THE STUDY OF COASTAL CHANGE FROM USING DIGITAL AERIAL PHOTO AND HYDROGRAPHIC SURVEY: THE EROSION LAND UNDER SEA

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Abstract: The erosion (or sediment) reaches very serious level due to the aftermath by the imprudent reclamation on the coast. Continuous studies for long on coastline erosion may be warranted and possible countermeasures proposed because the change of the coastline has been progressed slowly for a long period of time in a wide area. Many experts anticipate that the global sea level's average increase by 19-35 cm due to global warming may certainly have an effect on the coastal erosion throughout the world. Thus, a more rigorous study on the causes of changing coastlines is particularly proposed to find ways to counteract any possible threats against coastal environments. In this study, ortho aerial photo and hydrographic survey datum were utilized to quantitatively analyze coastal erosion and sediment patterns. This paper also seeks to prove that a parcel under the sea occurred due to relatively significant changes to the coastline. We created ortho aerial photo using aerial photos taken each decade ('81, '93, '00), overlaid them onto a cadastral registration map, and calculated each amount of erosion and sediment while accounting for the tide level and without considering it. As the result of this study, we could propose that the methods of ortho aerial photo and the marine observation datum were the effective ways of change detection in erosion, sediment, and artificial reclamation of the coastline for a long time.

Keywords: aerial photography, a parcel under the sea, coastal change, hydrographic survey

1. Introduction

For long term, the erosion(or sediment) is been generating slowly in the extensive region near the coast because of the rash development. And It is estimated that the sea level would be ascended as 19 35 within 100 years due to the global warming. Therefore studies on the cause of this state and the counterplan should be required.

In this paper, we studied the detection of the coastal change for long term. For detecting the coastline change, we analyzed some studies; the study on the coastline change by the typhoon and the storm, using the photogrammetry (Cho et al., 2001), the study that computed the change extent of the beach area and beach width and analyzed the trend of the erosion and the sediment using digital aerial photographs (Choi et al., 2001) and the study on the coastline change by the rising of the sea level (Lim et al., 2002).

We analyzed the trend of the coastal erosion and the coastal sediment at an interval of 10 years using the aerial photographs taken by periods. And we computed the coastline change when considering the height of the tide and when not considering it through the stock map overlaid with the aerial photographs. As a result, we could detect the land under the sea by the coastline change and compute the area of the land under the sea

The study area is Uduri, DolSan, YeoSu, JunLaNamdo, Korea. We compared the aerial photo taken at an interval of 10 years from 1948 to 1990 with the surveying of the coastline and the sounding by high precision GPS. Using ortho photos and GIS (Geographical Information System), we considered the coastline change and the land under the sea.

2. Method

1) Study area

The study area is Uduri, DolSan, YeoSu, JunLaNamdo, Korea. The artificial embankment is located in the eastern direction of study area, DolSan large bridge in the southern direction and JangGun Island in the northwestern direction. Uduri is the region that the coastline change is large because of the narrow waterway, the strong tide current and the large bridge.

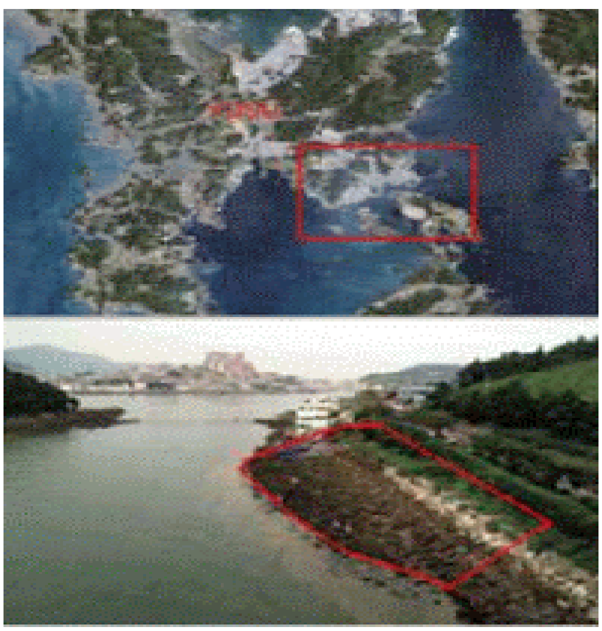

Fig 1. The study area

(top: satellite image, bottom : field photo)

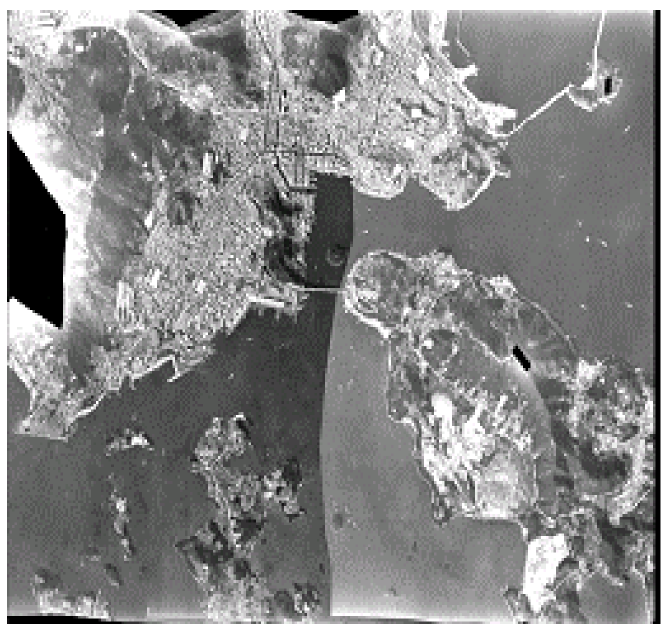

Fig 2. The ortho aerial photo of the study area(1999)

2) The construction of data

We analyzed the ortho aerial photos and accomplished the souding survey and the cadastral survey. We generated, constructed and interpreted the GIS data, using interpreted results as Table 1.

Table 1. Data used in the aerial phtogrammetry

Data Particular						
	Region	Scale	Course	Number	Multiple	Note
Aerial photo	‘48.10.10	1/16,000	47	45-46	2	Dep. Survey of Army, Korea
	‘69.05.06	1/30,000	00	37-38	2	
	‘68 YeoSu	1/15,000	2	5-7	3	National Geographic Information Institute
	‘79 Namhae	1/20,000	20	34-36	3	
	‘90 JunNam	1/20,000	15	89-91	3	
		Total			13	
	Name		Scale		Note	
Digital map	34703099 10		1/5,000		The digital map was manufactured in same year.	
	34704091		1/5,000			
	34707009 10		1/5,000			
	34707020		1/5,000			
	34708001		1/5,000			
	34708011		1/5,000			
	34707019		1/5,000			

3) Generation of DEM and ortho aeial photos

For generating ortho aerial photos, we used programs like ISPM, ISMS, ISDM, ISDC, ISDT, ISBR, ISOP, ISFC, ISRU, ISMT, ISAT and MGE of Z/I(Zeiss/Intergraph) Company Imaging and Microstation of Bently Company. The result is Fig. 2. We scanned aerial photos using Mirage II Film Scanner of Umax company and the resolution of the scanned photo was 1200dpi. DEM was generated using the scale 1/5000 topographic map issued by National Geographic Information Institute of Korea. We manufactured ortho aerial photos of 1948, 68, 79 and 90 but the ortho aerial photo was excepted due to the uncertain photographing date.

4) Interior and exterior orientation

As a result of the interior orientation, RMSE of each aerial photo were within 1~2 pixel. Thus aerial photos were available to apply. But the thirty-forth strip aerial photo taken in 1979 was excepted because its RMSE were over 4 pixel (86.19). The RMSE of the interior orientation by each aerial photo and RMSE of the exterior orientation by each strip are as like Table 2, 3.

Table 2. The result of the interior orientation by each photo

year	# of photo	X Residual (pixel)	Y Residual (pixel)	RMSE	
1948	45	0.061	0.061	0.12 pixel	2.55
	46	0.05	1.195	1.69 pixel	35.91
1968	07	0.502	0.152	0.74 pixel	15.70
	06	0.168	0.129	0.29 pixel	6.33
	05	-0.134	0.899	1.28 pixel	27.21
1969	38	0.064	0.032	0.10 pixel	2.15
	37	0.094	0.148	0.24 pixel	5.26
1979	36	-1.351	0.360	1.97 pixel	41.85
	35	-0.090	0.157	0.25 pixel	5.41
	34	2.859	0.304	4.06 pixel	86.19
1990	91	0.561	0.372	0.95 pixel	20.15
	90	0.249	0.564	0.87 pixel	18.47
	89	0.311	0.003	0.44 pixel	9.31

Table 3. The result of the exterior orientation by each photo

year	X Residual (pixel)	Y Residual (pixel)	RMSE
1948	2.3354	1.2200	2.6349
1968	0.3854	0.5977	1.5802
1969	0.3332	0.2181	0.5997
1979	1.3558	1.2020	2.0389
1990	2.9805	0.4381	2.2663

5) The survey of GCPs (Ground Control Point)

For the accurate detection of the coastline change, we surveyed GCPs by using GPS equipments ; Ashtech Z-fx and Ashtech Z-surveyor. As a result of GPS survey, the accuracy of GPS survey was under ±1.8 in the horizontal direction and under 5.7 in the vertical direction. We could acquire the excellent result.

6) The photographing date of the aerial photo and the information of the tide height

For computing the area of the coastline change and the width of the beach, it is very important to compute the tide height of the photographing date. Based on the year, the month, the day and the time recorded in the aerial photo, the photographing date of the aerial photo is computed. But in case of the 1948 aerial photo that only “10 Oct 48” was recorded, we computed the photographing time roughly using the direction of the shadow as Fig 3. The result of analyzing shadows of 3 objects, the directional angle of the shadow was about 140°±2. When comparing with Table 4, it is estimated that the 1948 aerial photo was acquired at AM 10:20 ~ AM 10:30.

Table 4. The result of computing the directional angle (1948.10.10)

Date	Hour	Minute	Directional Angle	Elevation Angle
1948.10.10	AM 10	20	140.6	38.8
	AM 10	30	143.3	40.0

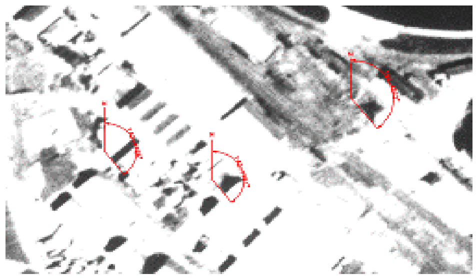

Fig 3. The computation of the shadow 's directional angle (1948 ortho aerial photo)

We computed the tide height of the study area, using the data that were surveyed after 01-02-1965 of YeoSu tidal station, National Oceanographic Research Institute, Korea. But in case of the former day, we used the estimated value by the non-harmonic constant. Table 5 is the result of analyzing the tide height by photographing time of each aerial photo.

Table 5. The result of analyzing the tide height by photographing time

Date	Time	Camera	Focal Length	Tide Height	Based on Mean Sea Level	Time of High/Low water and the tide height	Tide Trend
1948.10.25	10:20			205.7 cm	24.9 cm	7 h 139 cm 15 h 244 cm	Ascend
1969.05.06	10:00	KC	152.78	242 cm	61.20 cm	6 h 85 cm 12 h 284 cm	Ascend
1968.	15:13	UAG 40	152.00				Impossible to interpret
1979.09.20	12:37	UAG 3081	152.87	123.93 cm	-56.87 cm	9 h 300 15h 58	Descend
1990.10.26	14:05	UAG 15/4	153.40	249.17 cm	-68.37 cm	14 h 250 8 h 168	Descend

3. The Detection of the Coastline Change

We analyzed the coastline change to estimate the feasibility of the coastal erosion. We manufactured ortho aerial photo maps of 1948, 1969, 1979 and 1990 and extracted the coastline from each map and overlaid the coastline(ocean side) of 1948 with the coastline of 1990(land side). Fig. 4 is the result to extract the coastline change of Uduri, DolSan, YeoSu region at an interval of 10 years. It is estimated that about 552 erosion has been generated for 42 years when comparing with 1990 data. Therefore it is estimated that the study area has the property of the erosion.

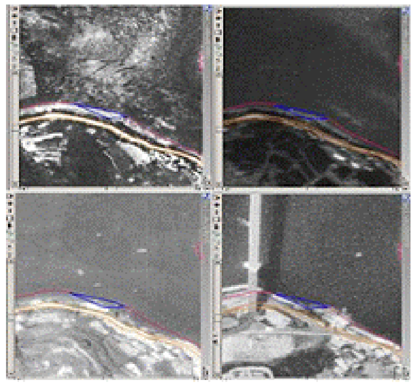

Fig 4. The coastline change of the study area (1948,1969, 1979 and 1990)

1) The computation of the land under the sea area when not considering the tide height

We scanned the stock map issued by YeoSu, using the Mirage II Film Scanner of Umax company and surveyed the coordinate precisely, using DGPS method. And we estimated the feasibility of the erosion in study area, overlaying the stock map with each ortho aerial photo. The result is Table 6 and Fig. 5. In case of 1979, it is estimated that area of the land under the sea was computed excessively. The cause of this is that the aerial photo was acquired when the tide height(123.93cm) was similar to the mean low water neap(127.60cm). In case of 1948, 1969 and 1990, the tide height was 205.7~249.17cm and the difference of the tide height was -80~120cm when comparing the 1979 tide height. Therefore it is estimated that area of the land under the sea was computed excessively.

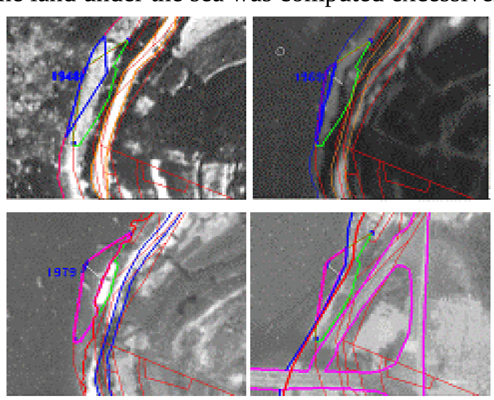

Fig 5. The area of land under the sea

Table 6. The area change above water and under water

<table>
<tr><th rowspan="2">year</th><th colspan="2">Above sea</th><th colspan="2">Under sea (a land under the sea)</th><th rowspan="2">Total Area</th></tr>
<tr><th>Before adjustment of tide height</th><th>After adjustment of tide height</th><th>Before adjustment of tide height</th><th>After adjustment of the height</th></tr>
</table>

1948	1021	1020	5	6	1026
1969	879	989	147	37	1026
1979	254	945	772	81	1026
1990	700	774	326	252	1026

2) The computation of the area the land under the sea when considering the tide height

The number of methods to detect the coastline change considering the tide height is two. One is the method to analyze the change between the real high water and the high water acquired through the digital drawing on the aerial photo. The other is the method to analyze the change between the real water level line and the coastline of the aerial photo. The former is more available than the latter. But in case of the middle scale aerial photo(1/16000~1/30000), we could extract the contour at interval 1.2~1.3m, if we use the first class plotting instrument(c-factor:2000), Therefore it is estimated that the degree of the reliance would be a little low if we compute the high water, making the digital drawing on the middle scale aerial photo. Therefore we computed the area(the extent of the erosion or the area of the land under the sea) under the sea and the area above the sea by subtracting the area under the sea from the total area in this study, using the method to detect the change between the coastline of the aerial photo and the water level line by surveying the topography and the sounding. As a result of analyzing the trend of the erosion, it is estimated that the erosion had been generated rapidly for early 20 years because of Saraho typoon. And it is estimated that the erosion had been decreased for 20 years from 1970 because the artificial embankment construction to protect the DolSan large bridge was constructed in middle 1980’s. As Fig 6, there was the large difference between considering the tide height and not. Therefore it is important to consider the tide height when detecting the coastline change. When there is no change of the tide height, the problem would be little. But it is essential to pay attention to the possibility of the excessive computation or the scanty computation when there is a large change of the tide height.

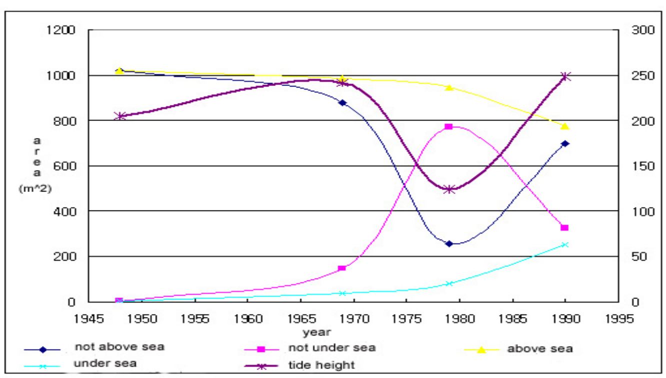

Fig 6. The coastline change of the study area

4. CONCLUSION

In this study, we conducted the aerial photogrammetry, the topographic survey, the sounding survey and the GCP survey and detected the coastline change during 55 years and the land under the sea. The trend of the coastline change in the study area was the erosion. The result of the analysis is as below.

First, we manufactured ortho aerial photos at an interval of 10 years and extracted the coastline. During 42 years, the eroded area was 552 based on the coastline of 1948. The coastline change was detected in the whole study area.

Second, for detecting the land under the sea, we scanned the stock map of the study area and computed the eroded area when considering the tide height and not. In case of 1990 that the change of the tide height was little, the eroded area to consider the tide height was 326 and the eroded area not to consider the tide height was 252 . They were similar. In case of 1979 that the change of the tide height was much, each value were 772 and 81 . There was the large difference. In case of 1948,1969 and 1990, the tide height was 205.7~249.17cm and the difference of the tide height was -80~120cm when comparing the 1979 tide height. It is estimated that the area of the land under the sea was computed excessively. Therefore the change of the tide height should be considered to compute quantitatively the coastline change and the area of the land under the sea, using the ortho aerial photo.

Third, the coastline change and the land under the sea are important factors. Therefore it is essential to construct the data periodically. But there is an difficulty in constructing the standardized data because the digital map, the topographic map, the nautical chart and the land registration map and so on are managed by the different organizations. The land under the sea and the unregistered land may be generated in all coast. Therefore the standard of the survey and the regulation should be established for the proof of the land under the sea. And the study on the coastline change should be accomplished continuously for the judgment of the ownership.

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