STUDY EROSION AND COASTAL DESTRUCTION AT PONDOK-BALI, NORTH COAST-WEST JAVA OF INDONESIA

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Abstract- Beach of Pondok Bali which located in Subang Regency West Java Province for 2 (two) decades suffered damage and coastline changes thus reducing its charm as a marine tourism destination. This paper aims to determine the historical magnitude of the changes caused by coastal erosion and damage during the period of 11 years (2002 – 2013). The analysis has been done in this study include tidal type analysis, analysis of wave from wind data, and the measurement of the coastline changes. Based on the authors' analysis, the type of tidal on the Pondok Bali Beach is mixed predominantly semi diurnal by riding tide 120.06 cm. The dominant winds moves from East and North, the dominant waves move from East to West, as well as the direction of flow from East to West. The movement of waves and currents correspond to transports sediment erosion proceeds toward to the West. This study shows from 2002 until 2013 average abrasion rate is 56.8 m/year, classified into very severe damage coast because more than 10 m/year. The effects of coastal erosion is up to 500 m inland, houses located in coastal border have been hit by the onslaught of waves. Coastline change followed by a reduction of mangrove forest area of 3.6 km^2 to 1.8 km^2.

Index Terms- pondok bali beach, coastline changes, damage beach, tide, wave, current, mangrove.

I. INTRODUCTION

Coastal zone of West Javain in two decades nowadays suffered erosion and abrasion which impact to shoreline retreat significantly. According regional study carried out by West Java Planning authority (BAPEDA, 2007), there are coastal zone retreat with rate 392.32 Ha/year from 1995 to 2001, while in 2001 until 2003 the rate of retreat around 370.3 Ha/year.

Abrasion occurred almost along the shoreline and the destruction which is combination with mangrove forest destruction. The mangrove field was changed due to the need for paddy culture, fish and shrimp pond, tourism and housing.

Pondok Bali beach is one of many coastal that suffers from coastal damage (shoreline retreat) because of erosion generated by wave action and sediment transport movement. Pondok Bali beach is located at Mayangan village Legon Kulon District – Subang Regency, with distance around 10 km from Pamanukan main National road. Pondok Bali beach in the past were known as a famous sea recreation spot in North West Java region, it attracted many tourists especially on Holidays.

But nowadays beside of destruction on coastal area, the flood and inundation frequently appears that impact to closed road access by water, therefore the tourists' number visit to Pondok Bali decrease and reduces significantly (BPLHD Jawa barat, 2006 & 2013) The comparisons between condition at year 2002 and year 20013 are given at Figure 1 and Figure 2.

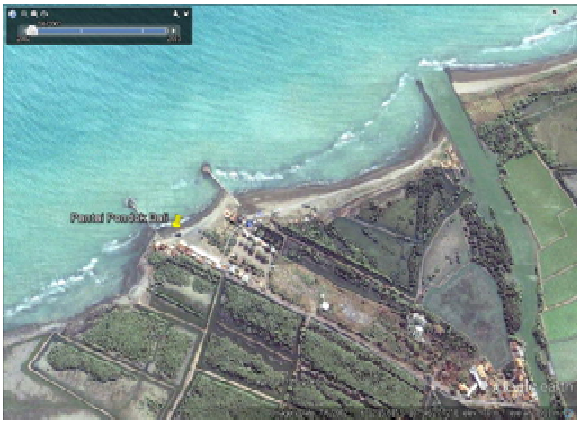


Figure 1. Pondok Bali beach condition at year 2002



Figure 2. Pondok Bali beach condition at year 2013

The aims of this paper are to describe and to study historically about the retreat on Pondok Bali beach – Subang district. The objective of this paper is also as lesson learnt for coastal defense and the counter measure that could be proposed in the future.

II. METHODS

A. Hydro oceanography data processing and analysis

Data Analysis hydro-oceanography covers data analysis of wind and wave hind casting, tidal analysis, and current data observation. The wind data process is used to obtain the wind characteristic that represented at study area and a wind data set for hind casting module. Furthermore by hind casting method we can extract the wave height, wave period and wave direction at the study location.

The tidal analysis uses the data released by Navy-Hydro-Oceanography agency or Dihidros (Dinas Hidro-Oseanografi TNI AL) of Cirebon port where this port is relatively near to study area. Mean while the current data is the result of primary measurement observation from the field.

B. Analysis the change of shoreline and the change of mangrove forest

The analysis of shoreline change of Pondok Bali and the mangrove forest+land use area change are referred to the map released by Information Spatial board or Badan Informasi Spasial (BIG) that we known as Peta Rupa Bumi Indonesia (RBI) dan Peta Lingkungan Pantai Indonesia (LPI). The publication year of this map is 2000 and used as initial / base map for analysis. To distinguish the land used change we overlay the satellite image from Google earth available for the years : 2002, 2006, 20011 and 20013.

Digitize the shoreline and mangrove are carryout by tracing the shore line and mangrove forest boundary for each year available on Google Earth software. The database extracted from digitize converted by Global Mapper software in order to enable further processing using GIS (Geographic Information System) software based.

III. RESULTS AND DISCUSSION

The result of processing of Hydro oceanography data of wind, hind casting module, tidal data and current observation are given as follows:

A. Analysis Result of Hydro-oceanography data

The tidal characteristics of Pondok Bali coastal waters are Mixed Predominantly Semi Diurnal where in one day occurs two times high tide (rise) and two times spring tide as shown at Figure 3.

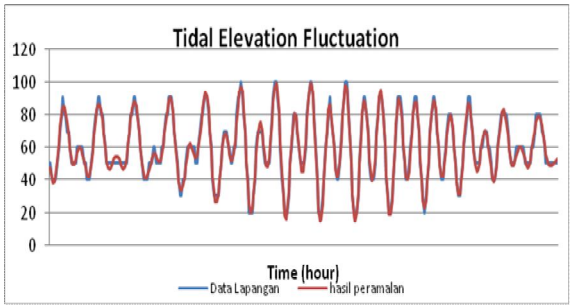


Figure 3. Water elevation at Pondok Bali area for 15 days

Based on wind data analysis for the year 1998 – 2007, it shows generally wind dominant direction come from East with probability of occurrence as 27.31% and average wind speed as 2.87 m/s. The wind-rose is shown as shown at Figure 4. The distribution of hind casting wave calculated for Pondok Bali beach based on wind data for the year 1998 - 2007 is given as wave-rose chart as shown at Figure 5.

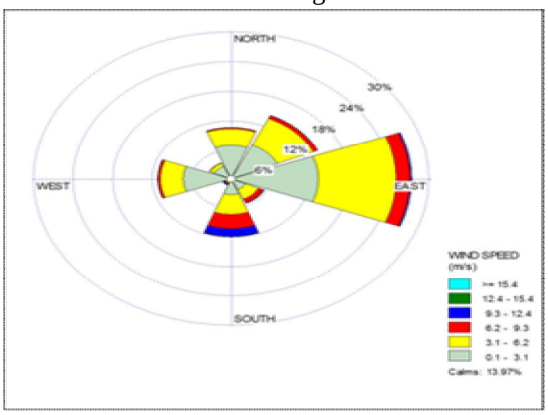


Figure 4. Wind-rose of distribution of hourly wind speed and direction for 1998 – 2007 at Cirebon Station

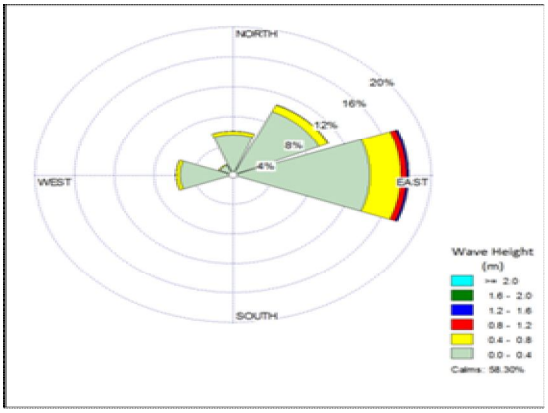


Figure 5. Wave-rose of Hourly wave height and direction at Pondok Bali for 10 years (1998 – 2007)

The results of current observation by using the equipment ACM (Acoustic Current Meter) at the distance around 100 m from the beach with the depth of 0.8 m, are given as Figure 6. Based on the dominant wave direction attacked to Pondok Bali beach we can predicted the long-shore transport dominant direction. The prediction of upper and lower drift of longshore sediment transport mechanism is illustrated as at Figure 7.

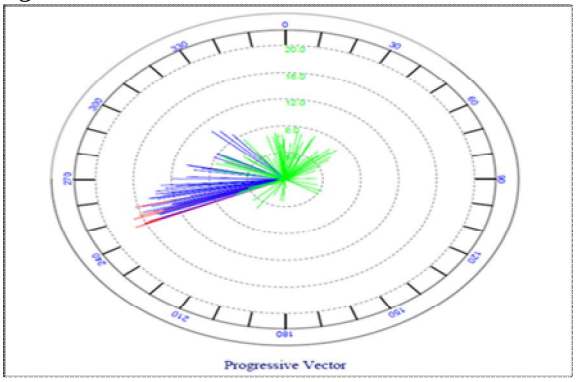


Figure 6. Current rose for Pondok Bali waters

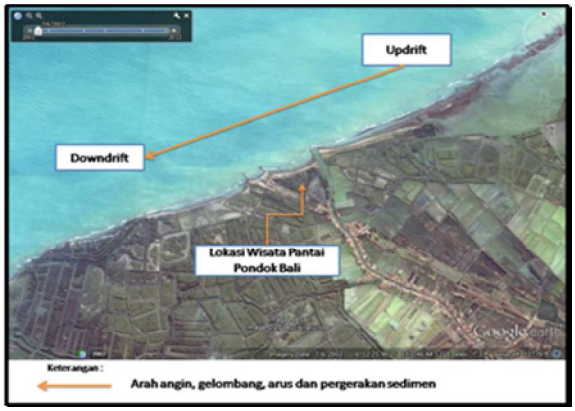


Figure 7. updrift dan downdrift of sediment movement at Pondok Bali coastal waters

B. Shore line change of Pondok Bali Beach - Subang

The distance of shoreline change in Pondok Bali coastal due to abrasion is not uniform for each point on the shoreline (see Figure 8). The shoreline change maximum occurred at the West part of the groin position, while the East part of the groin is relatively stable. The rate of shoreline change was increased almost every year by year. This increasing speed of shoreline retreat was predicted triggered by Jetty and groin. Table 1 informs us the fact of shoreline retreat happened at Pondok Bali.

Table 1. The rate of shoreline change at Pondok Bali

No	Time duration (year)	The maximum of shoreline change (m)	The average of shoreline change (m)
1	2002 – 2006	131	103
2	2006 – 2011	274	247
3	2011 – 2013	163	116

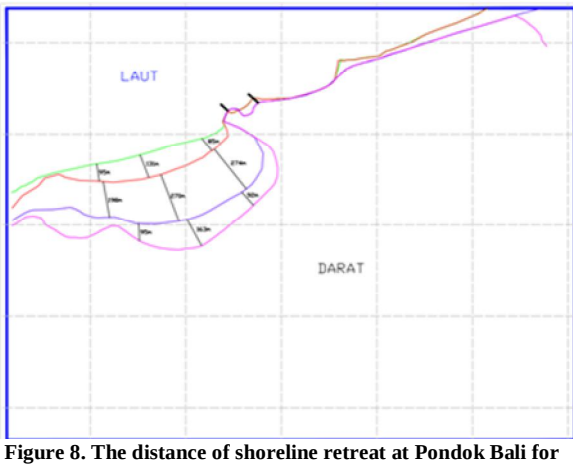


Figure 8. The distance of shoreline retreat at Pondok Bali for year 2002 -2013

A numerical simulation of coastal retreat by using Genesis software at Pondok Bali with the natural forcing based on ocean wave climate were carried out for 10 years simulation (2002 – 20011) (Achiari, et.al. 2014). The shoreline position and the results of this numerical simulation are given at Figure 9 and Figure 10.

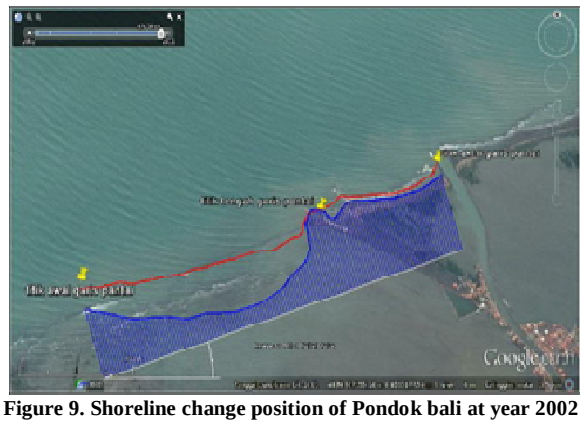


Figure 9. Shoreline change position of Pondok bali at year 2002 and 2011

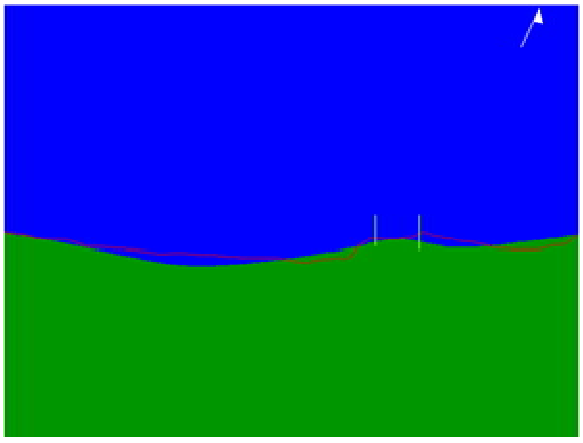


Figure10. GENESIS result of Pondok bali for 10 years

This result shows the erosion simulation for coastal of Pondok Bali although not 100% correspond to final position at 2011 but generally the shape and the trend still follows the real phenomena at the field. This simulation also indicated that a pairs of groin constructed at middle part of Pondok Bali made an impact to the shoreline contribution for retreat of shoreline especially at West part of the groin.

C. Mangrove destruction

Beside of the destruction of Pondok Bali shoreline where this area originally as tourist destination, the abrasion was also destructed the mangrove forest area, resident village, and fish-shrimp pond. Many resident houses destructed and flooded by sea waters and the resident people were evacuated from their house. From year 2002 until 20013 the maximum rate of shoreline retreat were calculated as 56.8 m/ year.

In 2002 (See Figure 11) at Pondok Bali coastal area, the total area of mangrove forest is 3.6 km^2, fish/shirp pond = 1,3 km^2, and paddy field is 0.13 km^2. In 2006, the total area of mangrove forest become 3.36 km^2, fish/shrimp pond become 1.36 km^2, paddy field 0.08 km2. in 2011, the total area of mangrove forest decreasing dramatically, it become 2.13 km^2. And in 2013 (Figure 12), the total area of mangrove forest was remaining as 1.8 km^2. Through this history and fact, it can be captured that since 2002 until 2013, the condition of land used at Pondok Bali already changed dramatically, the total area of mangrove reduced year by years and transform become to fish/shrip pond.

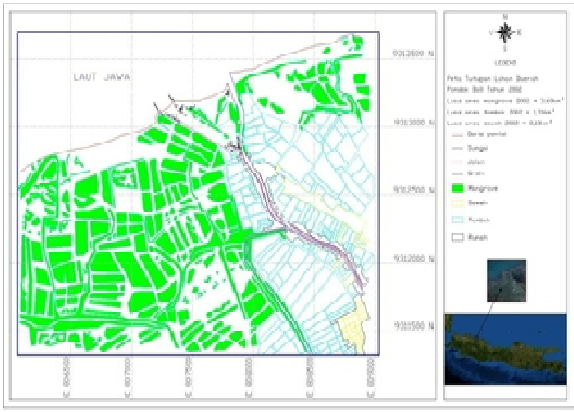


Figure 11. The condition of land used and its distribution at Pondok Bali year 2002

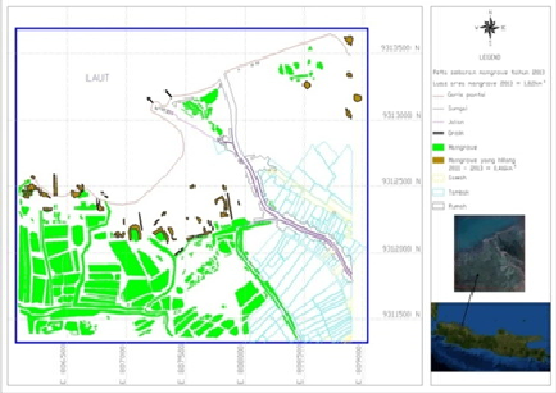


Figure 12. The condition of land used and its distribution at Pondok Bali year 2013.

CONCLUSION

From the year 2002 until 2013 Pondok Bali coastal area has been changed due to abrasion from the ocean, the rate of abrasion is around 56,8 m/year, the shoreline retreat more than 10 m/year is categorized as a coastal destruction in high intensity (worst). The areal of abrasion at Pondok Bali is around 100 – 500 m from original location, this condition is classified as heavy destruction of coastal area. Generally the erosion and destruction at Pondok Bali is due to the changing of land used of surrounding that coastal by human activities, and as well as by combination from hydro-oceanography factors as a natural forcing for the contribution of the erosion of transport sediment at coastal waters.

By mapping analysis, the total area of mangrove forest at Pondok Bali at year 2002, is 3.6 km^2, fish/shrimp pond = 1,3 km^2, and paddy field = 0.13 km^2. While at the year of 2006, the total area of mangrove forest is 3.36 km^2, fish/shrimp pond 1.36 km^2, paddy field 0.08 km^2. In the year 2011, the total area of mangrove forest reduced become to 2.13 km^2. And in the year 2013, the total area of mangrove forest was remaining as 1.8 km^2. This is evidence the land used transformation from mangrove forest to fish/shrimp pond for 10 years since 2002 is as main contributors for shoreline retreat at Pondok Bali coastal area.

ACKNOWLEDGMENTS

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