

Bottom Topography Observation in the Intertidal Zone Using the Camera Monitoring System

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ABSTRACT:

The intertidal zone is characterized by periodic exposures to water level changes between high and low tides. Time series of waterline changes during a flood/ebb cycle can be utilized for supplementary data for measuring bottom topography. The waterlines extracted from consecutive images are substituted for depth contours using water level data. The distances between contours are quantified through a rectification image process.

This technique is applied to the western coastal regions of Korea. This coastal area is famous for high tidal ranges over 7 meters and very mild slope expanding the intertidal mud flat for several kilometers. The traditional bottom topography measurement method is very difficult to apply in these regions because of the very mild slope and muddy environment.

A camera monitoring technique supported by natural water level changes produces bottom topography with high precision. It is also less time consuming and more economical. The technique can be utilized effectively to the physical modeling for measuring bottom changes in three dimensional basin.

1. INTRODUCTION

The man-initiated coastal development is increasing recently and provokes rapid changes of environments in coastal area by losing its equilibrium maintained for a long period in nature. These undesirable impacts to the coastal environments also occur in a wide area of mud flat in the intertidal zone caused by large scaled reclamation projects or construction of embankment around ports. The mud flat region has been regarded as very stable condition and not experiencing high external forces compared to the sand beach. However, the issues generated by the change of mud flat environments demand regular and longterm monitoring of the coastal environment with the immediate remedies against the loss of the flat. Especially, the mud flat area is now reevaluated as an important place ecologically and economically, and received nation wide interest for the preservation of that area, which has been deserted for a long time. In addition to the mud flat, sand beaches are also experiencing serious erosion problems being covered by shovels or mud and losing their merit as a resort.

Intertidal zone is the region that is above the low-water mark and below the high-water mark, and only exposed during lowest tides. The mild slope of these regions makes it difficult to measure the bottom topography and sometimes the soft mud flat is dangerous place to survey. Because of these reasons, the traditional *in-situ* measurements on the intertidal topography was done only at the small number of fixed points and had difficulties to figure out quantitatively the characteristics of wide region in the intertidal zone. Especially, considering a very little morphological changes of mud flat, new observation technique for the wide area of mud flat in the intertidal zone is needed. Also, in terms of numerical model, there is not enough

data for the comparison between the model results and the field data on the bottom changes in the intertidal zone.

The advancement of digital imaging technique with remote controlling system makes it possible to use a camera for monitoring many kinds of natural phenomena. It has an ability to look spatial features and is more intuitive. In recent years, the camera observation including satellite remote sensing is begun to be used for monitoring longterm shoreline changes in several countries. However, in a case of west coast of Korea, the wide range of intertidal zone and the continuously changing flood lines are regarded as shortcomings for image observation of shoreline changes. These shortcomings can be converted to very valuable conditions for measuring the topography in the intertidal zone. The rising of boundary lines between water and land during the flood indicates depth contours from the lowest waters to the highest waters. By extracting the contours, we can construct three dimensional bottom topography in the intertidal zone and monitor morphological changes.

In this research, new technique for the observation of bottom topography in the intertidal zone is introduced with some examples.

2. METHOD

This technique includes three important steps to configure three dimensional topography from time series image data. The first one is to extract boundary lines between water and land from time series image data during a flood. The second one is to estimate the depth of each flood lines extracted from images.

The third one is to rectify the image to get quantitative spatial

information. Figure 1 shows the flow chart of the procedure to get intertidal topography information.

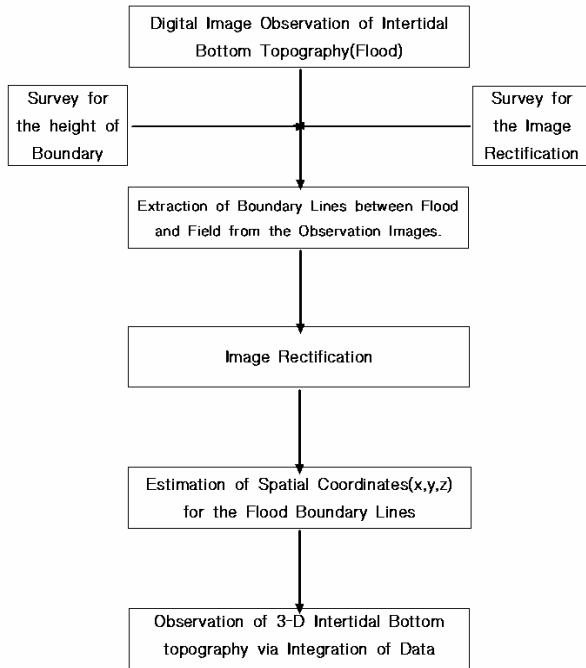


Figure 1 Flow chart to extract 3-D intertidal bottom topography from the time series images during the flood

Gathering images for the depth contours is done during a flood because dried portion of the land makes it easier to extract the water lines compared to the period of an ebb tide. The time interval of images depends on the slope. For example, in case of intertidal region with 1.2 km width and 6 hour flooding, the water line migrates 33 m for 10 minutes. Figure 2 is the example of time series images taken during a flood.



Figure 2. An example of time series image data showing the change of boundary between water and field in the intertidal zone during a flood.

The principle to get depth contours from time series images is shown in Figure. 3. The Top figure shows the migration of water level line from the low water line to the high water line during a flood. The bottom figure illustrates depth contours extracted from each water lines in the top figure. Figure 3 explains the simplest case for the plane beach with constant slope, but the advantage of this technique is that it can even present irregular and various features of bottom with details. In order to label each water lines with depth value, field survey is executed to get a depth profile during an ebb tide along a line seen clearly on the image. This survey can be substituted by measuring the change of water level outside the low water line. One of the most important procedure for this technique is a rectification of image.

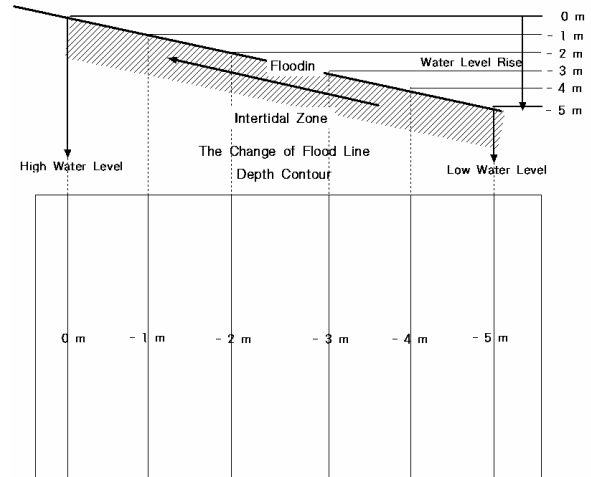


Figure 3. Schematic map to show the relationship between water level and depth contours.

The rectified image from the oblique image provides quantitative value on the distance between two points shown in the image such as a scaled map. For the rectification, field survey is needed to measure the distances between the GCPs(Ground Control Points). In order to extract the boundary lines between water and land automatically, edge detection image process is applied using RGB or HSV characteristics of water and land.

Through the processes explained above, spatial coordinates(x , y , z) for each water lines extracted from images are achieved. Three dimensional bottom topography is constructed integrating all the water lines into one data set and resampling the depth data at the new regular grids. This process is shown in Figure 4.

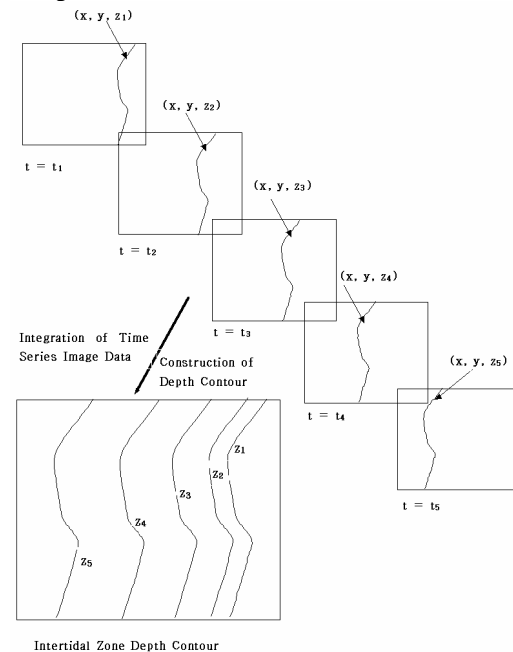


Figure 4. Construction of depth contours by integrating image data