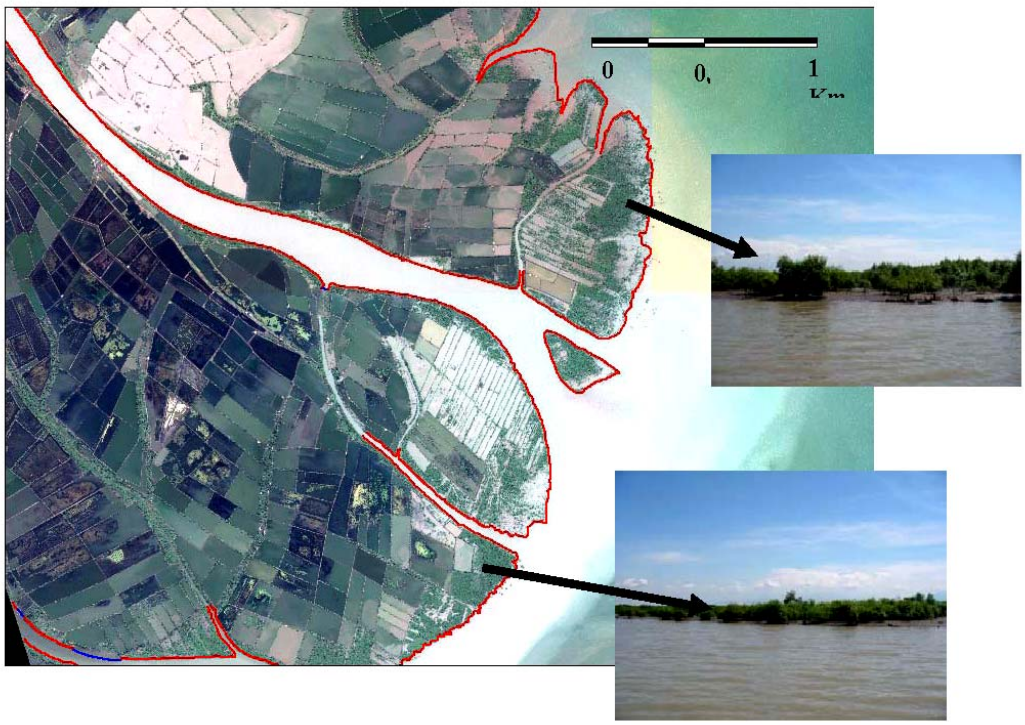


Figure 5. Flat area with muddy sediment and mangrove forest that rare – moderate solid and fish pond area

ACKNOWLEDGEMENT

The author wish to thanks Ir. Subaktian Lubis, MSc, the director of Marine Geological Institute who has encourage me in preparing and publishing this manuscript. The author also thanks Porong team, especially Mr. Kris, whose support me to study the material.

REFERENCES

Dahuri, R., Jacob, R., S.P. Ginting, dan M.J. Sitepu. 2004. Pengelolaan Sumberdaya Wilayah Pesisir dan Lautan Secara Terpadu. Pranadya Pramita. Jakarta.

Santosa dan Suwarti. 1992. Peta Geologi Lembar Malang, Jawa. Pusat Penelitian dan pengembangan Geologi. Bandung

Lillesand, T.M. and R.W. Kiefer. 1994. *Remote Sensing and Image Interpretation*. John Willey and Sons. New York.

Roslam Mohamed, Kamal. 2008. Kuliah sedimentologi, Delta. UKM, Malaysia. (http://pkukmweb.ukm.my/~kamal/sedimentologi/kuliah16-9-delta.pdf)

(http://www.sabah.edu.my/mrc030.wcdd/sungai.html#deltamuara)