Phenomena Stratification of Sea Water Volume and the River Flowing Mass of Beach Estuary

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Abstract

Ups and downs are sea level fluctuations due to the attraction of celestial bodies, especially the sun and moon to the mass of water on earth. The flow of sea water to the estuary is accompanied by the transport of sea water volume. The entry of sea water into the estuary is called the saltwater intrusion and the distance of salt water intrusion to the estuary depends on the characteristics of estuaries, tides and river mass. The higher the tide and the smaller the volume of the river flow, the further the saltwater intrusion. Conversely, the smaller the tides and the greater the volume of the river flow, the shorter the distance of salt water intrusion. The inclusion of river flow volume to coastal waters (salt water) is much influenced by the pattern of river flow velocity and tidal patterns that depend on sea level fluctuations due to the attraction of celestial bodies, especially the sun and moon to the sea water mass on the earth. The stratification length of saltwater intrusion to estuary depends on the characteristic profile of river flow velocity, suspended sediment transport pattern, tidal, month and season phases. The estuary stratification analysis is intended to obtain the length of the curve mixing of sea water volume and the mass of the river flow. Data of coastal estuary stratification phenomenon is presented in flow rate data profile at depth of 0.6 ($v_{0,6h}$) river, suspended sediment distribution data profile at full moon phase, first quarter phases, rainy season and full moon dry phase during tidal. The accuracy of modeling and interpolation of tidal data conditions is expressed by the absolute deviation of averages as well as the bias of the modeled data and the extrapolation data to the measured data. The flow velocity ($v_{o.6h}$) is physically related to the suspended sediment deployment, since the suspended sediment based on the sediment transport mechanism moves as a float load at depth ($v_{o.6h}$). With increasing distance accompanied by reduced velocity ($v_{o.6h}$) followed by a decrease in suspended sediment prices, or by decreasing speed (by distance) was followed by a decrease in the amount of suspended sediment. Increasing sea level will increase the gradient rating curve and shift the position of zero velocity (mix in estuary) upstream. The phenomenon of stratification of the volume of sea water and the mass of the river flow that carried the suspended sediment at the estuary of the Ronoyapo Amurang estuary follows the length of the curve mixing estuary. The full moon phase of the dry season stratified the volume of seawater and river mass with a curve mixing length of 87 meters estuaries. The first quarter rainy season stratified the volume of sea water and river mass with a curve mixing length of estuary of 139 meters. The full moon phase of the rainy season stratified the volume of sea water and the mass of the river flow following the length of the curve mixing estuary of 151 meters. The area along ± 150 meters (950 meters to 1200 meters position) is a mixing estuary location of sea water volume and river mass that carries suspended sediment load in full moon period, first quarter phase of rainy season and full moon period of dry season estuary.

Keywords: Mixing estuary, mass of water flow, sea water volume, estuary

1. *Introduction*

Humans and all other living beings need water that is an essential part of natural resources with unique characteristics compared to other natural resources (Kodoatie and Syarief, 2010). The problems associated with water passing through the hydrological cycle process are very complex in relation to all river mouths becoming the end of the flow to the coast. The problem arises in the coastal estuary area is the mixing of sea water entering the waters of river water. This is caused by the influence of sea water propagation due to ups and downs.

The flow circulation pattern in estuary is influenced by river morphology, river flow velocity character, suspended load dispersion pattern, tidal, moon phase and river discharge. The flow circulation includes tidal wave propagation, mixing of freshwater mass and sea water volume, flow velocity and suspended sediment pattern at the coastal estuary. River flow velocity is the movement of a mass-water element (containing suspended sediment) across a cross-section of a river of unity of time. Suspended sediment is principally related to sediment discharges transported by river mass, Asdak, (2010), Mulyanto, (2010). Ups and downs are sea level fluctuations due to the attraction of celestial bodies, especially the sun and moon to the mass of water on earth. The flow of sea water volume to the estuary is accompanied by mass transport of salt. The entry of saltwater into the estuary is called the salt water intuition. Distance stratification of salt water volume and mass of stream to estuary depends on estuary characteristics such as; Tides and river discharges (which carry suspended sediment). The higher the tide and the smaller the river discharge, the further the saltwater intrusion. Conversely, the smaller the tide and the greater the flow of the river, the shorter the distance of the salt water intrusion. The influx of freshwater into the coastal waters (salt water) is much influenced by the pattern of river flow velocity and the phase of the moon that is always changing when viewed from the earth. The moon phase is very influential on the ups and downs of the estuary, because the tides are the fluctuation of sea water because of the attraction of celestial bodies, especially the sun and moon to the sea water mass in the earth and the tidal period is the time required from the position of the water level at Average water level to the next position. Tidal periods that occur each day are determined by the earth's rotation for 24 hours. Tidal conditions that occur against the sea water mass at the time of the perigee, where the position of the nearest month to the distance to the earth. The receding condition occurs at apogee, where the farthest moon poses to the earth. The highest tides occur in the full moon phase and the lowest tide in the first quarter phase (seven days after the full moon). The flow discharge / estuarine water level during highs and lows are strongly influenced by the conditions of the season (rain and drought). River flow and seasonal changes are one of the important parameters in the mixing circulation in the estuary.

The phenomenon of stratification of seawater volume and river mass to estuary depends on the characteristics of stream flow profile, suspended sediment transport pattern, tidal, full moon phase, first rainy season phase and full moon dry phase. The stratification and mixing estuary analysis is intended to obtain the length of the curve mixing where it is suspected that the higher the pairs and the greater the river flow (Full moon) the further the saltwater intrusion and the further curve rating stratification of sea water volume and river mass. Conversely, the smaller the pairs and the smaller the river flow (drought) the shorter the stratification distance of sea water volume and river flow or the shorter the curve mixing rating of sea water volume and the mass of the river flow. Field observations indicate that river flow varies, during periods of large flow associated with increased sediment transport rates or river flows, when peak flow discharge has been exceeded and flow discharge decreases rapidly, sediment rates are rapidly reduced resulting in river degradation. Time series analysis based on the sediment curve rating on the discharge conducted by Summer et al. (1992) concluded that there is no time delay between increasing discharge and increasing sediment transport (which means also an increase in transport sediment material.) Schwab (1981), describes the speed of moving bed transport material shifts as suspended sediment with the speed of water flow Seen from the way it is transported by water, the sediment load can be differentiated into suspended sediment and bed load (Ffolliott, (1990), Sulastriningsin (2001).

The flow circulation pattern in the estuary is influenced by estuarine hydro physical properties, such as flow velocity, suspended dispersion pattern, moon phase, tidal and seasonal changes. One of the important parameters in circulation in the estuary is the flow rate and tidal flow patterns that depend on hydrological and watershed characteristics. Good watersheds (forests are maintained) provide relatively constant flow discharge throughout the year. Medium if the condition is ugly variation of discharge between wet and dry season is very large. Hydrograph in the upstream estuary is a function of time with flow direction always downstream (towards the sea). In the rainy season the flow of large flow while in the dry season discharge small flowing.

Time flooding the river flow pushes the volume of sea water into the sea, so the intrusion of saltwater and turbidity is pushed more downstream, while at small discharge the volume of sea water move upstream (Salamun, 2008, Tendean, 2013). At the mouth of the river there is a meeting between saltwater from the sea and freshwater from the river. The location of the intersection and the level of mixing between saltwater and fresh water varies greatly depending on the strength of tidal and river flow. In the event of periodic tide, the tide from the sea will enter the river channel upstream through the opening of the river mouth.

At rising tide, the heavier, heavier sea / salt water will infiltrate the freshwater flow from upstream with its lighter weight to form salt wedge under the freshwater flow downstream (Mulyanto, 2010).

Regardless of the irregularity of the basic shape and cross-section of the estuary, there will be a clear boundary plane between the saltwater and fresh water above it, which tilts with the upstream grace. Due to turbulence, there will be mixing between the two types of water in that field. Far salt water or salt bail length of this need to be known for the purposes of river management as freshwater resources. The shape of the plane of the encounter between the two types of water may be one of the three estuary species below: a). Coating or stratification occurs slightly mixing. B). Partial mixing. C). Complete mixing (Mulyanto, 2010). Estuary types (a), when low tides and large river discharge. Fresh water / river flows over seawater, between freshwater and salt water occurs Angle Salts(salt wedge). The salinity in the lower layer is the same as the salinity of seawater, while the top layer is fresh water. The position of the salty angle may change, can move upstream at high tide and downstream at low tide. (B) Partially mixed estuaries develop in moderate tides. Tidal current is quite influential and the water mass moves up and down following the ups and downs of tidal water.

As a result of current shear at the brine or freshwater encounter, the shear at the estuary base creates shear stress and raises the turbine, (c) On the wide and shallow estuaries, where the tides are high and the tidal currents are stronger than the river flow, the water pool becomes Mixed completely, the estuary mixed perfectly and when the big tides and small river discharge, there will be better mixing. No longer occur the boundary plane between salted brines and fresh water. Salinity variations occur only along the estuary, with no vertical and lateral stratification. (Salamun, 2008). Tidal conditions generally occur, can be distinguished in four different types namely: (1). Double tidal daily (semidiurnal tide). In one day there are twice the tide and twice the low tide at about the same height, the tidal occurs regularly where the average tide is 12 hours 24 minutes (2). Single tide daily (diurnal tide). In one day there was one tide and one tide. Tidal period is 24 hours 50 minutes. (3). Tidal mixture is biased toward double daily (mixed tide prevailing semidiurnal). In one day there is twice the tide and twice the water receded, but the height and period are different. (4). Tidal mixed bias to double daily (mixed tide prevailing diurnal). This type in one day occurs once the tide and once the water recedes, but often occurs twice and twice with low and different periods (Mulyanto, 2010).The tidal link at the Ranoyapo estuary has double tidal (semidiurnal tide) where in one day there is twice the tide and twice the low tide with the same height and period. The highest tides occur in the full moon phase and the lowest tide in the first and quarter phase (seven days after full moon).

2. *Methods*

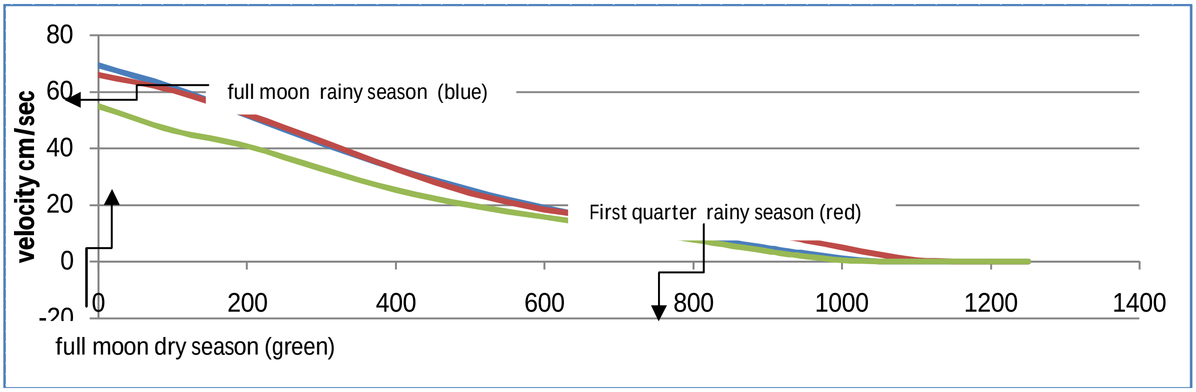
The phenomenon of stratification of seawater volume and river mass refers to a method of measuring flow velocity at a depth of 0.6 meters, suspension charge moving as suspended sediment. Measurements carried out in the rainy season full moon phase, rainy season first and quarter phase and dry season full moon phase. Identification of estuarine stratification phenomena in which there is no upstream or downstream water movement (transition between upstream and downstream ($v_{0,6h = 0}$), estuarine mixing (mixing of seawater volume and river flow mass carrying suspended sediment) under conditions Rainy season and dry season during tide and according to full moon phase, first and quarter phase (seven days after full moon). Measurements of physical variables flow velocity ($v_{0,6h}$) and suspended sediment starting from position - 0 meters to 1200 meters toward the coastline. Data collection procedures include: (1) Determination of research location boundary from example from upper boundary tide to limit the occurrence of significant changes in physical variables. (2) Determination of measurement positions along the river mouth. (4). Measurement of measurement segments according to direction of river width. (5), Determination of measurement point ($v_{0,6h}$) in vertical direction. Measurements in the vertical direction of river flow to present flow profile ($v_{0,6h}$), suspended sediment and curve length of stratification in estuary, as well as suspended sediment deployment indicating stratification phenomena of sea water volume and coastal riverine river flow (Foster et al., 1992 , Jasson, 1992, Tendean, 2012).

The analysis of coastal estuarine stratification phenomenon based on river flow velocity data profile ($v_{0,6h}$) and dispersion pattern of moving transport material as suspended sediment in full moon phase, first and quarter rainy season and full moon phase of dry season at high tide. The accuracy of modeling and interpolation of tidal data conditions is expressed by the absolute deviation of averages as well as the bias of the modeled data and the extrapolation data to the measured data.

3. *Results and Discussion*

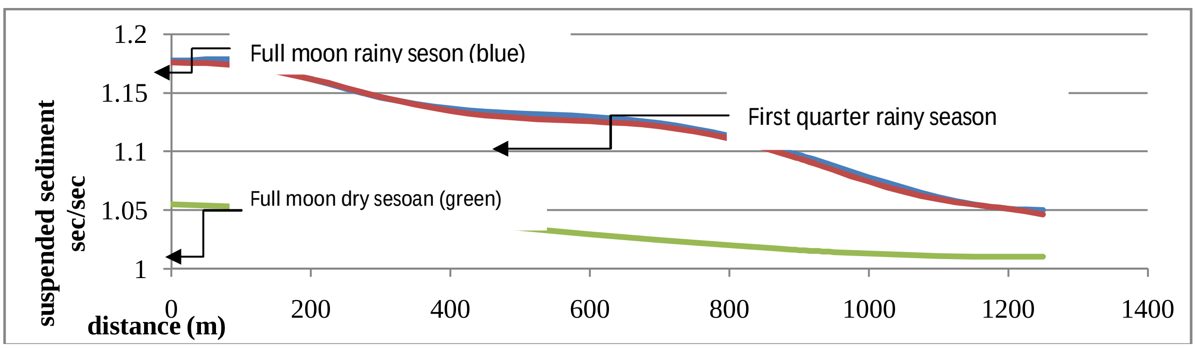
The analysis of the phenomena of seawater volume stratification and mass of coastal estuary flow of Ranoyapo Amurang is presented in river flow velocity profile ($v_{0,6h}$) and dispersion pattern profile of moving material transport material as suspended sediment in full moon phase, first and quarter phase of rainy season and phase Full moon dry season in high tide. The results of modeling and interpolation-extrapolation of the tidal condition data are expressed in the absolute deviation and bias of the modeled data and the extrapolation data obtained from the measurement data. The analysis provides an average of absolute deviation for the overall measurement data at a small enough price so that the modeling result can be expressed as having high accuracy to present the change in flow rate and suspended sediment price along the estuary. The result of the velocity modeling ($v_{0,6h}$) during the tide for the three phases of the month and the condition of the measuring seasons is shown by the following image curve rating

Figure 1. Flow rate (v0,6h) tide condition.



Rating curve velocity ($v_{0,6h}$) during tide in full moon rainy season shows relatively similar prices with similar gradients compared to the rating curve charts during the first quarter tide in rainy season. Being different from the speed curve rating on the full moon dry season phase water conditions, lower with a gradient lower than the full moon rainy season. The result of suspended sediment data modeling during tides for three phases of the month and season of measurement season is shown by the following image curve rating.

Figure-2. Spreading suspended sediments during tide.

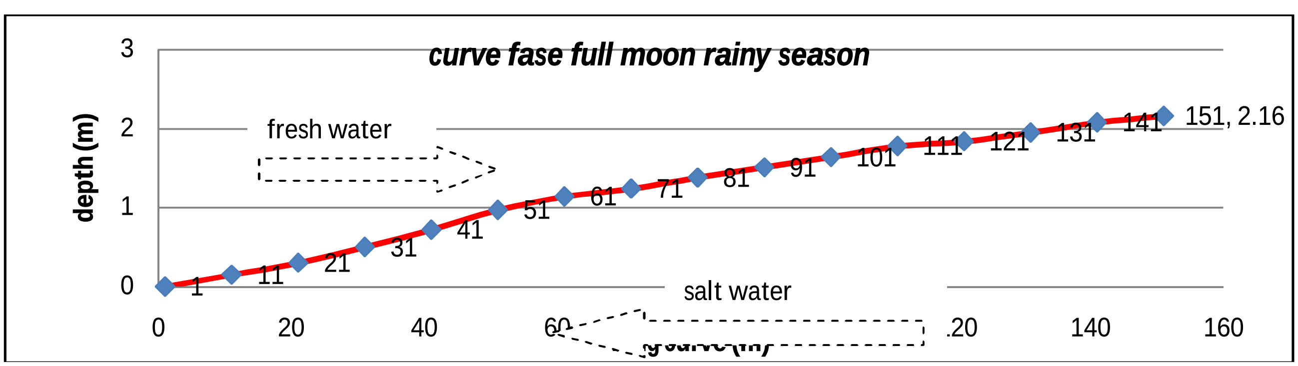


Rating curve suspended sediment at high tide, for all three flow conditions of course the same shape because the data distribution pattern in the same three flow conditions. The change in suspended sediment along the estuary can be based on the third curve rating analysis of the conditions at the measurement position according to the width of the river. The curve rating comparison analysis shows that the suspended sediment in the full moon phase and the first quarter phase of the rainy season has a similar price as the gradient decreases. In the full moon phase the dry season will decrease with the horizontal gradient along with the decrease of river flow velocity and the decrease of river flow mass (river flow discharge).Asdak (2010), explains sediment transport in principle with regard to the flow of sediment transported by the stream. The condition shown by the graph of figure-2, the full moon phase and the first quarter phase in the rain, in each position measuring the suspended sediment price is almost the same as the full moon phase curve rating is slightly above the first quarter phase, will differ in the full moon phase of the dry season Curve rating far below the rainy season.

Physically this is because, in the dry season, the river flow does not carry a lot of sediment material, so when the measurement of suspended sediment concentration is small, it is marked by the rating curve with horizontal gradient. The flow velocity at depth ($v_{o.6h}$) is physically closely related to suspended sediment deployment, since suspended loads based on a moving sediment transport mechanism as a floating load are included at a depth of 0.6 ($v_{o.6h}$). The curve velocity ($v_{o.6h}$) flow pattern (image-1) and suspended sediment deployment (figure-2) in the measurement position one to the two measurement positions shows the price reducer according to the distance function, which means that with increasing distance the speed decreases (vo. 6h) was followed by a decrease in the price of suspended sediment, or by decreasing the speed (by distance) was followed by a decrease in the amount of suspended sediment. In the third measurement position (x = 200), the velocity ($v_{o.6h}$) value decreases compared to the quantity at position x = 0, to the position of measurement 1200 m decrease following the polynomial function, this condition is followed by the decrease of the suspended sediment price to the position Measurement of 1200 meters. This means that the drop in velocity ($v_{o.6h}$) of flow along the measurement position is always accompanied by a decrease in the spread of suspended sediment along the estuary. This condition corresponds to the theory that, upstream water with the sediment material it transport will reduce the flow velocity, while the softer material which can still be transported by the flow at a reduced speed will be forwarded to the sea (Mulyanto. 2010, Tendean. 2013). In the 1200 m measurement position it can be clearly seen that the flow velocity ($v_{o.6h}$) of the tidal stream for rainy and dry seasons is considerable, and this condition applies to the measurement position x = 0 m to the measurement position x = 950 m, Because at the measurement position 1000 m and so on the flow velocity becomes zero. The magnitude of the rainy season is above the dry season as a result of the increased flow of river flow in the rainy season. Thus the gradient changes and the zero velocity position (the position at which the sea water volume volumes and the tidal river mass from the tide) will depend on the flow rate and the high tide. Increasing sea level will increase the gradient rating curve and shift the position of zero velocity (mixing estuary) upstream. Asdak (2010), illustrates that the speed of sediment transport (suspended sediment) is a function of river flow velocity and sediment particle size.

The dispersion of suspended sediment relies heavily on seasons, flow velocity and flow and the amount of sediment transport in the stream is a function of the supply of sediment and stream energy. Lensley (1972), states that suspended sediment generally drifts under the flow, the larger the riverbed, the same opinion expressed by Dickinson and Bolton (1992). Mixing in the estuary is caused by turbine diffusion and speed field variation. Mixing occurs due to the turbine movement of small particles of water particles that deviate from the average speed caused by tidal, river flow (river mass) and sea water volume. In the full moon phase of the rainy season occurs stratification and slightly mixing estuaries during tides of conditions where large river flows or peak river mass flow. Freshwater under the stream along with the mass (suspended sediment) flows over seawater, between the mass of the river flow and the volume of sea water occurs salt angle (salt wedge). The bottom layer is the same as the salinity of seawater, while the top layer is fresh water. The position of the salty angle may change, can move upstream at high tide and downstream at low tide. Stratification of seawater volume and river mass is shown the curved profile of vertical flow velocity at the maximum tide where the price (vo.6h) is zero at the surface of the river with a water level of 0 meters (1000 meters downstream position) and 1 meter long curve, figure -3

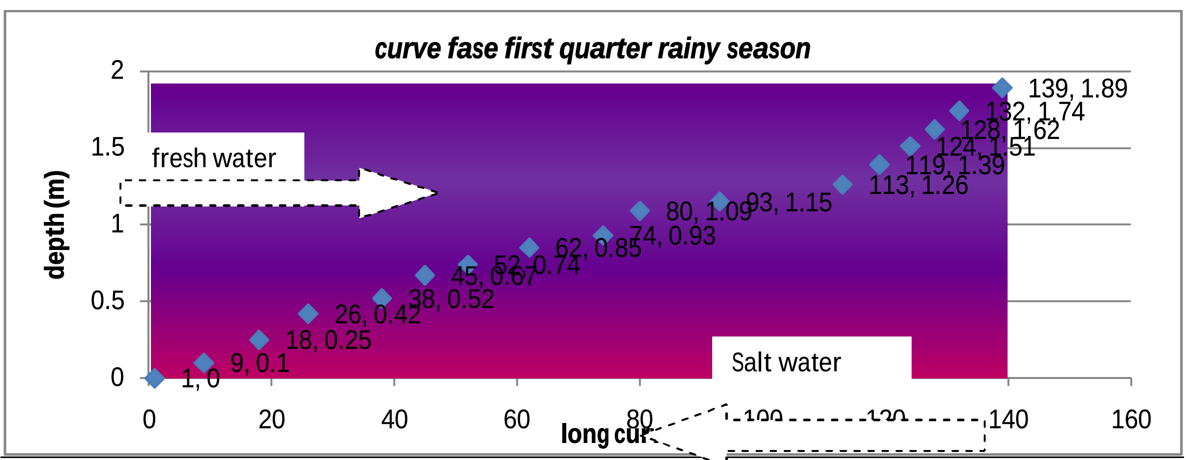
Figure-3. Stratification of sea water volume and river mass during the full phase Moon rainy season.



At a depth of 0.15 m curves ($v_{o.6h}$) to zero with a 15 meter curve length, at a depth of 1.14 meters curve ($v_{o.6h}$). To zero length curve 61 meters. At a depth of 2.16 meters the curve position ($v_{o.6h}$) also becomes zero with a 151 meter curve length. This is due to the volume of sea water holding back the velocity of the river (which transports the river mass) so that at 1200 meters downstream the velocity on the river surface becomes zero. This means stratification of sea water and river discharge that carry suspended sediment along the 151 meters following the length of the curve. The hydro physical phenomenon explains that all bed transport material has been deposited in position before the zero position of freshwater and saltwater stratification or before the salt wedge process occurs. The suspended sediment suspension rating gradient in full moon phase rain conditions will change depending on sea level. If the sea level increases then the gradient increases and the stratification position and suspended sediment deposition will shift towards the upstream, on the other hand if the sea level drops, the gradient will decrease and the stratification position will shift towards the river mouth.

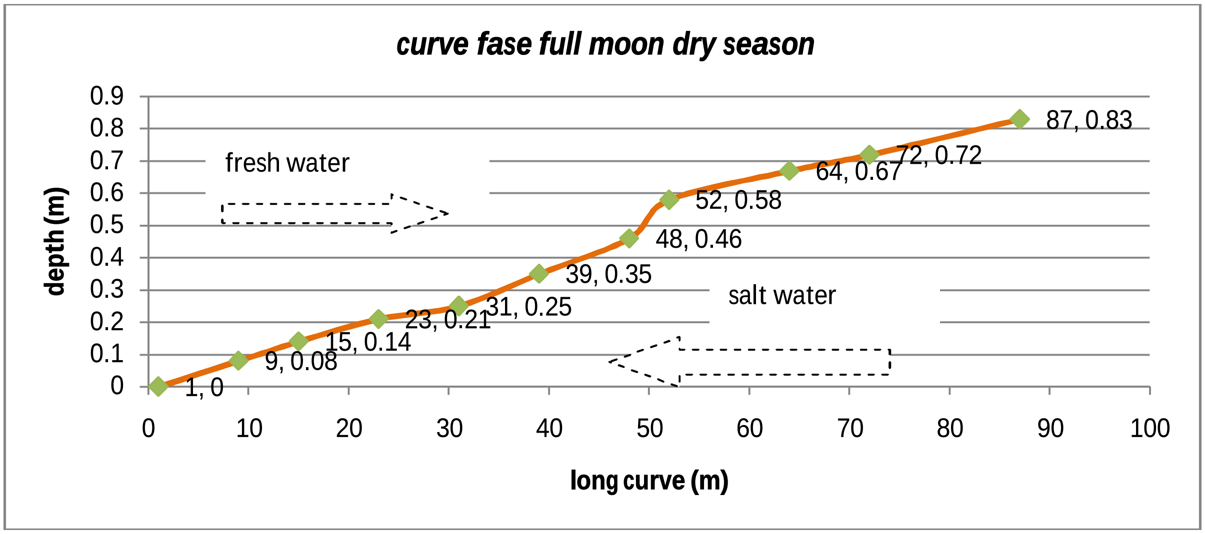
The first quarter rainy season stratified the volume of water and the mass of river flow is shown by the vertical profile of the flow velocity at the time of the minimum tide with 1.89 cm of water level at 1100 meters downstream of the river flow velocity ($v_{o.6h}$) to zero. The position of stratification and mixing estuary with a length of 139 meters curve. At a depth of 1.51 meters ($v_{o.6h}$) to zero with a curve length of 124 meters. Inside 0.67 meters ($v_{o.6h}$) occurs ($v_{o.6h}$) zero with a 45 meter long curve, this condition occurs as a result of the volume of sea water carried by the river water stream which carries the suspended sediment, so that the velocity ($v_{o.6h}$) zero. This means that suspended sediment spreads further upstream from 1200 meters, and gradient rating curve suspended sediment during tides during the first quarter rainy season will change depending on sea level. If the sea level increases then the gradient increases and the position of the stratification (mixing estuary) will shift towards the upstream, on the contrary if the sea level drops, the gradient will decrease and the stratification position will shift towards the river mouth. The length of the stratification curve (mixing estuary) of seawater volume and rainfall season river mass of first quarter phase occurred along the length of 139 meters.

Figure-4. Stratification of sea water volume and river mass during tide phase first qquarter rainy season



The full moon phase of the dry season stratified the volume of sea water and the mass of the river flow is shown by the maximum vertical limit profile of the maximum tidal (vo.6h) at 950 meters from the upstream downstream of the flow rate curve to zero at a depth of 0.83 meters with a curve length of 87 meters , At a depth of 0.58 meters (vo.6h) to zero with a 52 meter curve length and at a depth of 0.25 meters also occurs (vo.6h) zero with a 31 meter curve length. Thus the Stratification curve (mixing estuary) in the full moon phase of the rainy season along the 87 meters.

Figure-5. Stratification of sea water volume and river mass during the full mount phase dry season



Stratified areas of sea water volume and river mass that transport suspended sediment in a position as long as 87 meters. The estuary mixing phenomenon explains if the sea level increases, the gradient increases and the stratification position will shift towards the upstream, on the contrary if the sea level falls, the gradient will decrease and the estuary mixing position will shift towards the river mouth. The combined stratification rating of two functions (seawater volume and river flow) tide conditions, for each phase of the moon and season as shown in Figures 3, 4 and 5 have the same shape. Full moon phase monsoon long curve 151 meters, phase first quarter rainy season curve length 139 meters, while full moon phase long dry season curve is 87 meters. Thus an area of ± 150 meters (950 meters to 1200 meters) is a stratified (mixing estuary) volume of seawater and river mass that carries suspended sediment in full moon phase, first quarter phase of rainy season and full moon phase of dry season pairs along the coastal estuary of Ranoyapo Amurang.

4. *Conclusion*

The flow velocity at inward ($v_{o.6h}$) is physically related to the spread of suspended sediment. With increasing distance the decrease in velocity ($v_{o.6h}$) is followed by a decrease in suspended sediment prices, or by decreasing speed (by distance) apparently followed by a decrease in the amount of suspended sediment. Increased sea level will increase the gradient rating curve and shift the position of zero velocity (stratification and mixing in the estuary) upstream. The phenomenon of stratification of sea water volume and the mass of river flow that carried the suspended sediment of Ranoyapo Amurang estuary for each phase of the moon and season has the shape, for the full moon phase of long rain season of 151 meters curve, first quarter phases rainy season curve length 139 meters, While the full moon phase of the long dry season curve is 87 meters. Thus an area of ± 150 meters (950 meters to 1200 meters) is a stratified (mixing estuary) volume of seawater and river mass that carries suspended sediment in full moon phase, first quarter phase of rainy season and full moon phase of dry season Pairs along the coastal estuary of Ranoyapo Amurang.

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