The Study of Coastal Topographic Changes on the Haeundae Beach of Korea Using Aerial Photo

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Abstract: Coastal collapses and losses have been accelerating because of sudden changes in the natural environment and increases in artificial development. So, the analysis of coastal topographic changes has needed to see this problem but there are not enough related data. Therefore, we analyzed the long-term coastal topographic changes in the Haeundae Beach of Korea that is the most famous beach in the country. We extracted the coastline from aerial photos and corrected for the heights of the tides using sounding and GPS survey data. As a result, we could see that the coastline get nearer to land and the area of beach has been reduced in general.

Keywords: Coastline, Aerial Photogrammetry, Sounding and GPS survey data.

1. Introduction

Recently, Marine erosion results in a loss of beaches are much debated. This phenomenon has greatly affected in the tourism industry of Busan. Especially, Haeundae Beach is the popular beach in the country, so summer visitors have been increasing every year. But the width of beach is going to decreasing due to losses of sands. Therefore we analyzed the change of coastal environment quantitatively by detected the change of coastline. We analyzed a trend of coastline changes using aerial photos in the three decades. Aerial photo is more economical and high resolution than survey, so we used it.

In this study, we analyzed data about detection of coastal environment based on aerial photogrammetry. In order to produce ortho-aerial images, as indicated by Fig.1, first we collected aerial photos by every ten years (75, 85, 95, and 05) and created the GIS data (coverage and DEM). Finally, we carried out ortho-rectification using generated GIS data. After that we extracted coastline by digitizing on ortho-aerial images. Also, we analyzed change of the beach area and width using extracted coastline.

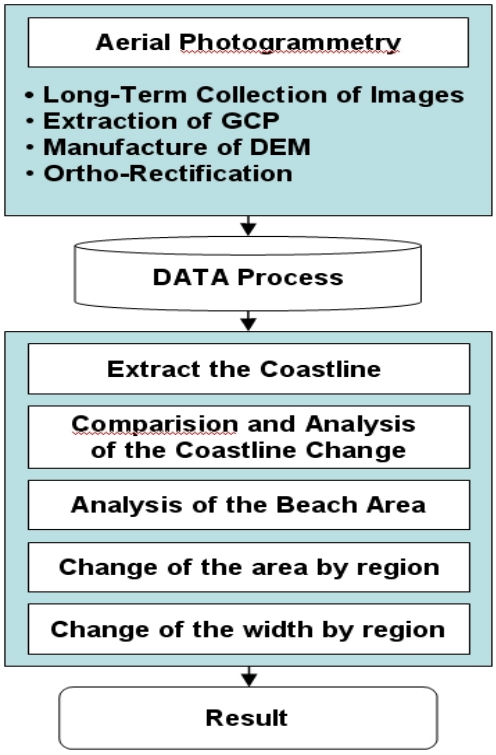

Fig. 1. Study methodology

2. Methods

1) Manufacturing of Ortho-Aerial Photos

At first, we obtained aerial photos of 1975, 1985, 1995 and 2005 by cooperation from the Department of the Cadastral Survey, Busan City Hall. Table 1 provides the information of photos

The second time, we scanned aerial photos by Umax Mirrage film scanner and generated coverage and DEM data using GIS software(Arcview 3.2 and ArcInfo 8.0.1). The created coverage and DEM are as shown in Fig. 2.

The third time, we carried out an image processing such as interior and exterior orientation using ERDAS Imagine 8.6. As a result, we obtained ortho-aerial images. These are illustrated in Fig. 3.

Table 1. The index of photos used in this study

Date	Time	scale	number of photos	camera type	focal length
1975.05.25	11:22	1:6000	4	Wild UAG	152.00
1985.05.02	9:56	1:6000	4	Wild	152.36
1995.05.24	10:34	1:6000	3	Zeiss	153.10
2005.05.14	13:55	1:6000	3	Wild UAG Ⅱ	153.09

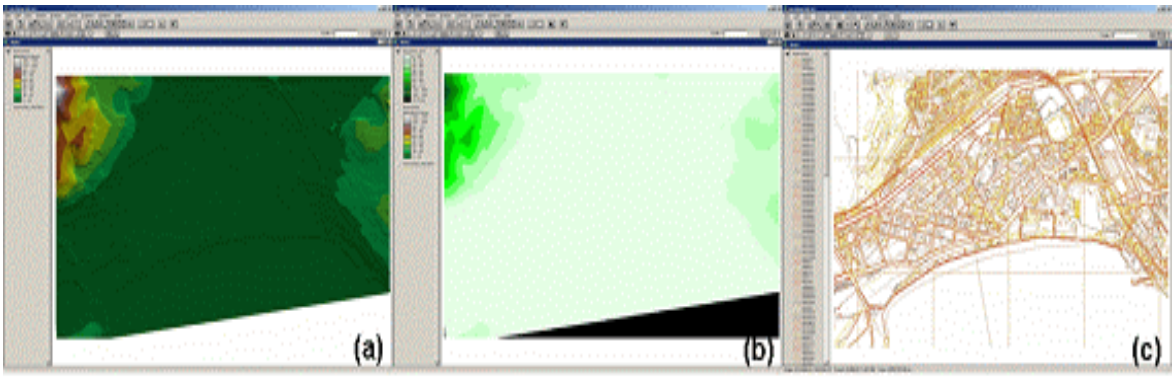

Fig. 2. (a) Created TIN, (b) Created DEM, (c) Created coverage

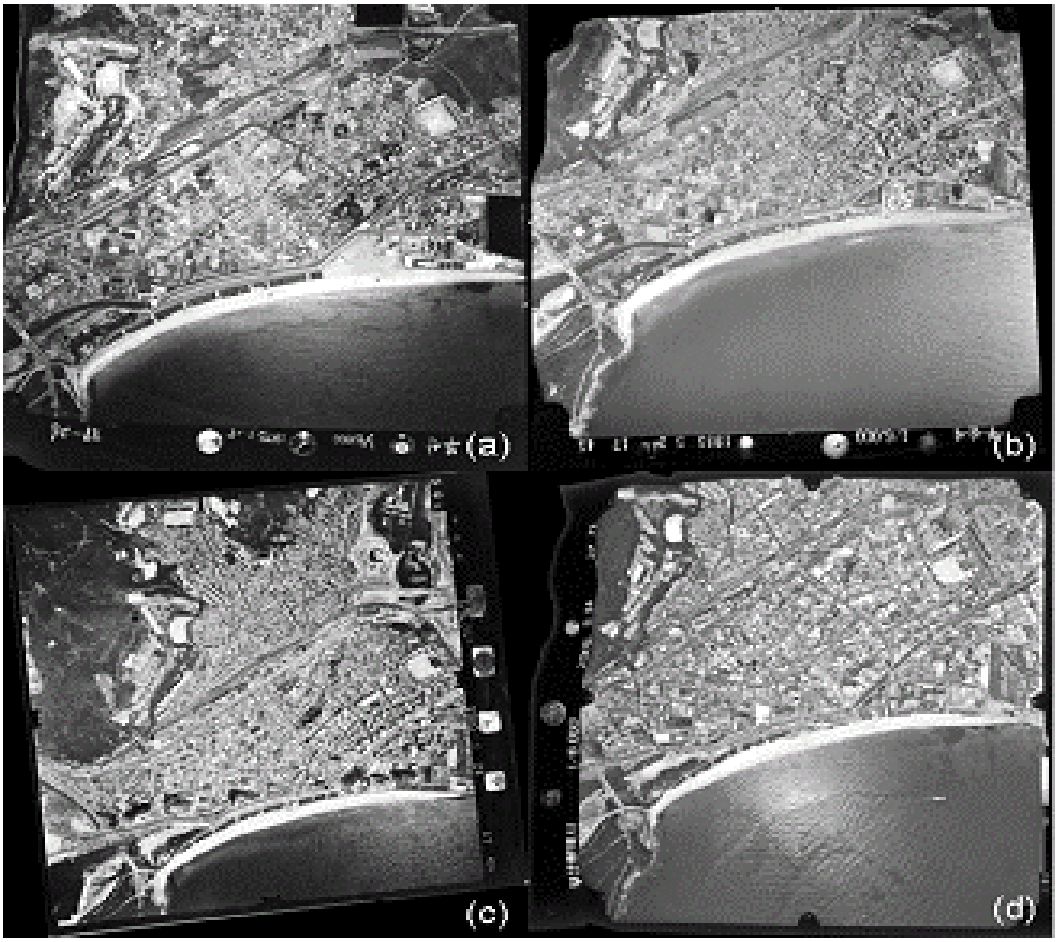

Fig. 3. (a) Ortho-aerial photo of 1975, (b) Ortho-aerial photo of 1985

(c) Ortho-aerial photo of 1995, (d) Ortho-aerial photo of 2005

2) Extraction of the Coastline

We digitized coastline on ortho image using Image Analyst and then analyzed the trend of coastline, area and width changes in the Haeundae Beach. The extracted coastlines as illustrated in Fig. 4.

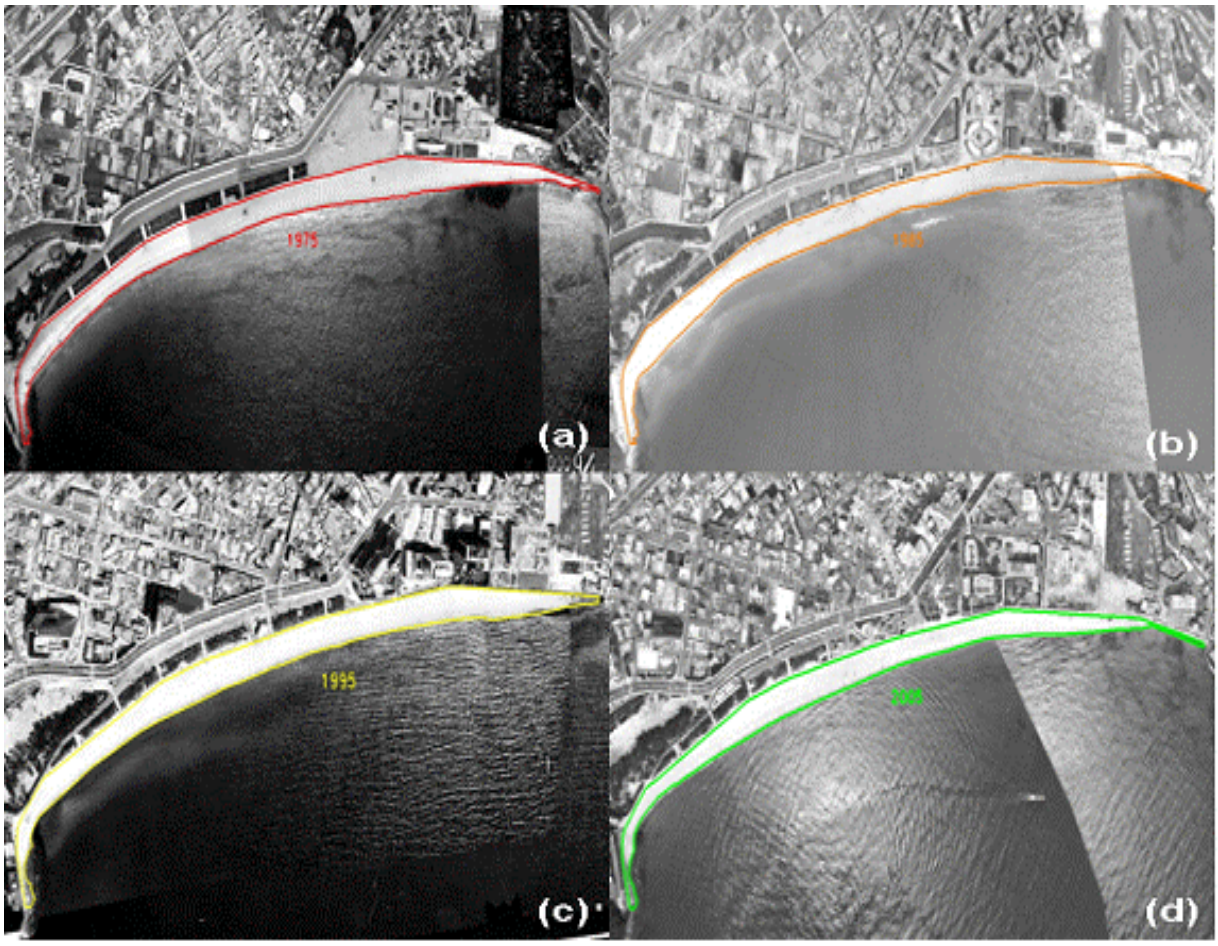

Fig. 4. (a) Extracted coastline of 1975, (b) Extracted coastline of 1985

(c) Extracted coastline of 1995, (d) Extracted coastline of 2005

3) Correction of the Coastline After Consider a Tide Level

It is necessary that correction of the coastline according to the tide level because each aerial photo was taken different time. To compute the correction value, on the assumption that the coastline slope is easy, we extracted contours which apply to the tide level and MSL (Mean Sea Level) from sounding survey data. The extracted contour as presented in Fig. 5. We employed sounding survey data from the South Sea Oceanographic Research Office, of the National Oceanographic Research Institute of Korea [4].

We calculated the correction value of 1985 and 1995 using sounding survey data of 1980 and 1994. Also, the correction value of 2005 was computed from both sounding and GPS survey data. Because of we have not sounding or GPS survey data at that time, we are excepted aerial photo of 1975. We corrected the coastline based on calculated values that considered tide levels which are provided in Table 2 and 3.

The results corrected coastlines are illustrated in Fig. 6. Generally, the coastline has been closed to land. As a result of analysis the coastline, in the center of beach, coastline remains unchanged but in the sides of beach, there are some major changes. And this trend continues till now.

Table 2. The Non-Harmonic tidal constant of the Busan tide station, Korea

Tide station	35° 05' 35"N / 129° 02' 15"E	**Approx. H.H.W**	129.8㎝
Mean High Tide Level	104.9㎝	**Mean Low Tide Level**	24.9㎝
Difference High Tide Level	117.8㎝	**Difference Low Tide Level**	42.2㎝
M.S.L	64.9㎝	**M.H.W.I**	08h 02m

Table 3. The tide level analysis by taken times of aerial photo

Photo Date	Photo Time	Tide level(cm)	Based on M.S.L(cm)	High Tide level / Low Tide level
1975. 05. 25	11:22	62	-	8h11m : 119 / 13h50m : 9
1985. 05. 02	9:56	30	-35	-
1995. 05. 24	10:34	31	-34	4h39m : 9 / 10h54m : 31
2005. 05. 14	13:55	74	+9	11h40m : 86 / 18h02m : 39

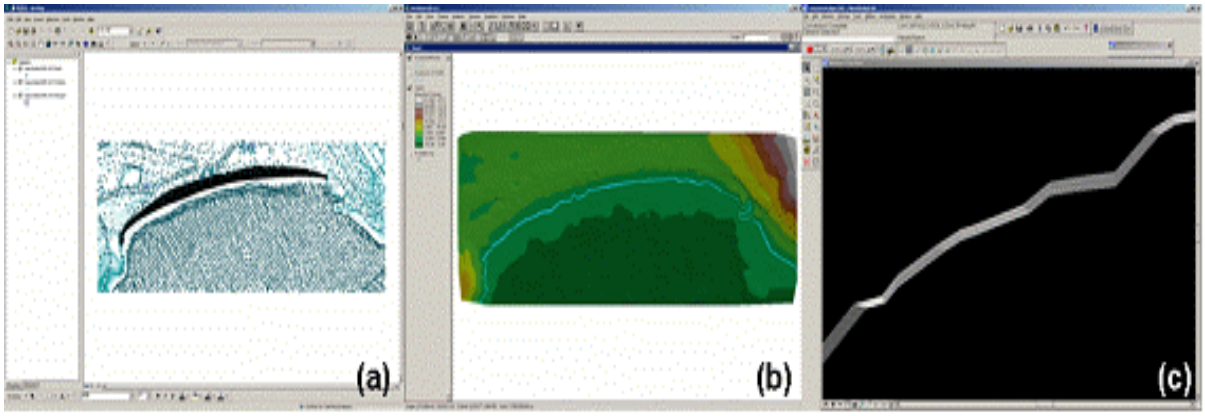

Fig. 5. (a) Sounding survey data, (b) Created TIN, (c) Extracted the necessary contours

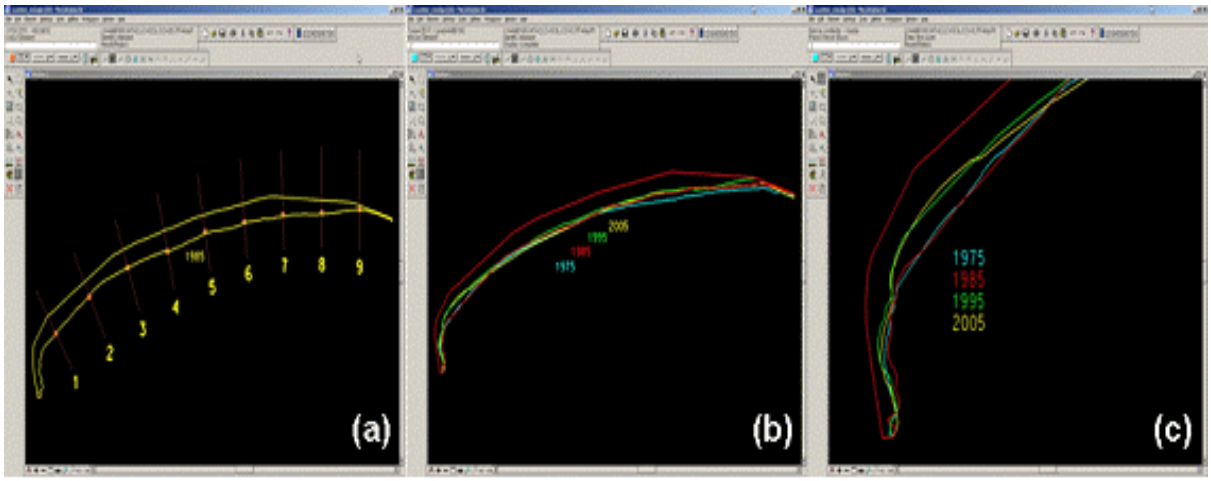

Fig. 6. (a) correction for the tide level, (b)overlaid the corrected coastlines, (c) a remarkable change in the west of beach

4) Computation of the Beach Area

We analyzed the area of beach based on standard lines. The back of beach standardized to the shore protection 1975. The front of beach standardized to the coastline. As a result, generally, the area of beach has been reduced during in last 30 years. This result as presented in Table 4 and Fig. 7.

In the Fig. 7 the area of 1975 is more less than 1985. This is why the area of 1975 is uncorrected the tide level because of we haven't depth data of 1975.

Table 4. Area changes of the Haeundae beach

	Extracted area from aerial photo	Computed area after considering tide level based on MSL	Area of the Haeundae Beach
1975	68334.61	-	-
1985	64967.62	6123.62	70604.90
1995	58999.68	9401.61	67696.13
2005	56490.26	1206.09	57696.35

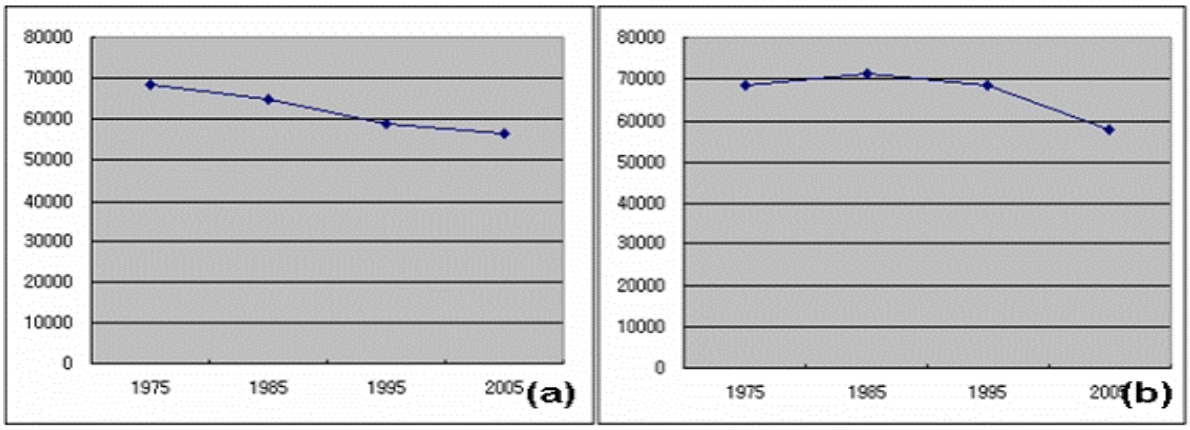

Fig. 7. (a) Extracted area from aerial photo, (b) Computed area after considering tide level based on MSL(except for 1975)

At present (2005), the area of beach was reduced about 16% when compared with 1975. If this decreasing trend is going, the Haeundae Beach would not continue long in existence.

When compared the extracted area of 2005 from aerial photo(57696.35㎡) and GPS survey(58942.21㎡), the extracted area used GPS was higher than aerial photo as 1245.86㎡. A comparison with the quantitative sounding data indicated little difference, which was 1245.86㎡, at approximately 2% of the total area of Haeundae, 66380.87 ㎡

The reason for the difference is by not an error according to using analysis of aerial photo but also an artificial work on the beach. The taken time of aerial photo is 14 May 2005 and GPS is 19 September 2005. The beach season is included during these times. So there were filled up with the sand artificially by Busan City Hall. Therefore, we guess that an error by aerial photo is smaller. Accordingly, the extracted area from aerial photo is effective data.

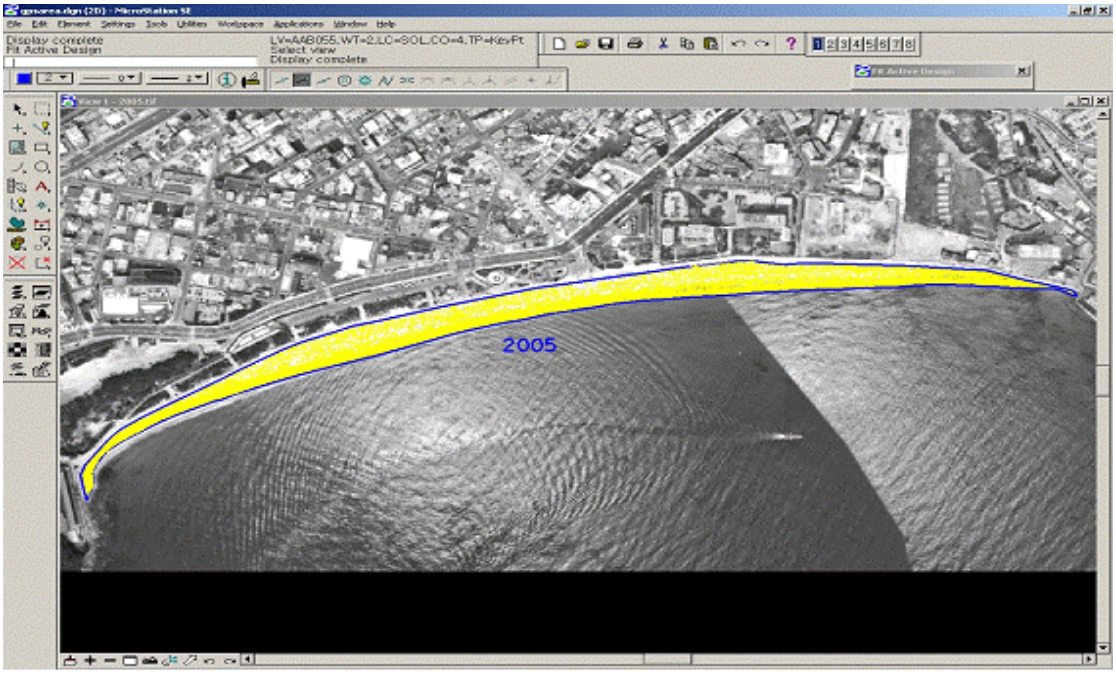

Fig. 8. Computed the area of 2005 (used aerial photo and GPS survey data)

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An extracted coastline from aerial photo of 2005 and GPS survey data of 2005 as shown in Fig. 8.

5) The Analysis of Area Changes by Region

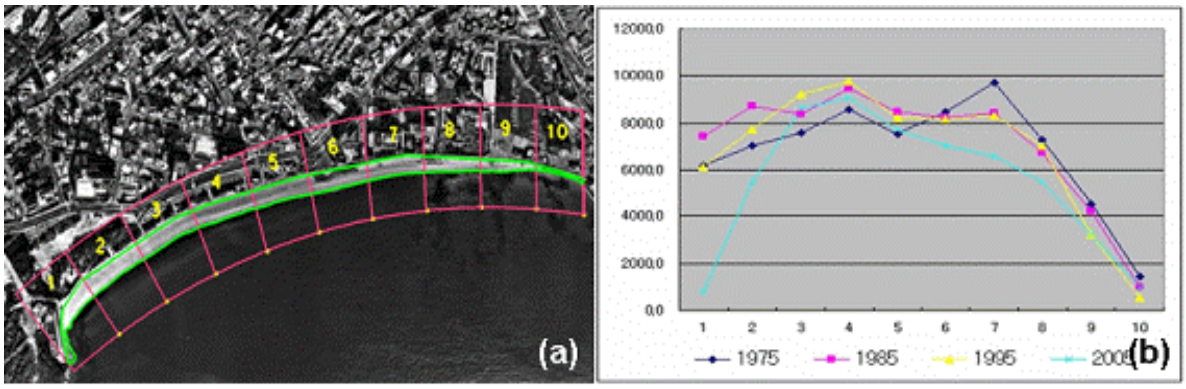

Fig. 9. (a) a base line to compute area of beach by region, (b) Area changes by region

Table 5. Area changes by region of the Haeundae Beach

	1	2	3	4	5	6	7	8	9	10
1975	6176.1	7029.4	7570.5	8556.6	7548.0	8466.3	9716.7	7303.3	4545.5	1432.9
1985	7428.2	8748.0	8358.2	9448.0	8479.7	8248.3	8412.6	6761.4	4232.4	974.2
1995	6167.1.	7734.4	9211.7	9747.8	8242.7	8193.8	8323.6	7018.4	3239.9	522.1
2005	774.8	5491.2	8609.2	9056.5	7739.3	7035.7	6600.4	5488.1	3198.8	989.2

The changes, based on 1975, of beach area by ten regions during 30 years are illustrated in Fig. 9 and indicated Table 5. Collectively, the areas of ten sections tend to decreasing. In the middle of beach (sector 4, 5 and 6), there was a little change of area, but in the sides of beach, area was heavy losses: A decrement- sector 1(87%), sector 10(31%),

6) The Analysis of Width Changes by Region

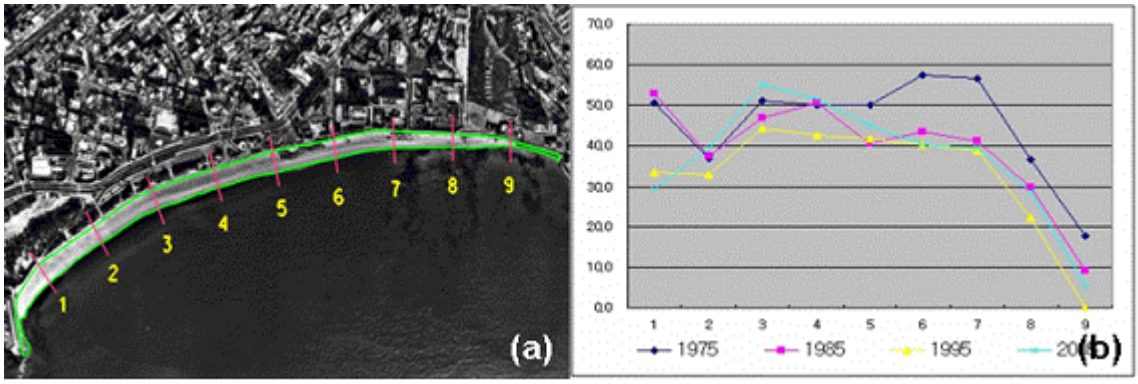

Fig. 10. (a) A base line to compute width of beach by region, (b) Width changes by region

Table 6. Width changes by region of the Haeundae Beach

	1	2	3	4	5	6	7	8	9
1975	50.6	37.1	51.3	50.0	50.0	57.6	56.5	36.7	17.6
1985	53.1	37.4	46.8	50.7	40.8	43.5	41.2	29.9	9.2
1995	33.5	32.9	44.3	42.6	41.9	40.3	39.0	22.1	0.0
2005	29.4	39.6	55.2	51.4	45.3	40.4	39.6	28.6	5.5

The changes, based on 1975, of beach width by regions during 30 years are illustrated in Fig. 10 and indicated Table 6. In the middle of beach, there is a little change, but in the sides of beach, the change of area is very quickly: A decrement- sector 1(42%), sector 9(69%). Beach was filled up with the sand artificially by Busan City Hall for every year. So we think that this is affecting the change of the middle part.

3. Conclusions

As a result of the analysis of coastal changes on the Haeundae Beach using aerial photo with sounding and GPS survey data, the area of beach is reduced about 16% during last 30 years. And this reducing phenomenon is continues till now. The result of study can be summarized into the following six points.

The first, the result of analysis about the coastline changes of the Haeundae Beach, generally, the coastline was closed to land. In the center of beach, there are a few changes. but in the sides of beach, there are some major changes. And this trend continues till now.

The second, when the area of 2005 compared with area of 1975, area of 2005 was reduced about 16%. It was probably caused by development around the beach that is cut off the source of sand supply.

The third, when the aerial photo extracting and GPS surveying result was differences under 2 % of total area of Haeundae Beach. Therefore it is judged that the analysis using aerial photo is useful.

The forth, as an analyzed result about change of area by region, west(sector1), center(sector6) and east(sector10) of the beach was each reduced about 87%, 17% and 31%. Generally, area of the beach has been decreased especially the sides part of beach was decreased sharply in the last 30 years.

The fifth, as an analyzed result about change of width by region, mostly area was reduced; especially the sides of beach were more decreased than the center of beach.

The sixth, area of the Haeundae Beach was on the decreased from 1975 to 2005.

It has high possibility that these trends would be continuing. So we must take some measure to cope with this problem.

In this study, we were able to analyze the coastal change using aerial photo, and this result is useful to long-term monitoring of coastal region. Result of this study is available to the oceanographic information.

Acknowledgement

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