Journal of Korean Society of Remote Sensing, Vol. 2, No. 2, 1986

Three Dimensional Study of the Tidal Flat Geomorphology in the Kŭm River Estuary by Multidate Image Analysis

Yoo, Hong-Rhyong
Korea Ocean Research and Development Institute
P.O. Box 29, Panwol Ind. Asan, 171-14 Korea
(Received July 15, 1986; Accepted August 1, 1986)

Abstract

The geomorophology of the tidal flats near Kŭm river estuary on the west coast of Korea was studied using satellite images.

Three Landsat images of different tidal moment were geometrically corrected to be overlapped one another. Then topographic contours were extracted for the analysis with the concept of 3-D.

According to the morphological analysis, the tidal flats around Kŭm river estuary area can be classified in three morphologically different groups: one is developped in a belt type along the shore; another is a delta type in the estuary; the other is developped between the shore line and islands.

The morphological characteristics of the tidal flats in the study area seems to be mainly influenced by the tidal dynamics which are very strong on the western coastal zone of Korea. However the waves and human activities seem also to be important in some part of the area.

1. Introduction

In the western coastal area of the Korean Peninsular, the tidal flats are vastly developped almost all along the coast.

These tidal flats can be territorial resources when they are reclaimed but they supply important foods to the living creatures in the sea when they are left unreclaimed. In the other hand, the water ways for marine transport are often changed or even blocked by the evolution of the tidal flats near them. Thus the study on the geomorphology of the tidal flats and their evolution is very important for deciding land relamation and also for efficient maintenance of water ways.

The Kŭm river drains land area of about 10,000 square kilometers with a length of about 400 kilometers. Its average annual river run off is about 6.4 billion cubic meters (Chung and Bhang, 1984). According to the study by comparing between the existing data and recently obtained data(Choi, 1986), the tidal flats in this area changed much during the last 8 decades. Furthermore, a barrage was constructed in 1985 only about 20 kilometers to the upstream from the Kunsan port near the mouth of the estuary. Thus a rapid evolution of tidal flats is anticipated in this area unless a proper management to maintain the navigation channel is planned.

It seems to be proper to use the satellite images in the study of the tidal flats mainly because of their synoptic view, and the availability of the multispectral data, which permit an easy configuration of tidal flats at a moment.

The purpose of this study is to develope the application technique of the satellite remote sensing on the problems of the tidal flat geomorphology. For this, the topographical contours of the tidal flats were obtained by overlapping three Landsat images of different water heights, and then the topographic profiles were derived from the contour map to be briefly analized in the concept of 3-D.

2. 3-D Concept of Multidate System for Intertidal Geomorphology

The water line in the intertidal areas observed on satellite image can be considered as a topographic contour of the heights corresponding to the water height at the moment of the image acquistion. Thus by overlapping several images of different water heights, we can obtain the same numbers of the contours as the used images, if it is supposed that the evolutions of the tidal flats during the image acquisitions were negligible and that the water levels are almost uniform in the study area(Fig. 1). The topographic informations can be obtained for the intertidal zone as the above without any stereoscopic image data (Verger, 1977).

3. Image Processing

Three Landsat Multispectral Scaner(MSS) images obtained at the water height of 102cm, 325cm and of 502cm (Table 1) from the zero level of hydrographic charts at Kunsan port were used for the study(Fig. 2). This images were firstly visualized after a brief classification to identify tidal flats from the seawaters and from the solid lands at the acquisition moments.

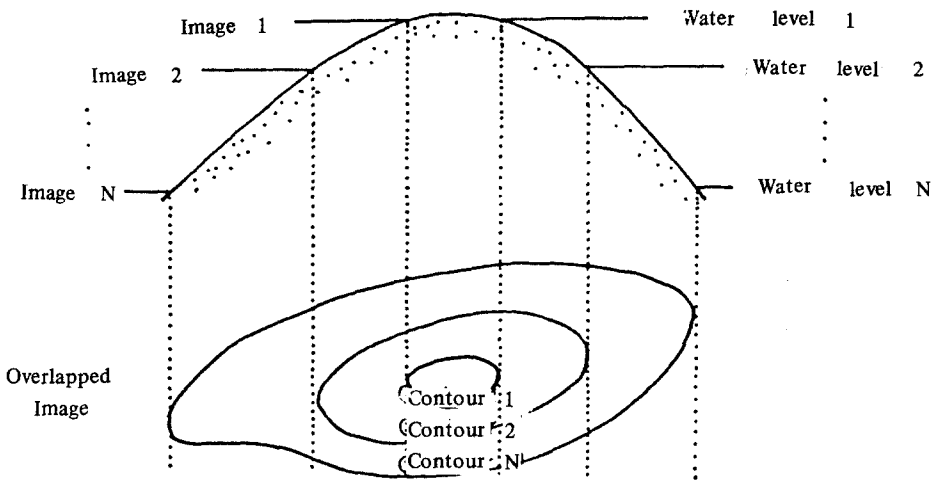


Fig. 1. 3-D. concept of Multi-date processing for the intertidal geomorphology.

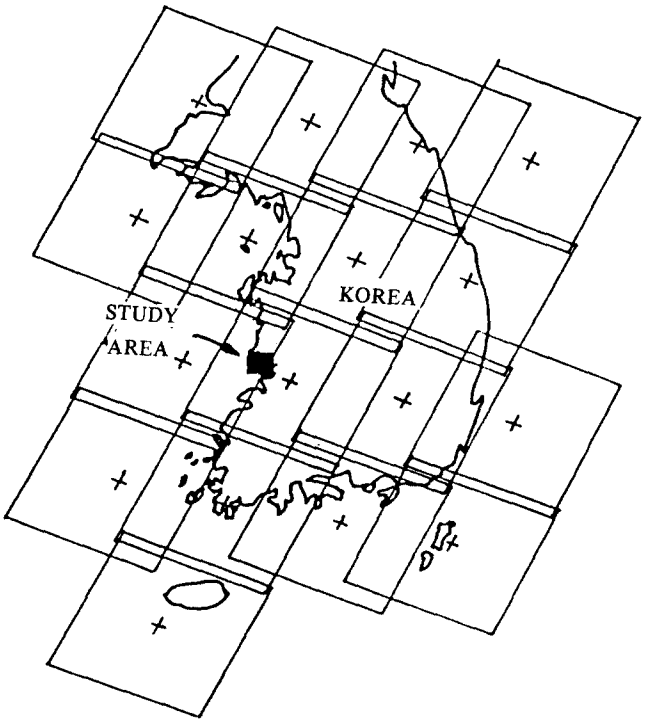


Fig. 2. Landsat coverage map on the Korean peninsular showing the location of study area.

Table 1. Used Landsat images and the water heights at the acquisition moments

Date	Satellite	Water height at Kunsan
1981. 4.13	Landsat 2	502 cm
1983 5.17	Landsat 4	325 cm
1983. 10.24	Landsat 4	102 cm

Each of the images were geometrically corrected in the Transversal Mercator Projection using the physical map of 1/50,000 scale. The geometrical corrections were processed by Geocor system (KORDI, 1986) in which the resamplings were carried out by the nearest neighbour method (Bernstein, 1983). The images were then overlapped one another by Multidate system (Yoo *et al.* 1986) as in the figure 3 to obtain contours of the tidal flats.

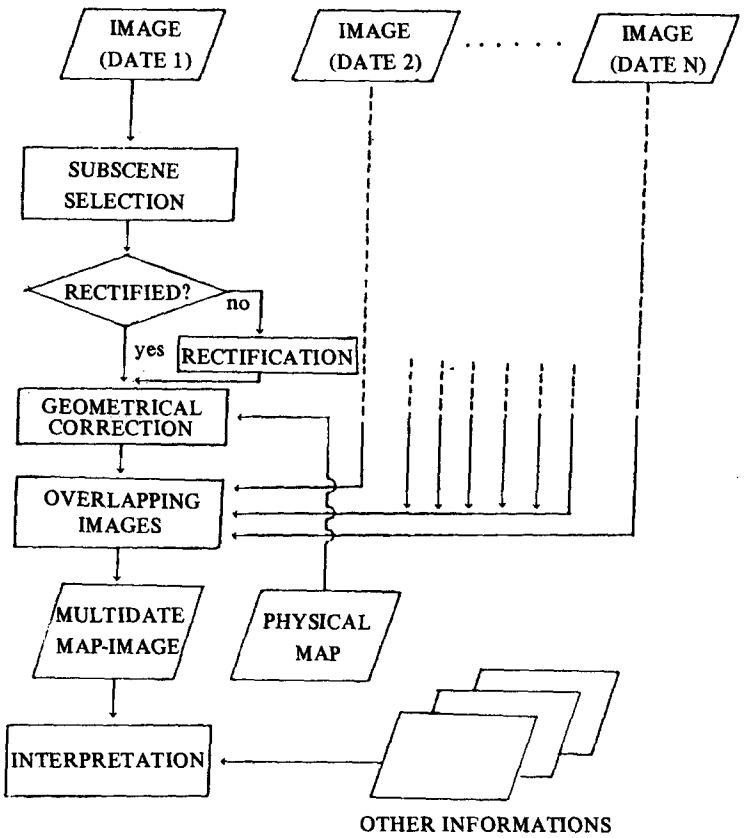
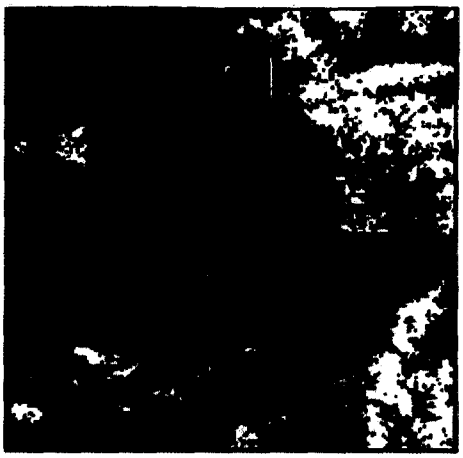


Fig. 3. Schematic flow chart of multidate processing system.

For the processing, a VAX-11/780 system(CPU: 4MB) and its peripherals were used. For the output displays and hardcopies, a Tektronix 4113B color displayer with a Tektronix 4691 inkjet printer and a Calcomp 906 X-Y plotter were used. For the geometrical correction, a Complot 7000 X-Y digitizer(Houston Instrument) was used.



a. 24 OCT.1983

b. 17 MAY 1983

c. 13 APR.1981

d. OVERLAPPED IMAGE

Fig. 4. Geometrically corrected images (a, b and c) and the map-image (d) established by overlapping them.

4. Geomorphology of Tidal Flats Near Kŭm River Estuary

The figure 4 shows the tidal flats in the area at the water levels of 102cm(a, 24 Oct. 1983), 325cm(b, 17 May 1973) and of 502cm(c, 13 Apr. 1981) and the map-image(d) which was established by overlapping the three images. The overlapped image shows very well the water lines of the upper three cases at once: the areas colored in green represent the surface height between 102cm and 325cm: the yellows represent the height between 325cm to 502cm: the reds represent the surface higher than 502 cm from the zero of hydrographic chart.

The image of the October 24, 1983 which was obtained at the moment near low water(Fig. 4. a) shows very well the tidal flats distribution in the area. With only this image the tidal flats in the area can be preliminarily classified into three morphologically different types as follows: one is developped in a belt type along the northern shore of the estuary; another is a delta type in the central part of the area; the other is developped between the shore line and the islands.

The figure 5 is the topographic contour map extracted from the ovelapped image, and the Figure 6 shows the topographic profiles along the lines plotted on the figure 5. The topographic profiles show different characteristics of slopes of the tidal flats. In general, the slopes are very steep on the upper part of the tidal flats away from the mouth of the estuary(Fig. 7, A–A', B–B' and C–C'), while steep slopes are observed on the lower part of the tidal flats near the estuary(Fig. 7, D–D', E-E'), On the other hand, the slopes shown by the profiles F–F' and G–G' on the delta typed tidal flat seems particular. On the seaward part, the steep slopes are observed on the upper part of the tidal flat while on the landward part, the slopes are steep on the lower part of the tidal flats. The profiles H–H' and I–I' show different slopes between the northern part and the southern part of the tidal flat and those of J–J' K–K' and L–L' shows similar characteristics to those of A–A', B–B' and C–C'. It is interesting to note that the profiles of F–F' and G-G' show that the top of the delta type tidal flat is slightly sloped toward the upstream.

It seems that the difference in the characteristics of slopes among the parts of the area is related to the dynamic regimes in the area. And three regimes can be considered in this area: Strong tidal current, the wave generated by strong wind from NW in the winter(Choi, 1986) and the river water discharge during the rainy season.

The figure 7 is a schematic slope map, based on the topographic profiles, which was established to examine briefly the relationship between the geomorphology of the tidal flats and the dynamic regimes. A combined analysis of the figure 6 and the figure 7 permited to note that the strong slope areas in the lower part of the tidal flats are parallel to the adjacent channels while those in

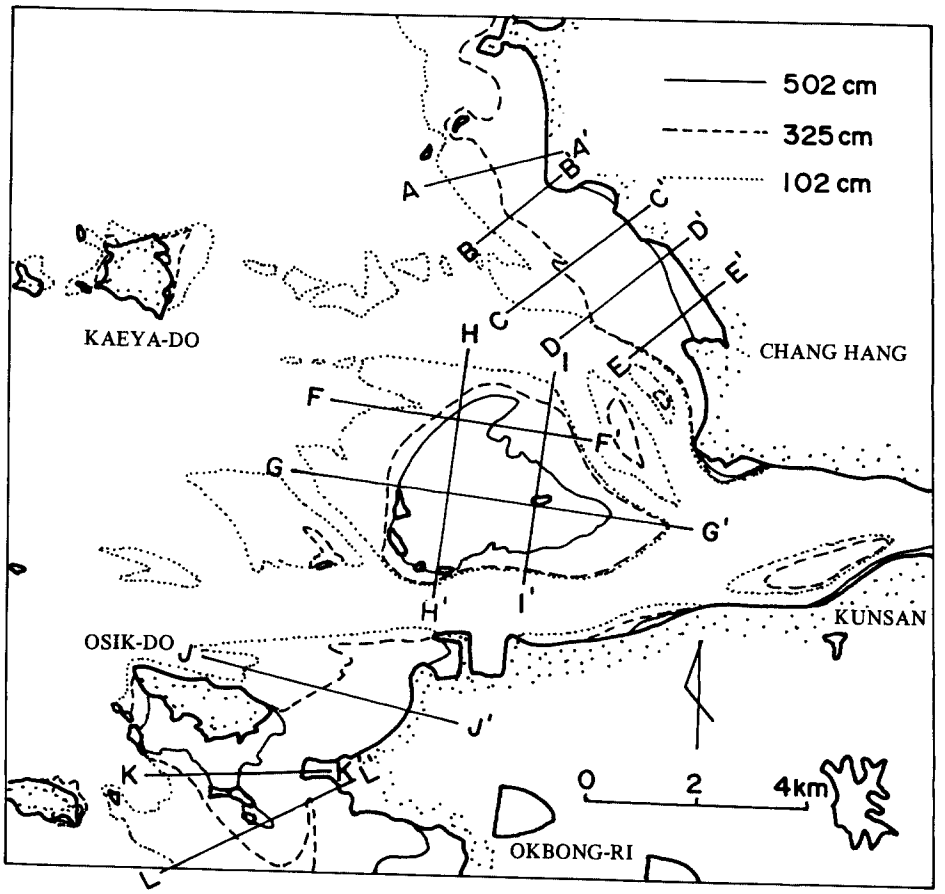


Fig. 5. Topographic contour map extracted from the overlapped image.

the upper part do not seem to have so much relation with the channels but they are almost perpendicular to the direction of waves coming from NW. The slight slope of the top of the delta type tidal flat in the central part of the area seems to be resulted from the outerward sand migration by river discharge. In the other hand the shape of the tidal flats between the island of Osik-do and the land seems to be much influenced by the dike which form a sheltered zone from the strong dynamics.

The figure 8 is the schmatic map of the relation between the geomorphological characteristics of the tidal flats and the influencing regimes in the study area. Besides the influence of the human activity, the tidal flats in the area seem to be differently influenced by each dynamic regime: The tidal currents on the lower part of the tidal flats and the wave and sand migration respectively upper part and on the top of the tidal flat in the central part of the area.

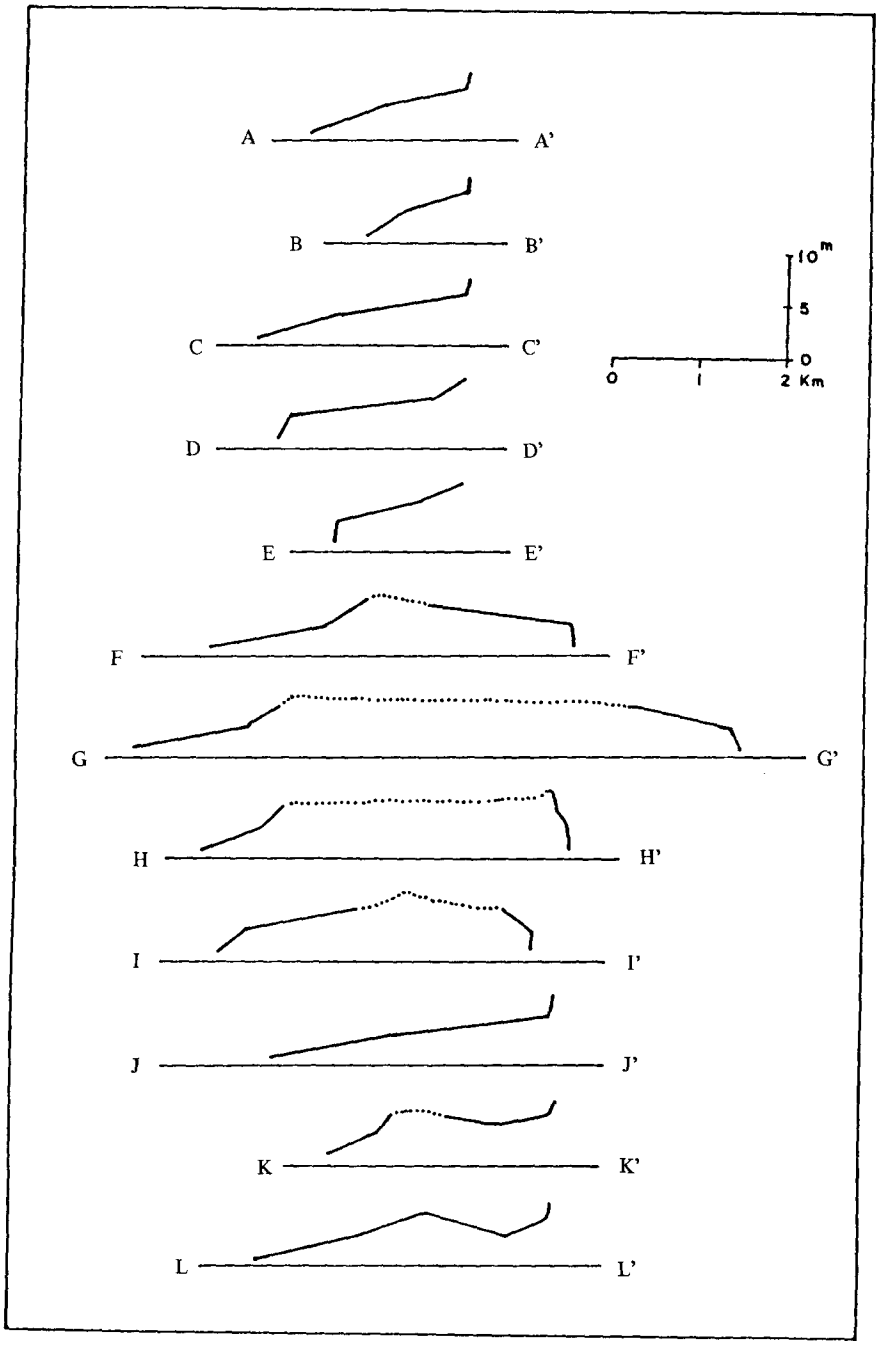


Fig. 6. Topographic profiles derived from the contour map.

5. Concluding Remarks

By a multi-date processing system of satellite images, the geomorphology of tidal flats was studied with the concept of 3-D. And the their influencing factors were examined by several schematic maps based on the satellite images.

Even though we have yet only preliminary results, this study seems to show a strong applicability of the remotely sensed data on the problems of intertidal geomorphology. The further study is proposed as follows:

- Overlap of more images of better resolution
- Establishment of 3-D images as Batson et al.(1976) or as Sakai et al.(1985).
- Study on the relationship between the surface status of the tidal flats and the image data
- Detailed study on the relationship between the physical parameters and the geomorphology
- Establishment of a synoptic geomorphological map of tidal flats.

6. Acknowledgements

Enthusiastic assistance of C. H. Ann and N. D. Chang in the image processing and calculations is greatly acknowledged.

This work is a part of the first year results of "A study on Application Techniques of Remotely Sensed Data" which was sponsored by the Ministry of Science and Technology of Koare for 3 years, and based on the result of the research project BSPE065-115-5 of Korea Ocean Research and Divelopment Institute.

References

Batson R. M. Edward K. and Eliason E. M., 1976, Stereo and landsat Pictures. *Photogrammetric Engineering and Remote Sensing*, 42:1279-84.

Bernstein, R, 1983, Image Geometry and Rectification. In: Colwell R. N.(ed.) *Manual of Remote Sensing*(2nd edit). American Society of Photogrammetry, 873-922.

Choi B. H., 1986, Morphological evolution of inter-tidal Sandiflats, port and harbour, *Jour.*

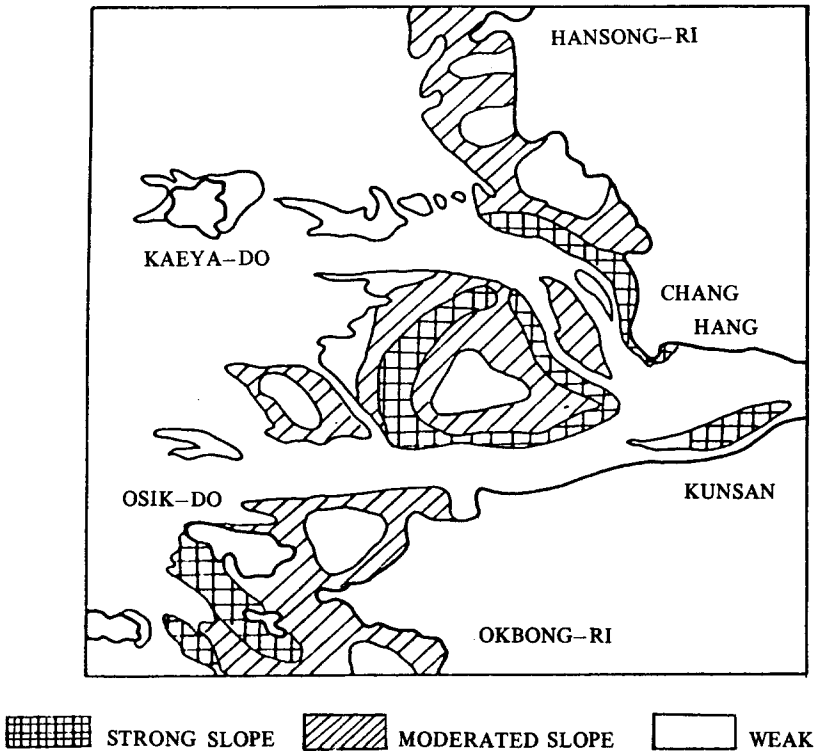


Fig. 7. Schematic slope map of the tidal flats.

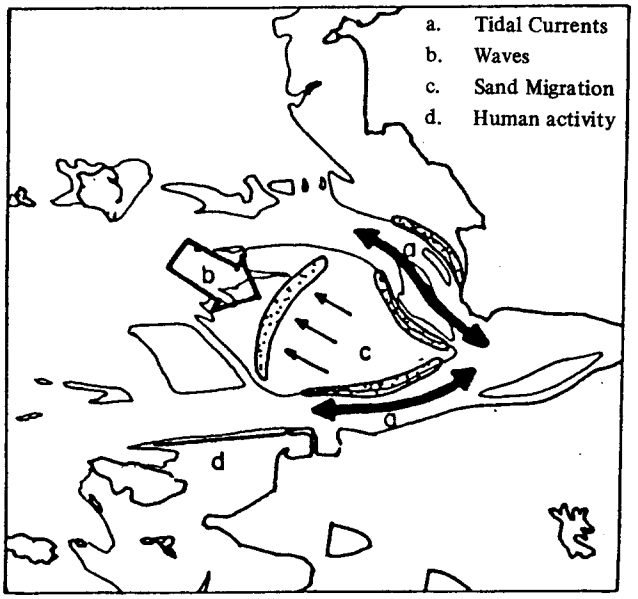


Fig. 8. Scheme of the relation between the geomorphology of tidal flats and the influencing regimes on it (dotted areas indicate strong slope area).

Kor. Port and Harbour Assoc., Vol. 10, No. 3, 15-23.

Chung J. Y. and I. K., Bhang, 1984, Circulation dynamics of the Keum River estuary II. *Fluid Dynamic Characteristics. Proc. Korea-US Seminar and Workshop on Marine Geology and Physical Processes of the Yellow Sea,* June 1984.

KORDI, 1986, A Geometrical correction system of landsat image data. *Application on Keum River Estuary Tidal Fidats Geomorphology,* KORDI Res. Rep., Seoul, Korea.

Yoo H. R. et al., 1986, Study on the Geomorphology and the water turbidity using TM data of landsat. In: *A Study on Application Techniques of Remotely Sensed Data,* KIER. Res. Rep., 151-190.

Sakai T., Nishikawa H., Fukuyama S., and Sugimura T., 1985, A study of land slides in Hayakawa Watershed by using landsat MSS data. Detection of new land slides. *Jour. of the Remote-Sensing Soc. of Japan,* Vol. 5, No. 1, 5-16.

Verger F., 1977, L'apport des satellites Landsat à la connaissance du littoral francais. Géomètre, Paris France, Feb. 1977. 44-50. (in French)