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Sediment Texture and Topography Features Control on Coastal Morphodynamics State

H. Sirajuddin[1], D.A. Suriamihardja[2], A.M.Imran[3], and M. A. Thaha[4]

[1]Graduate Doctor Program Civil Engineering Dept. Hasanuddin University, Indonesia
Email: haerany_sirajuddin@yahoo.com
[2]Professor of Physics Department, Hasanuddin University
[3]Professor of Geology Engineering Department, Hasanuddin University
[4]Lecturer of Civil Engineering Department, Hasanuddin University

ABSTRACT

The characteristic of the change sediment texture and topography features are primary variable for coastal morphodynamics state, besides Ω is known as the dimension fall velocity, period and breaker wave height. Morphodynamic state as a coastal system is an important issue for a proper coastal management and planning. Study area is located at Parepare and Pinrang Regencies. The purpose of this study is to explain coastal morphodynamics. The study methods are field study and petrography analysis. To examine the coastal sediment and topography features along the beach is used Gradistat software. The results indicate that the lithology of the study area mainly consists of tuff and volcanic breccia which might has formed in Late Miocene. The Lapakaka beach is a tide-modified beach, has a steep slope, coarse grain sediments, cusped and reflective. Lumpue beach is also a tide-modified beach, however it has fine grain sediments, low gradient and often featureless; Tassiwalie beach is wave-dominated beaches of reflective states, has coarser grain sediments and consist of relatively steep beach slope (5-20^o); Sibo beach is tide-dominated beaches, very low waves, low elevation, coarse-grained and irregular; Maroneng beach include in dissipative, fine sediment, low gradient swash (~1^o) and containing bar. The all beaches type above shows different state in sediment texture and topography. The study needs to be continued in order to understand deeply the beach morphodynamics state in supporting an integrated coastal management.

Keywords: beach, morphodynamics, texture, reflective, dissipative

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1. INTRODUCTION

Beaches are wave-deposited accumulations of sediment located at the shoreline. They require a base to reside on, usually the bedrock geology, waves to shape them, sediment to form them, and most are also affected by tides. The beach extends from wave base where waves begin to feel bottom and shoal, across the nearshore zone, though the surf zone to the upper limit of wave swash. In the coastal zone ocean waves are transformed by shoaling, breaking, and swash. In doing so they interact with the seabed, and determine the beach morphology or shape, a process called beach morphodynamics [1].

Sandy beach are accumulations of sand lying between modal wave base and swash limit. They are deposited primarily by waves, but also influenced by tides and topography. Their morphology and dynamics should therefore function of their sand size, the breaker wave climate, including height and periode, tide range and major topographic features. Each of this variable has considerable spatial and temporal variations, resulting in a range of beach types. At the level of an individual beach where sediment size may be assumed constant, temporal change in wave height and period and lunar tidal cycles induce beach response and change. At a regional level, change in both sediment and breaker wave height induce spatial and temporal change, while at global level a wide range of variable combinations and beach response occurs [2].

The study of coastal systems evolution is an important issue for a proper coastal management and planning of sandy beaches. For this reason, it is often recommended the use of morphodynamic classification of the beach system in order to forecast changes in beach morphology, when dealing with coastal management. The classification should be based on the mutual interaction of all hydrodynamic and morphological parameters (i.e. wave climate, mean grain size, beach shape) in order to provide a complete description of the physical processes occurring in coastal areas and affecting the beach response [3].

A. Conceptual Beach Model

The conceptual beach classifications are empirical models based on the relationships between the characteristics of different types of beaches (wave climate, sediment size and tidal regime) and field observations [4]. This classification also called the Australian beach model, is based on the field observations collected. This classification indicates the prevailing conditions in the surf zone: dissipative, intermediate or reflective, as a function of the dimensionless fall velocity parameter (Ω), also known as the Dean's number :

$$\Omega = \frac{Hb}{WsT}$$

where Hb is the breaking wave height, T is the wave peak period corresponding to the breaking conditions and Ws is the sediment fall velocity.

The relationships between the dimensionless fall velocity and the relative tide range parameters that are used to establish the modal beach state, shows in Fig 1. As the RTR parameter increases the beach evolves from a classic reflective state through the formation of a low tide terrace at the toe of the

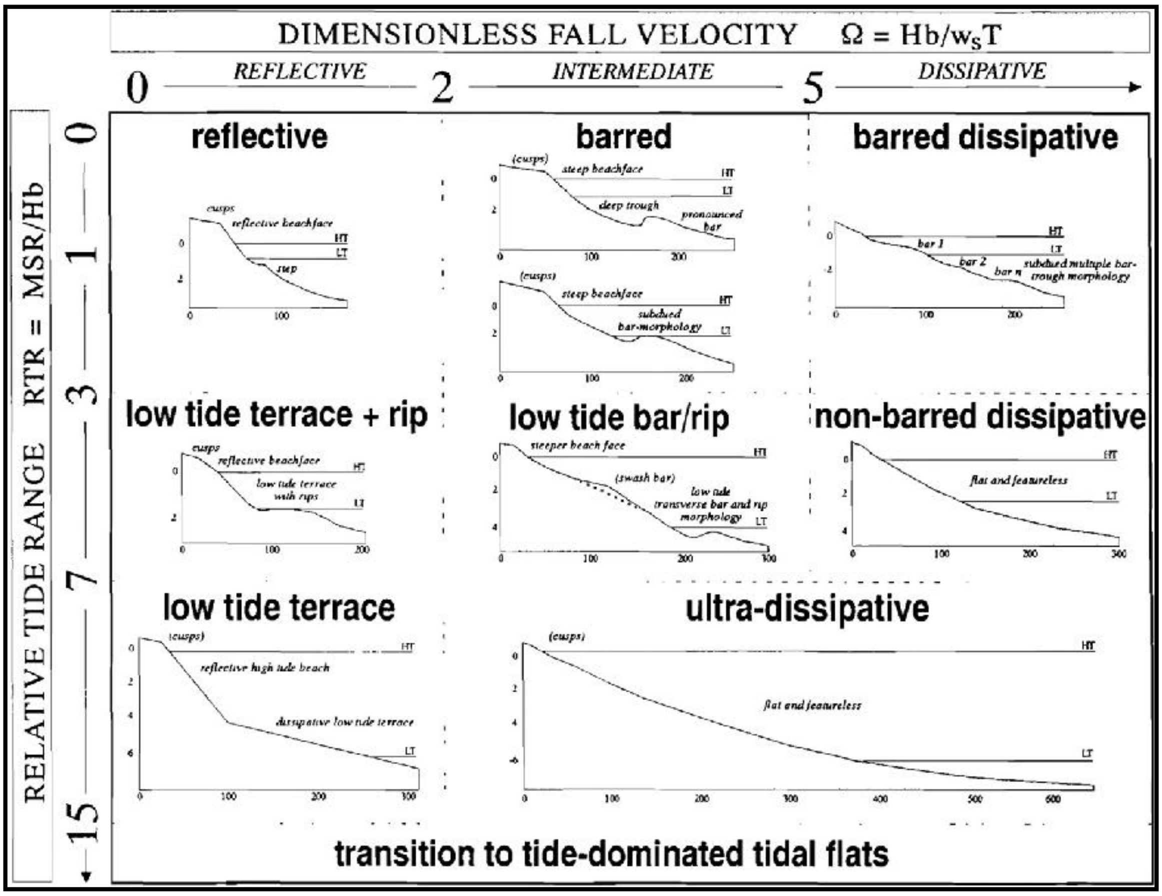

Fig. 1. Conceptual beach model (Masselink and Short, 1993 in [4]).

beach face and low tide rips to a steep beach face fronted by a dissipative low tide terrace. In the case of an intermediate barred beach, the increase in the tidal range moves the bar down to the low tide level generating a low tide bar and rips.

Finally, for barred dissipative beaches characterised by multiple subdued bars at different water depths, the increase of RTR results in the disappearance of these bars. The latter two groups shift to ultra-dissipative beaches with values of RTR between 7 and 15.

For values of RTR greater than 15 the resulting beach is fully tide-dominated.

The aim of this study is to determine the beach morphodynamic state based on sediment texture and topography features. The study will first determine beach morphodynamic in areas Lapakaka and Lumpue at Parepare Municipality. Second, beach of Tassiwalie, Sibo, and Maroneng at Pinrang Regency.

B. Study Area

The study area extends from Lapakaka to Maroneng (3°35'72" – 4^0 4’ 51”S and 119°30'.59" - 19°37'12." E) along the western coastal tract of South Sulawesi, Indonesia covering about 30 km. Bounded in the northern by Polewali Mamasa District, eastern by Sidenreng Rappang District; in the South by the Barru District and in the west by Makassar Strait. There are two river mouth consist of Saddang River in Pinrang District and Karajae River in Parepare Municipality (Fig. 2). Some of the beach are a tourism area.

Regionally, study area which located Sulawesi Island in the center of the Indonesian archipelago, formed by the accumulation of micro plates derived from a variety of sources such as fragments of Asia, Pacific and Australia [5]. Since its formation in the Tertiary period to the present, it consequently produces continuous complex geological and tectonic phenomena. Due to the insistence of influence/pressure by the three major plates, it becomes a very vulnerable condition and includes one of the most active islands in the world.

Geological and tectonic phenomena that can be observed in the field are presence of Lumpue caldera, lava, volcanic breccia and tuff, geological structures (fold, joint and fault), and the sign of tectonic uplift; coast terrace, abrasion terrace, Quarter coral reef outcrops, alluvial flat and earthquakes for periodic activeness in every 15 to 30 years. Geological condition and tectonic uplift, causing shoreline changes advancing towards the sea, the occurrence of abrasion, sedimentation and uplift, threatened marine biota (benthos), shallower seabottom in the front of port of Parepare, bedrock stability disturbance and threat of an earthquake at any time, will lead to vulnerable coastal area.

2. METHODS

In this study, direct observation has been conducted into the field to see beach topographic features, besides lab analysis. All of sand samples were collected at 5 sandy beaches. Samples were taken at several the shore at locations with different morphological features (e.g. beach face, surf domain, troughs or bars). Samples dried 24 hours in the oven at 90°C and divided into sub-samples for sieving and petrographic analysis. Dry sieve net analysis was performed using a series of sieves ranging in mesh size from 0.063 mm to 4.76 mm. Grain size distributions were determined using the GRADISTAT software package. For each fraction textural analysis was performed using D_{50} sieve size.

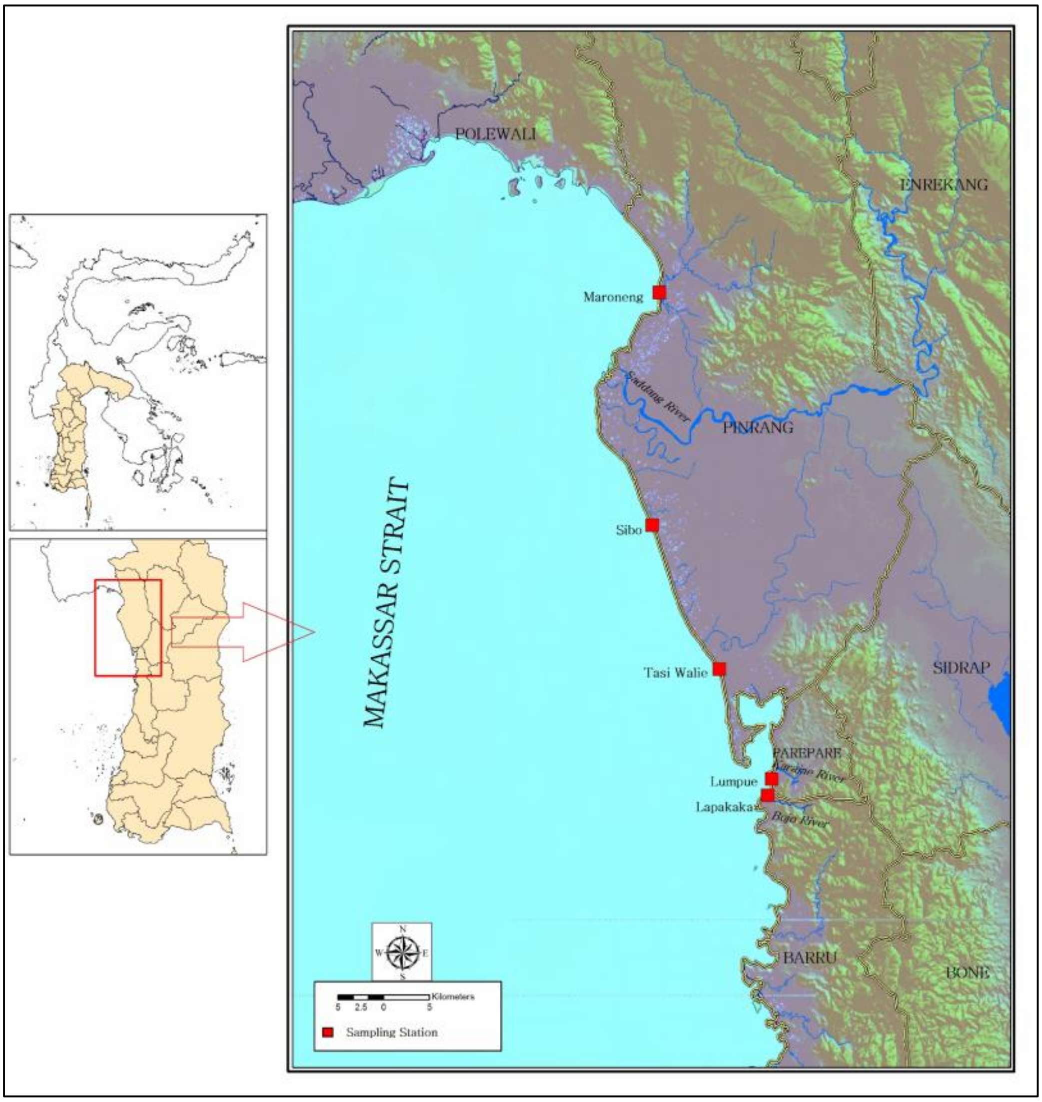

Fig. 2. Location map of the study area

3. Result and Discussion

Geological conditions [5] in study area can be described as follows,

A. Physiography

The coast is defined as the areas including land and sea interaction. Lumpue coastal area is hilly and rugged coastal base, as a result from tectonic formation, geological structure and abrasion (maturity abrasion) which reveal the winding irregular shoreline. From the aspects of tectonics, uplift in Lumpue coast characterized by the coastal terrace and uncovering Quaternary coral reefs and also Quaternary alluvial flat, including emergence coast.

B. Lithology

The rocks found in study area [6] consist of lava, volcanic breccia, tuff (Upper Miocene),

Quaternary sandstones and alluvial deposits. Lava, volcanic breccia and tuff are trachytic sourced from the eruption of Parepare and Pangkajene volcano [7] with Lumpue coastal caldera, alluvial and sandstones are Quaternary sediments from the terrestrial erosion processes.

C. Geological Structure

Geological structure that appear in the study area are join and fault. The joint in the form of open and closed irregular joint, while the fault through Bojo River in the east-west trending and I Karajae River in the north, both are dextral slip fault.

D. Beach Morphodynamic Condition

The morphodynamic state of the beaches along the study area can be divided into various types on the basis of their composition/texture sediment, gradient and topographic features. Along the study area, beaches are both sandy and rocky in nature. Some are of mixed type. A highly complex interaction between natural beach conditions such as the forcing waves, currents and winds; and the effect of man modify the beach morphology. The following are descriptions of beach mrphodynamic state based on Short classification [1] and [2]

Lapakaka beach classified as tide-modified beaches, tide range is increasing and wave height decreasing, reflective, high tide beaches, have a steep, coarse-grained and cusped (Fig. 3).

Lumpue is tide-modified beaches, tide range is increasing and wave height decreasing. This is fronted by a wide, finer-grained, low gradient, often featureless, up to 200 m wide (Fig 4).

Fig. 3. Lapakaka beach shows steep reflective high tide beach, coarser grain, at Parepare Municipality.

Fig. 4. Lumpue beach at Parepare Municipality, shows finer grain sediments and low gradient.

Tassiwalie beach is reflective, lower waves, longer wave periods, coarser sediment, such that coarse sand, they consist of relatively steep beach face (5-20^{o}), affected by the erosional processes (Fig. 5).

Fig. 5. Tassiwalie beach at Pinrang District, shows groin manufacture plan to erosion control.

*Sibo beach is c*lassified into tide-dominated beaches, very low waves. They consist low elevation, coarse-grained, irregular, low gradient (<< 1^{o}) and tidal flats prevail (Fig. 6 and 7, Table 1). Grain size analysis results show coarse grain dominant.

Maroneng beach includes in morphodynamic beach state of dissipative, high waves, short wave periods, fine grain sediment, low gradient swash (~ 1^{o}), 300-500 m wide surf zone and containing at least two bars (Fig. 8).

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Fig. 6. Sibo beach at Pinrang District, coarse grain sediment and low elevation.

Fig.8. Maroneng beach at Pinrang District, shows bar as wave acumulation deposit results.

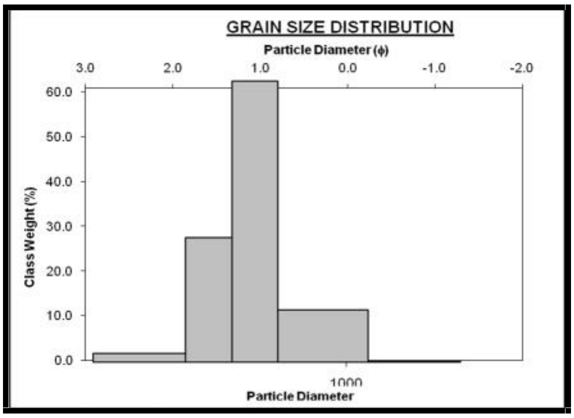

Fig. 7. Diagram shows grain size of Sibo beach.

4. CONSLUSION

1. The study area varies in morphology composed of lava, volcanic breccias, tuffs and alluvial, cause different beach material.
2. Lapakaka and Lumpue beaches include in tide-modified beach, but different in topographic features and sediment texture. Sibo beach classified in tide-dominated beach. Meanwhile, Maroneng is dissipative and Tassiwalie is reflective beach morphodynamic states.

Table 1. Grain size analysis of Sibo beach

3	SAMPLE IDENTITY: **Stasiun 11**			ANALYST & DATE: Haerany Sirajuddin	
4	SAMPLE TYPE: Unimodal, Well Sorted			TEXTURAL GROUP: Slightly Gravelly Sand	
5	SEDIMENT NAME: Slightly Very Fine Gravelly Medium Sand				
6					
7		µm	ϕ	GRAIN SIZE DISTRIBUTION	
8	MODE 1:	512.5	0.986	GRAVEL: 0.3%	COARSE SAND: 42.4%
9	MODE 2:			SAND: 99.4%	MEDIUM SAND: 49.4%
10	MODE 3:			MUD: 0.3%	FINE SAND: 2.4%
11	D_{10}:	329.8	0.231		V FINE SAND: 0.1%
12	MEDIAN or D_{50}:	493.1	1.020	V COARSE GRAVEL: 0.0%	V COARSE SILT: 0.1%
13	D_{90}:	852.0	1.601	COARSE GRAVEL: 0.0%	COARSE SILT: 0.1%
14	(D_{90} / D_{10}):	2.584	6.924	MEDIUM GRAVEL: 0.0%	MEDIUM SILT: 0.1%
15	$(D_{90} - D_{10})$:	522.2	1.369	FINE GRAVEL: 0.0%	FINE SILT: 0.1%
16	(D_{75} / D_{25}):	1.412	1.634	V FINE GRAVEL: 0.3%	V FINE SILT: 0.1%
17	$(D_{75} - D_{25})$:	169.3	0.497	V COARSE SAND: 5.2%	CLAY: 0.1%
18					

3. The beach morphodynamics states show different appearance because there are different behavior of wave mechanism.

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