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Utilizing MIKE 21 Software to Create Simple Hydrodynamic Simulations

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Abstract

This paper aim to create simple hydrodynamic simulation by using MIKE 21. The module used in MIKE 21 is LITPACK. LITPACK is one of the modules in MIKE 21 to solve hydraulic and sedimentation problems in coastal areas. Especially in this paper, the LITTLITE engine in LITPACK will be used. LITLINE determines the coastline position using a timeseries of wave climatic data. The model is based on a one-line theory, in which the cross-shore profile is expected to remain unaltered during erosion/accretion, with minor adjustments. Coastal morphology is thus only defined by coastline location (cross-shore direction) and coastal profile at a given long-shore position. The simulation used in this paper is the influence of groins on shoreline dynamics. The results of the simulation show that some areas will experience abrasion and some will experience accretion.

Keywords: abrasion, accretion, LITPACK, LITLINE, MIKE 21.

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1. Introduction

The shoreline is the physical transition between land and water, and the coastline is a proxy for the shoreline location that is used in shoreline management to mark the land-sea boundary. The following researchers use several software to analyze shoreline dynamics. Zeinali et al., (2021) uses artificial neural network for the prediction of shoreline changes in Narrabeen, Australia. Because of their relevance in people's lives, shorelines are important all over the world. As a result, it appears that knowing its behavior is critical. Shoreline changes and realignments are highly nonlinear, therefore devising a method to model their patterns would be quite beneficial. ANNs are common methods that have been used to solve a variety of problems. Recurrent ANNs like as NARNET and NARXNET are used to model shoreline changes on Australia's Narrabeen Coast between 1980 and 2014. Their results show that they can accurately forecast shoreline changes based on historical data. Santos et al., (2021) uses Digital Shoreline Analysis System (DSAS) to Analysis of long- and short-term shoreline change dynamics: A study case of João Pessoa city in Brazil. Over the past 34 years (1985-2019), this study looked at the spatiotemporal behavior of short- and long-term characteristics of the shoreline, as well as the driving mechanisms responsible for shoreline changes in Joo Pessoa. Throughout the study period (1985-2019), accretion behavior was seen across the region. Only Zone-I has erosion as a major feature in both the long and short periods, according to the analysis by zone. Throughout the study period, the short-term research revealed some cyclical pattern in erosion and accretion. Troy et al., (2021) uses unmanned aerial vehicle (UAV) LiDAR to analysis shoreline changes in lake Michigan. During the years 2018-2019, the vehicle surveyed two beaches along the Indiana shoreline of southern Lake Michigan, Dune Acres and Beverly Shores, which were compared to current aircraft-based LiDAR surveys. Since the low water circumstances of 2012-2013, the UAV scans reveal substantial coastline erosion and recession at both beaches, with both beaches losing 70.7 and 64.8 m^3 /m of dry beach volume. For both beaches, the shoreline receded by about 35 meters throughout this time. The UAV data demonstrate continuous beach erosion and the shift of beach morphology to a steep, actively eroding foredune in the 2018-2019 period. Konlechner et al., (2020) uses Normalized Difference Water Index (NDWI) to identify shoreline change. They present the first regional analysis of shoreline movements along the 1230 km long wave-exposed coast of Victoria, south-east Australia. Dewi & Bijker (2020) studied the dynamics of the shoreline in the coastal region of Sayung, Indonesia, using remote sensing and GIS (Geographic Information System) techniques from 1988 to 2017. As a result of growing coastal flooding, the results demonstrate a general tendency of continual coastline modifications. Between 1988 and 2017, 25% of the area was converted from non-water to water, while 5% was converted from non-water to shoreline margin. These changes were linked to the conversion of other crops and rice fields into fishponds, as well as the conversion of fishponds into water bodies, according to LUC maps. Muskananfola et al. (2020) use geographic Information System (GIS) and Digital Shoreline Analysis System (DSAS) to analysis shoreline changes. Coastline data for the year 1994, 2000, 2005, 2011 and 2018 were analysed using an overlay technique. Statistical analyses were conducted to calculate erosion and accretion rates. The average end point rates (EPR) were 25 meters per year, while the net shoreline movement (NSM) was 592 meters. For the five-year measurement period, the EPR value was 7 m/year and the NSM value was 39 m; for the five-year measurement period, the EPR value was 15 m/year and the NSM value was 77 m. The EPR value was 20 m/year and the NSM value was 123 m from 2005 to 2011, while the EPR value was 41 m/yeat and the NSM value was 290 m from 2011 to 2018. Sriwulan, Bedono, and Timbulsoko all have severe erosion. Surodadi has experienced slight accretion as a result of shifting wave and storm surge characteristics, tidal currents, bathymetry formations, and mangrove cover. In this paper, the use of Mike 21 software will be carried out to simulate the dynamics of simple shoreline changes.

2. LITLINE Scientific Background

The LITLINE system is based on a co-ordinate system in which the *x* axis is a baseline that runs parallel to the major coastline orientation, and the y axis runs offshore from the baseline (see Figure 1). 1. The distance between the baseline and the shoreline is $y_c(x)$:

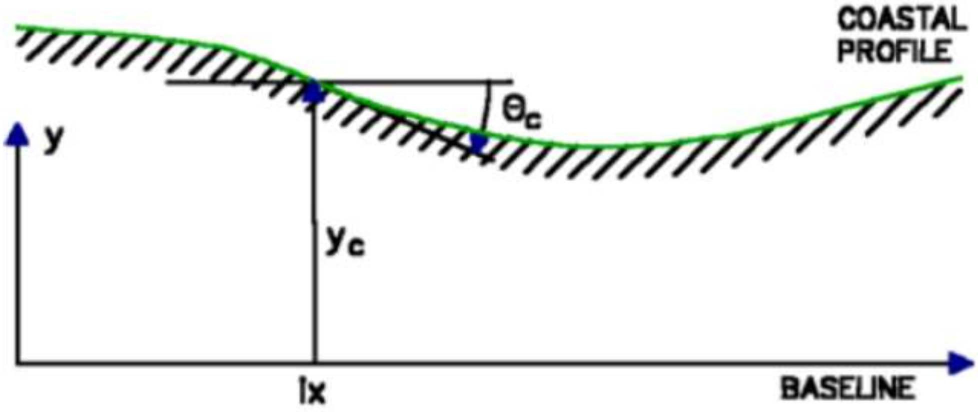

Figure 1. Co-ordinate system in LITLINE (DHI, 2014)

The term "coastal- or coastline profile" refers to the fluctuation of y_c in the longshore (x) direction, whereas the term "cross-shore profile" refers to the water depth (bottom position) as a function of cross-shore position relative to coastline position y_c. When it comes to waves, the terms "upstream" and "downstream" are frequently employed, with "upstream" referring to the longshore direction from which the waves are coming. The continuity equation for sediment volumes, represented as, is the main equation of LITLINE:

$$\frac{\partial y_c}{\partial t} = -\frac{1}{h_{act}(x)}\frac{\partial Q(x)}{\partial x} + \frac{Q_{sou}(x)}{h_{act}(x)\Delta x} \qquad (1)$$

where the symbols are displayed

$y_c(x)$	distance from the baseline to the coastline
t	time
$h_{act}(x)$	height of the active cross-shore profile
$Q(x)$	longshore transport of sediment expressed in volumes
x	longshore position
Δx	longshore discretization step
$Q_{sou}(x)$	source/sink term expressed in volume/Δx.

The longshore transport rate $Q(x)$ is produced using tables connecting the trans port rate to the hydrodynamic conditions at breaking, while $h_{act}(x)$ and $Q_{sou}(x)$ are calculated based on user parameters. The user specifies x, while the stability criteria decide t. Solving eq. (1) with an implicit Crank-Nicholson scheme from an initial coastal position $y_{init}(x)$ determines the evolution in time.

3. Numerical Simulation on Groin with a Uniform Coastline

The impact of a 300 m long groin on a long uniform coastline that was previously in equilibrium was explored in this simulation. The simulation conditions are:

- There are no dunes along the beach. The beach's active height is set to 1.5 m, the offshore contours' limiting depth is set to 5 m, and the profile's active length is set to 500 m.
- From a depth of 10 m to 2 m above mean surface level, the cross-shore profile exhibits a constant slope with a gradient of 0.01. The bed's roughness is assumed to be constant at 0.004 m. The beach faces north at 90 degrees.
- With a mean grain diameter of 0.2 mm and a fall velocity of 0.022 m/s, the grain material in the area is assumed to be uniform.
- For a month, the wave conditions at 10 m depth are consistent. The wave has a height of 1 m, is propagating from 60 degrees north, and has a period of 6 seconds. The waves are Rayleigh Distributed.
- There is no wind or tidal current. The mean water level has been adjusted to 0 meters.

The groin's grid point is set to 250 meters, which is the midpoint of the long consistent shoreline. The groin length is 300 m, while the apparent length is 290 m; due to 2-dimensional current effects at the groin tip, the effective blocking effect of a groin is frequently less than 100%. The Type of output frequency is set to Time interval, with an Interval in hours of 120 hours, indicating that the coastal data will be written in the output every 5 days in the wave climate time series as shown in Figure 2.

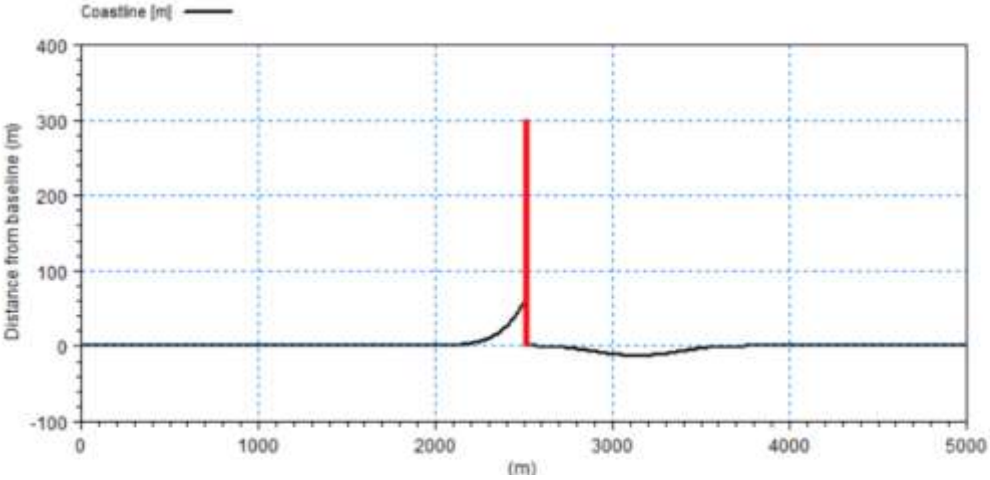

Figure 2. Numerical result on groin with a uniform coastline.

In LITLINE, a groin is a relatively short structure that extends perpendicular to the baseline in the offshore direction. A method to limit longshore sediment transport that would have occurred if the groin had not been present incorporates the sheltering effect downstream of a groin. The groin, like a jetty, is identified by its longshore position. the distance between the baseline and the groin's tip, as well as an apparent length (measured from the baseline) that indicates the effective length for blocking longshore sediment transport. The effects of a groin on longshore sediment transport are similar to those of a jetty. Depending on the groin's effective length compared to the active width (in cross-shore direction) of the cross-shore profile, the littoral current and sediment transport are partially or completely obstructed. The building provides protection from the waves on the beach downstream. A strategy to lower the "undisturbed" transport capacity is used to estimate sediment movement in the shielded area.

4. Conclussion

In most cases, obstructing transportation will result in an advancing shoreline upstream and erosion, as well as a receding coastline downstream of the building. The relationship between transport rates and the orientation of the local shoreline determines the upstream coastline profile. The coastline will approach an equilibrium profile for a given wave direction. Due of the structure's obstructing effect, there is a shortage of silt downstream. The orientation of the local coastline and its position relative to the groyne have an impact on the local transport rate.

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