4.7 Mechanism of Littoral Transport

4.7.1 Observation on Site Survey

The coastal line in the study area is roughly divided into three parts based on topographic characteristics: North Area from Khanom to Pak Phanang, Middle Area from Laem Talumphuk of Nakhon Si Thammarat province to Pattani, and South Area from Laem Ta Chi of Pattani province to Tak Bai at the southern extreme end of the study area (see Figure 4.7.1-1).

The results obtained about the mechanism of littoral drift in the study area is summarized as follows:

(North Area)

1. In the north part of the study area, Sichon to Tha Sala in Nakhon Si Thammarat province, the predominant direction of littoral drift is southward.
2. Rate of littoral transport in this area is larger to the south.
3. Southern shoreline of Tha Sala channel is seriously eroded.
4. Southern limit of littoral transport in this area may be at Ban Sa Bua (2) village in Tha Sala district.
5. Bottom materials in Pak Phanang Bay mainly composed of marine mud and, offshore area from 17 km point along the Pak Phanang channel, is sand.

(Middle Area)

6. In the coastal area from Laem Talumphuk in Nakhon Si Thammarat province to Laem Son On in Songkhla province, the predominant direction of littoral drift is northward.
7. From Ban Na Kot to Ban Nam Sap area in Nakhon Si Thammarat province erosion is taking place.
8. In the middle part of the study area, Songkhla to Pattani, the predominant direction of littoral drift is northward.
9. Rate of littoral transport in this area is a comparatively large amount.
10. Eroded areas in this area are situated in the northwest or west side of existing jetties, such as Na Thap, Sakom, Thepha in Songkhla province and Bang Ra Pha, Tanyong Pao in Pattani province.
11. Shoreline of Bang Ta Wa area in Pattani province is also seriously eroded even though no jetty has been constructed.
12. Eastern limit of littoral transport in this area is at the most eastern groin in Bang Ta Wa near the irrigation canal of the west of Ru Sa Mi Lae in Muan Pattani district.
13. Bottom materials in Pattani Bay are mainly composed of marine mud.

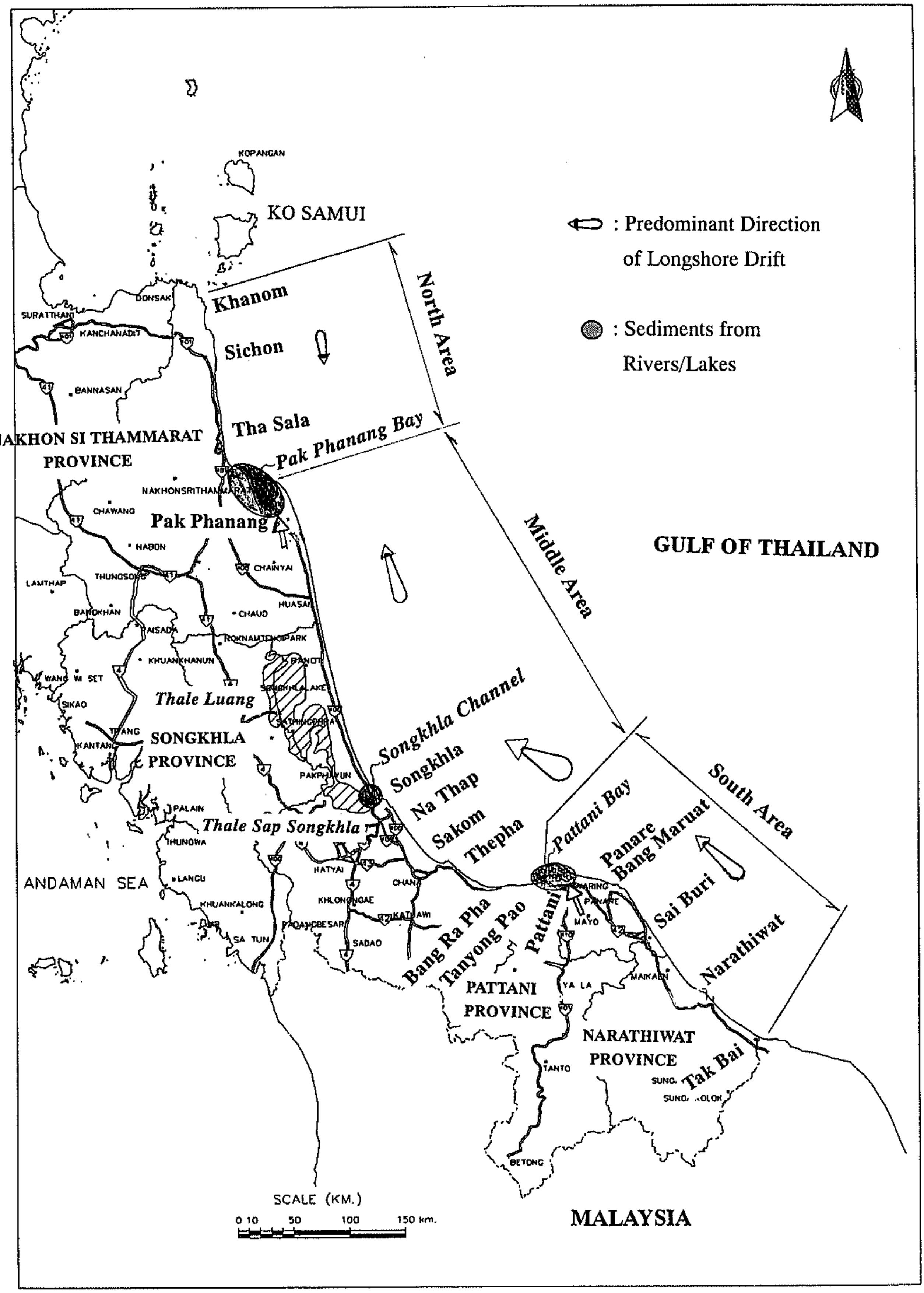


Figure 4.7.1-1 General Coastal Conditions in the Study Area

(South Area)

14. In the coastal area from Laem Ta Chi in Pattani province to Tak Bai in Narathiwat province, the predominant direction of littoral drift is northward.
15. Rate of littoral transport in this area is rather large.
16. Eroded areas in this area are also situated in the west or northwest side of existing jetties, such as Panare, Sai Buri in Pattani province and Narathiwat in Narathiwat province.
17. Coastal area of Tak Bai district in Narathiwat province located at the boundary with Malaysia is one of the areas of the heaviest littoral drift in the study area.

4.7.2 Analysis of Shoreline Changes by Aerial Photographs

Analysis of shoreline changes by using existing aerial photographs was carried out for approximately 6 kilometers length along shorelines in Sichon, Tha Sala, Songkhla, Sakom and Thepha areas.

Aerial photographs collected for the analysis are listed in Table 4.7.2-1.

Table 4.7.2-1 Aerial Photographs Collected for Analysis of Shoreline Changes

Area	Latest Photograph Date (Time)	Previous Photographs Date (Time)	Construction of Jetty
Sichon	February 2, 1995 (16h44m)	April 28, 1975 (09h37m)	1997 – 1998
Tha Sala	March 2, 1995 (16h39m)	July 8, 1974 (10h05m) April 26, 1975 (09h37m)	1997 – 1998
Songkhla	April 19, 1995 (08h00m)	March 11, 1974 (11h13m) August 29, 1977 (15h29m)	1987 – 1992
Sakom	April 9, 1995 (08h08m)	April 28, 1973 (08h40m)	1998 – 1999
Thepha	April 11, 1995 (09h09m)	May 20, 1973 (09h47m) May 22, 1973 (09h59m)	1998 – 1999

Neither aerial photographs nor satellite images were available after jetties construction. Therefore, field surveys for shoreline after jetties construction were carried out at every 500 meter intervals along the shorelines in Sichon, Tha Sala, Songkhla, Sakom and Thepha areas in March 2001.

Results of the analysis of shoreline changes in each area are summarized in Tables 4.7.2-2 and 4.7.2-3, and shown in Figures 4.7.2-1 to 4.7.2-10.

Table 4.7.2-2 Results of Shoreline Change Analysis by Aerial Photographs

Coastal Area	Area No.	Deposition Area (Max. Width)	Erosion Area (Max. Width)	Remarks
Sichon	No. 1	227,881 m^2 (140 m)		1975 – 1995
	No. 2		4,683 m^2 (86 m)	(20 years)
	No. 3	6,056 m^2 (105 m)		
	No. 4	17,635 m^2 (53 m)		Shoreline Length
	No. 5		2,053 m^2 (35 m)	6 km
	No. 6	10,162 m^2 (27 m)		
	No. 7		8,507 m^2 (48 m)	
	No. 8	21,632 m^2 (53 m)		
	Sum	283,367 m^2	15,243 m^2	
	Net	268,124 m^2		
	Rate of Change	13,406 m^2/year 2.23 m/year		
Tha Sala	No. 1		8,818 m^2 (23 m)	1974 – 1995
	No. 2	34,043 m^2 (73 m)		(21 years)
	No. 3	10,285 m^2 (40m)		
	No. 4		25,915 m^2 (34 m)	Shoreline Length
	No. 5		4,211 m^2 (14 m)	6 km
	No. 6		65,281 m^2 (75 m)	
	No. 7		38,374 m^2 (42 m)	
	Sum	44,328 m^2	142,599 m^2	
	Net		98,271 m^2	
	Rate of Change		4,680 m^2/year 0.78 m/year	
Songkhla	No. 1		18,912 m^2 (44 m)	1974 – 1995
	No. 2	341,609 m^2 (189 m)		(21 years)
	No. 3		19,849 m^2 (29 m)	
	No. 4	5,672 m^2 (39m)		Shoreline Length
	No. 5		1,607 m^2 (21 m)	6 km
	No. 6	8,559 m^2 (31 m)		
	No. 7	69,377 m^2 (92 m)		
	Sum	425,217 m^2	40,368 m^2	
	Net	384,849 m^2		
	Rate of Change	18,326 m^2/year 3.05 m/year		
Sakom	No. 1	81,388 m^2 (120 m)		1975 – 1995
	No. 2	75,193 m^2 (156 m)		(20 years)
	No. 3	205,820 m^2 (320 m)		
	No. 4		161,242 m^2 (123 m)	Shoreline Length
	No. 5	49,636 m^2 (93 m)		6 km
	No. 6		34,397 m^2 (88 m)	
	No. 7		7,212 m^2 (35 m)	
	Sum	412,037 m^2	202,851 m^2	
	Net	209,186 m^2		
	Rate of Change	9,508 m^2/year 1.58 m/year		
Thepha	No. 1	197,288 m^2 (88 m)		1973 – 1995
	No. 2		42,838 m^2 (100 m)	(22 years)
	No. 3	4,277 m^2 (40 m)		
	No. 4		32,990 m^2 (72 m)	Shoreline Length
	No. 5		23,852 m^2 (23 m)	6 km
	No. 6	17,714 m^2 (50 m)		
	No. 7		50,138 m^2 (117 m)	
	No. 8	189,790 m^2 (180 m)		
	Sum	409,069 m^2	149,818 m^2	
	Net	259,251 m^2		
	Rate of Change	11,784 m^2/year 1.96 m/year		

Table 4.7.2-3 Results of Shoreline Change Analysis

Coastal Area	Area No.	Deposition Area (Max. Width)	Erosion Area (Max. Width)	Remarks
Sichon	No. 1		180,116 m^2 (104 m)	1995 – 2001
	No. 2	21,272 m^2 (124 m)		(6 years)
	No. 3		11,001 m^2 (121 m)	
	No. 4		1,570 m^2 (12 m)	Shoreline Length
	No. 5	10,264 m^2 (45 m)		4 km
	No. 6	3,156 m^2 (20 m)		
	No. 7		812 m^2 (17 m)	
	Sum	34,692 m^2	193,499 m^2	
	Net		158,807 m^2	
	Rate of Change		26,468 m^2/year 6.62 m/year	
Tha Sala	No. 1		6,395 m^2 (15 m)	1995 – 2001
	No. 2	56,005 m^2 (66 m)		(6 years)
	No. 3	37,135 m^2 (80 m)		
	No. 4		6,724 m^2 (33 m)	Shoreline Length
	No. 5		19,804 m^2 (85 m)	4.4 km
	No. 6	26,060 m^2 (72 m)		
	No. 7		67,491 m^2 (75 m)	
	Sum	119,200 m^2	100,414 m^2	
	Net	18,786 m^2		
	Rate of Change	3,131 m^2/year 0.71 m/year		
Songkhla	No. 1		63,092 m^2 (119 m)	1995 – 2001
	No. 2	346,322 m^2 (203 m)		(6 years)
				Shoreline Length 4 km
	Sum	346,322 m^2	63,092 m^2	
	Net	283,230 m^2		
	Rate of Change	47,205 m^2/year 11.80 m/year		
Sakom	No. 1	7,665 m^2 (57 m)		1995 – 2001
	No. 2		724 m^2 (18 m)	(6 years)
	No. 3	64,941 m^2 (120 m)		
	No. 4		10,784 m^2 (26 m)	Shoreline Length
	No. 5		9,528 m^2 (20 m)	3 km
	No. 6	72,810 m^2 (177 m)		
	No. 7	13,933 m^2 (46 m)		
	No. 8		38,602 m^2 (115 m)	
	Sum	159,349 m^2	59,638 m^2	
	Net	99,711 m^2		
	Rate of Change	16,619 m^2/year 5.54 m/year		
Thepha	No. 1	44,091 m^2 (62 m)		1995 – 2001
	No. 2		415 m^2 (12 m)	(6 years)
	No. 3		12,083 m^2 (82 m)	
	No. 4	368,644 m^2 (500m)		Shoreline Length
	No. 5		2,382 m^2 (23 m)	6 km
	No. 6	2,744 m^2 (38 m)		
	Sum	415,479 m^2	14,880 m^2	
	Net	400,599 m^2		
	Rate of Change	66,767 m^2/year 11.13 m/year		

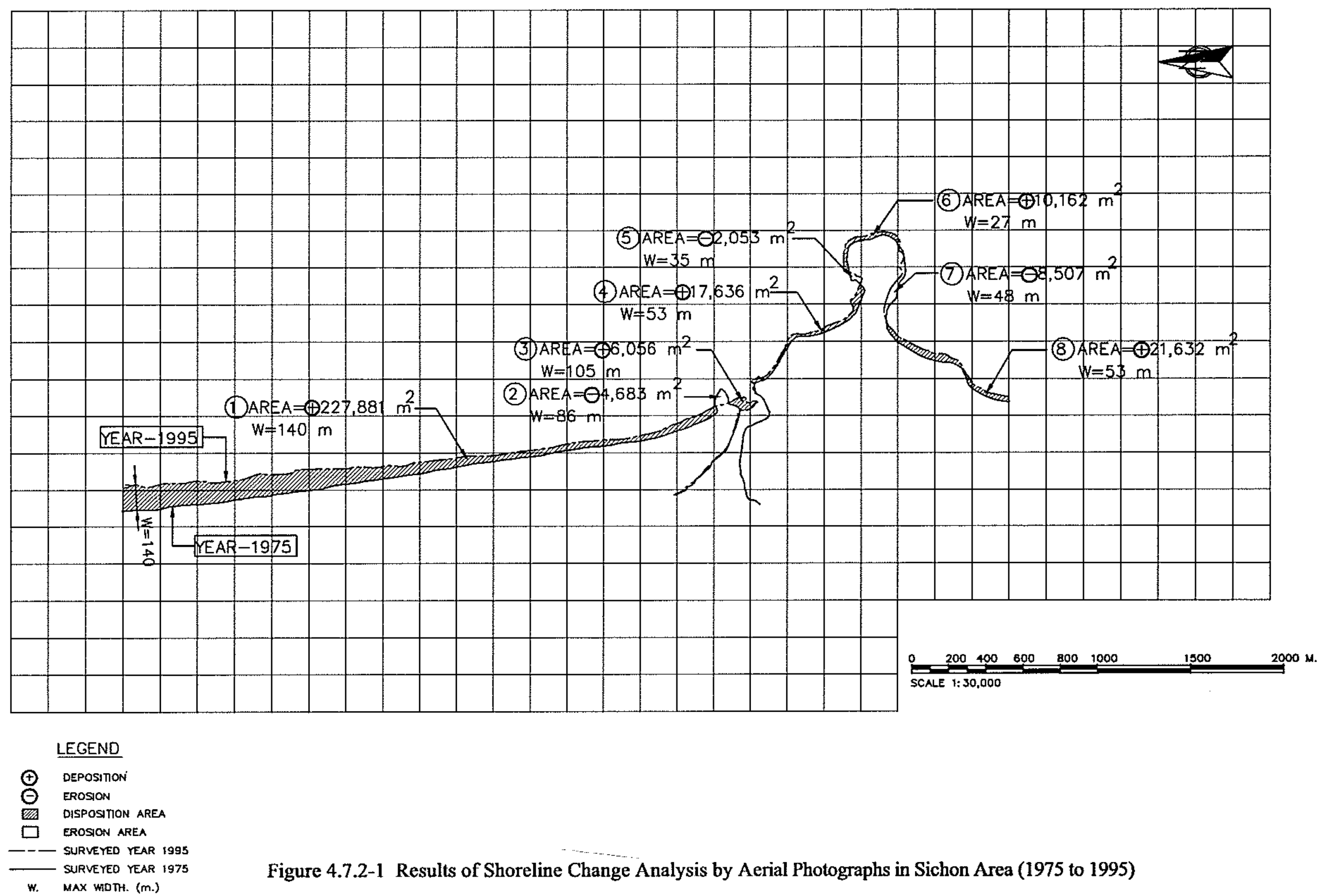


Figure 4.7.2-1 Results of Shoreline Change Analysis by Aerial Photographs in Sichon Area (1975 to 1995)

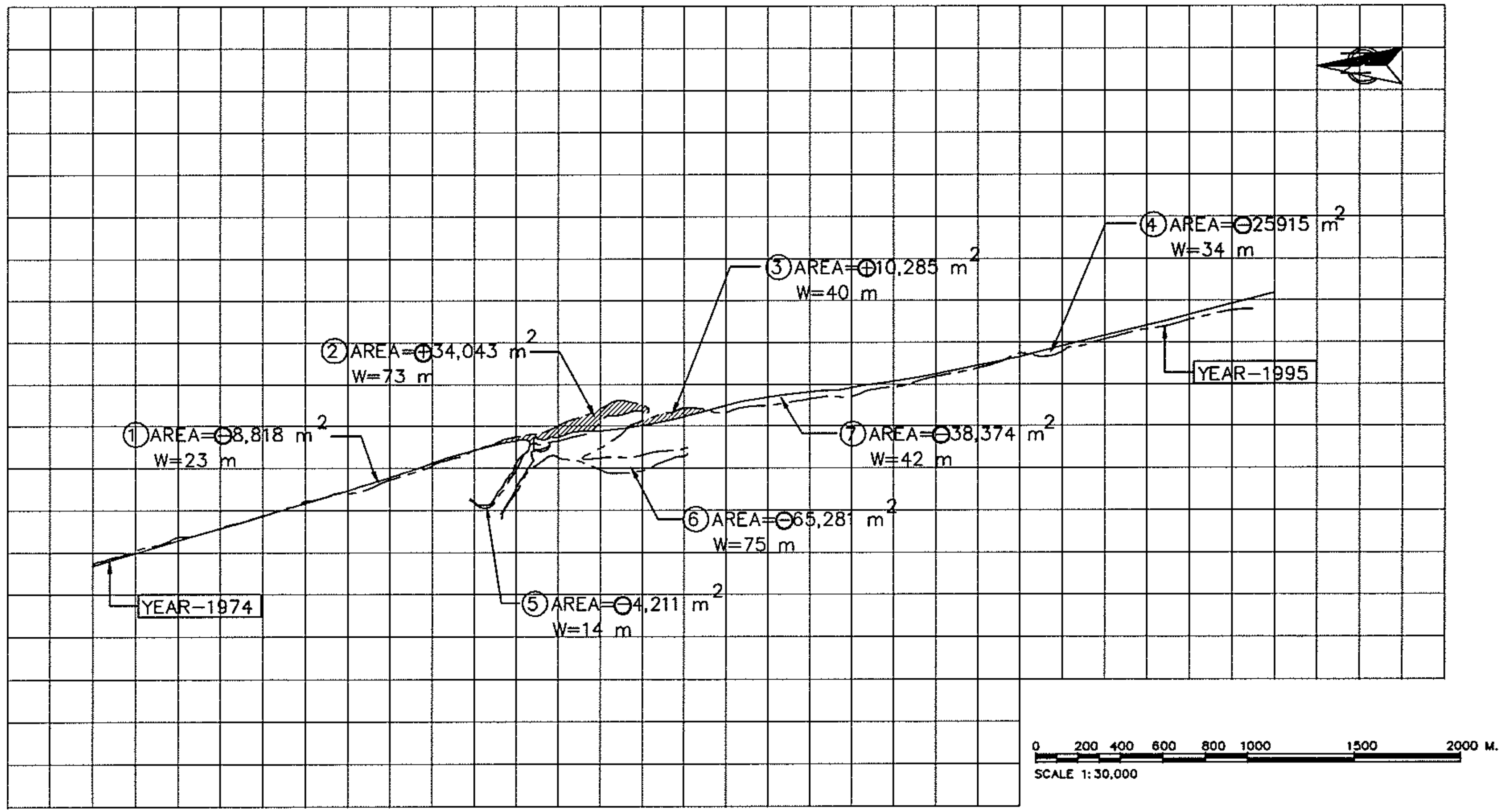


Figure 4.7.2-2 Results of Shoreline Change Analysis by Aerial Photographs in Tha Sala Area (1974 to 1995)

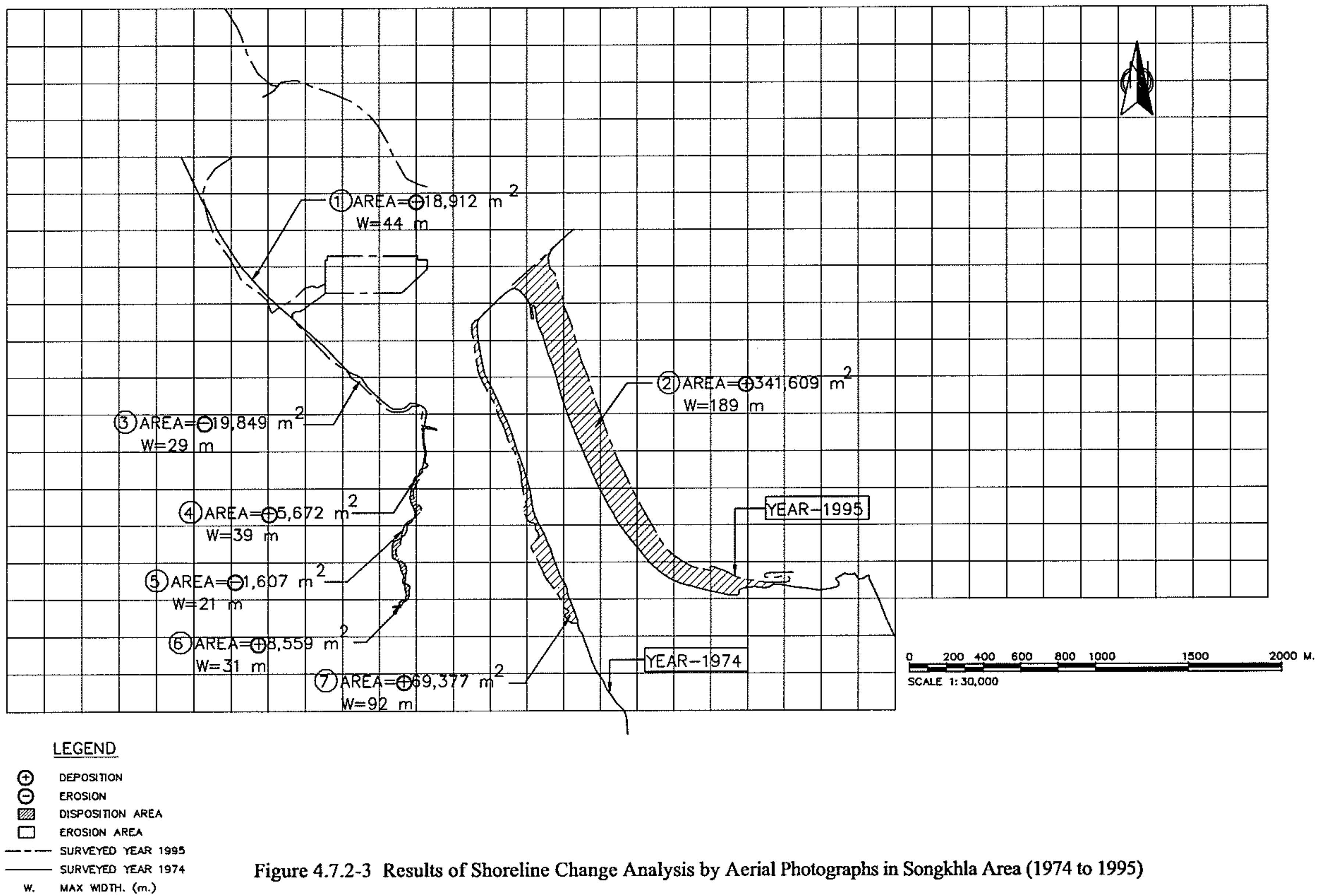


Figure 4.7.2-3 Results of Shoreline Change Analysis by Aerial Photographs in Songkhla Area (1974 to 1995)

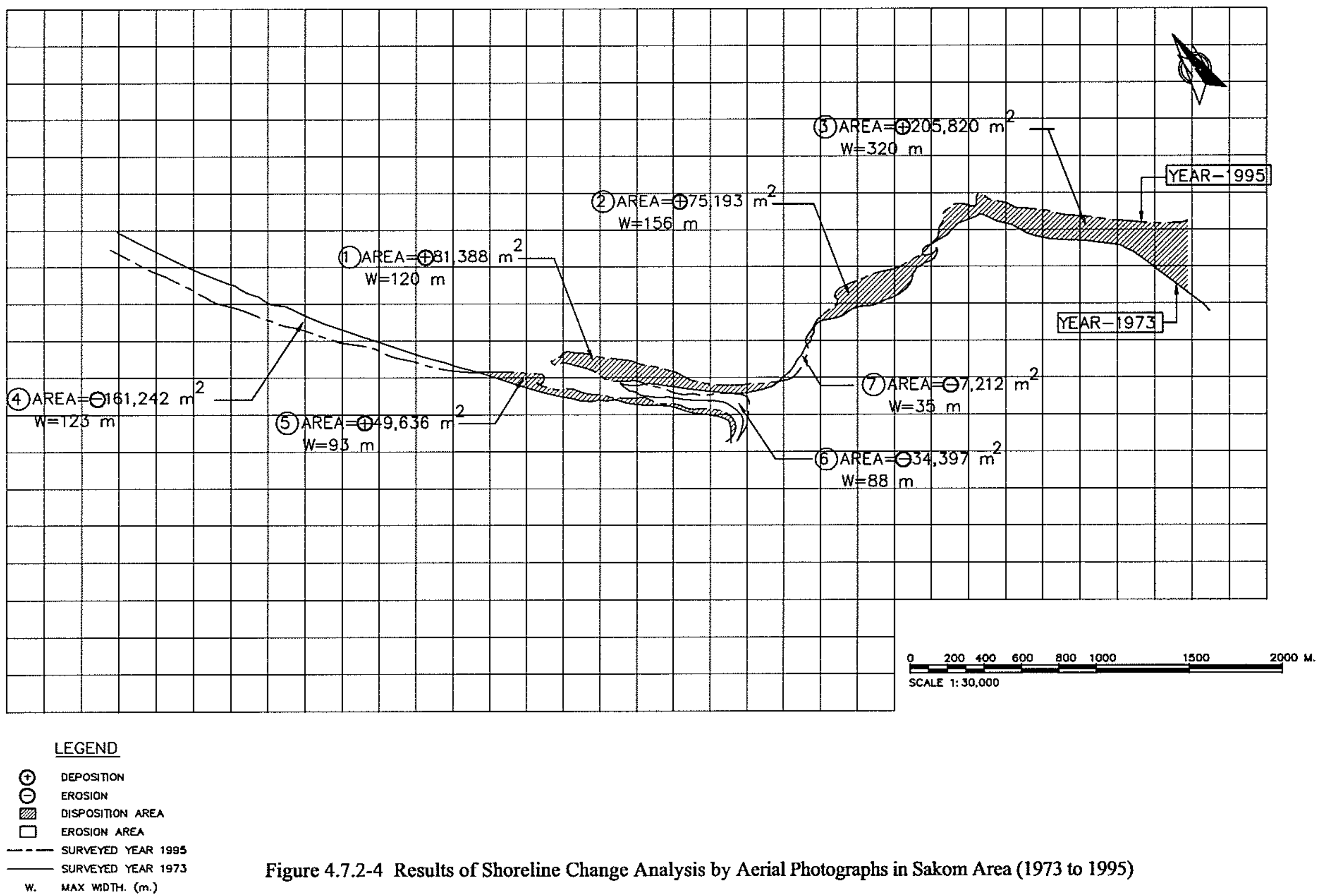


Figure 4.7.2-4 Results of Shoreline Change Analysis by Aerial Photographs in Sakom Area (1973 to 1995)

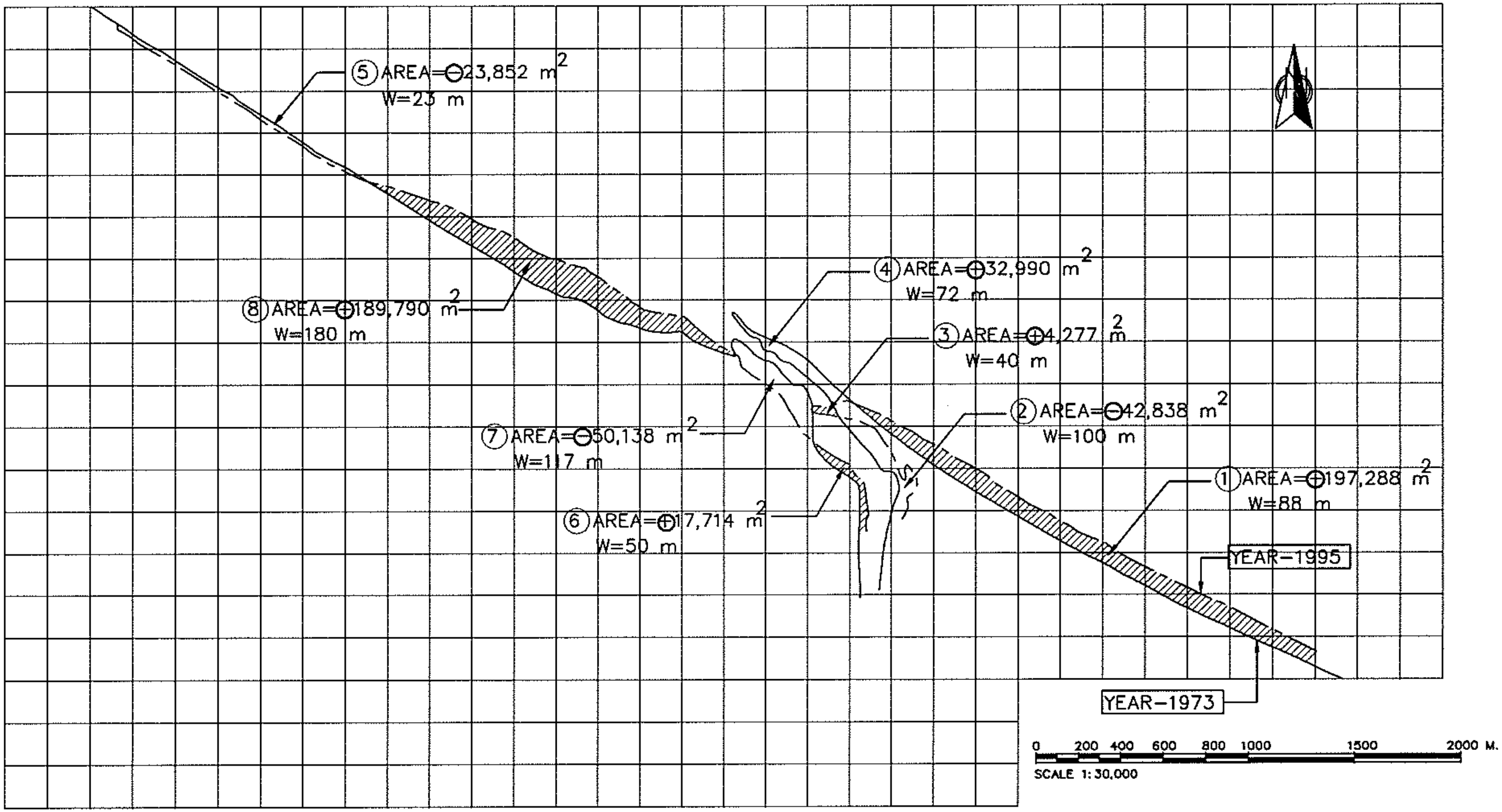


Figure 4.7.2-5 Results of Shoreline Change Analysis by Aerial Photographs in Thepha Area (1973 to 1995)

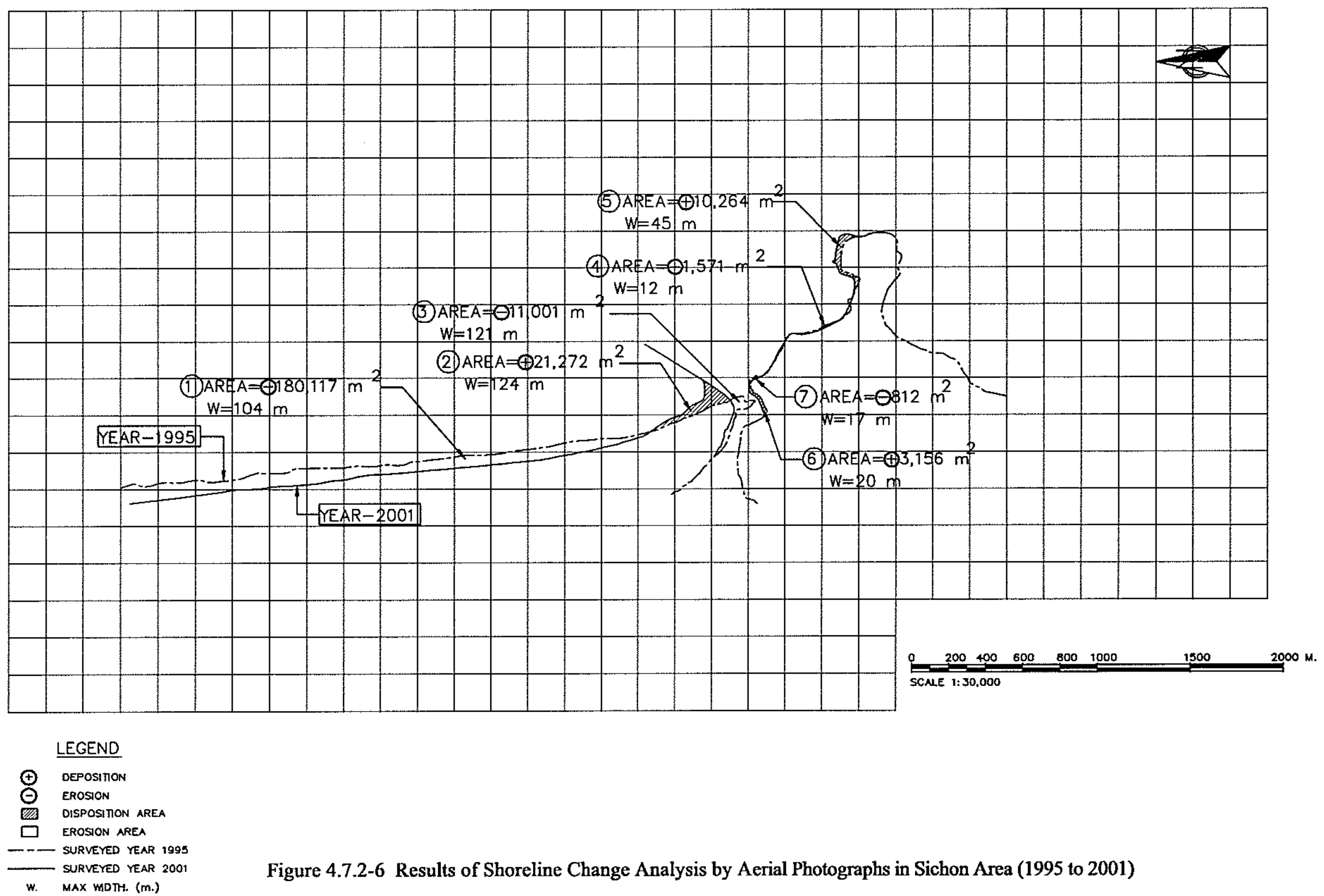


Figure 4.7.2-6 Results of Shoreline Change Analysis by Aerial Photographs in Sichon Area (1995 to 2001)

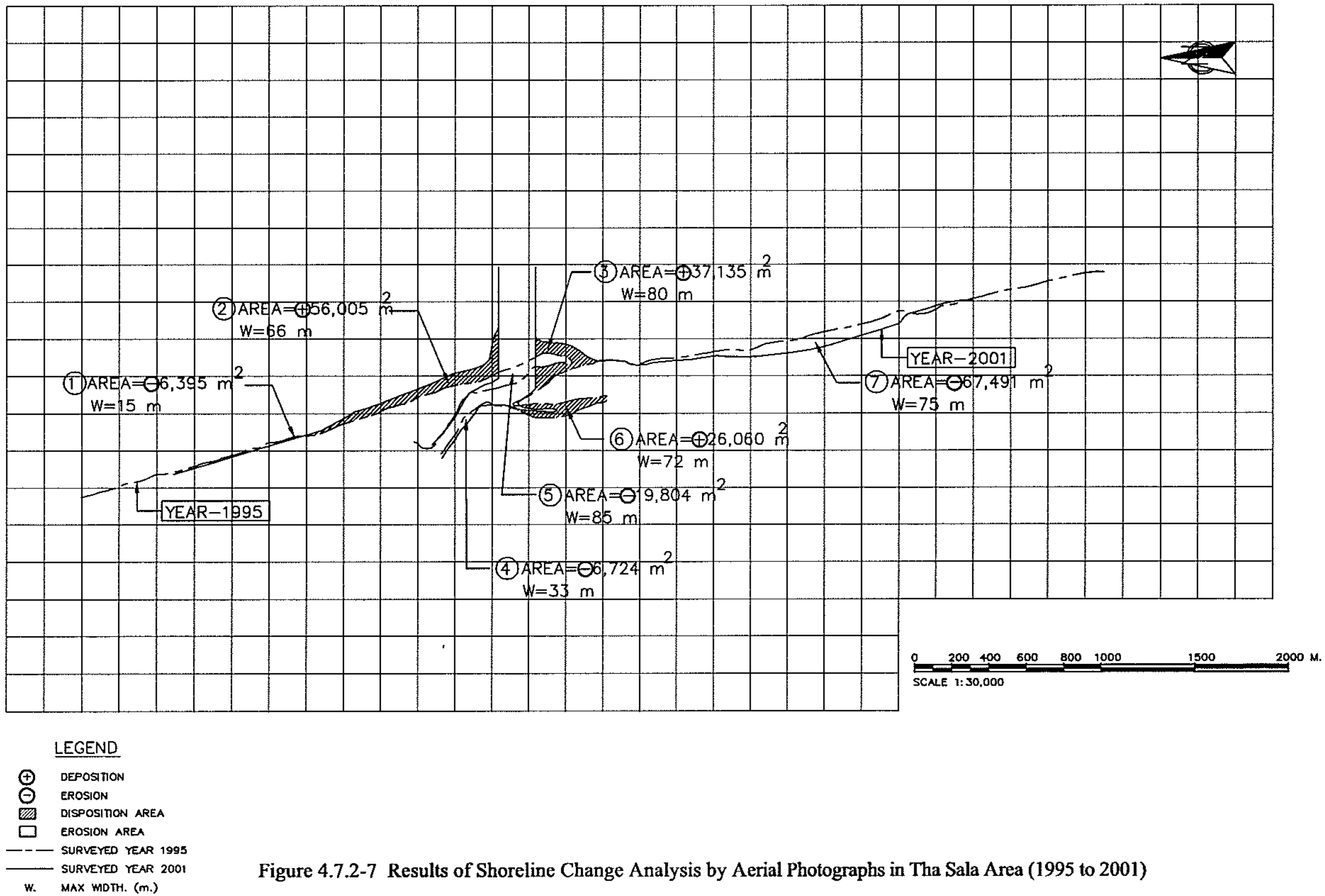


Figure 4.7.2-7 Results of Shoreline Change Analysis by Aerial Photographs in Tha Sala Area (1995 to 2001)

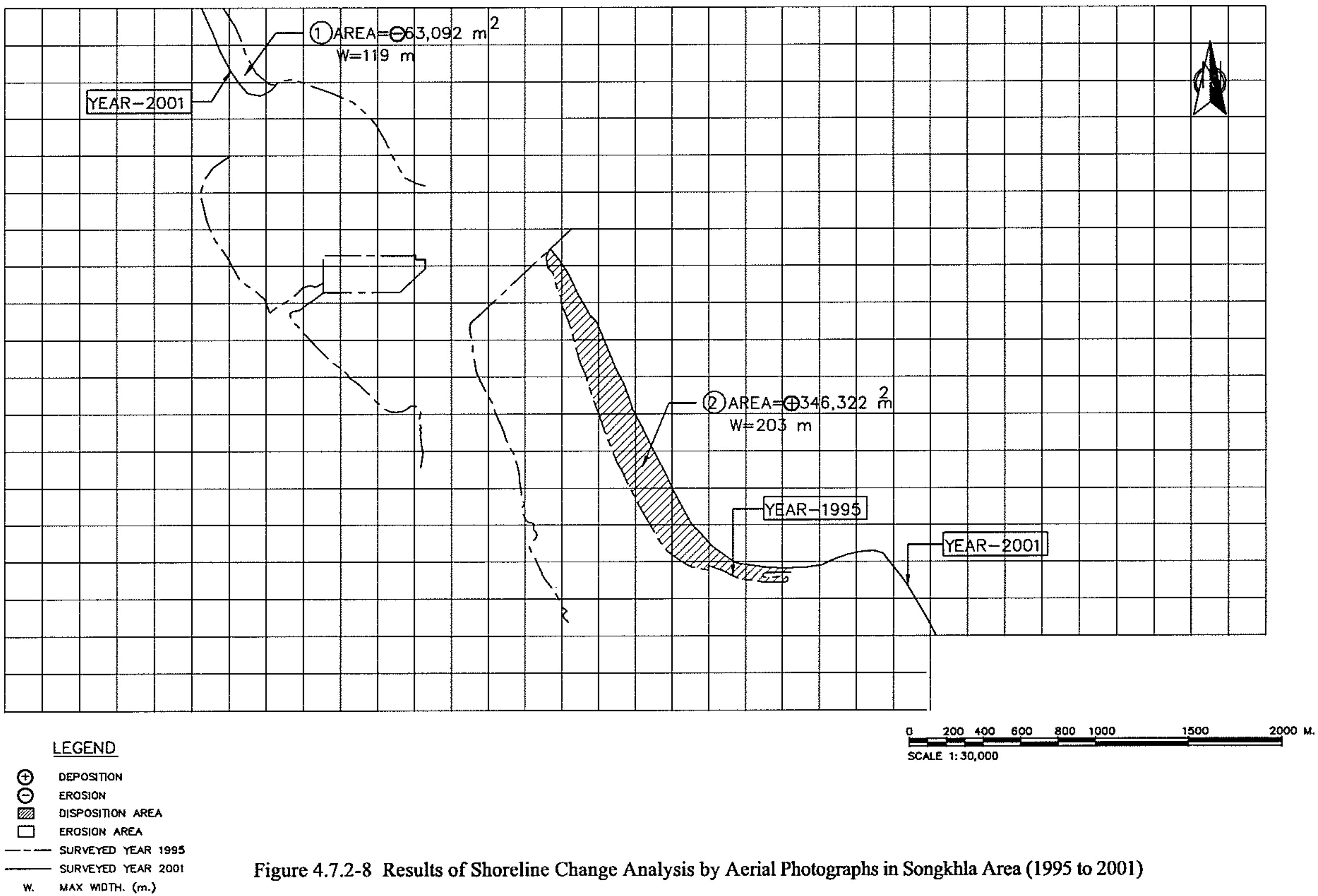


Figure 4.7.2-8 Results of Shoreline Change Analysis by Aerial Photographs in Songkhla Area (1995 to 2001)

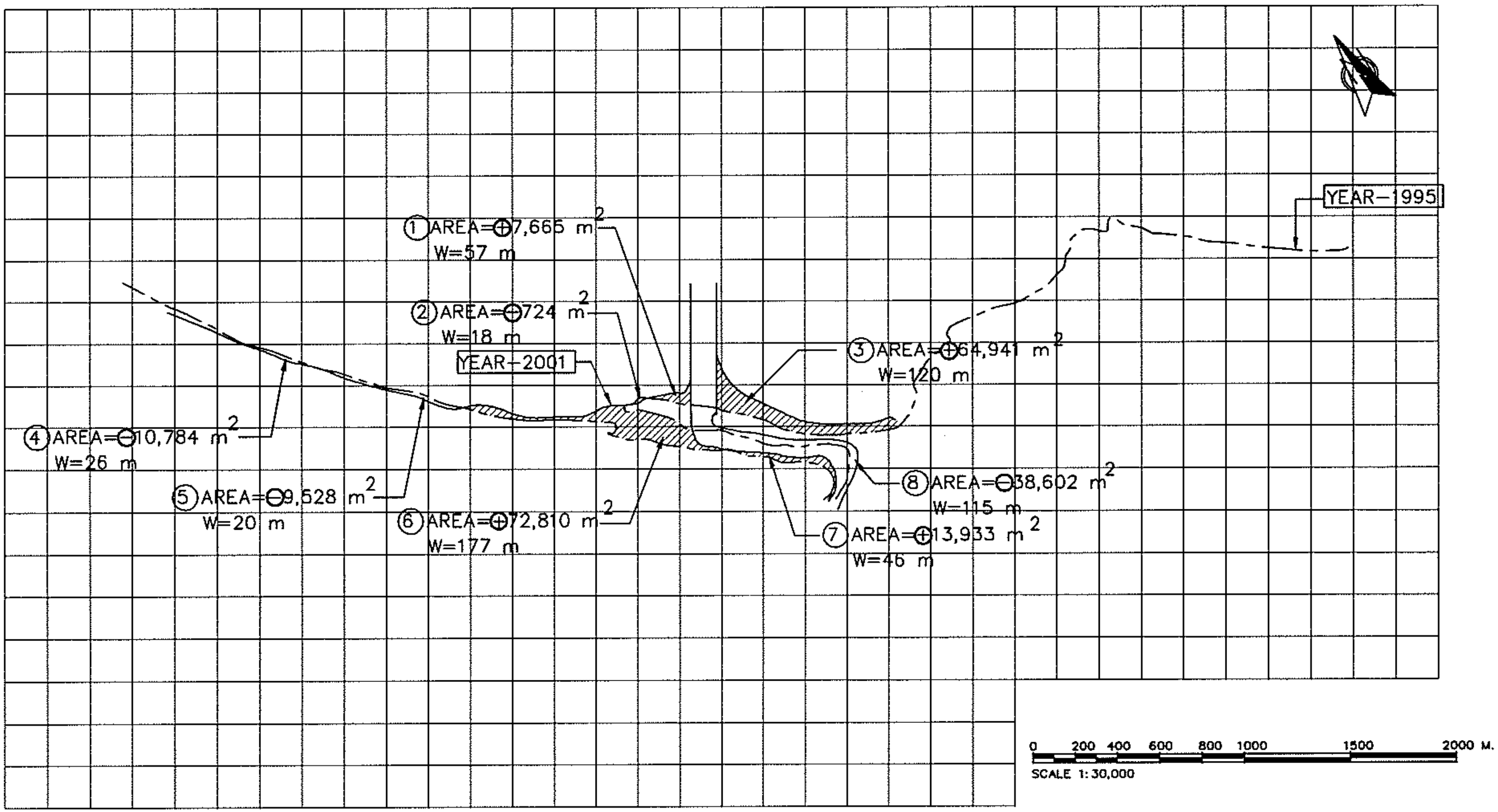


Figure 4.7.2-9 Results of Shoreline Change Analysis by Aerial Photographs in Sakom Area (1995 to 2001)

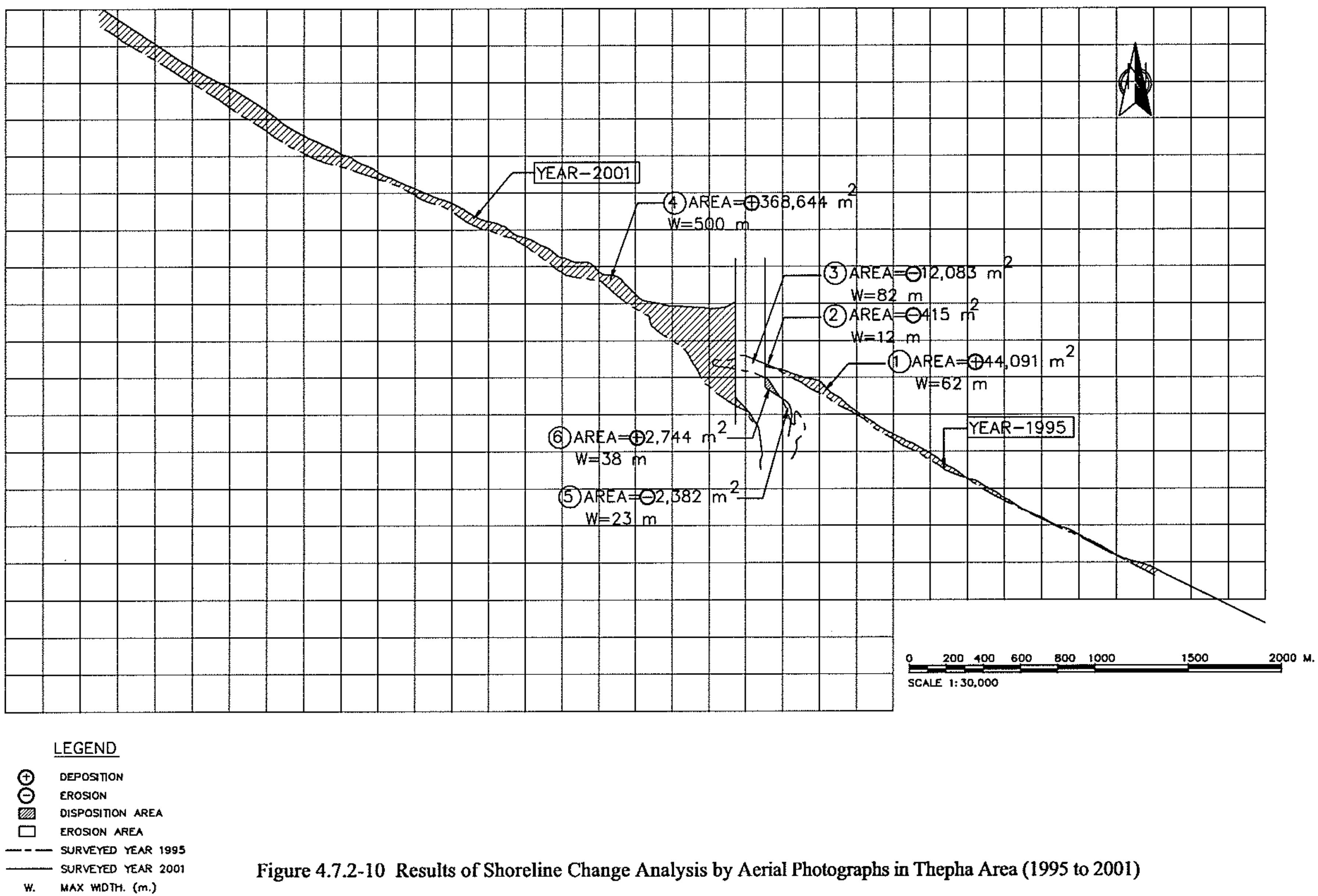


Figure 4.7.2-10 Results of Shoreline Change Analysis by Aerial Photographs in Thepha Area (1995 to 2001)

4.7.3 Analysis of Shoreline Changes by N-Line Model

The analysis of shoreline changes using numerical methods was carried out to reproduce the phenomena of littoral drift and to forecast the effect of littoral drift in the future in Sichon, Sakom and Thepha areas.

The n-line model used for this study calculates longshore transport to each depth-line and determines the amount of bathymetric changes in the area concerned.

1) Calculation of Waves

(a) Basic Equation

When the wave is irregular with direction spectrums, Karlsson has drawn an energy balance equation as follows:

(Energy Conservation Equation)

$$\frac{\partial}{\partial} + \nabla \cdot (DV) - Q = 0 \qquad (1)$$

Here,

$$\nabla = \left(\frac{\partial}{\partial x}, \frac{\partial}{\partial y}, \frac{\partial}{\partial f}, \frac{\partial}{\partial \theta} \right) \qquad (2)$$

D (x, y, f, θ, t) : energy density

V : speed of energy density

x, y : coordinates

f : frequency

θ : angle

Q : energy transfer

Follows will be obtained as an energy balance equation for an irregular wave, if refer to Q= 0 in equation (2).

$$\frac{\partial}{\partial x}(DV_x) + \frac{\partial}{\partial y}(DV_y) + \frac{\partial}{\partial \theta}(DV_\theta) = 0 \qquad (3)$$

Here,

$$V_x = C\,g \operatorname{cod}\theta \quad , \quad DV_y = C\,g \sin\theta$$

$$V_\theta = \frac{Cg}{C}\left(\frac{\partial C}{\partial x}\sin\theta - \frac{\partial C}{\partial y}\cos\theta\right)$$

Cg : group velocity , C : wave velocity.

Directional spectrum of irregular wave is expressed as a product of frequency spectrum and direction function as follows;

$$D(f, \theta) = S(f)\ G(f, \theta) \qquad (4)$$

Here,

$D(f, \theta)$: directional spectrum

$S(f)$: frequency spectrum

$G(f, \theta)$: directional function

Frequency spectrum expresses the distribution of energy density to frequency and can be obtained by integrating direction spectrum.

$$S(f) = \int_{-n/2}^{n/2} D(f, \theta)\, d\theta \qquad (5)$$

The distributed type of this frequency spectrum is standardized as follows;

$$S(f) = a\, f^{-5} \exp(-bf^{-4}) \qquad (6)$$

(Bretschneider type)

$$a = 0.2572\frac{H^2}{T^4}, b = \frac{1.0288}{T^4} \qquad (7)$$

H and T : significant wave height and its period

Direction function expresses the distribution by the direction of energy density, and Bretschneider's function is shown as follows:

$$G(f, \theta) = G_1'(S)\cos^{2S}\frac{\partial}{2} \qquad (8)$$

Here,

$$G_1'(S) = \left\{\left(\int_{-\theta\max}^{\theta\max} \cos^{2S}\left(\frac{\partial}{2}\right) d\theta\right)\right\}^{-1} \qquad (9)$$

G1' (S) is a standardization function for satisfying the lower equation which is a general definition of directional function.

$$\int_{-n}^{n} G(f, \theta) d\theta = 1$$

Moreover, S is given as follows with parameters showing directional function and concentration.

$$\tilde{f} > \tilde{f}m \qquad S = 11.5\tilde{f}m^{-2.5} \tag{10}$$

$$\tilde{f} \geqq \tilde{f}m \qquad S = 11.5\tilde{f}m^{-7.5}\tilde{f}^{5}$$

Here,

$$\tilde{f} = 2.656 \qquad S\max^{-0.4}\ \tilde{f}m^{-1}$$

$$\tilde{f} = 2.656 \qquad S\max^{-0.4}$$

fm : peak of frequency spectrum

Smax : maximum value of concentration factor (11)

$$fm = \frac{1}{1.05T_{1/3}} \tag{12}$$

Use E for total energy of wave,

$$H_{1/3} = 4\sqrt{E} \tag{13}$$

$$E = \int_{-\theta\max}^{\theta\max}\int_{0}^{\infty} D(f,\theta)df \cdot d\theta \tag{14}$$

D : spectrum energy

Although θmax expresses the range of wave height, if the direction of incident waves is not narrowed by geographical feature, it usually becomes π/2.

Next, the ratio of offshore wave height : H_0 as an incident wave to wave height obtained by equation (13) at incident boundary is multiplied by wave heights at every calculation point. This is a correction for integration to all directions : -π～π in equation (14).

Period is calculated by following equation:

$$T_{1/3} = \sqrt{((E/fc^{2} \cdot \Sigma_{\theta}D))/0.8287)} \tag{15}$$

fc : representative frequency

θ : direction giving a maximum value among ΣD (predominant wave direction)

If taking only shoaling and refraction into consideration, wave height is shown in following equation:

$$H_{1/3} = K_{si} H_0' \quad : h / L_0 \geqq 0.2$$
$$= \min((\beta_0 H_0' + \beta_{1h}),\ \beta_{max} H_0',\ K_s H_0') \quad : h / L_0 < 0.2 \qquad (16)$$

Here,

$H_0' = Hs^{※} / K_{si}$

min( ) : minimum value within ( )

H_0' : significant wave height

Ks : shallow wave factor

Ksi : shallow wave factor of small amplitude waves

$Hs^{※}$: significant wave height, taking only shoaling and refraction into consideration

Shallow wave factor in equation (16) was calculated basing on nonlinear modification theory of Sudo,

$$\beta_0 = 0.028 (H_0' / L_0)^{-0.38} \exp(20\tan^{1.5}\theta)$$
$$\beta_1 = 0.52 \exp(4.2\tan\theta)$$
$$\beta_{max} = \max(0.92,\ 0.32 (H_0' / L_0)^{-0.29} \exp(2.4\tan\theta)) \qquad (17)$$

Here,

L_0 : wave length of offshore wave

$\tan\theta$: bottom slope

(b) Calculation Conditions

The conditions used for calculation of wave refraction are as shown below.

① Wave Direction

Using the frequency distribution of winds in the northeast monsoon season : November to January during 1980–2001, wave directions were decided as the highest frequency of N－E－S direction, which is a direction from the sea side.

The most predominant wind directions at each station in and near the study area are shown in Table 4.7.3-1.

Table 4.7.3-1   Predominant Wind in the Study Area

Station	Direction	North Area	South Area
Ko Samui	E + 2.62 ° N		
Nakhon Si Thammarat	(E +10.34 ° N)	E + 3.3 ° N	
Songkhla	E + 4.01 ° N		
Pattani	(E + 1.96 ° N)		E + 5.2 ° N
Narathiwat	E + 6.37 ° N		

(Note) 1. E + 3.3 ° N for North Area is the average of directions in Ko Samui and Nakhon Si Thammarat.

2. E + 5.2 ° N for South Area is the average of directions in Songkhla and Narathiwat.

② Wave Height and Wave Period

Wave height and wave period were decided as 2.0 m and 5.0 seconds, referring to observation results at Plathong (St. No.4), Songkhla (St. No.6) and Nakhon Si Thammarat (St. No.9) by NRC.

(c) Results of Wave Calculation

The distribution of waves for a typical extreme storm obtained by calculation is shown in Figure 4.7.3-1.

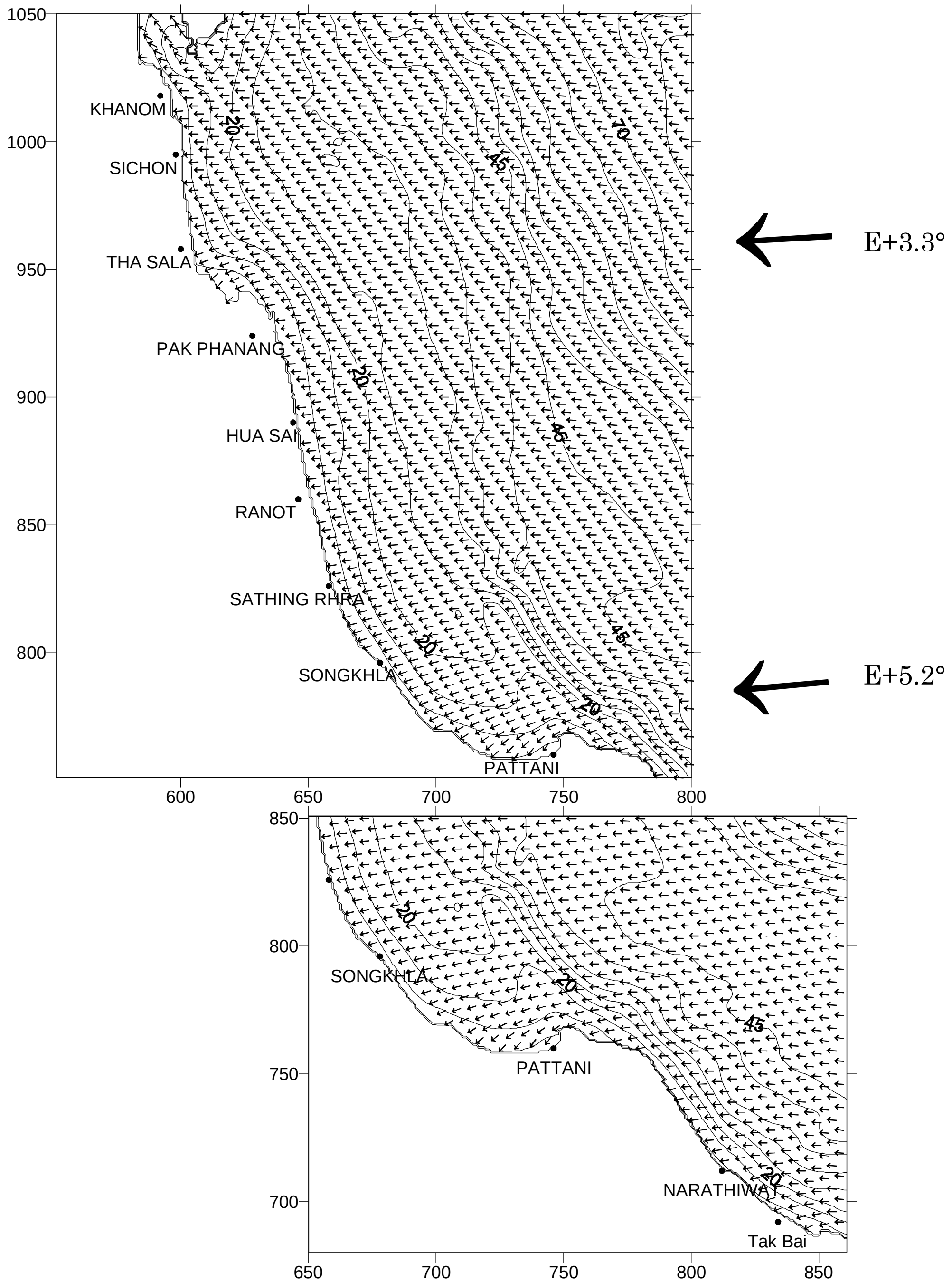


Figure 4.7.3-1 Wave Refraction Map in the Study Area

(offshore wave direction : E +3.3 ° & E +5.2 °)

H_0 = 2.0 m, T_0 = 5.0 sec

2) Analysis of Shoreline Changes

(a) Basic Equation of N-Line Model

① Basic Equation of Longshore Littoral Transport

The n-line model calculates longshore littoral transport to each depth-line and determines the amount of bathymetric changes.

The longshore littoral transport rate : Q will be given by equation (1)

$$Q = \frac{f}{8}\rho g H_b{}^2 (Cg)_b \sin\alpha_b \cos\alpha_b$$
$$= F_0 \sin\alpha_b \cos\alpha_b \qquad (1)$$

Here,

- f : littoral transport factor
- ρ : seawater density
- g : gravity
- H_b : breaking wave height
- α_b : breaking wave direction
- $(Cg)b$: group velocity of breaker wave point

X-axis is taken in the direction of coast, and y-axis is taken in the direction of right-angle on x-axis. When we assume that α_b is fully small, equation (2) will be:

$$Q = F_0(\tan\alpha_b - \frac{\partial x}{\partial y}) \qquad (2)$$

This equation is adapted for the area divided into "n" contours. Equation (3) can be gotten, we use q_k for littoral transport rate of the depth to k = 1,…, n and suppose that the same relation as equation (2) is adapted between the distance among contour lines : y_k and q_k.

$$q_k = F_0 k(\tan\alpha_0 - \frac{\partial y_k}{\partial x}) \qquad (3)$$

Here,

$$F_0 k = F_0 \mu_k, \ \Sigma \mu_k = 1.$$

μ_k is a comparison constant which gives littoral transport for each water depth and is calculated using equation (4) by giving a vertical distribution of longshore littoral transport rate : ξ (z).

$$\mu_k = \int_{zk}^{zk+1} \xi(z)dz \Big/ \int_{hc}^{hr} \xi(z)dz \qquad (4)$$

Here,

z : upper distance above sea surface

h_r : limit height moving by wave on land

h_c : limit depth for sediment movement

On the other hand, equation (5) holds from continuity equation of littoral transport rate.

$$\frac{\partial q_k}{\partial x} + h_k \frac{\partial y_k}{\partial t} = 0 \qquad ; k = 1, \cdots, n \tag{5}$$

h_k (k= 1, ⋯, n) is the moving height of littoral transport in bathymetric changes represented by each contour, and is given by following equation:

$$h_k = z_k - z_{k-1} \tag{6}$$

Therefore, if the function type of ξ (z) is given, the amount of change of each contour is calculated by solving equations (3) and (5), because μ_k is calculated by equation (4).

② Compensation by Kozasa and Brampton

Kosasa and Brampton (1979) have proposed the littoral transport rate formula of (7), considering that littoral current generated by it caused additional sediment transport, when the distribution of breaking wave heights in coastal direction has a change.

$$Q = F_0 (K_1 \sin\alpha_b \cos\alpha_b - \frac{K_2}{\tan\beta} \cos\alpha_b \frac{H_b}{\partial y}) \tag{7}$$

Model used on this study is also taking the above adjustment into consideration.

(b) Calculation Conditions

Conditions used for the calculation are shown in Table 4.7.3-2.

Table 4.7.3-2 Calculation Conditions of N-Line Model

(Wave Conditions)

Area	Incident Waves			Breaking Waves		
	H_0	T_0	α_0	H_b	α_b	h_b
Sichon	2.0 m	5.0 sec	46.7 ° (E +3.3 ° N)	1.8 m	49.5 ° (E +0.5 ° N)	2.2 m
Sakom	2.0 m	5.0 sec	64.8 ° (E+5.2 ° N)	1.3 m	47.0 ° (E+23.0 ° N)	2.2 m
Thepha	2.0 m	5.0 sec	49.8 ° (E+5.2 ° N)	1.3 m	30.0 ° (E+25.0 ° N)	2.2 m

Note:

H_0 : offshore wave height

T_0 : offshore wave period

α_0 : offshore wave direction (incident angle)

H_b : breaking wave height

α_b : breaking wave direction (incident angle)

h_b : breaking water depth

(Coefficients & Others)

Items	Values	Remarks
Coefficient of Littoral Transport (vicinity of jetty)	0.010	K_1
Coefficient of Littoral Transport (other area)	0.005	K_2
Critical Angle of Slope (onshore, degree)	10.00	-
Critical Angle of Slope (offshore, degree)	10.00	-
Boundary Condition at Left Side (Transit Rate of Littoral Transport)	1.00	-
Boundary Condition at Right Side (Transit Rate of Littoral Transport)	1.00	-
Mean Gradient of Seabed	0.01〜0.003	tan b

(c) Calculation Results

Shoreline changes after five and ten years forecast by n-line model are shown in Figure 4.7.3-2. The initial shoreline in this figure means the state in 2001 and the shoreline means zero meter of chart datum level.

Results show that the shoreline in the future will not change so much except in the vicinity of the left side jetty in Sichon area.

In Sakom area, the deposition will increase on the right side of the jetties. On the left side of the jetties, detached breakwaters show an effect and a large erosion area will appear after the detached breakwaters.

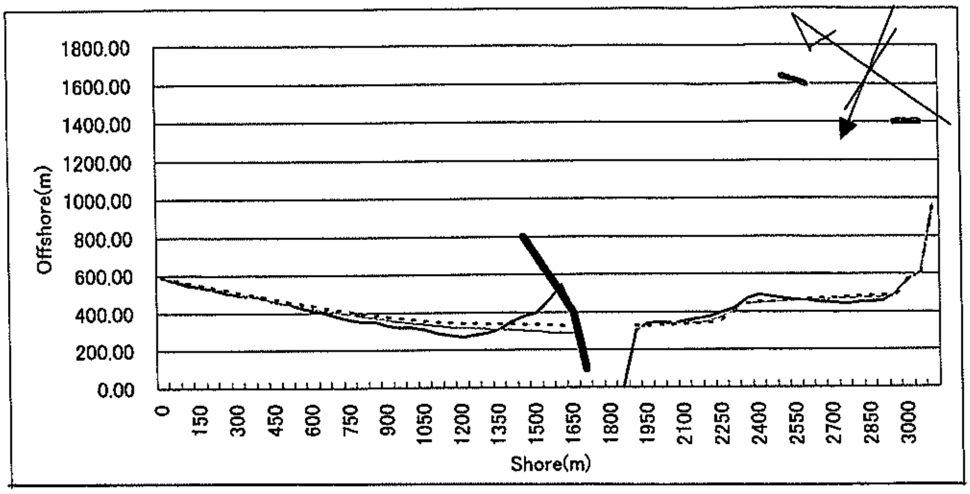
The shoreline change in Thepha area is almost the same as that in Sakom area.

Rates of littoral transport in Sichon, Sakom and Thepha areas calculated by n-line model are shown in Figure 4.7.3-3.

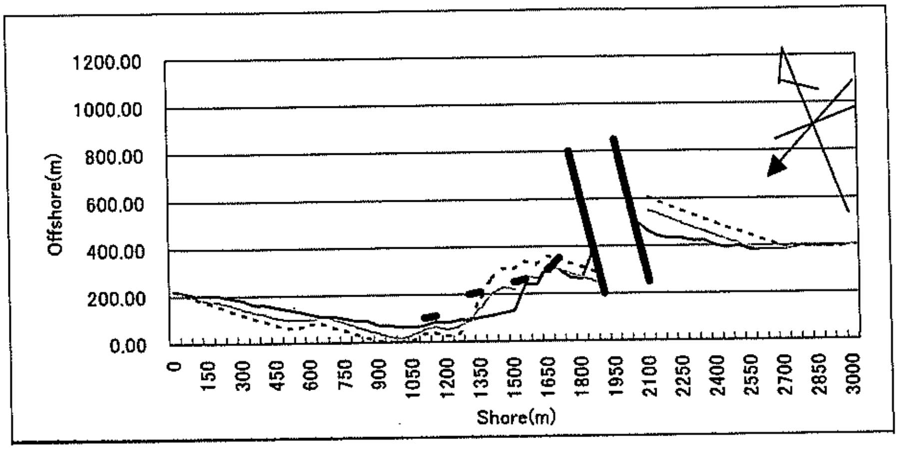
The amount of deposition and/or erosion at every calculation point, which is the difference of littoral transport rates between adjoining points, is also shown in Figure 4.7.3-4.

Rates of littoral transport were calculated as about 2.5 x 10^4 m^3/year, 1.1 x 10^5 m^3/year and 1.0 x 10^5 m^3/year in Sichon, Sakom and Thepha areas, respectively.

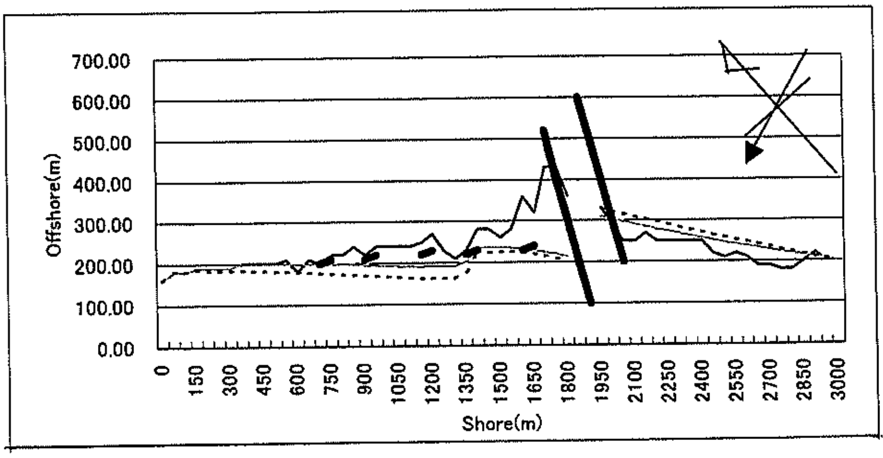
Sichon Area



Sakom Area



Thepha Area



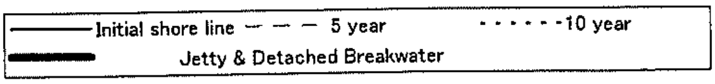
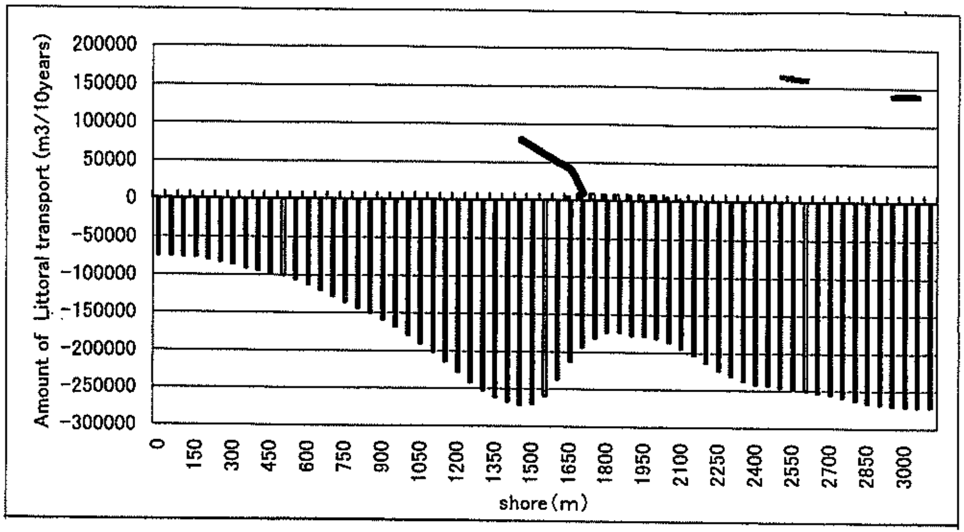
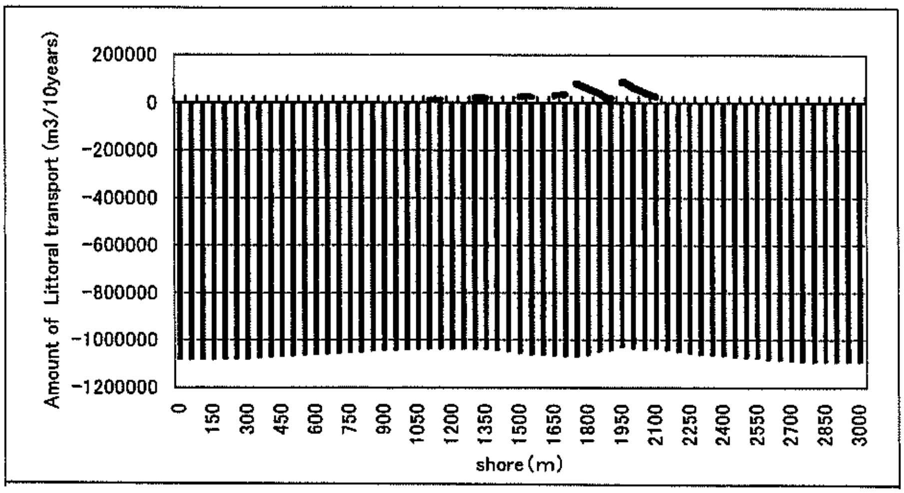


Figure 4.7.3-2 Results of Shoreline Change Analysis by N-Line Model

Sichon Area



Sakom Area



Thepha Area

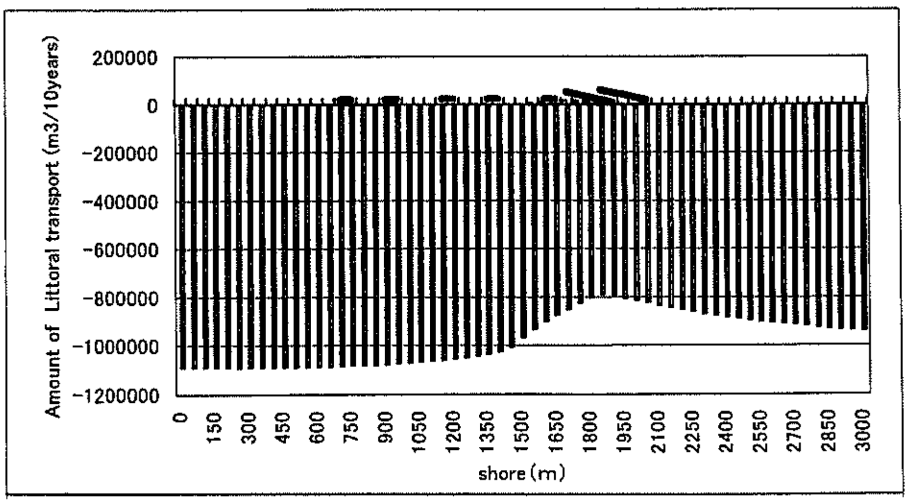
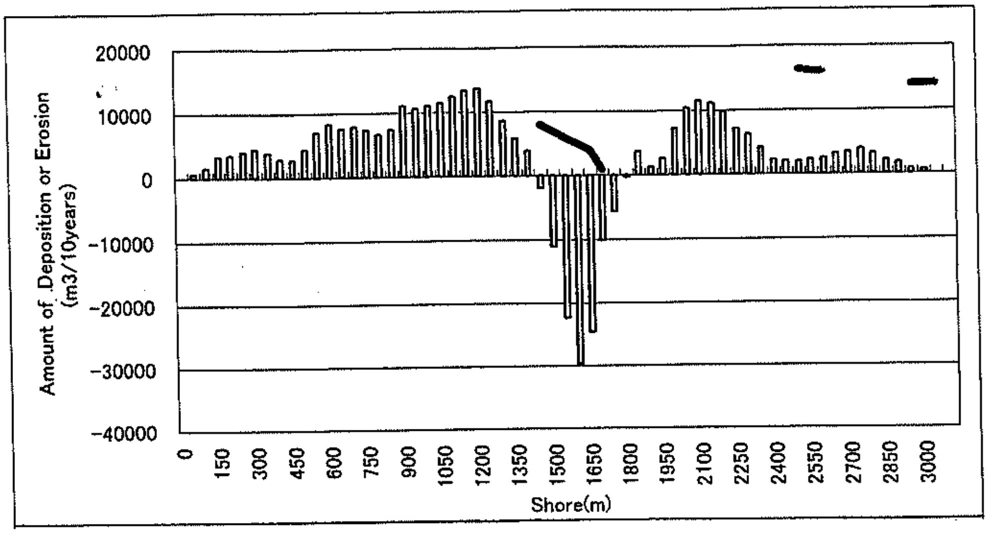
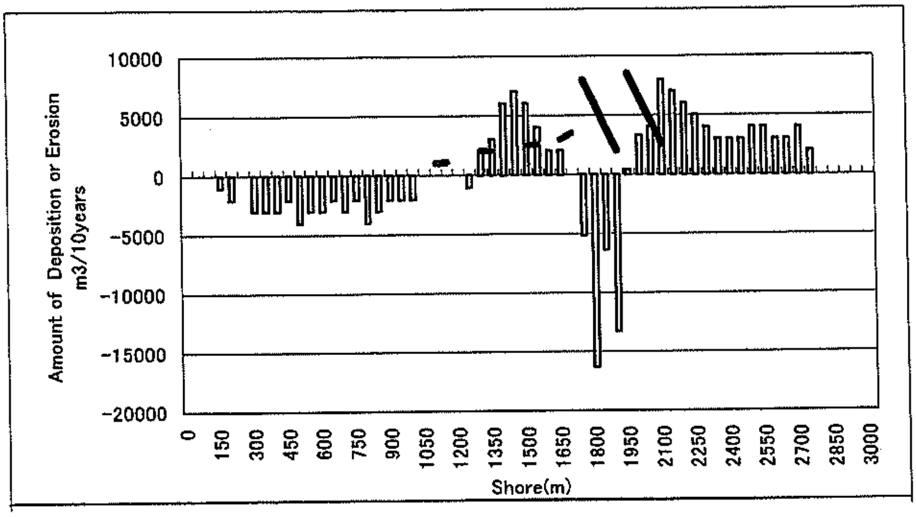


Figure 4.7.3-3 Rate of Littoral Transport by N-Line Model

Sichon Area



Sakom Area



Thepha Area

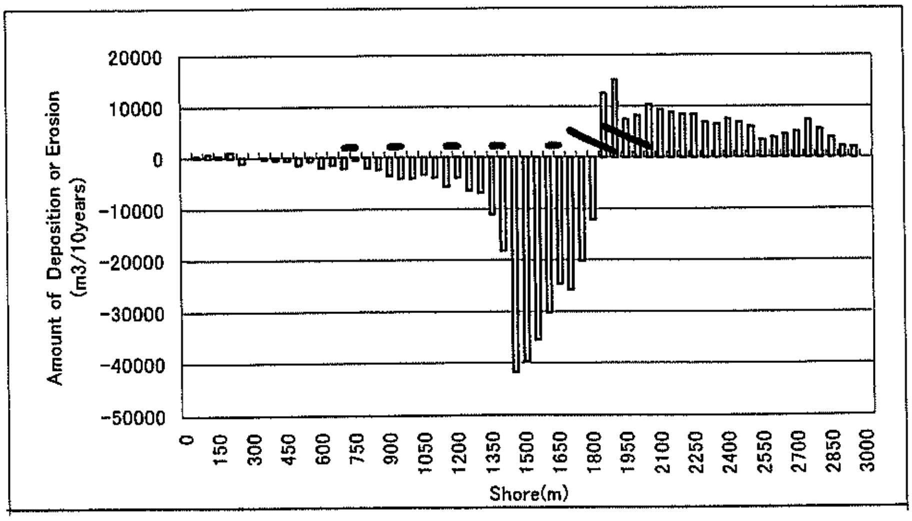


Figure 4.7.3-4 Amount of Deposition and Erosion by N-Line Model