8. Sedimentation Simulation

8.1 Sedimentation in Lach Huyen Channel

Lach Huyen channel had finished dredging in November, 2005 and has been brought into operation since early 2006. The channel was dredged by the depth of -8 m (the control depth =-7.2m) and the width of 100m for ships of 10,000 DWT. Lach Huyen port development plan includes channel deepening by the depth of -14 m for 100,000 DWT. Because the channel deepening will induce more sedimentation, prediction of future sedimentation is needed to grasp volume of maintenance dredging and propose effective countermeasures to minimize sedimentation.

In this chapter, characteristics of sedimentation on the present situation of Lach Huyen channel are analyzed by using bathymetric survey results, and sedimentation with the planed topography is predicted by numerical simulations.

8.1.1 Topography of Lach Huyen channel

The latest topography of Lach Huyen channel was surveyed in November, 2009, with dual-frequency echo sounder. The topography map measured by high frequency of 200 kHz is shown in Figure 8.1.1 and the depth difference between the topography measured by 200 kHz and that by 30 kHz is shown in Figure 8.1.2. In the two figures, the numbers of 26-47along the channel indicate distance from Hai Phong port for the reference. Figure 8.1.3 shows topography on the center line of the channel, and Figure 8.1.4 and Figure 8.1.5 show cross-sections of the channel.

From the figures, characteristics on the channel topography are obtained as follows.

- The area from Km27 to Km29, the narrowest area between Cat Hai and Cat Ba island, is approximately -12 m in depth and deeper than other part of the channel.
- In the area from Km30 to Km36, topography along the center line of channel is almost flat with -8 m in depth.
- In the area from Km36 to Km40, the bed level is slightly shallower than the area from Km30-36 and its shape is like a mound. The sallowest position is located in Km38-Km39 with -7 m in depth.
- The area from Km40 to the offshore is getting deeper toward offshore.
- The cross-section profiles of Km27 to Km29 are the shape of large depression being naturally formed.
- On the cross-section profiles of Km30 to Km 38, the channel shape is kept. Particularly, although the both sides of the channel on the cross-sections of Km35 to Km37 are shallow with about -3 m in depth, the channel bottom is kept about -8 m in depth.
- On the cross-sections of Km39 to Km42, the channel shape is not clear and the depth difference between the shoulder and the bottom of the channel is quite small.

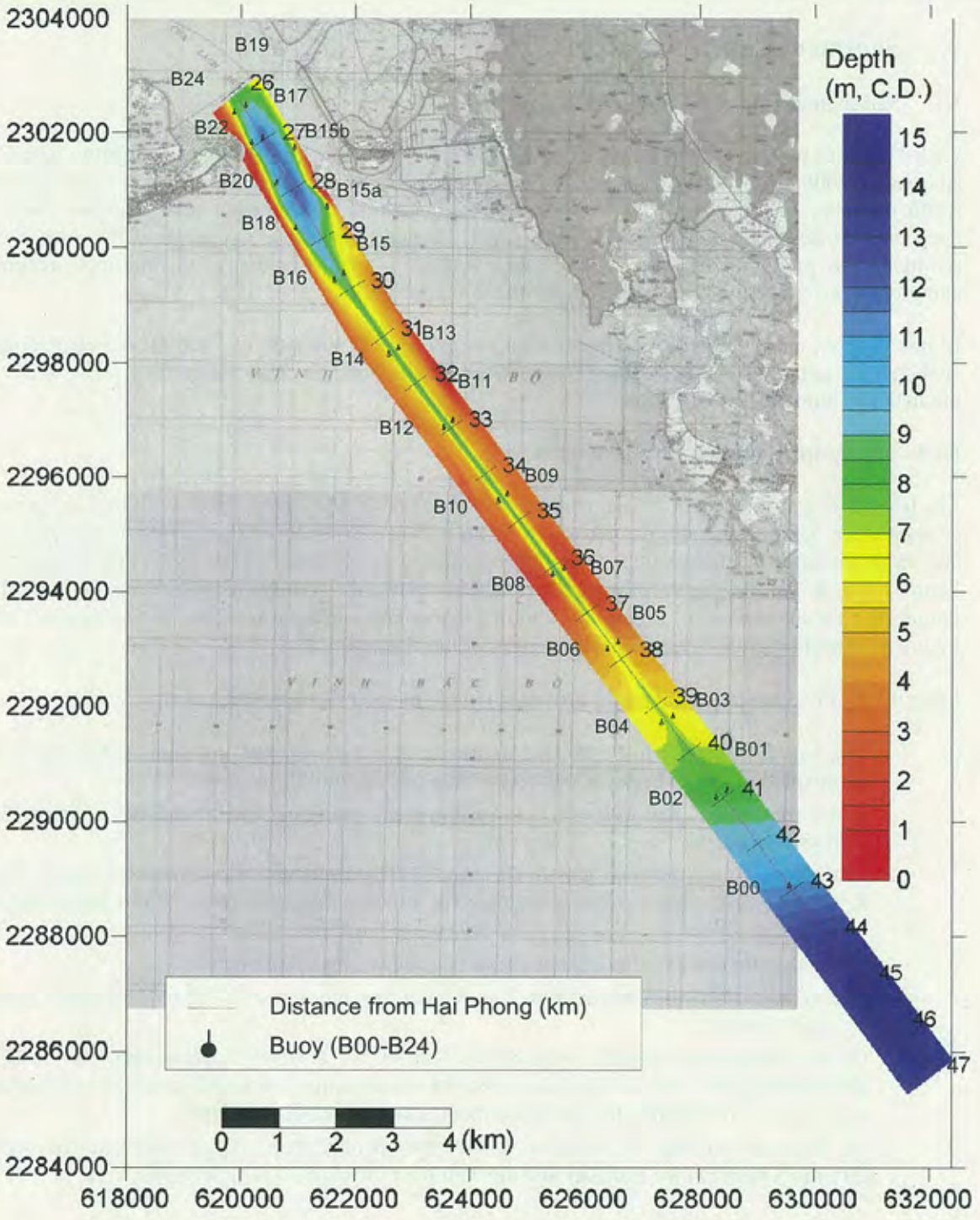

Figure 8.1.1 Depth Contour map of 2009-11 (200kHz) and location of buoys

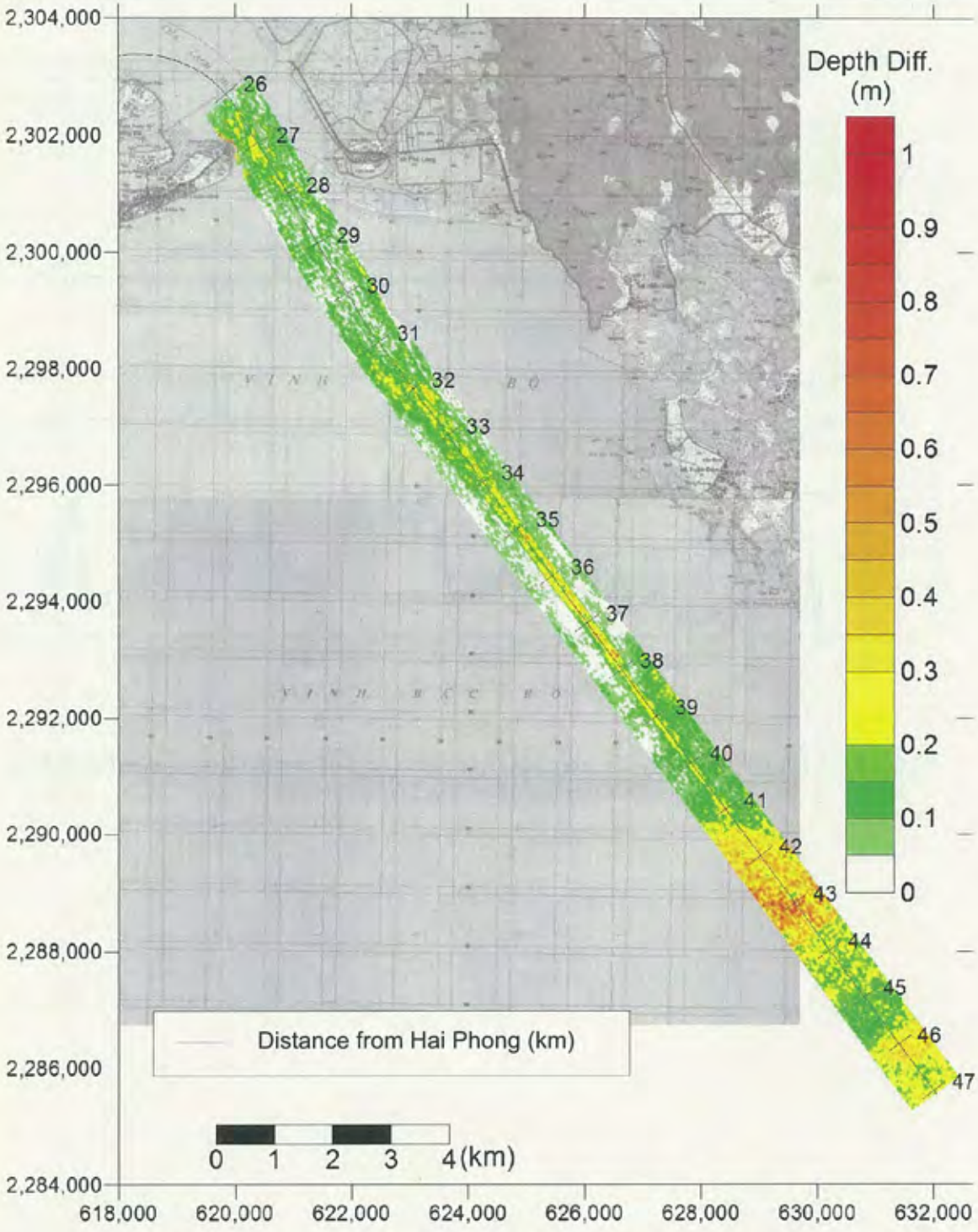

Figure 8.1.2 Depth difference between high (200kHz) and low (30kHz) frequency

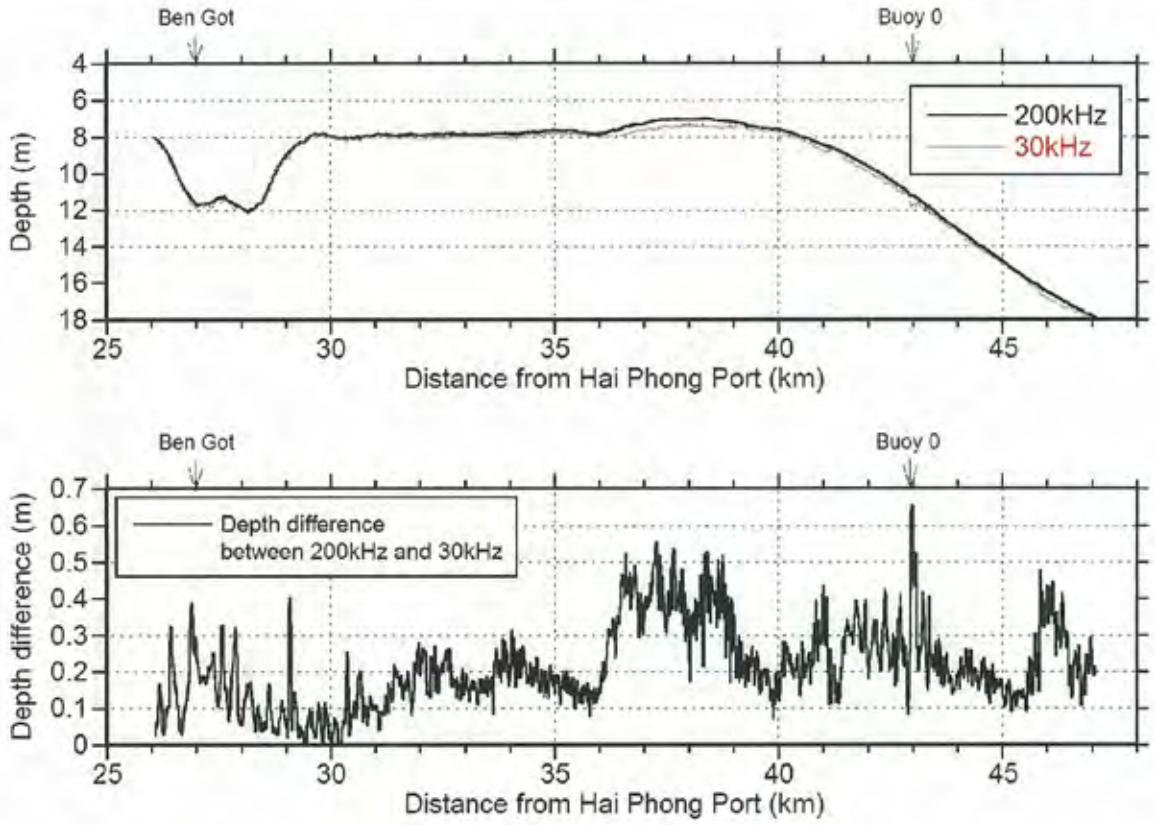

Figure 8.1.3 Topography on the center line of the channel and depth difference between high (200kHz) and low (30kHz) frequency

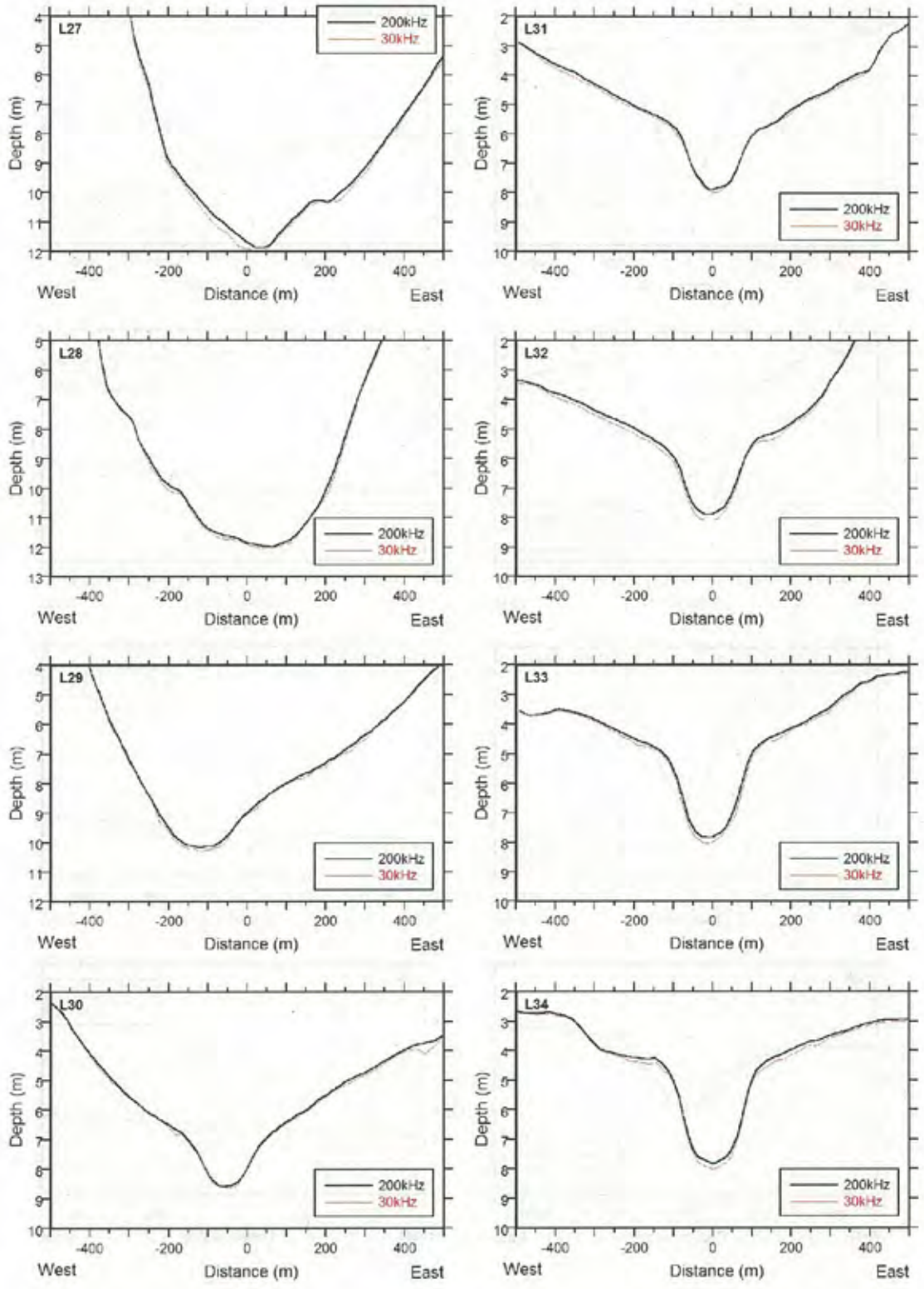

Figure 8.1.4 Channel cross-sections of 200 kHz and 30 kHz (Location 27-34)

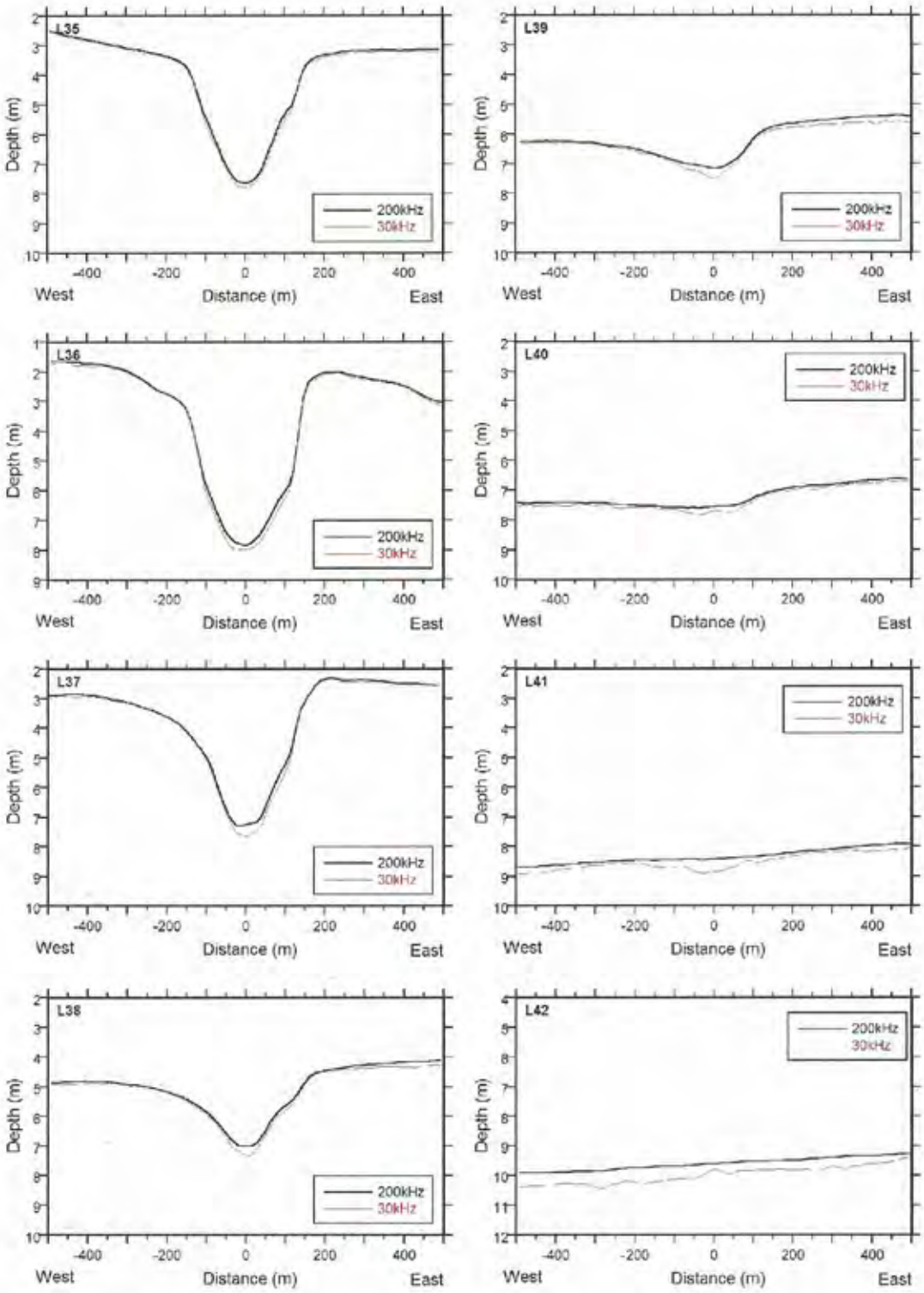

Figure 8.1.5 Channel cross-sections of 200 kHz and 30 kHz (Location 35-42)

8.1.2 Sediment around Lach Huyen channel

In general, the depth difference between the two frequencies indicates the thickness of fluid mud. As shown in Figure 8.1.2 and the bottom of Figure 8.1.3, the fluid mud thickness is characterized as follows,

- Along the channel, the depth difference between high and low frequency is 0.1-0.2m of Km26-36, 0.2-0.4m of Km36-39, and 0.3m of Km40 to offshore, approximately.
- As shown in Figure 8.1.4 and Figure 8.1.5, the depth difference is relatively large in the center of the channel comparing to out the channel.

Shown in Figure 8.1.6 and Figure 8.1.7 are the spatial distribution of particle size of the sediment and mud contents, respectively. These are the results of sediment sampling carried out at 80 points in November, 2009. The number on each circle in Figure 8.1.6 indicates grain size in micrometer. As shown in the figures, most of sediments on the center of the channel are silt or clay, the averaged grain size of which is 22 μm. Also, it is seen that the grain size is getting smaller and the mud content is getting higher in the offshore area. These tendencies indicate that the quite fine sediment is deposited on the channel bottom, particularly the offshore part of the channel.

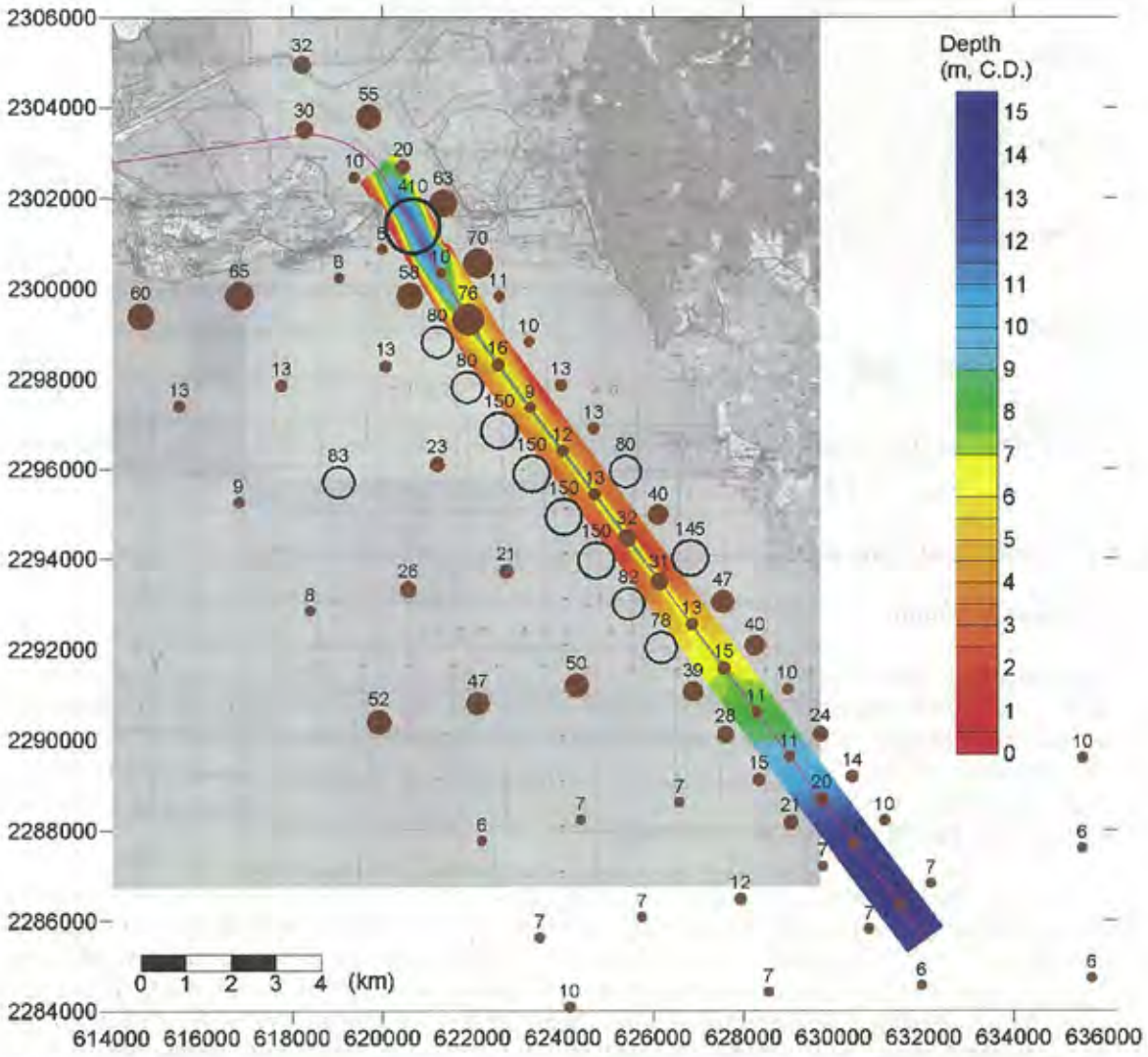

Figure 8.1.6 Distribution of grain size, d_{50} (μm). The filled circle indicates mud (d_{50} <75μm) and the blank circle sand (d_{50} >75μm)

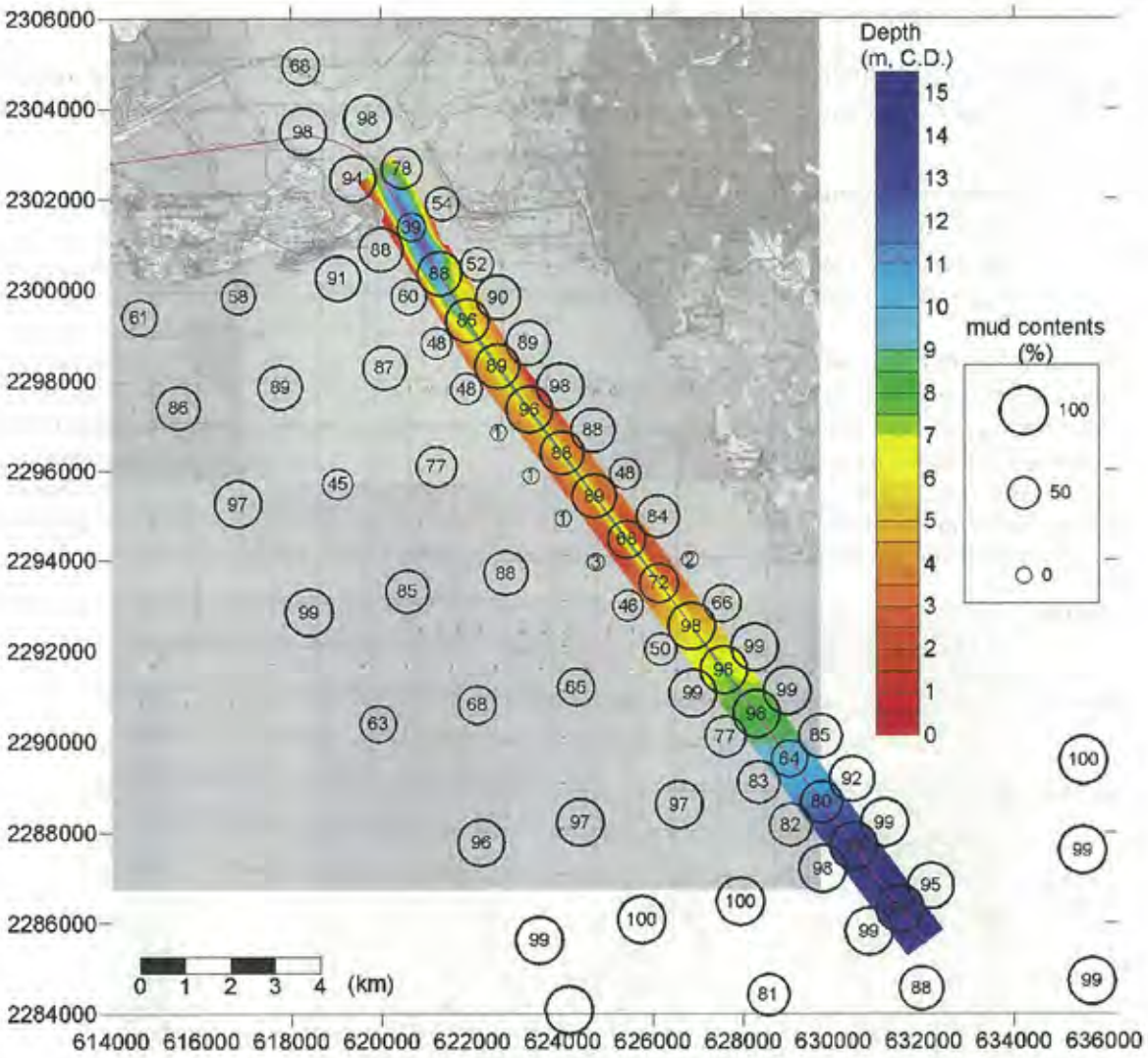

Figure 8.1.7 Distribution of mud contents (%) in the sampled sediment

8.1.3 Analysis of Bathymetric survey data

1) Data Collection

The bathymetric survey results in and around the Lach Huyen channel have been collected as listed Table 8.1.1. The bathymetric survey results are analyzed in this section to understand sedimentation process in the channel. The contour maps of the survey results are shown in Figure 8.1.8 with depth differentiation in color. The contour maps are drawn by VN2000 coordinate system. The six color maps are shown in the figure with shifting 1000 m in horizontal axis. The numbers of 26-43 show the distance from Hai Phong Port along the channel.

The depth of the present access channel was dredged to -8.0 m or deeper in October 2005, so that the color should be green. The color of yellow to red indicates the depth shallower than –7.5 m because of sedimentation. The area around Km36-40 was 7.5 m or deeper below the datum in November 2006. However, the survey in November 2009 revealed the depth nearly 6.5 to 7 m, though the change in color may be difficult to discern. On the other hand, in the area around Km29-30, the color of light blue (the depth range is 9.5-10 m) extended offshore with time, indicating that the area has been eroded.

Table 8.1.1 Collected bathymetric survey data

No.	Date of survey	Description
1	2006-11-16	
2	2007-06-13	
3	2007-12	
4	2008-06-25	
5	2008-12-25	
6	2009-11a	High Frequency (200kHz)

The changes in the water depth in and around the access channels are graphically presented in Figure 8.1.9. In the figure, net depth change based on the survey in November 2006 is shown. The colors of yellow to red show accretion and those of light blue to blue show erosion.

The area around Km27 to Km32 shows erosion tendency both in and out the channel. The area around Km 32-34 shows erosion out the channel and accretion in the channel. The area around Km34-38 shows almost accretion. This section was partly dredged to the width of 200m though the channel width is about 100m in the other part of the channel. In the area of Km38-41, the majority of the access channel has been accreted 0.5-1.0m, while the seabed next to the channel is eroded.

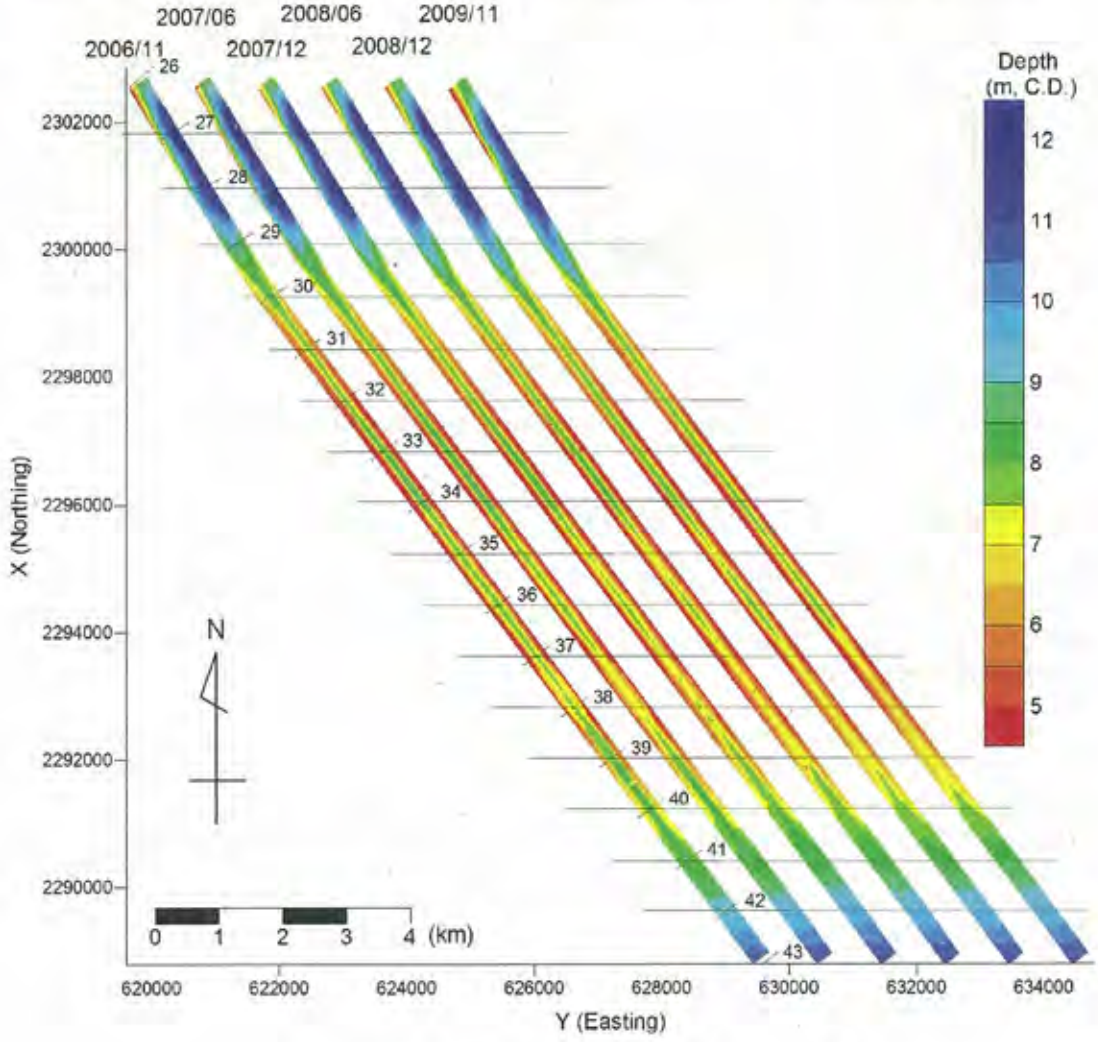

Figure 8.1.8 Depth Contour maps of collected data

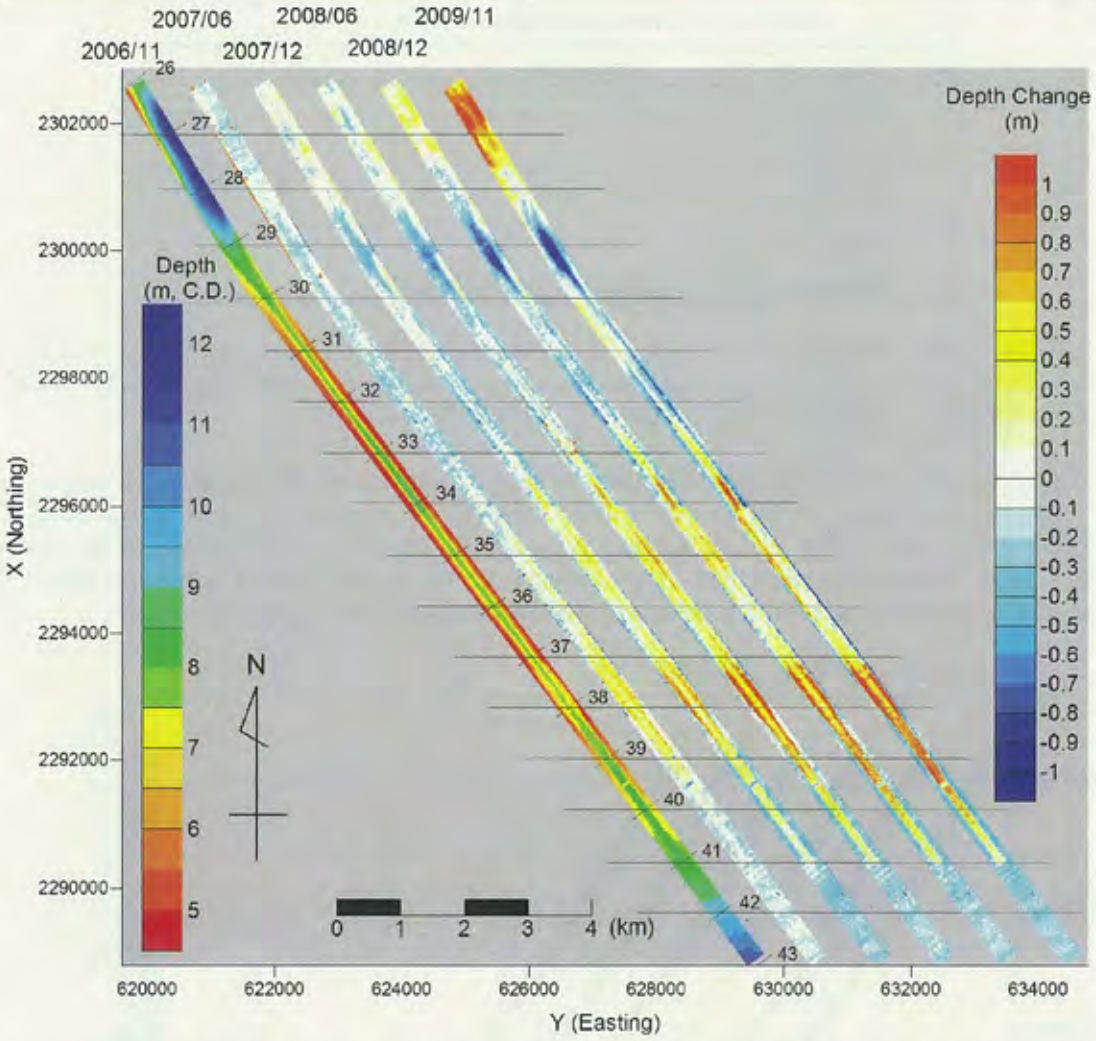

Figure 8.1.9 Net depth change from topography of 2006/11 (Accretion is positive)

2) Depth changes in Longitudinal Cross section

The changes in water depth within the channel are shown in Figure 8.1.10 in the form of longitudinal cross section obtained by successive bathymetric surveys. The top of the figure shows longitudinal profile on the center line of the channel and the bottom shows the net depth change plotted based on the profile in November 2006.

The survey in November 2006 shows the channel bottom one year after completion of the initial dredging work. The figure indicates that significant sedimentation has occurred in the area of Km36-42 and slight erosion has occurred in the area of Km29-32. Around Km34, the depth in November 2006 was partly deep and has been flat by December 2008. After that, sedimentation around Km34 seems to be reduced. From these characteristics, it is confirmed that sedimentation in Lach Huyen channel is significant in the offshore part of the channel.

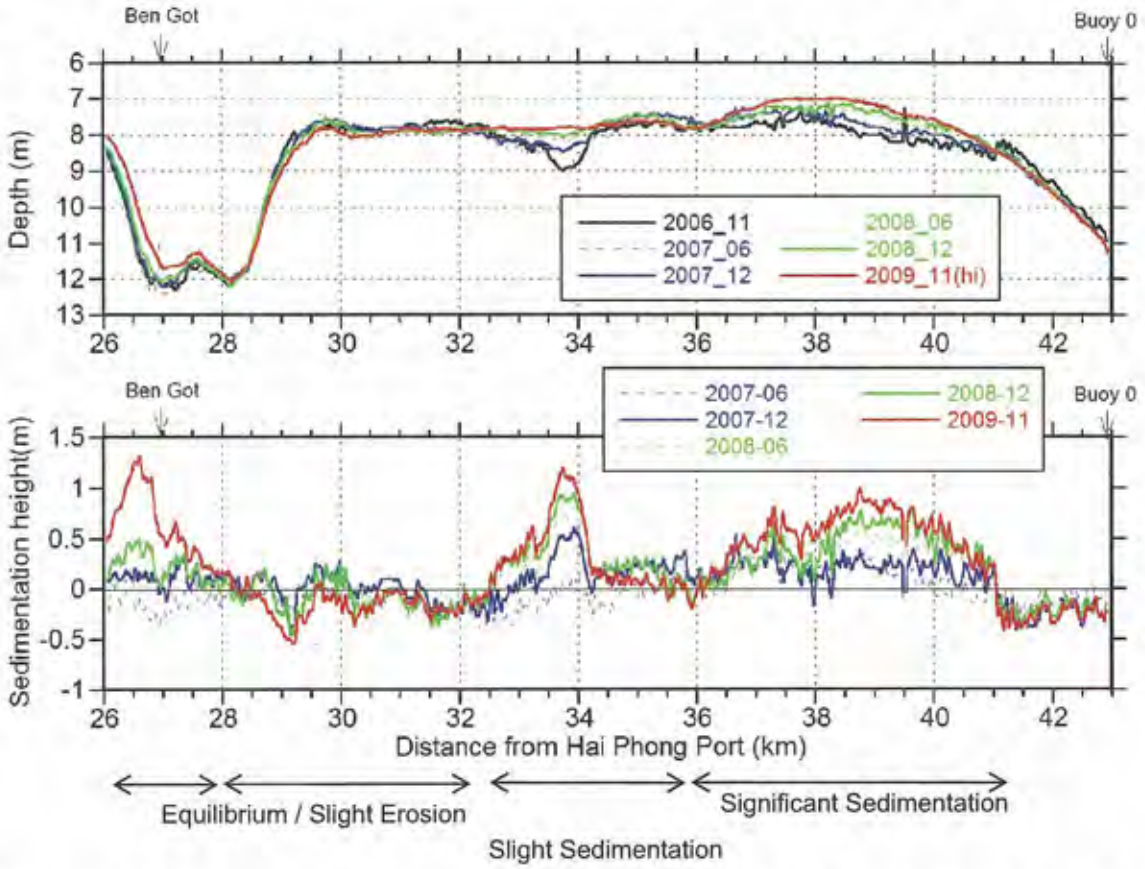

Figure 8.1.10 Topography on the center line of the channel and sedimentation height based on 2006-11

3) Depth changes in Transverse Profiles of the Channel

In the present report, the locations along the channel are designated with the numbers that shows distance from Hai Phong port as shown in Figure 8.1.1. The transverse profiles of the channel at Location 27 to 42 measured in different dates are shown in Figure 8.1.11 and Figure 8.1.12.

The seabed level outside the channel exhibits some fluctuations, which are gradually getting deeper from the data in November 2006 to those in November 2009.

The changes in seabed level inside the channel are different from location to location. On locations of 29 and 30, the seabed level of the channel center is slightly getting deeper. On locations of 38 to 41, the seabed level is getting shallower.

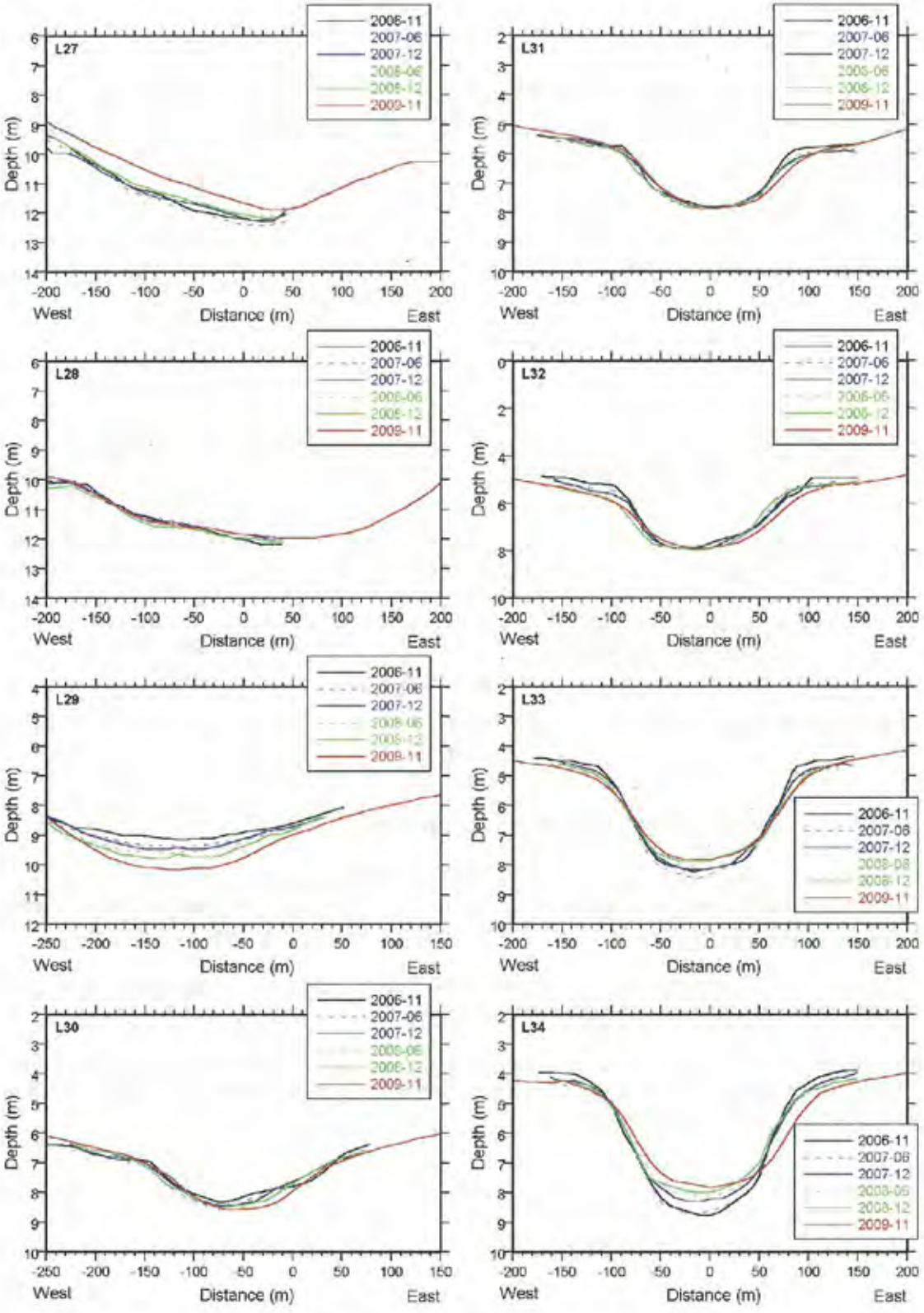

Figure 8.1.11 Cross-section of the channel (Location 27-34)

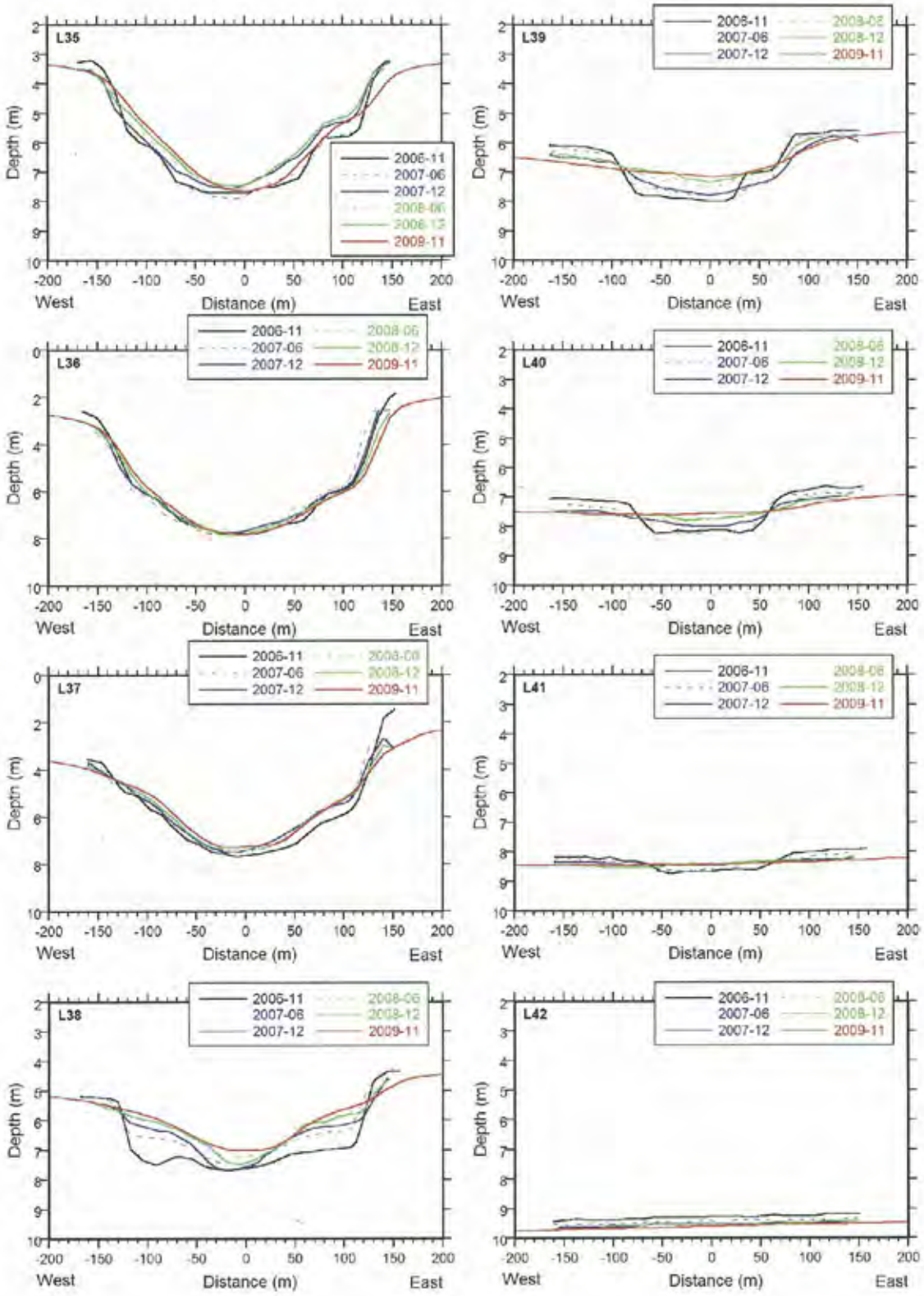

Figure 8.1.12 Cross-section of the channel (Line 35-42)

4) Sedimentation Speed

Sedimentation speed at locations of Km27 to Km42 has been analyzed. Figure 8.1.13 shows the change in depth at locations of Km27 to Km42 with respect to the survey date. The lines in the figure are results of regression analysis and indicate that the depth changes linearly with time at each location. Seasonal effect due to rainy and dry season is not so clear in the change in depth.

Figure 8.1.14 shows the sedimentation speed at each location. The sedimentation speed is different from place to place as described in the section d). The sedimentation speed is relatively fast in Km37 to Km42, the offshore part of the channel. The sedimentation speed is negative in Km29 to Km32, which shows erosion. In Km33 to Km35, the sedimentation speed is fast because the area is partly deeper and refilled.

The averaged sedimentation height was calculated by integration of the net accretion area along the channel. The result is shown in Figure 8.1.15. In the figure, the averaged sedimentation height is plotted with respect to elapsed months after the completion of initial dredging in the end of October 2005. The plotted data include the data written in the report by JOPCA (2009) (JOPCA-collected) with the data collected by this study (SAPROF-collected). The curve in the figure is the regression curve of the all data. As shown in the figure, the averaged sedimentation height gradually increases with the elapsed months, but decreasing the sedimentation speed. The annual sedimentation speed estimated by the regression curve is shown in Figure 8.1.16. In the figure, the sedimentation in first year is much higher than that in second year or later. According to the survey data of October 2005 shown in Figure 8.1.17, however, it is confirmed that the high sedimentation in the first year is induced by that the excessive dredged area around Km34 to Km41 had been refilled. On the topography of November 2006, the excessive dredged area is almost refilled, and therefore it is considered that the sedimentation speed decreased significantly after November 2006.

From the analysis described above, characteristics in sedimentation in Lach Huyen channel are summarized as follows.

- Most of sediments around the channel are mud (silt and clay), and the sedimentation is induced by siltation.
- Sedimentation speed is different from place to place along the channel, and the location of significant sedimentation is from Km37 to Km41, the offshore part of the channel.
- In the area of Km29 to Km32, no sedimentation has been occurred in the present situation. Because the area is located near the entrance of Lach Huyen estuary, the strong tidal currents usually act on the bottom and do not allow sediment to deposit.

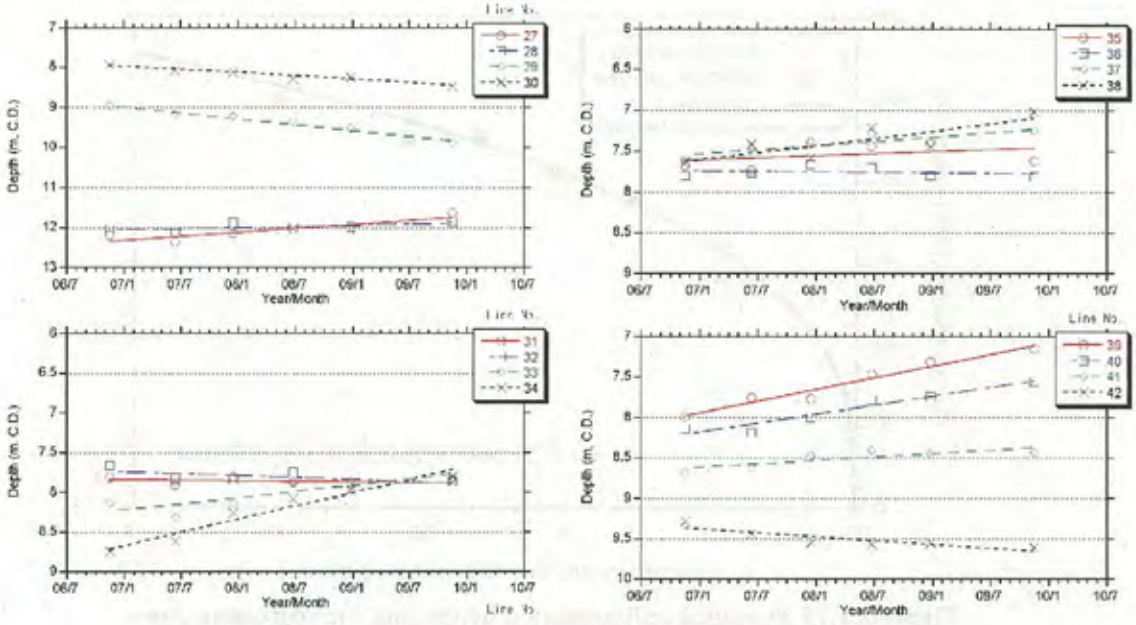

Figure 8.1.13 Change in depth at location Km27 – Km42.

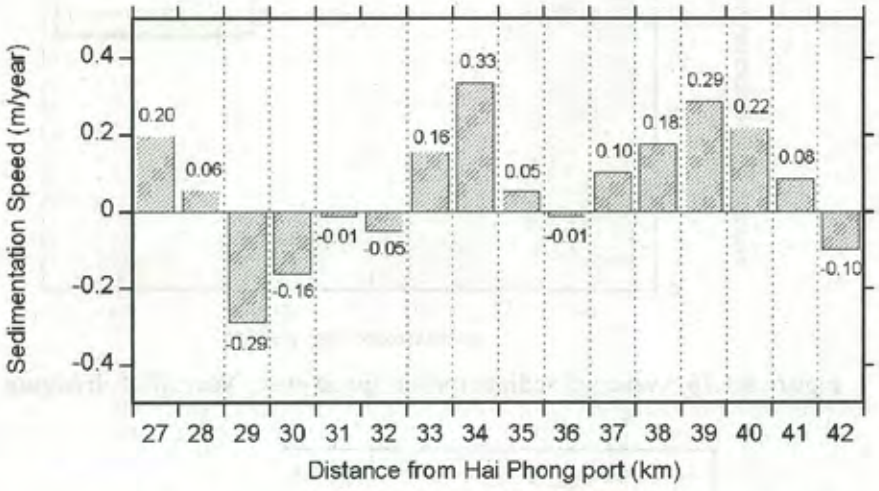

Figure 8.1.14 Recent sedimentation speed of Lach Huyen Channel

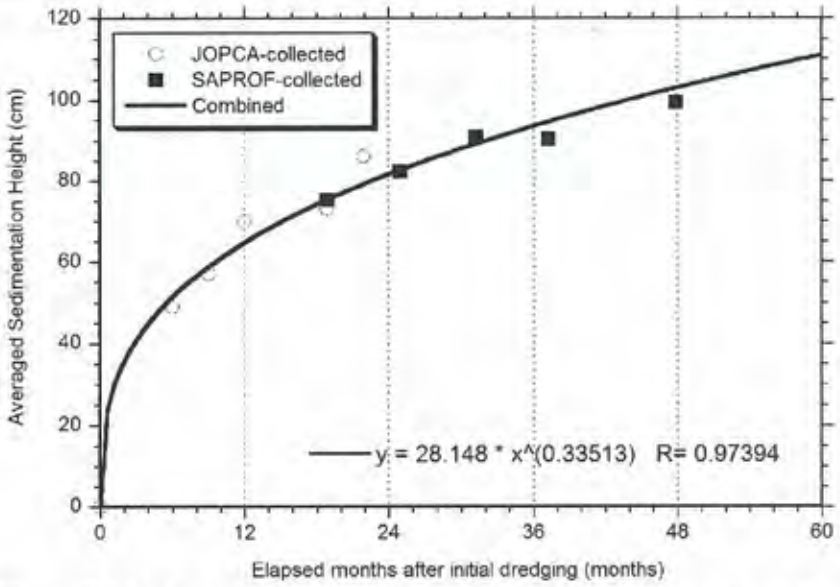

Figure 8.1.15 Averaged sedimentation height and the regression curve

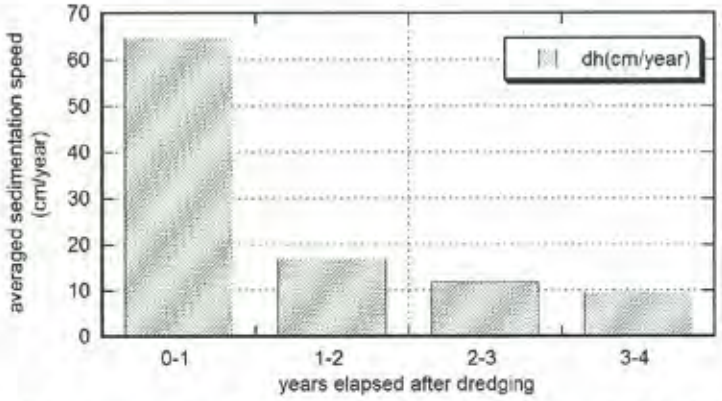

Figure 8.1.16 Averaged sedimentation speed every year after dredging

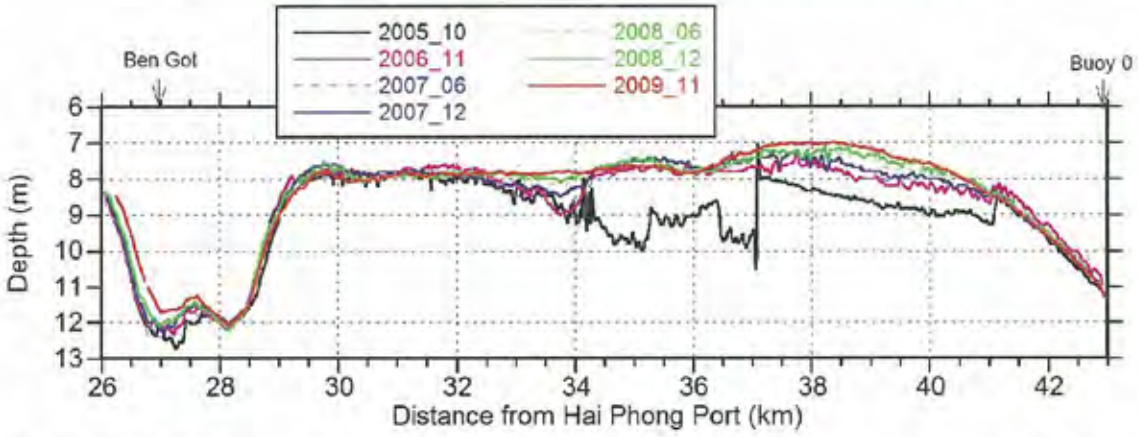

Figure 8.1.17 Longitudinal cross-section along the channel including the data of October 2005

8.2 Numerical Simulation

8.2.1 General

In order to predict sedimentation in Lach Huyen channel, numerical simulations have been carried out. As seen in the results of sediment sampling, very fine material of silt or clay is deposited in the bottom of the channel. Therefore, the sedimentation in Lach Huyen channel is supposed to be induced by siltation. The siltation is a phenomenon that the cohesive sediment such as silt and clay is moved up from the seabed by waves and currents and flows into channel bottom. As the cohesive sediment is typically transported as suspended load, the advection-diffusion sediment transport model is applied to simulate the sedimentation.

In Lach Huyen area, tidal range is approximately 3.5m and the tidal current flows along the channel. In particular, the area between Ben Got and Cat Ba island, the entrance of Lach Huyen estuary, is locally deep in depth because of the strong tidal currents usually occurs. Also, waves from south to south-east often attack the area, agitating the mud on the sea bed into suspension. Actually, on the date when the survey team carried out the cylinder sampling of sediment, waves were about 1 - 1.5 m in height and the color of sea water was yellow everywhere the area due to suspended mud. Therefore, it is considered that the main factor for sedimentation in Lach Huyen channel is mud transport due to waves and currents. The simulations in this study described below treats the mud transport due to waves and currents. It is considered that river discharge is also important in rainy season, but it is not included in the simulations because the no seasonal effects appeared in the sedimentation speed analyzed in previous section, and the river discharge of Chanh river which directly flows into Lach Huyen estuary is small.

8.2.2 Methodology

In this study, mud transport due to waves and currents has been calculated to estimate the sedimentation of the channel. Waves, currents, and sediment transport are calculated by using the following numerical models. The outline of the models is summarized below.

1) Wave transformation model

For numerical analysis of wave transformation, the energy balance equation with addition of the wave diffraction term and the energy dissipation term by breaking is employed. The basic equation of the model is written as,

$$\frac{\partial}{\partial x}(SV_x)+\frac{\partial}{\partial y}(SV_y)+\frac{\partial}{\partial \theta}(SV_\theta)=\frac{\kappa}{2\sigma}\left\{(cc_g\cos^2\theta S_y)_y-\frac{1}{2}cc_g\cos^2\theta S_{yy}\right\}-\varepsilon_b S \qquad (8.1)$$

where, $S(f,\theta)$ is the directional wave spectral density, (x,y) are the horizontal coordinates, θ the wave direction measured counterclockwise from the x axis, ε_b the coefficient of energy dissipation, and the characteristic velocities, (V_x, V_y, V_θ), are defined as follows:

$$V_x = c_g\cos\theta \qquad (8.2)$$

$$V_y = c_g\sin\theta \qquad (8.3)$$

$$V_\theta = \frac{c_g}{c}\left(\frac{\partial c}{\partial x}\sin\theta-\frac{\partial c}{\partial y}\cos\theta\right) \qquad (8.4)$$

where c is the wave celerity and c_g the group velocity. The first term in the right side of Eq.(8.1) is the additional term for representing wave diffraction, where σ is the wave angular frequency and κ is the coefficient to optimize the degree of diffraction, the typical value of which is 2.5.

2) Current model

The numerical model for current simulation is based on a finite-difference numerical representation of the two-dimensional (2-D) depth-integrated continuity and momentum equations of water motion. Cells are defined on a staggered and rectilinear grid. Momentum equations are solved in a time-stepping manner first, followed by solution of the continuity equation, in which the updated velocities calculated by the momentum equations are applied.

The governing equations of the 2-D, depth-integrated continuity and momentum equations are:

$$\frac{\partial(h+\eta)}{\partial t}+\frac{\partial Q_x}{\partial x}+\frac{\partial Q_y}{\partial y}=0 \tag{8.5}$$

$$\frac{\partial Q_x}{\partial t}+\frac{\partial(UQ_x)}{\partial x}+\frac{\partial(VQ_x)}{\partial y}=-g(h+\eta)\frac{\partial \eta}{\partial x}+\frac{\partial}{\partial x}\left(D_x\frac{\partial Q_x}{\partial x}\right)+\frac{\partial}{\partial y}\left(D_y\frac{\partial Q_x}{\partial y}\right)+fQ_y-\frac{\tau_{bx}}{\rho_w}+\frac{\tau_{Sx}}{\rho_w} \tag{8.6}$$

$$\frac{\partial Q_y}{\partial t}+\frac{\partial(UQ_y)}{\partial x}+\frac{\partial(VQ_y)}{\partial y}=-g(h+\eta)\frac{\partial \eta}{\partial y}+\frac{\partial}{\partial x}\left(D_x\frac{\partial Q_y}{\partial x}\right)+\frac{\partial}{\partial y}\left(D_y\frac{\partial Q_y}{\partial y}\right)-fQ_x-\frac{\tau_{by}}{\rho_w}+\frac{\tau_{Sy}}{\rho_w} \tag{8.7}$$

where t is the time, (x,y) are the horizontal coordinates, η is the water surface elevation, U is the depth-averaged velocity in x-direction, V is the depth-averaged velocity in y-direction, η is the water depth, (Q_x,Q_y) are the flow rate per unit width in x- and y-direction, g is the gravitational acceleration, (D_x,D_y) are horizontal diffusion coefficients, ρ_w is the water density, f is the Coriolis parameter, (τ_{bx}, τ_{by}) are the bottom stress parallel to x- and y-axis, and (τ_{Sx}, τ_{Sy}) are the wave stress parallel to x- and y-axis.

3) Sediment transport and morphology change

The mud transport is usually treated as suspended load, the basic equation of which is the advection-diffusion equation of sediment concentration written as,

$$\frac{\partial C}{\partial t}+\frac{\partial CUh}{\partial x}+\frac{\partial CVh}{\partial y}=\frac{\partial}{\partial x}\left(K_x h\frac{\partial C}{\partial x}\right)+\frac{\partial}{\partial x}\left(K_y h\frac{\partial C}{\partial y}\right)+(E-D) \tag{8.8}$$

where C is the depth-averaged concentration, (U, V) is the depth-averaged horizontal velocity in x- and y-direction, h is the water depth, (K_x, K_y) is the horizontal diffusion coefficients in x- and y-direction, E is the erosion rate, and D is the deposition rate ($= C_b w_f$, C_b is the bottom concentration and w_f is the sediment falling velocity). The erosion rate is estimated as,

$$E=M\left(\frac{\tau-\tau_{cr}}{\tau_{cr}}\right) \tag{8.9}$$

where τ is the bed shear stress, τ_{cr} is the critical shear stress for erosion, and M is the empirical coefficient (kg/m^2/s). Eq. (8.8) is solved on the concentration, C, by using the calculated velocities and bed shear stress.

The bed shear stress for sediment transport is estimated by sediment grain size and local forcing conditions. In the present model, the following formula proposes by Soulsby (1997) is used. The maximum shear stress under wave and current motion is,

$$\tau_{max}=\sqrt{(\tau_{ms}+\tau_{ws}\cos\phi)^2+(\tau_{ws}\sin\phi)^2} \tag{8.10}$$

where τ_{ms} is the mean shear stress defined as,

$$\tau_{ms} = \tau_{cs}\left[1+1.2\left(\frac{\tau_{ws}}{\tau_{cs}+\tau_{ws}}\right)^{3.2}\right] \tag{8.11}$$

ϕ is the angle between directions of wave and current. τ_{cs} and τ_{ws} are the shear stress due to current and wave, respectively.

$$\tau_{cs} = \frac{1}{2}\rho_w f_c |U|^2 \tag{8.12}$$

$$\tau_{ws} = \frac{1}{2}\rho_w f_w u_w^2 \tag{8.13}$$

Here, $|U|$ is the current speed ($=\sqrt{U^2+V^2}$), u_w is the wave orbital velocity amplitude, f_c and f_w are the friction factor and defined as,

$$f_c = 2\left[\frac{\kappa}{1+\ln(k_s/30d)}\right]^2 \tag{8.14}$$

$$\begin{aligned} f_w &= \exp\left[-5.977+5.213\left(\frac{A_w}{k_s}\right)^{-0.194}\right] && for\ \frac{A_w}{k_s} > 1.57 \\ f_w &= 0.3 && for\ \frac{A_w}{k_s} < 1.57 \end{aligned} \tag{8.15}$$

where κ is the Karman constant, d is the total depth ($=h+\eta$), A_w is the orbital diameter by wave ($=u_w T/\pi$), k_s is the roughness height estimated as $k_s = 2.5D$, and D is the sediment grain size. The shear stress τ in Eq.(8.8) is estimated as τ_{max} of Eq.(8.10).

The bed level change is calculated by the sediment continuity equation written as,

$$\frac{dh}{dt} = \frac{1}{1-\lambda}\left(\frac{\partial q_x}{\partial x}+\frac{\partial q_y}{\partial x}\right) = \frac{1}{1-\lambda}(E-D) \tag{8.16}$$

where λ is the sediment porosity, and (q_x, q_y) are the sediment transport rate in x- and y-direction.

8.2.3 Model setup

1) Computational domain

For numerical simulations of wave, current, and topography change, a computational domain was prepared based on chart data of Hai Phong area and bathymetric survey data around the channel. The topography maps of computational domain are shown in Figure 8.2.1 and Figure 8.2.2. As shown in the figure, two computational domains were prepared. The large domain consists of 500 x 500 m cells and the small one consists of 50 x 50 m cells. The Lach Huyen channel is located center parallel to the y-axis in the figure.

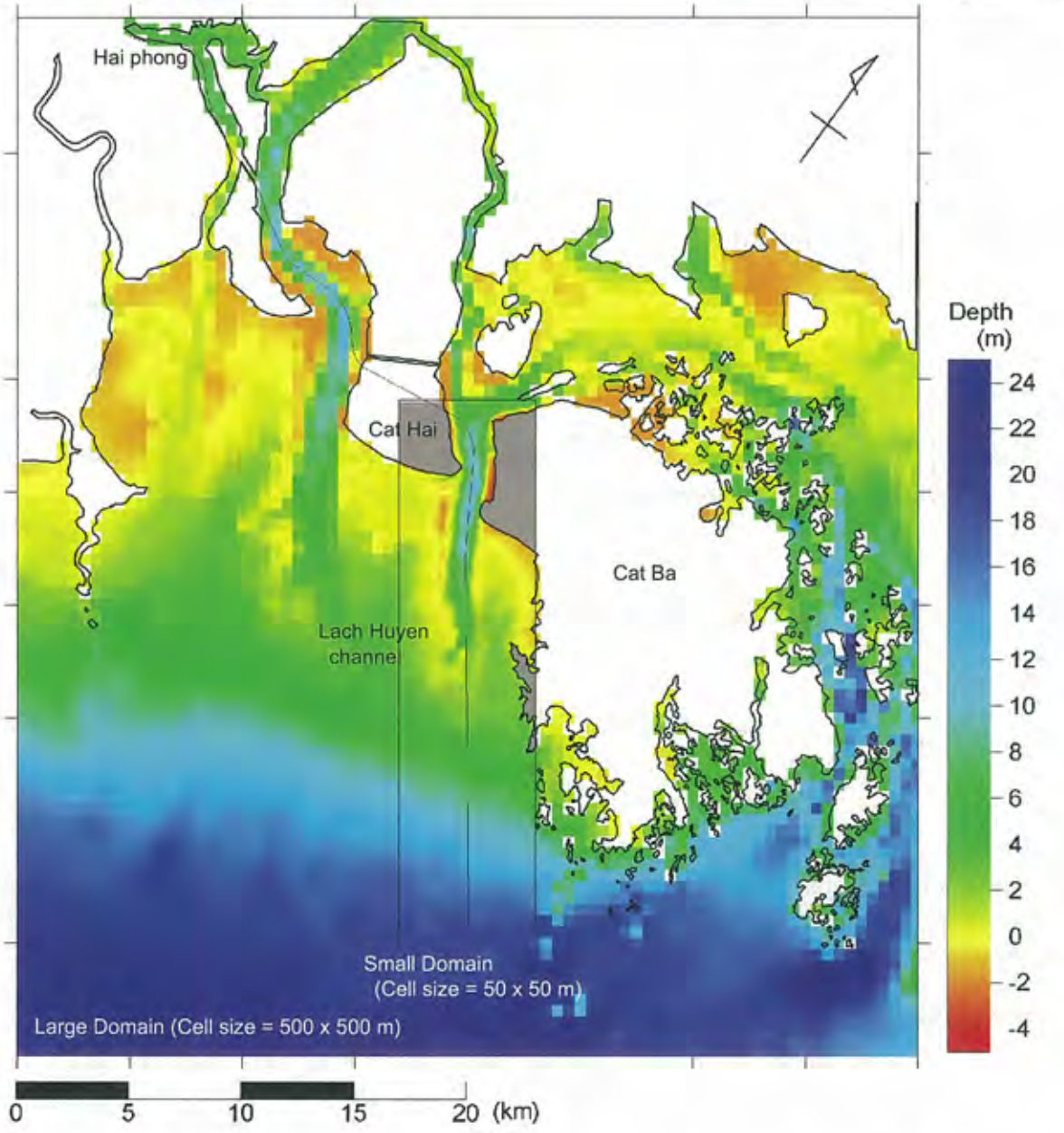

Figure 8.2.1 Topography data for tidal current simulation (Large domain)

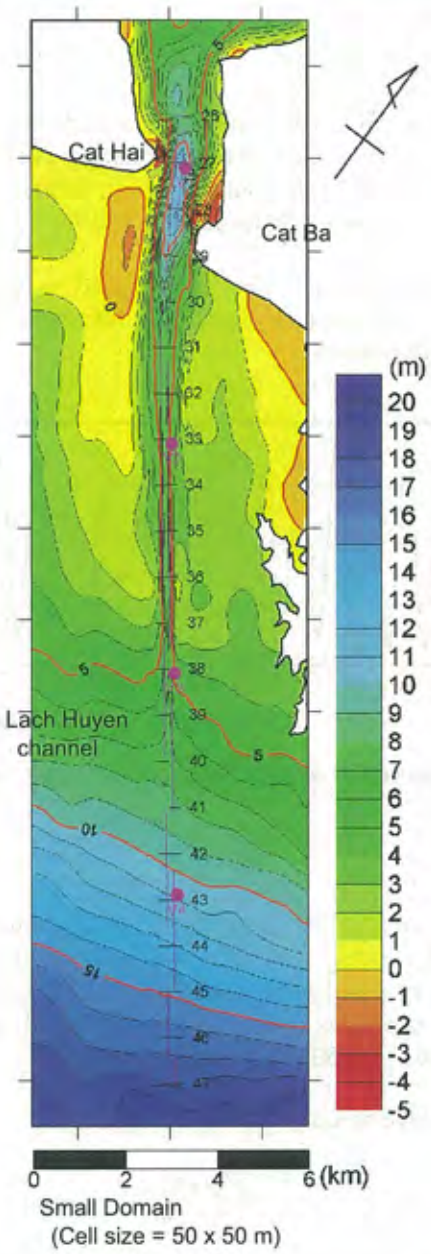

Figure 8.2.2 Topography data for numerical simulation (Small domain)

2) Computational conditions

a) Water surface elevation

To compute tidal currents, time series of water surface elevation is needed for boundary condition. In this study, the water surface elevation for boundary condition is calculated by NAO.99b tidal prediction system developed by Matsumoto et. al. (2000) [1]. Figure 8.2.3 is an example of the predicted tide by the NAO.99b at the location of 107°00'00''E and 20°30'00''N.

The time series of water surface elevation is used as the boundary condition for the large computational domain. The boundary condition for the small domain is given by the output of simulation with the large domain.

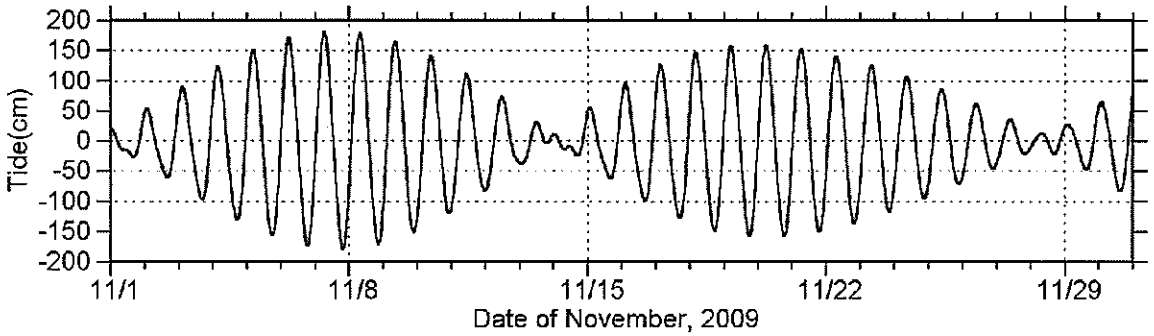

Figure 8.2.3 Time series of water surface elevation set as boundary condition

b) Incident wave

To compute wave transformation, properties of offshore wave height, period, and direction are needed. In this study, energy-averaged wave is used for the representative wave. The energy-averaged wave is calculated by using the joint frequency of wave height and direction as shown in Table 8.2.1. According to the FS-report by TEDI, the data in the table are based on long term observation of 1961 to 1983 at Hon Dau station.

The energy averaged wave height is calculated as,

$$H_e = \frac{\sum p_i (H_i^2 T_i)}{\sum p_i T_i} = 0.95 \text{ (m)}$$

where p_i is the probability of occurrence in the rank i of wave height, H_i is the wave height of rank i, and T_i is the wave period in the rank i. The wave period of the energy-averaged wave is obtained by the relation between wave height and period of T=1.5539H+3.9222.

$$T_e = 5.4 \text{ (sec.)}$$

[1] Matsumoto, K., T. Takanezawa, and M. Ooe (2000), Ocean Tide Models Developed by Assimilating TOPEX/POSEIDON Altimeter Data into Hydrodynamical Model: A Global Model and a Regional Model Around Japan, Journal of Oceanography, 56, 567-581

The probability of appearance in wave direction is shown in Figure 8.2.4. As shown in the figure, the dominant wave direction is E to S, but high waves seem much prevail from SE and S directions. As Lach Huyen channel is sheltered by Cat Ba Island against waves from E-direction, the wave from S direction is considered as the representative wave that affects sedimentation in the channel.

The probability of non-exceedance of wave height is shown in Figure 8.2.5. The probability of non-exceedance for the energy averaged wave is approximately 70 %.

Table 8.2.1 Joint frequency of wave height and direction based on data observed at Hon Dau 1961-1983

Dir / Height(m)	N	NE	E	SE	S	SW	W	NW	Total	Probability of non-exceedance (%)
0-0.25									4281 (18.046)	18.05
0.25-0.5	221 (0.932)	178 (0.750)	544 (2.293)	785 (3.309)	197 (0.830)	38 (0.160)	30 (0.126)	47 (0.198)	2040 (8.599)	26.65
0.50-0.75	647 (2.727)	757 (3.191)	1988 (8.380)	2399 (10.113)	722 (3.043)	181 (0.763)	42 (0.177)	117 (0.493)	6853 (28.888)	55.53
0.75-1.00	344 (1.450)	421 (1.775)	1300 (5.480)	1219 (5.138)	498 (2.099)	131 (0.552)	7 (0.030)	23 (0.097)	3943 (16.621)	72.15
1.00-1.50	310 (1.307)	376 (1.585)	1524 (6.424)	1263 (5.324)	1092 (4.603)	357 (1.505)	11 (0.046)	18 (0.076)	4951 (20.870)	93.02
1.50-2.00	45 (0.190)	75 (0.316)	355 (1.496)	291 (1.227)	444 (1.872)	135 (0.569)	4 (0.017)	1 (0.004)	1350 (5.691)	98.71
2.00-2.50	12 (0.051)	11 (0.046)	46 (0.194)	56 (0.236)	81 (0.341)	22 (0.093)	1 (0.004)	1 (0.004)	230 (0.970)	99.68
2.50-3.00	3 (0.013)	2 (0.008)	11 (0.046)	13 (0.055)	7 (0.030)	3 (0.013)		2 (0.008)	41 (0.173)	99.86
3.00-3.50			6 (0.025)	6 (0.025)	6 (0.025)	3 (0.013)		1 (0.004)	22 (0.093)	99.95
3.50-4.00			2 (0.008)	1 (0.004)					3 (0.013)	99.96
4.00-5.00										
5.00-6.00										
6.00-7.00										
7.00-8.00										
8.00-9.00				3 (0.013)	1 (0.004)	2 (0.008)			6 (0.025)	99.99
9.00-10.0			1 (0.004)		1 (0.004)	1 (0.004)			3 (0.013)	100.00
>10.00										
Total	1582 (6.669)	1820 (7.672)	5777 (24.352)	6036 (25.444)	3049 (12.853)	873 (3.680)	95 (0.400)	210 (0.885)	23723	

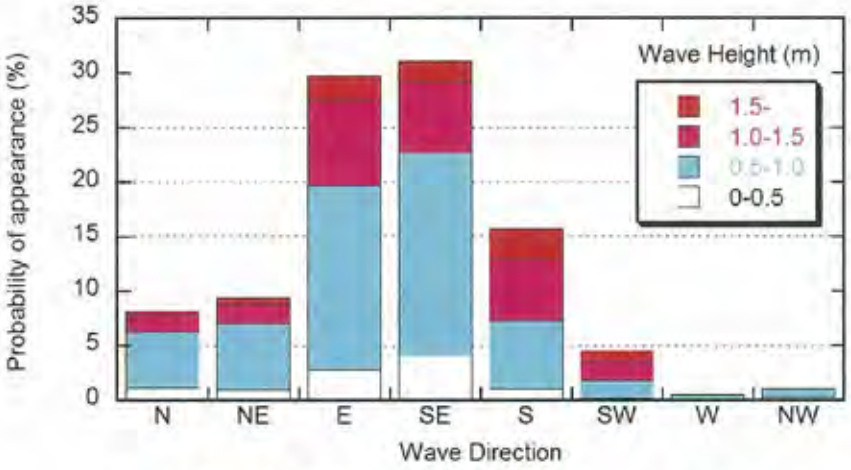

Figure 8.2.4 Probability of appearance in wave direction

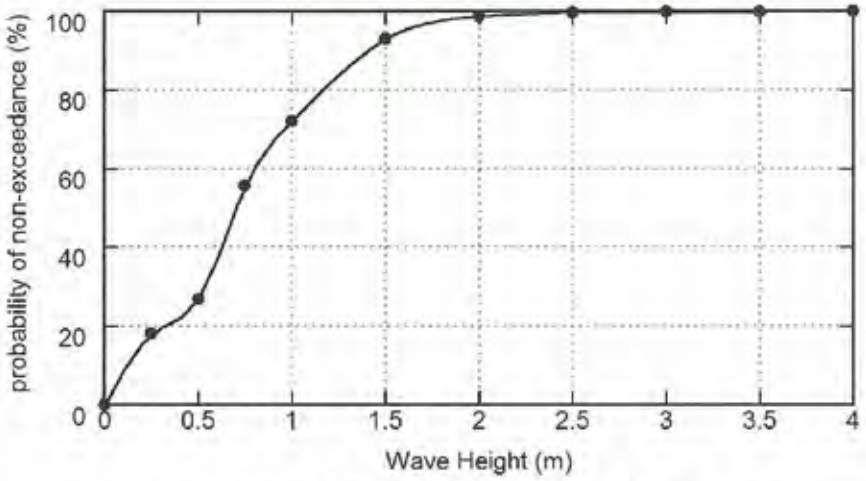

Figure 8.2.5 Probability of non-exceedance of wave height

c) Sediment property

As described in 8.1.2, most of sediment around Lach Huyen channel is silt and clay. For sedimentation simulation, sediment with 22 μm in particle size and 2680 kg/m3 in density is used as the representative sediment. According to the Stokes formula, the settling velocity of the particle is 0.39 mm/s in 20 degrees of water temperature.

8.2.4 Sedimentation simulation on the present situation

To verify and calibrate the numerical models, numerical simulations have been carried out on the present situation. The target of reproduction is the sedimentation speed along the channel as shown in 8.1.3, which is the averaged sedimentation speed after second year shown in Figure 8.2.16.

1) Tidal current

An example of tidal current simulations is shown below. Figure 8.2.6 shows vector maps of ebb and flood tidal current on a spring tide. As shown in the figure, the main direction of the current is along the channel, and the strong current occurs near the narrowest area between Ben Got and Cat Ba island.

Figure 8.2.7 and Figure 8.2.8 show the comparison between measured and calculated current velocities at 4 points. The current survey was carried out by multi-layer measurement, and the result indicated no stratification in the tidal currents. Therefore, the comparison is made by the depth-averaged current velocity. From the figures, the calculated current velocities are slightly under estimation compared to the measurements, but give reasonable results.

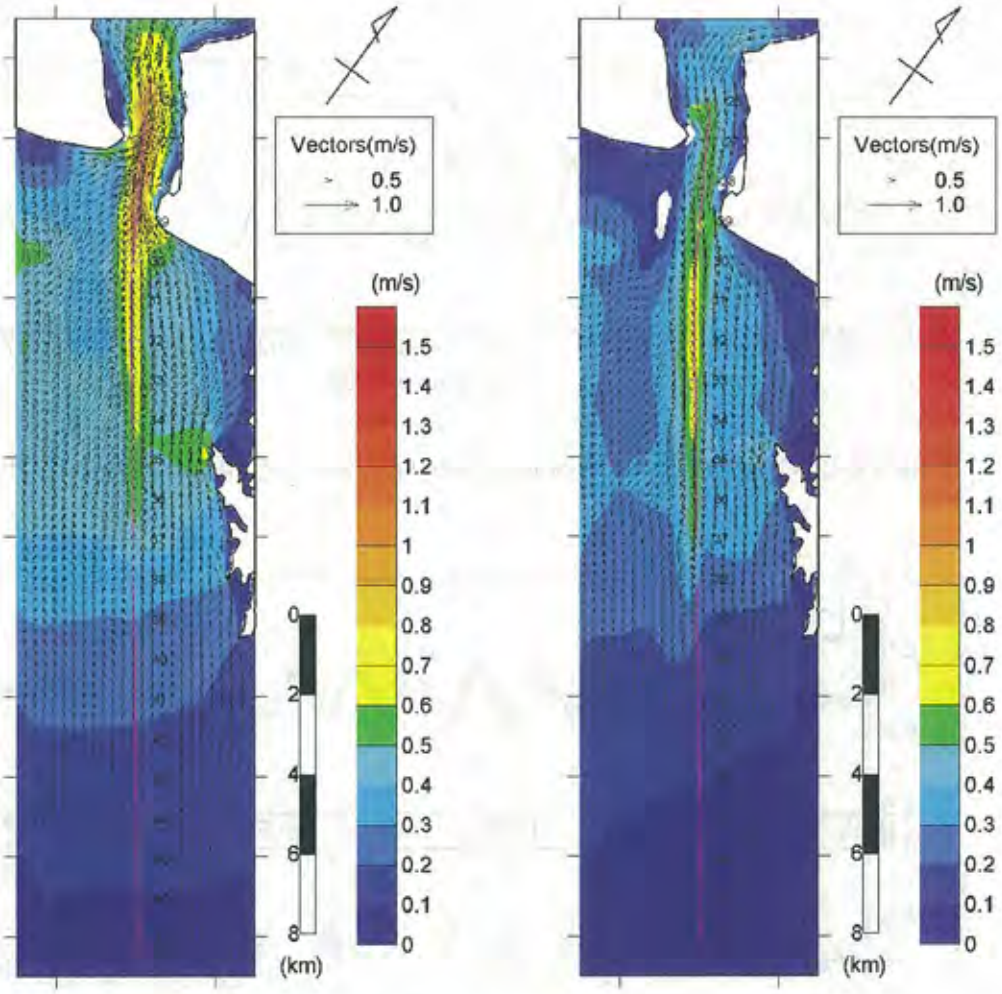

Figure 8.2.6 Flood and ebb tidal current on spring tide (11/7 2:00 11/7 16:00)

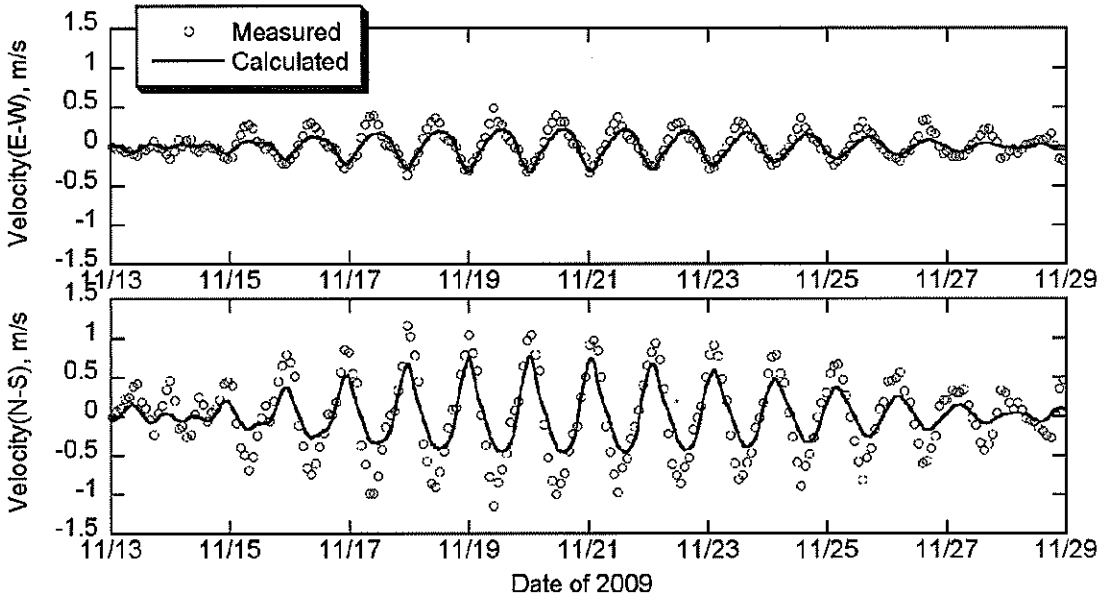

Figure 8.2.7 Comparison between measured and calculated tidal currents (Station V1)

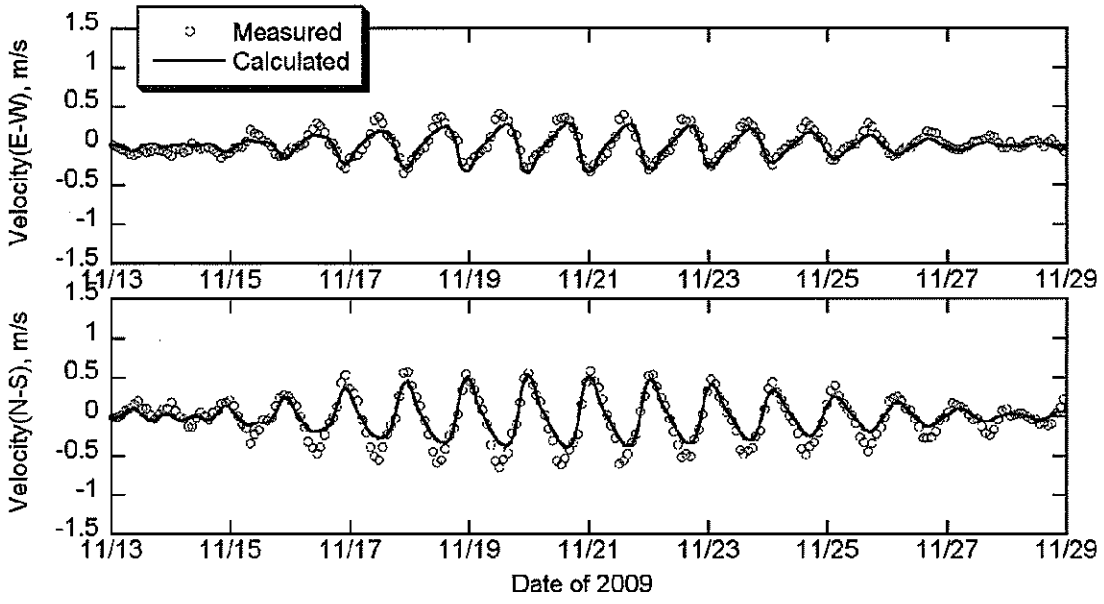

Figure 8.2.8 Comparison between measured and calculated tidal currents (Station V2)

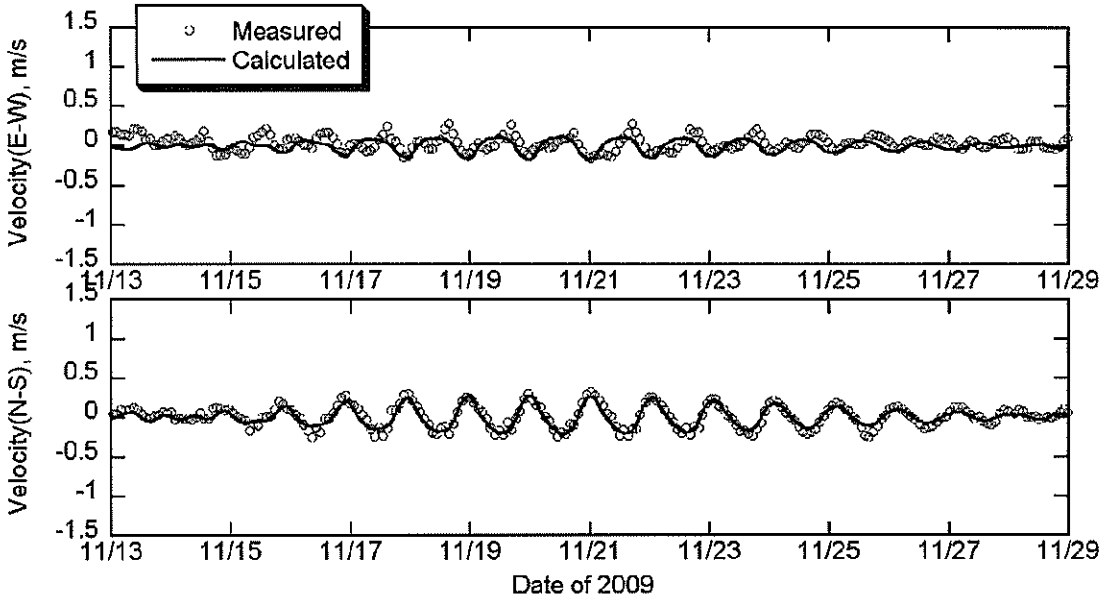

Figure 8.2.9 Comparison between measured and calculated tidal currents (Station V3)

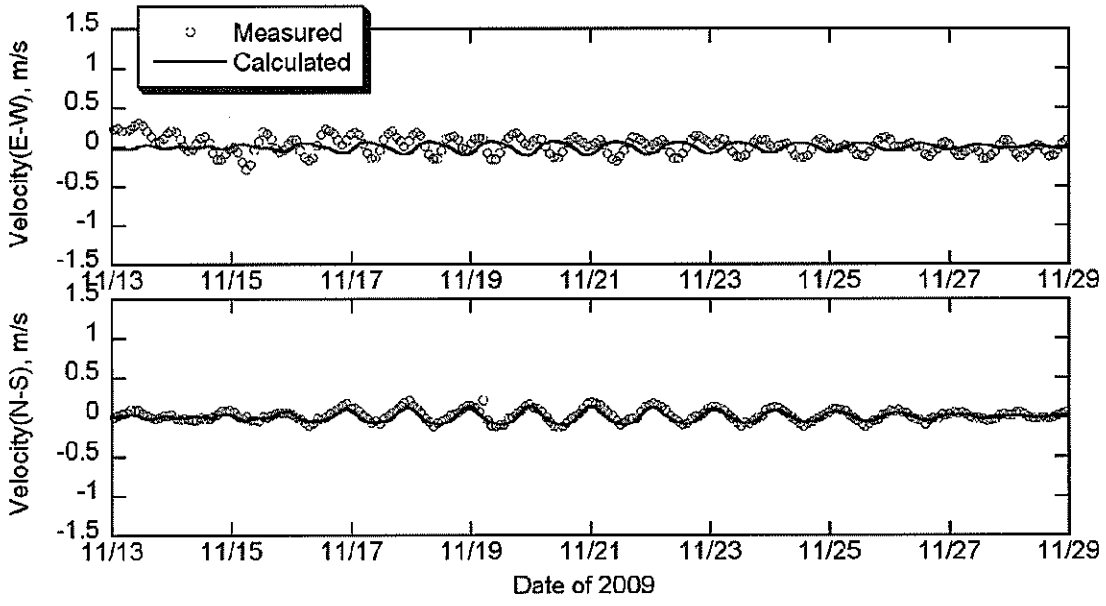

Figure 8.2.10 Comparison between measured and calculated tidal currents (Station V4)

2) Wave transformation

Wave is the one of the most important factor for sedimentation because the strong shear stress due to high waves moves sediments up into suspension. The suspended sediments are transported by currents such as tidal current or wave-induced currents and settle down on the locations which the bed shear stresses become weak.

The numerical analysis of wave transformation is presented here. Waves incident to Gulf of Tonkin change their heights and directions due to the refraction phenomenon in response to the bathymetric change within the Gulf. Behind the islands, waves are further transformed by the diffraction phenomenon. As waves come near to the shore, waves are attenuated by breaking.

The selected representative waves is the energy-averaged waves of $H_0 = 0.95$ m with the period of T= 5.4 s, where the wave height is defined in terms of significant height. The computed wave distributions are shown in Figure 8.2.11. In the figure, wave height and direction are shown with respect to incident wave directions of E, ESE, SE, SSE, S, and SSW.

As seen in the figure, the wave height around the access channel is relatively low when the incident wave direction is E or ESE, while the one is relatively high in SSE or S. In the figure of S in wave direction, waves show a certain degree of concentration along the channel, in particular left side of the channel. The concentration of waves at the location is considered due to existence of a shoal developed at south-east of Cat Hai island. Along the channel, wave height gradually decreases from offshore to onshore, and waves do not penetrate inside the Lach Huyen estuary beyond the narrow section.

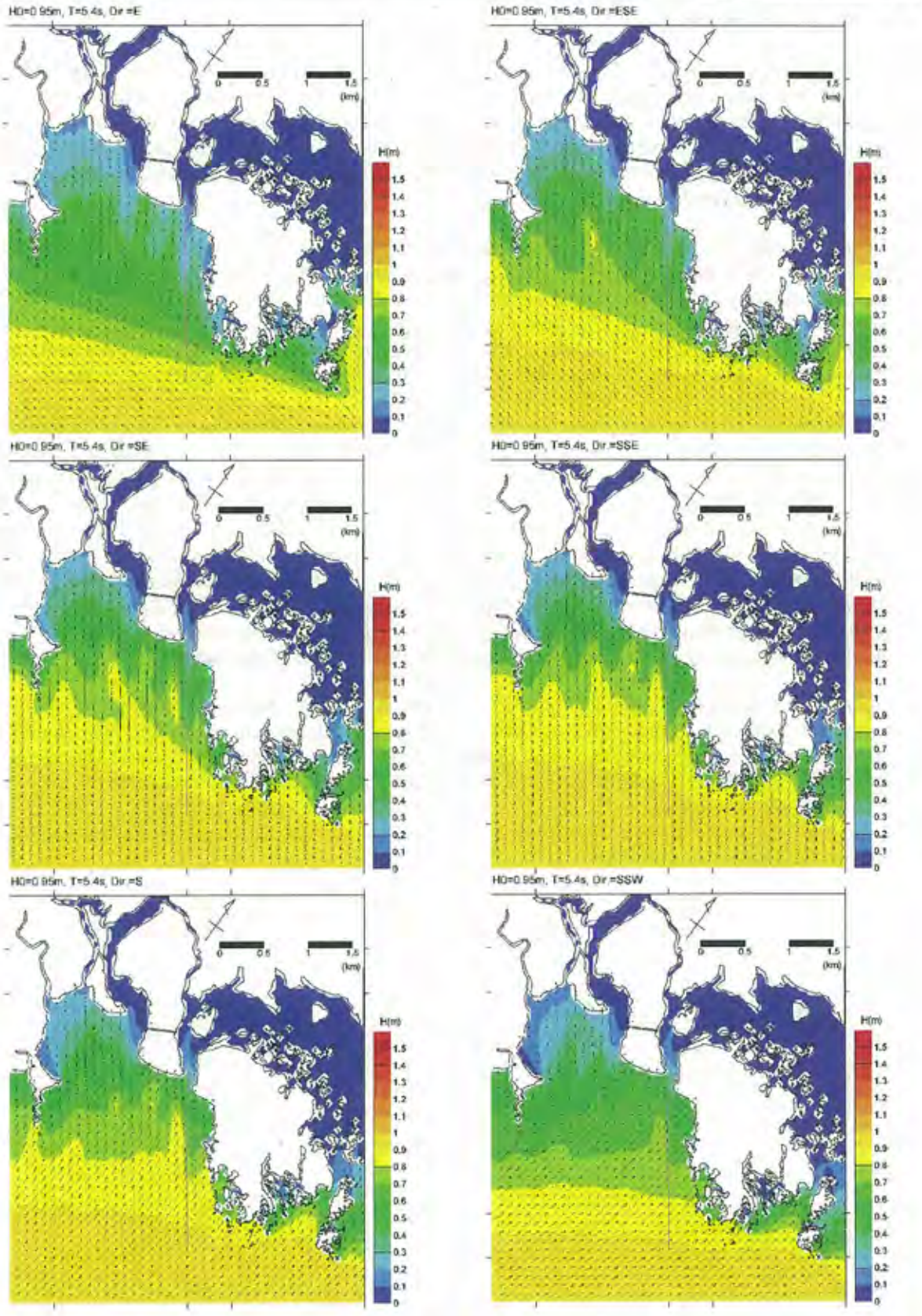

Figure 8.2.11 Calculated wave height and direction with respect to incident wave directions of E to SSW

3) Sedimentation process

On the present situation of Lach Huyen channel, sedimentation due to tidal current alone and that due to wave plus tidal current were calculated to examine the each effect on the sedimentation. Both calculations were conducted for the 15 days sedimentation including neap and spring tide. Also, on the case of wave plus tidal current, the energy averaged wave of 0.95 m in height, 5.4 s in period, and S in wave direction is given with the variation of tide level. Figure 8.2.12 shows the resultant depth change for 15 days on the center line of Lach Huyen channel.

As shown in the figure, it is seen that erosion is occurred in case of tide alone, whereas significant accretion in case of tide plus wave. The results indicate that wave is dominant for the sedimentation in Lach Huyen channel. Figure 8.2.13 shows the calculated suspended concentration in case of tide alone and that of tide plus wave. In case tide plus wave, the suspended mud with high concentration is distributed around Lach Huyen channel, while low concentration in case tide alone. The result also indicates that a large amount of suspended mud flows into the channel when high wave comes.

As described in 8.1.3, the results of analysis of bathymetric survey data indicate that sedimentation is significant in the area from Km36 to the offshore and slight erosion has been occurred in the area of Km28 to Km32. The erosion in the area of Km28 to Km32 is explained as the effect that the strong tidal current flushes the sediment out as shown in the top of Figure 8.2.13. As the mud of silt and clay widely distributed in the area, the sediment flowing into the channel at high wave is almost mud, the settling velocity of which is very slow. In addition, the suspended mud forms so-called fluid mud in the deposition process when waves become calm. The fluid mud is high concentration layer near the channel bottom and it takes much time to completely consolidate. Therefore, the fluid mud is easy to re-suspend, moves along the channel with tidal current, and finally settle down at the location where the shear stress due to current is very weak, that is, the offshore part of the channel.

Figure 8.2.14 shows the longitudinal profile of the channel, net depth change based on the survey in November 2006, and the bed shear stress averaged 15 days of tidal current simulation. From the figure, the characteristics of sedimentation seem to deeply relate to the averaged shear stress. The averaged shear stress is greater than 0.06 N/m2 in the onshore area of Km32 and no sedimentation has occurred. Also, the peak of sedimentation is appeared around Km39, where another peak around Km34 can be negligible because the depth of November 2006 is locally deep, and the shear stress is less than 0.015 N/m^2 in the offshore area of Km39.

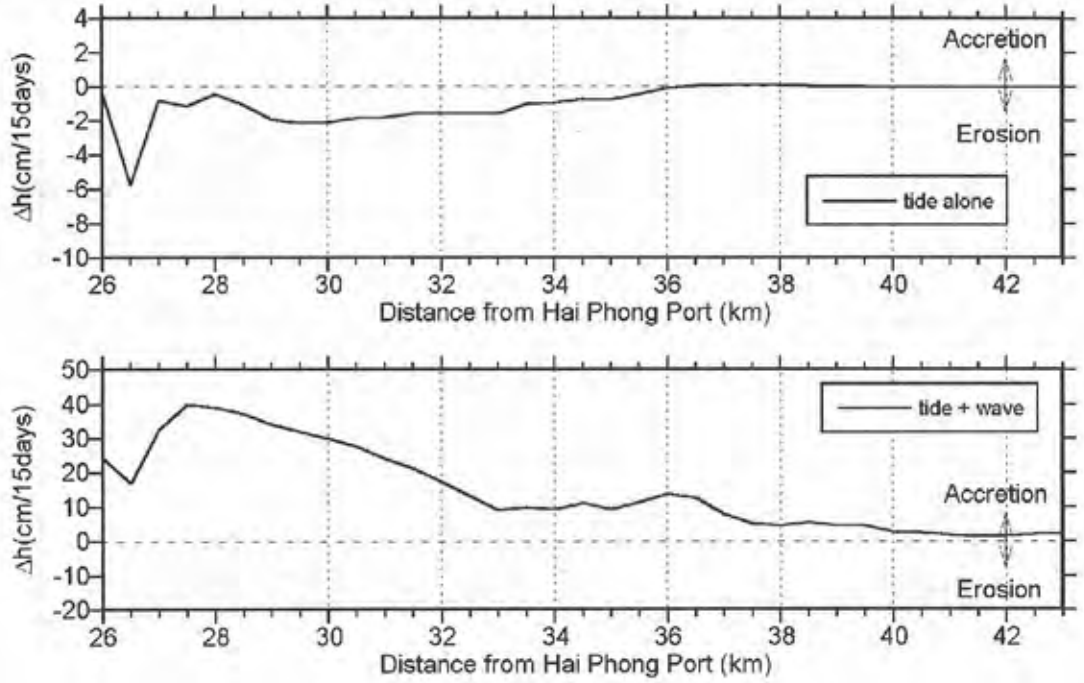

Figure 8.2.12 Simulated net depth change on the center line of the channel. (Top=tide alone. Bottom=tide + wave)

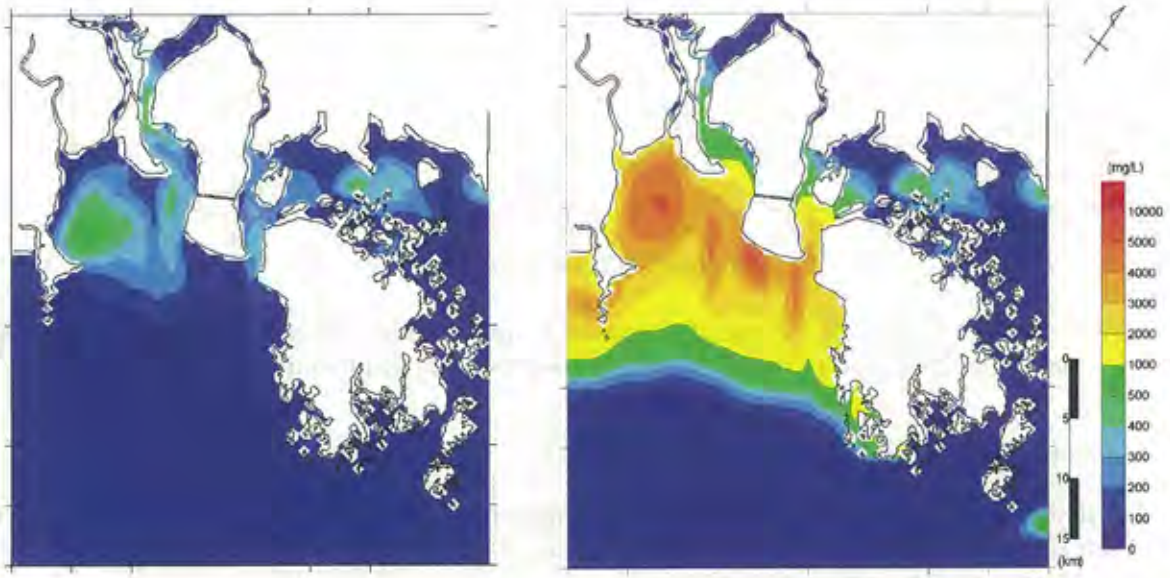

Figure 8.2.13 Concentration at maximum flood current (Left=tide alone, Right=tide + wave)

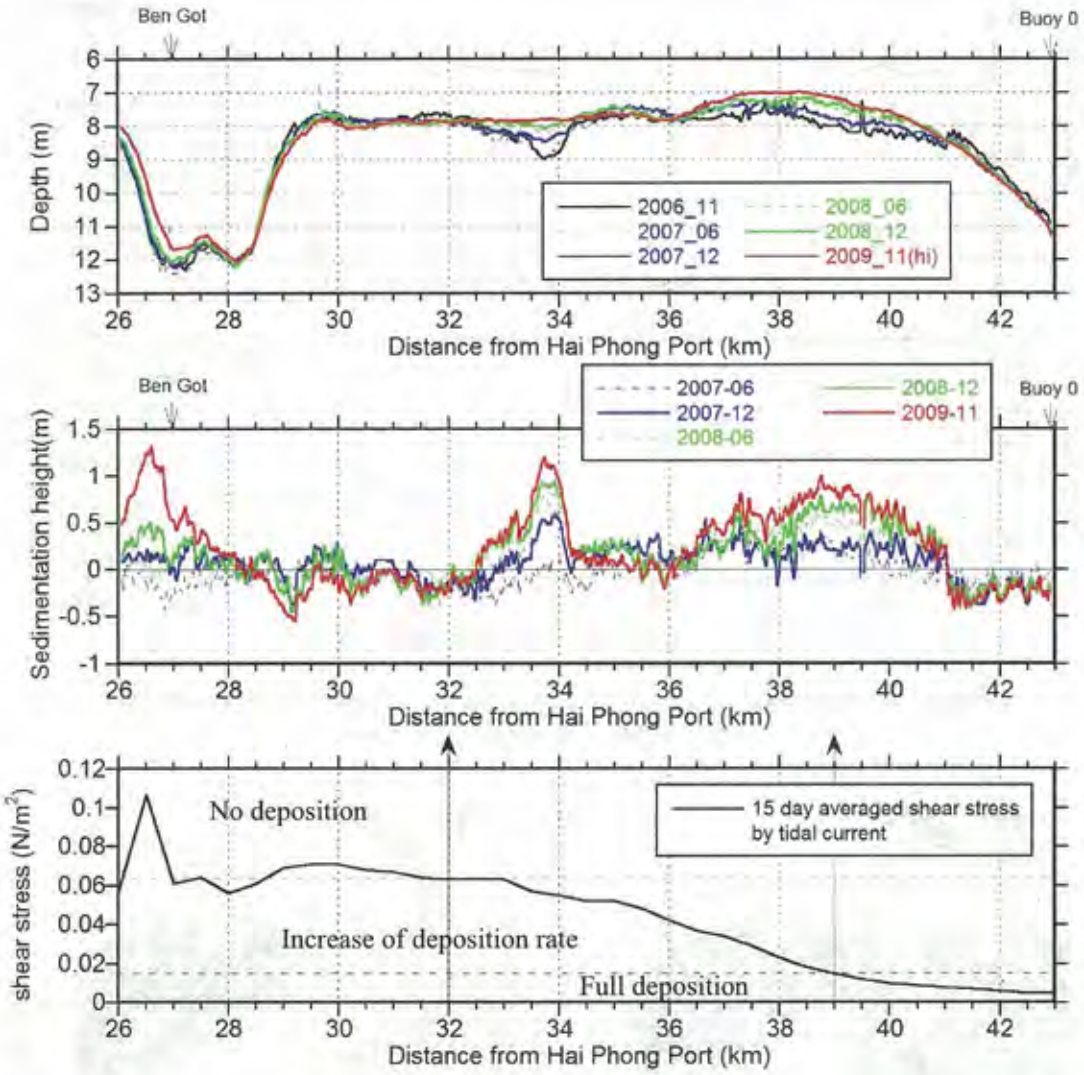

Figure 8.2.14 Longitudinal profile of the channel (top), net depth change based on the survey of November 2006, and 15 day averaged shear stress estimated by tidal current simulation

4) Reproduction of the sedimentation speed

As shown in the previous section, both tidal current and wave affect on the sedimentation process in Lach Huyen channel. In this study, to reproduce actual sedimentation speed along the channel, both simulation results are combined as follows,

$$V_{sed} = \alpha \times \Delta h_t + \beta \times \Delta h_{tw} \times P \qquad (8.17)$$

where V_{sed} is the sedimentation speed (m/year), Δh_t is the net depth change of 15 days simulated with tide alone, Δh_{tw} is the net depth change of 15 days simulated with tide plus wave, α is the coefficient determined by probability of appearance of calm days, β is the coefficient determined by ratio between the total wave energy flux a year and total wave energy flux acted in the simulation, and P is the probability of sediment to deposit and defined as,

$$P = \begin{cases} 1.0 & for\ \bar{\tau} < \tau_{cd} \\ 1-(\bar{\tau}-\tau_{cd})/(\tau_{ce}-\tau_{cd}) & for\ \tau_{cd} < \bar{\tau} < \tau_{ce} \\ 0.0 & for\ \bar{\tau} > \tau_{ce} \end{cases} \quad (8.18)$$

where $\bar{\tau}$ is the 15 day averaged bed shear stress due to tidal current, τ_{cd} is the critical shear stress for full deposition, and τ_{ce} is the critical shear stress for no deposition. The τ_{cd} and τ_{ce} are determined as τ_{cd}=0.015 N/m^2 and τ_{ce}=0.06 N/m^2 by the relation between the actual sedimentation and $\bar{\tau}$ as shown in Figure 8.2.14. The change in P with respect to $\bar{\tau}$ is shown in Figure 8.2.15. The parameter functions as to reproduce the phenomenon that no deposition occurs where the tidal current is strong and deposition occurs where the tidal current is weak.

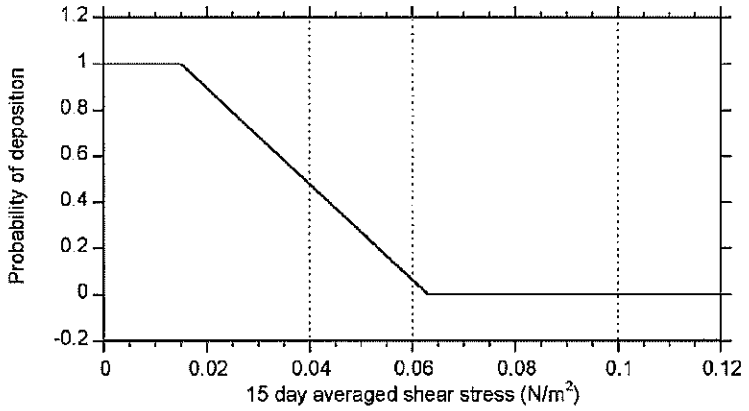

Figure 8.2.15 Probability of deposition

The sedimentation speed estimated by the above method is shown in Figure 8.2.16. In the figure, the case with present topography (Case 1) and the case with smoothed topography of 8 m in the channel depth are shown and compared to the measured data. From the figure, it is confirmed that the estimated sedimentation speed well reproduces the sedimentation pattern along the channel such as slight erosion in the area of Km29-33 and accretion in the offshore area of the channel.

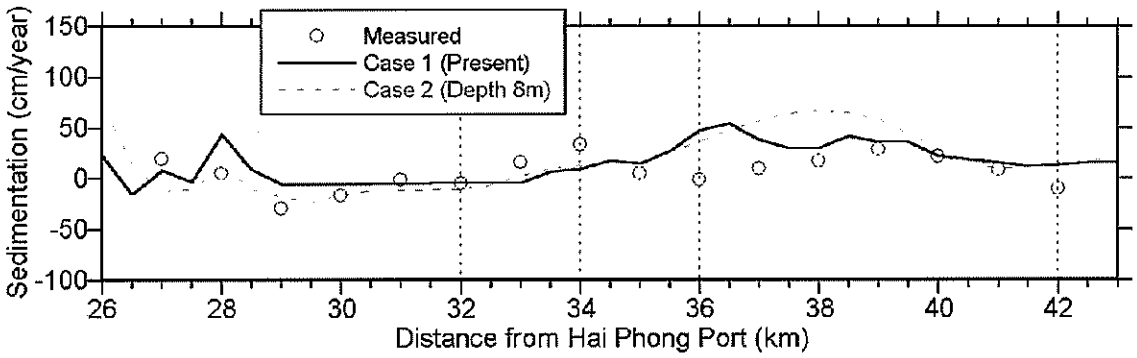

Figure 8.2.16 Comparison between measured and computed sedimentation speed with present topography (Case 1) and the smoothed topography with 8 m in depth (Case 2)

8.2.5 Numerical prediction of future sedimentation

In Lach Huyen channel, channel deepening and widening are planned with the development of the new port facilities. In general, channel deepening will induce further sedimentation and affect smooth port operation. According to the FS-report by TEDI, the sand protection dike of 7,000m along the channel is proposed to reduce the sedimentation. In this study, therefore, numerical simulations of future sedimentation have been carried out to predict volume of sedimentation and to examine reasonable position and length of the sand protection dike.

1) Prediction cases

The cases of numerical simulations are tabulated in Table 8.2.2. The each case contains two simulations which the forcing condition is different, and the sedimentation speed is estimated by the method described in the previous section. The case 1 and 2 are the cases of present situation with about 8 m in channel depth and 100 m in channel width. The cases have been already shown in the previous section in which the reproduction is verified.

The results of case 3 through 7b are presented in this section for the predictions of future sedimentation. The planning depth of the channel is 14 m and the width is 160 m in the area of Km27 to Km36 and 210 m from Km36 to the offshore. The three locations of the sand protection dike are examined in case 5 through 7. The locations of the dike, which are referred as Dike 1, Dike 2, and Dike 3 are shown in Figure 8.2.17. In simulations of case 5, 6, and 7, the sand protection dike is treated as an impermeable wall and in case 7b, the crown height of the dike is set to + 2.0 m, which is the same level as M.W.L., and allows the transmission of wave, current, and sediment transport across the dike when the water level is higher than M.W.L.

Table 8.2.2 List of prediction cases

Case	Channel depth	Forcing Condition	Realization Duration	Port facility / Protection measures
1	7.5m	Tide alone	15 days	None / None, Present situation
		Tide + Wave	15 days	
2	8.0m	Tide alone	15 days	None / None, the smoothed channel bottom with 8m in depth.
		Tide + Wave	15 days	
3	14.0m	Tide alone	15 days	None / None
		Tide + Wave	15 days	
4	14.0m	Tide alone	15 days	Port / None
		Tide + Wave	15 days	
5	14.0m	Tide alone	15 days	Port / Dike1
		Tide + Wave	15 days	
6	14.0m	Tide alone	15 days	Port / Dike2
		Tide + Wave	15 days	
7	14.0m	Tide alone	15 days	Port / Dike3
		Tide + Wave	15 days	
7b	14.0m	Tide alone	15 days	Port / Dike3 with the crown height of + 2.0m C.D.
		Tide + Wave	15 days	

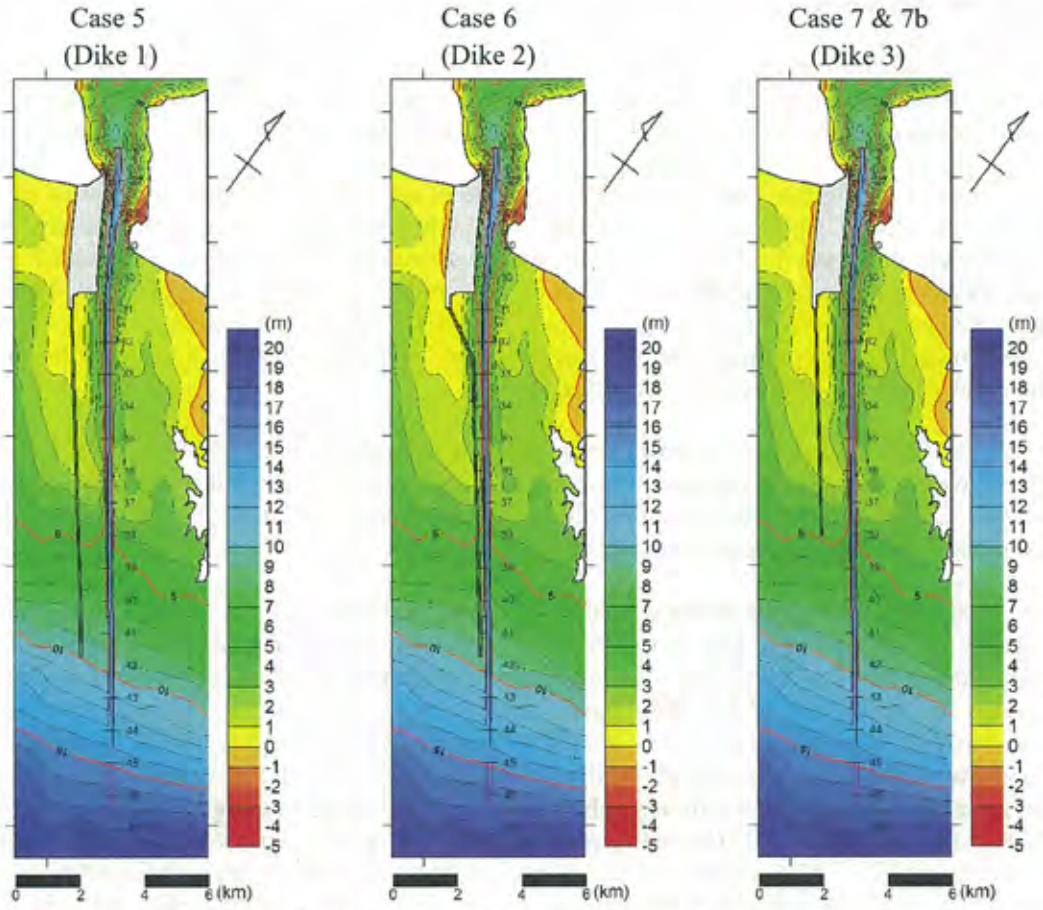

Figure 8.2.17 Positions of the sand protection dike

2) Simulation results

The longitudinal distributions of sedimentation speed estimated on case 3 to 7b are shown in Figure 8.2.18. Also, the comparison of total sedimentation volume is shown in Figure 8.2.19. The total sedimentation volume is calculated by the sedimentation speed, channel width, and channel length.

As shown in the figures, the sedimentation volume of case 3 is the highest and that of case 6 is the lowest. On case 4 which includes just the port facility and no dike, the sedimentation volume is slightly less than case 3 which does not include any structure. The cases of 5 through 7 include the port facility and the sand protection dike. The function of the dike is to prevent the suspended mud generated out the channel from flowing into the channel. Comparing the sedimentation volume among case 5, 6, and 7, it is confirmed that the longer the dike is and the closer to the channel the dike locates, the more effective it is to reduce sedimentation.

The case 7b is the case that the crown height of the dike is set as same as M.W.L. (=+2.0 m, C.D.) and allows wave, current, and sediment transport to pass over the dike when the water level is higher than M.W.L. Comparing the sedimentation volume between case 7 and 7b, the volume of case 7b is larger than case 7, but the difference is not so large.

The summary of the sedimentation volume is shown in Table 8.2.3. In the table, the sedimentation volumes of the first year and that after second year are shown. The sedimentation of 1.2M cubic meters in the first year of present situation (Case 1&2) is the value estimated by analyzing bathymetric survey data. The value is 4.6 times larger than the value after second year. The time variation of sedimentation speed may have been induced by attack of extreme high wave or an effect which some excessive dredging area are rapidly refilled as shown in Figure 8.1.17. As the simulations presented here are based on the actual sedimentation speed after the second year, the rapid sedimentation for the first year is not reproduced. The sedimentation for the first year is, however, generally larger than that of the second year or later, and it should be included the estimation of future sedimentation. Therefore, the values for the first year in the prediction cases (Case 3 – 7b) are estimated by 4.6 times larger than the second year.

Consequently, the simulation results indicate that the construction of the sand protection dike is effective in reducing sedimentation. The details of length, arrangement, and structure should be determined to minimize the life-cycle cost between initial and maintenance cost.

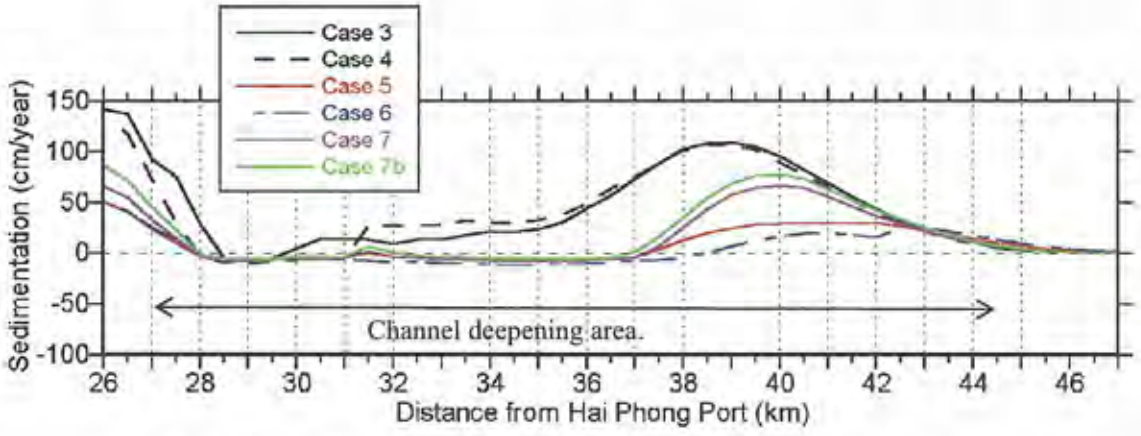

Figure 8.2.18 Predicted sedimentation speed with 14 m in channel depth

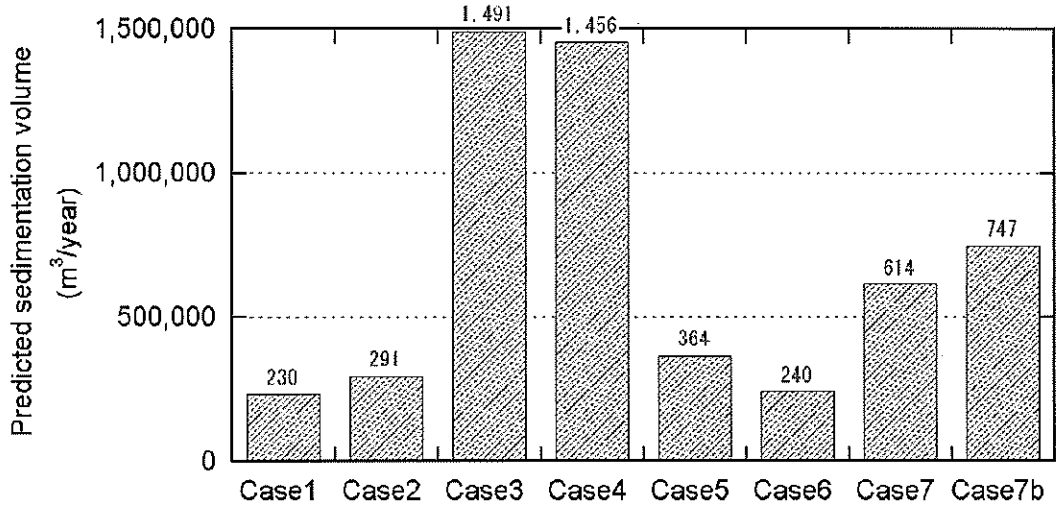

Figure 8.2.19 Predicted total sedimentation volume

Table 8.2.3 Summary of sedimentation

Case	Description	1st year (m^3/y)	After 2nd year(m^3/y)
1&2	8m in depth approximately, Present situation	1,200,000*	260,000
3	14 m, without any structures	6,873,000	1,491,000
4	14 m, with port facilities	6,712,000	1,456,000
5	14m, with port and dike of 10,000m, 1.5km apart from channel	1,678,000	364,000
6	14m,with port and dike of 11,000m, close to channel	1,107,000	240,000
7	14m,with port and dike of 7,000m	2,829,000	614,000
7b	14m, with port and dike of 7,000m (hc=+2m, C.D.)	3,442,000	747,000

*) Estimated by analyzing bathymetric survey data.

3) Sedimentation under construction

Sedimentation will be occurred even under construction work of the port, the sand protection dike, and channel deepening. Figure 8.2.20 shows a plan of work schedule assuming that the channel depth is 14 m and the arrangement of sand protection dike is case 7b. As shown in the figure, it takes 32 months for the completion of initial dredging and 40 months for construction of the dike. To estimate the channel depth at the completion of construction work, sedimentation under construction has been examined below.

These scenarios of dredging method as shown in Figure 8.2.21 were examined. Scenario 1 is the method to dredge from the port area to the offshore, Scenario 2 is the method which is seaward dredging by the location of Km36 at first and shoreward dredging from the offshore end of the channel, and Scenario 3 is the method to dredge from the offshore end to the port area. The sedimentation under construction for the three scenarios are calculated under the following assumptions,

- The effect of the sand protection dike is not included in the estimation because the completion of the dike will be at the end of 2015.
- Therefore, the sedimentation speed along the channel is estimated by the simulation result of

case 3 which is just dredged by 14 m in depth without any structures.

- In each dredging area a year, the sedimentation is calculated from its completion of dredging to the end of 2015.
- The time step of the calculation is 6 months and the sedimentation after dredging is accumulated in the estimation.

Construction Schedule for Lach Huyen Port Project

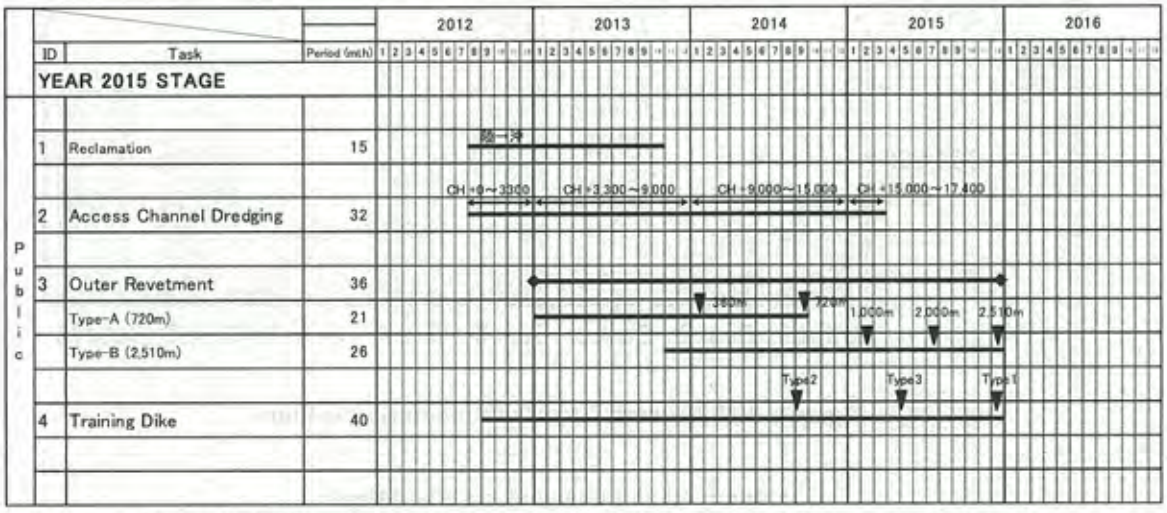

Figure 8.2.20 A plan of construction schedule for Lach Huyen port project

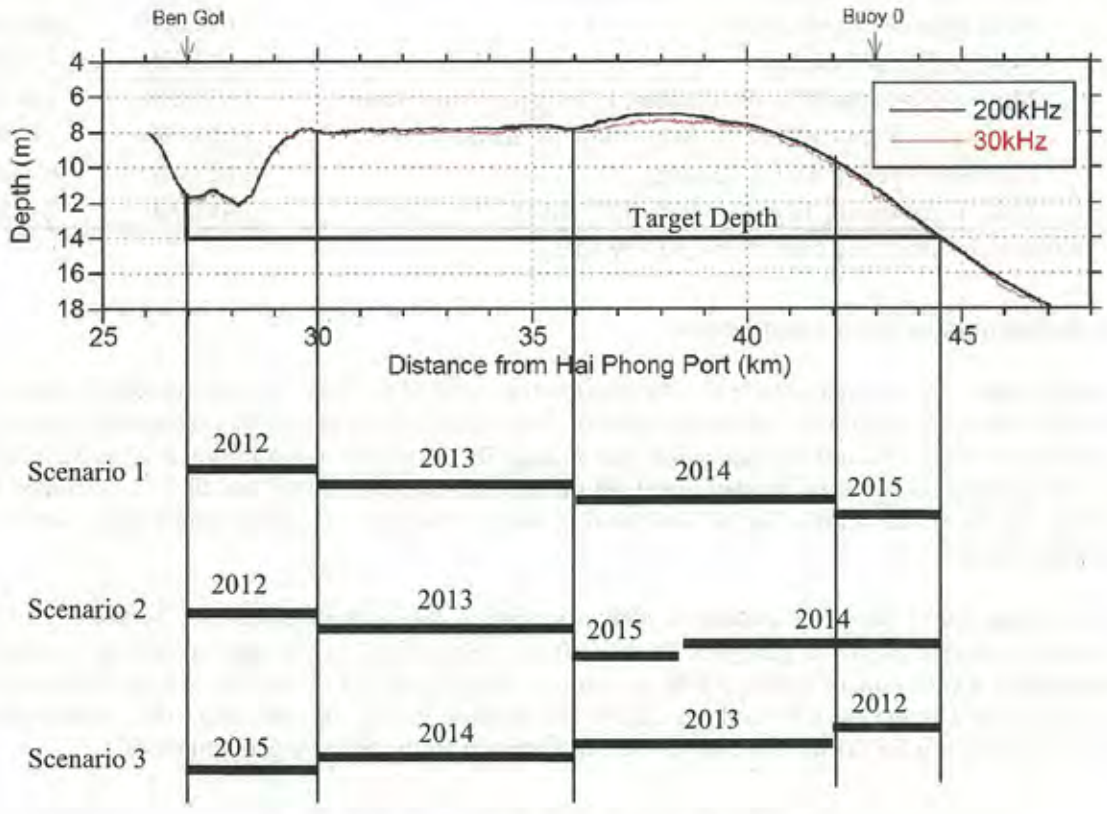

Figure 8.2.21 Scenarios of initial dredging

The sedimentation height along the channel estimated by the above assumptions is shown in Figure 8.2.22 and the averaged sedimentation height and total sedimentation volume are summarized in Table 8.2.4. From these results, the characteristics of sedimentation under construction are obtained as follows:

- Comparing among three scenarios, Scenario 2 shows the lowest sedimentation and Scenario 3 shows the highest.
- The peak of sedimentation appeared around Km39, the height of which is about 1.4m in scenario 1 and 2, and 2.5m in scenario 3.
- In Scenario 2, the reason of the lowest sedimentation is that the term after dredging is short in the area of Km36 to Km42 which shows the largest sedimentation.

These characteristics indicate that the channel depth around Km39 will be shallower than 14m at the completion of initial dredging. Also, the sedimentation under construction may be higher than the estimation because the sedimentation just after dredging tends to be high. Therefore, sedimentation during the construction works should be carefully monitored.

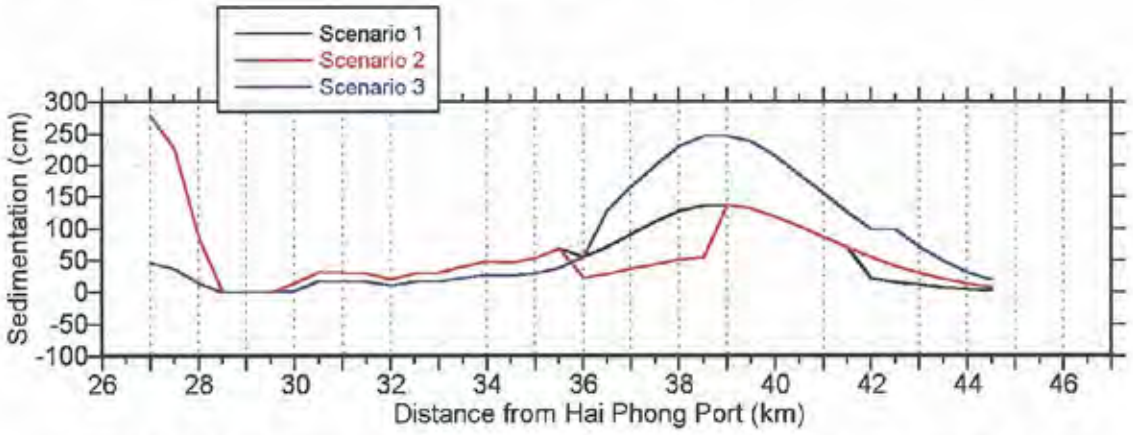

Figure 8.2.22 Estimated sedimentation height under construction, from August 2012 to December 2015

Table 8.2.4 Averaged sedimentation height and total sedimentation volume at the completion of construction (December, 2015)

Scenario	Averaged sedimentation height (cm)	Volume (m^3)
Scenario 1	68.3	2,203,709
Scenario 2	60.0	1,933,947
Scenario 3	90.5	2,919,638

4) Concluding remarks

In this study, numerical simulations were carried out to predict sedimentation of Lach Huyen channel. On the topography of present situation, which is approximately 8 m in channel depth, the sedimentation speed along the channel was reproduced by calibration of the models. After the reproduction phase, sedimentation for the channel deepened by 14 m is predicted and some arrangements of the sand protection dike to reduce sedimentation were tested. Also, sedimentation under construction was examined by using the simulation results. The conclusions obtained here are as follows:

- The sedimentation speed of the present situation is well reproduced in the numerical models on the total sedimentation volume and sedimentation pattern along the channel.
- The simulation results show that the sedimentation volume increased by increasing the channel depth and the sand protection dike is effective in reducing sedimentation.
- Also, as the sand protection dike functions to prevent the suspended mud from flowing into the channel, the longer and the closer to the channel the dike is, the more effective it is in reducing sedimentation. However, the details of length, arrangement, and structure should be determined to minimize the life-cycle cost between initial and maintenance cost.

The sedimentation volume predicted in this study is based on the actual sedimentation speed which is analyzed on the bathymetric survey data of Nov. 2006 to Nov. 2009. The term is the second year or later after the completion of initial dredging. The sedimentation speed is relatively slow and the depth of the channel is almost maintained in 8 m. However, the bathymetric survey data of Oct. 2005 and Nov. 2006 shows the rapid sedimentation in the first year after initial dredging. It is considered that the rapid sedimentation is mainly caused by that the partly deep area on the topography just after initial dredging was refilled rapidly, but the detail mechanism of the rapid sedimentation in the first year has not been clear yet. Therefore, the possibility that the rapid sedimentation occurs every year remains if the maintenance dredging is annually carried out. Thus, there is a risk of rapid sedimentation on the planned channel deepening, and therefore continuous monitoring during and after the port construction work are necessary to check and verify the sedimentation rate.

9. Natural and Social Environmental Conditions

9.1 Overall Information and Compliance for the JBIC Environmental and Social Considerations

9.1.1 Reviewed Reports

As a part of Japanese ODA loan procedures, the SAPROF study team has reviewed the approved environmental impact assessment (EIA) report*1 prepared by Center for Hydrography & Meteorology Network and Environment, MONRE (HYMENET) assigned by VINAMARINE Project Management Unit III in 2008. The proposed EIA and resettlement action plan (RAP) of the connecting highway between Tan Vu and Lach Huyen Port were also reviewed. The detailed comments on the highway EIA and RAP are described in Section 10. Review on Past Studies of Tan Vu-Lach Huyen Highway. Some selected reports were also reviewed to complement the EIA reports for the purpose of the verification of JBIC Environmental and Social Consideration (the JBIC Guideline). The following table is the list of reviewed reports and expected reports for the port project.

*1: Environmental Impact Assessment Report, Lach Huyen gateway port infrastructure construction project, approved by MONRE No.2231/QD-BTNMT, Hanoi 31 Oct. 2008

Table 9.1.1 List of Reviewed Reports

Reviewed Report	
Environmental Impact Assessment Report/ Lach Huyen Gateway Port Construction Project (2010-2015), September 2008	Prepared by HYMENET assigned by PMU III, VINAMARINE
Other reviewed reports	
Feasibility Study of Lach Huyen Gateway Port Construction Project	Transport Engineering Design Incorporation (TEDI) assigned by PMU I, VINAMARINE
Port Capacity Reinforcement Plan In Northern Vietnam, September 2009	Prepared by Nippon Koei Co.Ltd. & Associates assigned by MOT
General Construction Plan of Hai Phong City to 2025 and 2050	Prepared by Planning Institute of Hai Phong assigned by Hai Phong People's committee

9.1.2 Legal Framework of Environmental and Social Consideration in Vietnam

In general, Vietnam legal systems for environmental and social consideration are well developed to avoid unnecessary losses and to secure adequate compensation for the losses as fair philosophy as most of developed countries. Considering the fundamentals of the environmental and social consideration are defined by 1992 Constitution of the Socialist Republic of Vietnam amended in 2001. Under the constitution, the primary laws relevant to the environmental and social consideration are Environmental Protection Law No.52 (2005) and Land Law No.13 (2003). Due to the complexity of the issues and continuous changes in economic development, relevant regulations have been continuously issued to appropriately apply the legislations. Followings are the articles specifically stating the environmental and social consideration in the constitution of Vietnam.

- Article 17: The state's ownership of the land and other natural resources under the ownership of the entire people
- Article 18: State's power to allocate the rite to use
- Article 23: Assurance of Properly and Compensation
- Article 29: Environmental Protection

1) Relevant legislation on Environmental Protection Law, 2005

Year/ Objective	Law and Regulation
2005/ LAW	Environmental Protection Law No.52/2005/QH111
1998/ LAW	Water Resources Law 1998, effective in January 1st 1999
2008/ pursuant to Law on Environmental Protection, Dec.#21/2008/ND-CP, Dec.#80/2006/ND-CP	Circular No. 05/2008/TT-BTNMT guiding strategic environmental assessment, environmental impact assessment and environmental protection commitment, 08 December 2008
2008/ pursuant to Law on Environmental Protection, and amending Dec.#80/2006/ND-CP	Decree No.21/2008/ND-CP dated February 28th 2008 of the Government on amendment of some articles of Decree No.80/2006/ND-CP dated August 9th 2006 guiding the implementation of Environment Protection Law.
2008	Decision No.16/2008/QD-BTNMT dated December 18th 2006 of the Ministry of Natural Resources and Environment on obligatory application of Vietnamese standards on environment
2007/ pursuant to Law on Environmental Protection, Law on Water Resources	Decree No.88/2007/ND-CP dated May 28th 2007 of the Government on drainage for urban and industrial zones
2007	Decree No.59/2007/ND-CP dated April 9th 2007 of the Government on solid waste management
2007	Decree No.88/2007/ND-CP dated May 28th 2007 of the Government on drainage for urban and industrial zones
2006/ pursuant to Law on Environmental Protection, and amending Dec.#80/2006/ND-CP	Decree No.80/2006/ND-CP detailing and guiding the implementation of a number of articles of the Law on Environmental Protection
2006/ pursuant to Law on Environmental Protection	Decree No.80/2006/ND-CP detailing and guiding the implementation of a number of articles of the Law on Environmental Protection
2006	Decision No.22/2006/QD-BTNMT dated December 18th 2006 of the Ministry of Natural Resources and Environment on obligatory application of Vietnamese standards on environment
2006	Decision No.23/2006/QD=BTNMT dated December 26th 2006 of the Ministry of Natural Resources and Environment on list of dangerous waste
2006	Circular No.12/2006/TT-BTNMT dated December 26th 2006 of the Ministry of Natural Resources and Environment guiding the procedures for application, registration, licensing, code issuance for managing dangerous waste.
2002	Decision No.35/2002/QD-BKHCNMT dated June 25th 2002 of the Ministry of Science, Technology, and Environment on list of obligatory application of Vietnamese environment standards

2) Relevant legislation on Land Law, 2003

Year/ Objective	Law and Regulation
2003/ LAW	Land Law No.13/2003/QH111
2010/ pursuant to Land Law, Cir.#14/2009/TT-BTNMT, Cir.#14/2008/TT-BTNMT, Dec.#69/2009/ND-CP Dec.#84/2007/ND-CP	Decision No. 130/2010/QD-UBND on compensation on support & resettlement policy on Hai Phong City
2009/ pursuant to Land Law, pursuant to Dec.#69/2009/ND-CP, Dec.#84/2007/ND-CP	Circular No. 14/2009/TT-BTNMT detailing the compensation, support and resettlement and order of and procedures for land recovery, allocation and lease
2009/ pursuant to Land Law	Decree No.69/2009/ND-CP to amend a number of provisions on land use planning land rental rates land reclamation and resettlement and compensation
2008/ pursuant to Land Law, Dec.#84/2007/ND-CP	Circular No. 14/2008/TTLT/BTC-BTNMT Joint circular on guiding the implementation of a number of articles of the Government's Decree No.84/2007/DN-CP
2007/ pursuant to Land Law	Decree No.84/2007/ND-CP dated May 25th 2007 of the Government on granting land use right certificate, land collection, land use right, procedures for compensation, support, resettlement where the land acquired by the State and complain denunciation
2004/ pursuant to Land Law	Decree No. 197/2004/ND-CP on compensation, support and resettlement when land is recovered by the State. 03 December 2004
2004/ pursuant to Land Law	Decree No. 188/2004/ND-CP on methods of determining land prices and assorted-land price brackets. - 16 November 2004
2004/ pursuant to Land Law	Decree No. 181/2004/ND-CP on the implementation of the Land Law. - 29 October 2004

3) Other regulations related to the Lach Huyen Port Development Projects

- Decree No.71/2006/ND-CP on seaport management and maritime navigation channel dated July 25th 2006
- Decree No.131/2006/ND-CP on Issuance of Regulation on Management and Utilization of Official Development Assistance dated November 9th 2006

4) Decisions related to the Lach Huyen Port Development Projects

- Decision No.202/QD-TTg dated October 12, 1999 of the Prime Minister on approval of Master Plan for Vietnam seaports system to 2010.
- Decision No.04/2001/QD-TTg dated January 10, 2001 of the Prime Minister on approval of revised planning of Hai Phong city to 2020.
- Resolution No.32/NQ-TW dated August 5, 2003 of the Politburo on constructing and developing Hai Phong city in the process of industrialization and modernization.
- Decision No.885/QD-TTg dated August 22, 2004 of the Prime Minister on approval of the detailed planning for northern seaport group (Group 1) to 2010 and orientation for development to 2020.

- Decision No.2561/QD-BGTVT dated August 25, 2004 of the Ministry of Transport on allowing the preparation of Feasibility Study for Lach Huyen Gateway Port Construction Project.
- Decision No.766/QD-CHHVN dated December 31, 2004 of the Vietnam Maritime Administration on assigning the representatives of the Project Owner for making Feasibility Study for the Lach Huyen Gateway Port Construction Project.
- Decision No.2570/QD-BGTVT dated July 27, 2005 of the Ministry of Transport on approval of outline, cost estimation for survey and FS preparation for Lach Huyen Gateway Port Construction Project.
- Decision No.694/QD=CHHVN dated October 23, 2007 of Vietnam Maritime Administration on transfer of projects from the Maritime PMU I to Maritime PMU III.
- Letter No.8327/TTr-BGTVT dated December 25, 2007 of the Ministry of Transport on proposal for approving in principle the investment of Lach Huyen Gateway Port Project.
- Decision No.06/2008/QD-TTG dated January 10, establishing and promulgating regulation on operation of Dinh Vu-Cat Hai Economic Zone
- Decision No 2231/QD-BTNMT dated Oct 31, 2008 of Ministry of Natural Resources and Environment, approving environmental impact assessment of Lach Huyen International Gateway Port Project, Hai Phong.
- Decision No. 3793/QD-BGTVT dated Dec 22, 2008 of Ministry of Transport, approving Construction Project of Hai Phong International Gateway Port (starting phase).
- Decision No.34/2009/QD-TTG dated March 02, 2009, approving the Master Plan on Development of the Tonkin Gulf Coastal Economic Belt up to 2020
- Decision No.1808/QD-CT dated Sep 11, 2009 of Hai Phong City People Committee, approving steering committee establishment of the city on Hai Phong International Gateway Port Project
- Decision No.1448/QD/TTG dated September 16, 2009, approving adjustment on general plan on developing Hai Phong city up to 2025 and vision to 2050

9.1.3 Compliance with the JBIC Guideline of the Proposed Port Project

In principal, JICA respects the legal framework of the borrower's environmental and social considerations. However in the case of the borrower's legal framework and common practices for such consideration are significantly different from regional practices or/and internationally acceptable level, JICA may request the responsible authorities of the ODA recipient(s) to reconsider the acceptable level of environmental and social consideration to grant the ODA. Due to the recent reorganization of the Japanese ODA agencies in 2008, specifically JICA and Japan Bank for International Cooperation (JBIC), "Guidelines for Confirmation of Environmental and Social Consideration, April 2002 by JBIC" (the JBIC Guideline) is applied for the proposed Lach Huyen Port project.

1) Principles of the JBIC Guideline and Vietnamese Requirement

Principles of the JBIC Guideline and comparison of the JBIC Guideline's and Vietnamese regulations on environmental and social consideration are shown in Appendix 9-1. By the definition of the effective law and regulations of Vietnam, coverage and requirements of the EIA meet the JBIC Guideline except the analysis of the alternatives. Although the requirement of the Vietnamese EIA does not fulfill the definition of the JBIC Guideline, the analyses of the alternatives are certainly examined in the "Feasibility study report" of the assessed project, which is required for the appraisal of the EIA. The view point of such alternative analyses may not specifically focus on preventing or minimizing adverse impact and choosing a better project option for environmental and social considerations. Thus, additional analysis for alternatives may be needed in case the assessment of the alternatives by the feasibility study does not suit the JIBC Guideline. Following are the principles of the JBIC Guideline.

Table 9.1.2 Principles of the JBIC Guideline (Summary)

Principles	JBIC Policy
a) Examination of Measures	· Examination of multiple alternative proposals to prevent or minimize adverse impact and to choose a better project option for environmental and social considerations (Priority is the prevention of the impact, and when it's not possible, minimization and reduction are considered next. Compensation measures must be examined only when impact cannot be prevented · Preparation of appropriate follow-up plans and systems, costs of such plans and systems, and financial methods to fund such costs
b)Scope of Impact to be Examined	· Examination of environmental impact (air, water, soil, waste, accidents, water usage, ecosystems, and biota) and social concerns (involuntary resettlement, the indigenous people, cultural heritage, landscape, gender, children's rights and communicable diseases, and trans-boundary and global environmental problems)
c) Compliance with Laws, Standards and Plans	· Compliance with national and local laws, ordinances and standards relating to environmental and social considerations as well as environmental and social consideration policies and plans of the jurisdiction over the project · Principal avoidance of protected areas specifically designated by laws or ordinances of the government for the conservation of nature or cultural heritage
d) Social Acceptability and Social Impacts	· Appropriate acceptability of the project in the country and locality of the project site · Sufficient consultations with stakeholders, appropriate disclosure of project and impact information, incorporation of the outcome of such consultations into the project plan/design · Appropriate consideration for vulnerable social groups, such as women, children, the elderly, the poor, and ethnic minorities
e) Involuntary Resettlement	· Avoidance of involuntary resettlement and loss of means of livelihood, where feasible, exploration of all viable alternatives and effective measures to minimize impact and to compensate for losses, and agreeable measures for the loss · Assurance of sufficient compensation for the project affected people's losses (land and monetary compensation) and supporting the means for an alternative sustainable livelihood, and providing the expenses necessary for relocation and the re-establishment of a community at relocation sites at least as same level as pre-project condition in timely manner · Appropriate participation by the affected people and their communities in planning, implementation and monitoring the counter/compensation measures
f) Indigenous People	· Special safety guard for indigenous people to respect their rights in relation to land and resources in accordance with the spirit of the relevant international declarations and treaties · The consent of indigenous people
g) Monitoring	· <Desirable> by the project proponents to monitor: (i) whether any situations that were unforeseeable before the project began have arisen, (ii) the implementation situation and the effectiveness of the mitigation measures prepared in advance, and that they then take appropriate measures based on the results of such monitoring · <Desirable> making results of the monitoring process available by project proponents to project stakeholders · <Desirable> assurance of a forum for discussion and examination of countermeasures with the participation of stakeholders in the relevant project in the case of the improper care for the environmental and social considerations after the project implementation

2) Compliance of the Approved Lach Huyen Port EIA with the JIBC Guideline

Considering the compliance of the EIA report of Lach Huyen Gateway Port Construction Project (2010-2015), it principally complies with the JBIC Guideline except the proper consideration for the coastal fishing activities, which is beyond the Vietnamese safeguard policies at this moment. Such issues were pointed out by JICA at the fact finding mission in April 2010. Although there are few legal frameworks to address such issues under the present Vietnamese laws and regulations, the responsible agency to handle such issues is likely to be correspondent people's committees such as province or municipality and relevant districts and communes, which follows the safeguard policy of effective land law. Although MPMU II is not the responsible agency to develop the safeguard policy for coastal fishing activities, as the responsible implementation agency of the Lach Huyen port construction, MPMU II agreed to propose the additional safety guard measures with the consultation with Hai Phong City and Cat Hai district PC as well as other necessary authorities, if any, by the end of April 2010 to meet the JIBC Guide line.

In addition to the consideration for coastal fishing activities, slight gaps between Vietnamese involuntary resettlement policy and the world bank's involuntary resettlement policy (OP 4.12) is reported by a resettlement action plan* of "Tan Vu-Lach Huyen Highway Project" and the ongoing resettlement policy framework of "Northern Delta Transport Development Project**" by MOT supported by the world bank. Considering the applicable policy frameworks for the Lach Huyen port, the resettlement policy framework of the Northern Delta Transport Development Project should be applied due to the consistency of the ODA projects in the same region.

* Volume-IV: Resettlement Action Plan/ Planning Construction Investment Project, Tan Vu-Lach Huyen Highway Project in Hai Phong City, 14 July 2009 prepared by Japan Bridge & Structure Institute, HYDER Consulting, and Highway Engineering Consultants Joint Stock Company
** Project Appraisal Document on a Proposed Credit in the Amount of SDR 104.4 Million To the Social Republic of Vietnam for a Northern Delta Transport Development Project, 19 May, 2008, Transport, Energy and Mining Unit, Sustainable Development Department, East Asia and Pacific Region, The World Bank <http://web.worldbank.org/external/projects/main?pagePK=64283627&piPK=73230&theSitePK=40941&menuPK=228424&Projectid=P095129>

The detailed consideration of the safeguard policy for the coastal fishing activities and involuntary resettlement is described in PART-2: Medium Term Port Development Plan, Chapter 13. Consideration of Natural and Social Environment and the recommendable frameworks are given in PART-3: Implementation Plan as Japan's ODA Loan Project, Chapter 22.Mitigation Measures for Environmental Impacts.

Following are the summary of the compliance with the JBIC Guideline and the approved EIA and relevant documents.

Table 9.1.3 Summary of the compliance with the JBIC Guideline and the port EIA

Principles	Remarks
a) Examination of Measures	· Although the requirement of the Vietnamese EIA does not fulfill the definition of the JBIC Guideline, the analyses of the alternatives are examined in the feasibility study of Lach Huyen Gateway Port Construction Project, which is the attachment of the EIA report for the approval. · Three (3) alternative locations are comparatively evaluated from economic, environmental and social viewpoints on comprehensive manner. It is concluded that Lach Huyen as the most appropriate location. The other two alternative locations are 1) Cam Pha in Quang Ninh Province located north of Lach Huyen and 2) south of Do Son located south west of Lach Huyen, also located in Hai Phong. In environmental and social view points, Cam Pha and Do Son were not selected due to the significant impacts by the inland waterway access to the port through the world heritage-Ha Long Bay and the significant impacts on beach

Principles	Remarks
	resort oriented eco-tourism development respectively. · In addition to the selection of the project site, selection of the port structure and facilities were technically examined. Such technical consideration does not focus on the reduction of the environmental and social impacts, but in general the economical and technical options could be considered as the favorable options environmentally and socially.
b) Scope of Impact to be Examined	· Potential impacts on natural environment are well covered though it lacks the seasonal information. The seasonal information shall be added and monitored under the responsibility of the implementation agency and operator, which will be conducted in detailed design stage and specified in environmental management plan. · Potential impacts on social environment are also covered except coastal fishing activities as mentioned above. This SAPROF study conducted two sample surveys to understand the potential impacts on the coastal fishing. · Due to the change in design to add public portion on the Cat Hai island and the reclaimed land, the impacts on the extended portion on the Cat Hai island are additionally examined in this SAPROF study.
c) Compliance with Laws, Standards and Plans	· The approved EIA is fully compatible with the effective national law, regulations and standards. The Lach Huyen port is one of the key components of the general plan on developing Hai Phong city up to 2025 and vision to 2050.
d) Social Acceptability and Social Impacts	· Throughout the public consultation required by law and additional public hearing requested by JICA and conducted by MPMU II in April 2010, it confirmed that the port development projects are fully accepted by the community. At the additional public hearing in April 2010, announcement of the concrete project schedule and consideration for the costal fishermen were requested by the representatives of the local communities. MPMU II agrees to address the mentioned opinions with the collaboration with responsible authorities.
e) Involuntary Resettlement	· Due to the offshore construction, there are minimal requirements for the involuntary resettlement except coastal fishing activities. · Though some land clearance is required for the public facilities added by the change of design, the additionally required land clearance on Cat Hai island does not require any house resettlement but some community woods, tombs and aquaculture ponds. Though the specific land acquisition plan was not completed by the end of April 2010, people's committee of the Cat Hai dist, the responsible authority for the land clearance, has already consulted with the relatives of the potentially resettled tombs and received general acceptance of the resettlement. · The additional safeguard policies for coastal fishing activities is ongoing process of development at the end of April 2010, but such policies shall adequately treat project affected people due to the MPMU II and people's committee of the Hai Phong city's proactive intentions to treat people adequately.
f) Indigenous People	· It is not applicable for the proposed project.
g) Monitoring	· The monitoring program is strictly required by Vietnamese law and described in the EIA report, which is likely to meet the JBIC Guideline. · Reporting of the environmental monitoring and assurance of the adequate environmental management are also required by Vietnamese law and regulation, which secure the environmental and social consideration after the project implementation.

9.2 Natural Environment

Natural environmental condition in and around the Cat Hai Island, the target area for the Lach Huyen Gateway Port Development Project is described below principally based on the Chapter 2 on baseline (existing) condition as described in the finally approved EIA Report (2008) formulated by HYMENET (Center for Hydrography & Meteorology Network and Environment of MONRE). The final EIA report was approved by MONRE (Approval Letter No. 2231/QD-BTNMT dated 31 October 2008) for the project scale of the Lach Huyen Gateway Port corresponding to the capacity requirement for 2010-2015 as also indicated in the title of the EIA report (port development with the first 2 berths for container cargo and general cargo and the related works).

9.2.1 Location

Lach Huyen gateway port is planned as offshore extension of the southeastern corner part of the Cat Hai Island belonging to the Cat Hai District of Hai Phong city. The planned port area is located on the right side of Lach Huyen Estuary and Cat Ba Island (also belonging to the Cat Hai District) is located on the left side of the Estuary. Most of the western part of both the terrestrial and coastal seawater environment (Lan Ha Bay and also the southern part of Ha Long Bay) of Cat Ba Island is a well-known protected ecotourism area (Cat Ba National Park/Man and Biosphere reserve of UNESCO). Phu Long area in the eastern part of Cat Ba Island (that also includes the ferry terminal of Cai Vien) is the closest region to the Cat Hai Island across the Lach Huyen Estuary that also includes the vicinity of the planned gateway port development area located toward the south of the existing passenger boat terminal of Ben Got. This area also has the narrowest width of Lach Huyen Estuary of about 1000m (in between Cat Hai and Cat Ba islands).

This Lach Huyen Estuary is a part of the access channel for ships and vessels for Hai Phong port (existing port located inland along the right river bank of Cam River) to the open sea, as of the existing condition. This offshore access channel is a dredged one and at present its depth is about 7.8m.

Accordingly the shipping activity with vessel movement along Lach Huyen Estuary (offshore transport industrial activity) and the nearby Cat Ba Island in which most of its western part is a protected area (Cat Ba Nation Park, a nature reserve area) has been coexisting over a long period of time with no apparent adverse effects on the protected national park of Cat Ba Island.

9.2.2 Meteorological Features

1) Temperature

Cai Hai Island is located in the tropical wind region; its weather condition is moderate, less severe than neighboring inland mainland areas. Air temperature (literally known as temperature), in overall, is similar to tropical zone and is quite high (>210C) and does not vary much during months in a year. The average annual temperature varies in between 23°C to 24°C. There are two seasons per year and the temperature differ 11-12°C in each season.

- Winter season (November to March): Average temperature is below 20°C. January has the lowest temperature that varies in between 16°C-17°C with 10°C being the lowest.
- Summer season (May to October): Average temperature is 25°C. July has the highest temperature that varies in between 28°C-29°C with 32°C-33°C being the highest.

2) Rainfall

Similar to temperature variation induced 2 seasons of winter and summer, there are also 2 season induced by change in rainfall, namely rainy season and dry season in Cat Hai Island with rainy season from May to October and dry season from November to April. The average rainfall in the area ranges from 1,700 to 1,800 in which 85-90% of precipitation occurs in the rainy season.

High intensity rainfall due to tropical storm occurs during in the beginning of summer, normally in the afternoon. In particular in July and August, high intensity rainfall caused by tropical converge occurs for extended period of days that causes flooding. High intensity rainfall is a feature of summer season in general.

The rainfall distribution in the dry seasons is quite stable, interspersed with drizzle rain. Number of rainy days in a year defined as a day with a rainfall $\geq$ 0.1mm in Cat Hai area is about 113 rainy days accounting for 31% of days in a year. Drizzly rain is a feature confined to the northern regions of Vietnam. In drizzly days, the humidity is very high, approximately 100%. The number of drizzly days in Cat Hai is quite low compared to the nearby coastal areas in the mainland like Bai Chay and is about 11 days per year (Bai Chay has about 24 days per year) and concentrate mainly in February, March and April. The volume of drizzly rain is not much but it contributes significantly to the wellbeing of floral ecosystem. However, drizzly rain causes certain adverse effects, in particular on waterway transport, due to its poor visibility.

3) Air Humidity and Evaporation

The most humid time in a year in Cat Hai area and its surrounding mainland areas like Bai Chay is from February to August and the air humidity ranges at about 85 to 90% or even higher. This is the highest humid region of the country. Although the average air humidity is quite high, it still decreases very rapidly and becomes dry in winter season. In Cat Hai in particular, the survey data in 1999 in National Park registered the lowest value of 16% (December).

The average annual evaporation is about 700mm. During the dry season, the evaporation is higher than precipitation as could be expected that results in dryness and water shortage as well.

4) Solar Radiation

The pattern of solar radiation in the Cat Hai area is quite well defined though its annual distribution is still varied. The total quantity of solar radiation in a year is 107-108 kcal/cm2. Solar radiation at the end of winter and beginning of spring is only about 40 to 50% of summer months. The cloud thickness above Cat Hai Island is quite large, especially in winter days that very significantly hinder solar radiation.

Cat Hai area has in total about 1,650 to 1,750 sunny hours per year, higher than nearby coastal mainland area like Bai Chay. In summer, the total number of sunny hours is about 160-220 hours per month. In the beginning of spring, this decreases to only about 50 to 60 hours per month.

5) Wind

In Vietnam, in general, there are 2 major wind directions, namely, Northeast in the winter and Southwest in the summer. However, due to the regional location and topographical feature, the predominant wind direction could change. Moreover, due to the specific location of Cat Hai island, which is protected by larger Cat Ba island, the predominant wind direction in summer is Southeast or South. Besides the above feature, sea wind also plays an important role to regulate the weather condition in the island. This explains why this area is nominally warmer in the winter and cooler in the summer resulting in rather moderate weather condition throughout the year as noted above under temperature. The average wind speed in Cat Hai Island is rather stable throughout the year that ranges from 3.0 to 3.9 m/sec. High (maximum) wind speed at times causes significant adverse effects on normal socioeconomic activities, which ranges from 10 to more than 20 m/sec in Cat Hai Island. High wind speed in winter is normally caused by northeast wind during the end of the season. In the summer, high wind speed is nominally caused by thunder storms and tropical cyclones. During the spring and autumn, the high wind speed is caused by thunder storms.

6) Some Specific Weather Conditions

a) Fog

Though fog represents a good and stable climatic condition it limits visibility and hence affects safety in transportation. Number of foggy days recorded in nearby mainland coastal areas like Bai Chay varies from 13 to 30 days per year. Still, in Cat Hai area foggy condition is very rare and was recorded only 2 times over the past 5 years.

b) Rain storm

Rain storm is basically electric transmission between two clouds or between cloud and ground resulting in irradiation and thunderbolt. In Cat Hai area rainstorm occurs 40 to 45 days on average in a year same as other nearby coastal mainland areas like Bai Chay. Most rain storm days months are during the three months from June to August in which the number of rain storm days in a month ranges from 7 to 9 days. Rainstorm results in development of a large volume of cloud, rain, and whirlwind. This should be carefully taken into consideration in construction planning in particular.

c) Tropical cyclone

Tropical cyclone comprises both storm and tropical low pressure resulting in great atmosphere turbulence. This causes 3 most typical natural calamities, namely, strong whirlwind, heavy rain and rise in water level in coastal sea waters and rivers.

The most affected area by tropical cyclone is the northern coastal area with the frequency of about 0.62 times/100km/per year. Cat Hai Island, in general, is affected by 6-11 tropical cyclones in every decade (10 years). The maximum wind speed recorded during typical tropical cyclone is about 40 to 50m/s. Potential rise in sea level due to tropical cyclone need to be duly considered in the planning, design and operation of port facilities in Cat Hai Island.

9.2.3 Hydrographical Features

1) Tidal Condition

Tidal condition in Cat Hai island is defined as homogenous tidal condition with up (high) once and down (low) once tides level every day. The tide water level follows sine-wave form. The time of rising tide is slightly shorter than the time of falling tide. The tidal volume has 2 periods in a month with amplitude of 2.6-3.6m. The tidal condition in Cat Hai Island is almost same as in Hon Dau Island. The average monthly tidal variation is normally over 3.5m. The water level observed at Hon Dau is as follows:

- Average water level: 1.9m
- Highest water level: 4.21m (22/10/2985)
- Lowest water level: -0.07m (21/12/1964)
- Highest amplitude of tide: 3.94m (23/12/ 1968)

2) Wave Condition

High wave condition generally occurs in May and November while strongest wave condition occurs in July and September (h=5.6m).

3) River Flow

The river flow at Hai Phong coastal area is affected by river flow of Cam River, Bach Dang River, Chanh River and tidal level and hence very complicated. There is a strong interaction among factors

including water level, river-bed's topography, wave, wind, and tide. Based on the results of past surveys and studies at the Bach Dang Estuary and the surrounding coastal area, during winter when the wind and wave conditions are stable, the river flow is mainly influenced by tidal flow and differences in water level.

When the tide goes down in the Nam Trieu and Lach Huyen estuary, the flow in rivers may reach even up to 1 m/s. The average flow velocity in rivers is in the range of 40 to 60m/s. In reality, such high flow speed when tide level goes down results in erosion in riverbed. It is also noted that the river flow, even when the tide goes down, runs toward the Lach Huyen direction.

9.2.4 Environmental Condition in Cat Hai Island and its Vicinity

1) Ambient Air Environment (including noise and vibration)

The ambient air quality (including noise and vibration) was measured as part of the baseline primary data collection for the EIA Study at 5 sampling locations in Cat Hai Island in May 2006. The relevant meteorological factors (temperature, humidity, wind direction and velocity) were also measured at the sites in addition to the ambient air sampling work and noise and vibration measurements. The air quality parameters measured in laboratory are CO, NO2, SO2, dust (suspended particulate matter) and lead. The analysis results as expected confirmed that the ambient air environmental quality in Cat Hai Island is very clean with low noise and vibration effects, which fully satisfied the relevant national standards of Vietnam on ambient air quality (TCVN 5937-2005) and noise and vibration (TCVN 5949-1999 on noise and TCVN 6962-2001 on vibration).

It is noted that Cat Hai Island is very small and surrounded by open sea environment facilitating active air exchange between land and sea. Moreover, at present there is no significant economic or industrial activity to cause any significant air quality deterioration or noise and vibration. Major activity is confined to the 2 areas of ferry terminal in Ninh Tiep and passenger terminal in Ben Got only, where the frequency of ferry and passenger vessel transport is rather low.

2) Soil Condition

The soil condition (surface earth soil) was measured as part of the baseline primary data collection for the EIA Study at 5 sampling locations in Cat Hai Island in May 2006. To assess the soil condition including its quality the following parameters were measured. They are, soil composition, weight, oil and 6 heavy metals (Cu, Pb, Zn, Cd, As, Hg).

With respect to soil composition, the size≥0.02mm is most prevalent (mostly more than 80%), while the size ≤0.002 is least prevalent (mostly less than 5%). Hence the soil type is regarded as relatively coarse in nature. Regarding soil quality it is assessed as uncontaminated with respect all heavy metallic parameters measured and fully in compliance with the national soil quality standards of Vietnam (TCVN 7209-2002) and hence the soil quality is regarded as of natural condition.

3) Groundwater Quality

The public potable water supply system is not yet available in Cat Hai Island (the project area), and therefore the water for daily life is sourced from the dug-wells of 3-7m depth. The groundwater quality was measured as part of the baseline primary data collection for the EIA Study at 5 locations of existing dug-wells in Cat Hai Island in May 2006. The groundwater quality parameters measured include: pH, NO3, Fe, Hg, Pb, Zn, Total coliform and Fecal coliform. The groundwater quality is assessed as good with respect to all physical and chemical parameters measured and in conformity with the relevant national standards of Vietnam (TCVN 5944-1995). However, significant bacteriological contamination is noted. Accordingly, the groundwater is assessed as non-potable for direct consumption. Still, it is regarded as potable after boiling.

4) Coastal Estuarine Seawater Quality

The coastal seawater quality was measured as part of the baseline primary data collection for the EIA Study at 5 offshore sampling locations along the Lach Huyen Estuary in May 2006. These 5 offshore locations are basically along the access canal for existing Hai Phong Port and its vicinity (geographically located in between Cat Hai and Cat Ba islands), which is also the offshore location planned for the port development. The samples were taken at 3 different seawater depth levels, the surface, mid-depth, and near seabed (bottom). The seawater quality parameters analyzed included pH, temperature, turbidity, DO, TSS, BOD5, NH3-N, Cl-, F-, fenol, SO4-, CN-, Mn, Fe, As, Cd, Pb, Cr6+, Cr3+, Cu, Zn, Hg, total oil and total coliform.

The result of analysis indicated that the quality of the seawater in the project area is quite satisfactory and basically meets the relevant national standards of Vietnam (TCVN 5943-1995), in particular for industrial offshore water use like port water use. Still, considering the fact that this offshore area (Lach Huyen Estuary) is not yet a port water use area but is actually located in the proximity to the Cat Ba Island, most of which is protected national park (even though the protected area is located along the western part of Cat Ba Island opposite to the coast of Lach Huyen Estuary), the coastal seawater quality is assessed as slightly polluted for coastal water located in the proximity of an important national park (Cat Ba National Park). In particular seawater quality is evaluated as slightly deterioration with respect to ammonium level (NH3N), heavy metallic content of lead (Pb) and oil content in water. Seawater pollution due to oil content (even though pollution is still slight) in Lach Huyen Estuary is an issue potentially directly related to maritime transport including this project formulation.

5) Sediment Quality in Estuarine Seabed

The seabed material (sediment) quality sampling was done as part of the baseline primary data collection for the EIA Study in May 2006 at the same seabed locations of the 5 seawater quality sampling locations along the Lach Huyen Estuary as described above (item (d)). The seabed (sediment) quality parameters measured included 6 heavy metals (Cu, Pb, Zn, Cd, As and Hg) and total oil content in sediment.

No analysis of the results are included in the EIA Report that could be also attribute to lack of national standards in Vietnam concerned to sediment quality. Still as guidance the results of sediment quality were evaluated using the Sediment (dredged material) Quality Standards of Netherlands as given in the reference document of the World Bank (WB) "Environmental Considerations for Ports and Harbor Developments" (1990). Consequently, it is confirmed that all 6 heavy metals and oil content measured in all 5 location are within the limit of "Reference Value" according to the above standards of Netherlands, representing sediment quality under natural condition. Accordingly, the seabed sediment in the planned project area is regarded as unpolluted (in natural condition).

In addition seabed material quality in the planned dredging and reclamation area for this planned project was measured as part of this update natural condition survey at 80 number of seabed locations as also described in Chapter 7. The results of seabed material quality are also given in Section 7.3.1 of Chapter 7. The results obtained (with respect to the statistically relevant values) were evaluated using the Standards of Netherlands as shown in Table 9.2.1 of below. Accordingly, it is concluded that the seabed surface targeted for dredging in overall is not significantly contaminated and hence the dredged material is suited for unrestricted disposal management.

Table 9.2.1 Evaluation of Lach Huyen Port Seabed Quality

Parameter	Statistically Relevant Values (mg/kg)			Standards of Netherlands* (mg/kg)			Remarks
	Range	Mean	Median	Reference Value	Testing Value	Signaling Value	
Cu (Copper)	5.39~ 69.09	22.96	37.23	36	90	400	Slight contamination
Pb (Lead)	15.89~ 95.46	49.56	55.68	85	530	1000	Extremely slight contamination
Zn (Zinc)	35.69~ 249.35	106.41	142.52	140	1000	2500	Slight contamination
Cd (Cadmium)	0.12~ 1.86	0.75	0.99	0.8	7.5	30	Slight contamination
As (Arsenic)	0.51~ 6.38	1.88	3.45	29	85	150	No contamination (Natural condition)
Hg (Mercury)	0.13~ 1.47	0.45	0.80	0.3	1.6	15	Slight contamination
Cr (Chromium)	19.11~ 89.31	52.47	54.21	100	480	1000	No contamination (Natural condition)
Ni (Nickel)	10.00~ 52.90	29.03	31.45	35	45	200	Somewhat slight contamination
Total Oil Content	9.98~ 499.82	64.57	254.90	50	3000	5000	Slight contamination

*Source: Environmental considerations for ports and harbor developments (1990), World Bank technical paper 126
Reference value: Limit of guidance value representative to natural condition
Testing value: Limit of guidance value representative to allowable contamination
Signaling value: Guidance value representative to high level of contamination

6) Ecological Condition

Ecological condition survey targeting the aquatic seawater (estuarine seawater) and seabed environment of Lach Huyen Estuary of the project area and also the wetland coastal area of Phu Long region in Cat Ba Island (Cai Vieng ferry and passenger port terminal area of Cat Ba Island belongs to Phu Long region), the coastal region of Cat Ba Island located closest to the planned port area (the narrowest strait of Lach Huyen Estuary separating Cat Hai and Cat Ba Islands with a width of about 1000m) was also conducted in May 2006 as a very significant component of the baseline primary data collection for the EIA Study.

The proximity of Cat Ba Island to the planned port area in which most of its western terrestrial and coastal marine water environment is a protected national park (Cat Ba National Park) as also noted under Item (1) on Location also imparts the importance for the conduct of baseline (existing) ecological condition survey in the project area and its vicinity. Still, this survey was conducted only once in May 2006 (in fact all environmental surveys mentioned above are conducted only once in the same month of May 2006). This one time only survey without accounting for any seasonal variation (dry season and wet season, to be the least) is an important limitation of the ecological condition survey to have a broad interpretation of the results obtained. In addition to the primary sampling work, available past study data were also used in the EIA Report to elaborate both the existing (baseline) estuarine seawater and coastal wetland (Phu Long coast of Cat Ba Island) ecological condition of the project area and its vicinity.

The seawater and seabed areas targeted for surveys on aquatic marine ecology are the same 5 locations of Lach Huyen Estuary for seawater and sediment quality sampling as described under foregone items of (d) and (e). The marine (estuarine) ecological parameters measured included; phytoplankton and zooplankton in estuarine seawaters and benthos in estuarine seabed. Wetland ecological condition survey in Phu Long region of Cat Ba Island focused entirely on coastal floral ecology along 2 transects in perpendicular directions that also included seaweed species in the area. Regarding the ecological condition of higher order marine organisms like fish basically available secondary data were referred

for the EIA Study. Still, all survey results, in consideration to the limited one time sampling and the 5 sampling locations that are rather close to each other, were comprehensively analyzed in the EIA Report with reference to other available past survey results in Lach Huyen Estuary and its vicinity.

a) Phytoplankton in Estuarine Seawaters

Phytoplankton species are very small flora. They are very significant to marine ecological system as the primary producers for producing organic substance from inorganic substance (with photosynthesis) and are important source of food for larva and other young individual marine fauna including zooplankton. Phytoplankton species are unicellular in nature though they can connect with each other and become a chain. In case of blooms due high availability of nutrients (consequent to water pollution), they can connect and become a floating membrane on the water surface and create even red tide. Therefore, they are considered as important biological indicators of water environmental quality with their excessive concentration visually serving as indicators of water environmental pollution.

In total 135 species of phytoplankton are identified based on the survey results, which is in agreement with previous surveys in the area. No water quality deterioration that could be attributed to excessive concentration of phytoplankton is evident in Lach Huyen Estuary.

b) Zooplankton in Estuarine Seawaters

Zooplankton is very important to the food chain as the basic food source of animal origin (phytoplankton is the primary food source of vegetable origin) for the development of diverse fauna ecosystem composed of fish and other higher order marine fauna. They are the basic animals in the chain of food consumption (primary consumers) and they consume phytoplankton and organic humus thereby converting primary food sources (vegetable origin) into higher form of meat (animal origin). Then they become the food for other higher order marine fauna such as shrimps, crabs and fish. Therefore, in order to understand the species characteristics in marine seawater environment analysis of zooplankton is very important (similar to phytoplankton).

In total 22 species of zooplankton were identified in the 5 sampling locations surveyed, which is quite few in comparison to previous studies in the same area. In previous surveys covering Bach Dang Estuary in total 61 species were identified. The limited space of sampling (basically within the narrow strait of Lach Huyen Estuary confined by Cat Hai and Cat Ba islands and its vicinity) in combination with only one time sampling is considered as the reason for the low number of zooplankton species identified by this survey.

c) Benthos in Estuarine Seabed

Of the 5 seabed sampling seabed locations, seabed benthos was identified in 4 locations only. The location with no benthos is composed of seabed with sandy soil condition, which could be the reason for the nonexistence of seabed benthos in this location. In this survey for EIA Study, in total 41 seabed benthos fauna species were indentified in the Lach Huyen Estuary seabed area. This represents about 29% of the total species of benthos fauna reported to be in existence in the wider Bach Dang Estuary area. Again the limited space of sampling in combination with only one time sampling is considered as the reason for the low number of benthos fauna species identified by this survey.

d) Wetland Flora in Phu Long Region

In Lach Huyen Area, wetland flora in natural condition is still predominant only along the Phu Long Coast of Cat Ba Island. The wetland flora existed in Cat Hai Island has already been destroyed long ago for aquaculture ponds (conversion to totally manmade unnatural ecosystem). The survey found 23 different floral species in Phu Long Coast, which is a muddy clayey wetland

area. Of these 23 flora species, there are some species with high ecological and economic value as the area has very significant concentration of mangrove vegetation. Such ecologically important mangrove species identified included *Avicennia lanata, Excoecaria agallocha, Kandelia candel, Rhizophora stylosa* and *Annona glabra.* These mangrove species in addition to their intangible indirect economic benefits such as serving as spawning grounds for a variety of marine fauna like fish and shrimps and servicing as natural barrier against coastal erosion, also has direct economic benefits such as use of mangrove stems as firewood and charcoal, mangrove barks for extraction of tannin, mangrove flowers for raising honey bees and others. The other floral species identified mostly belong to the species type of sea grass and shrubs.

e) Sea Fish

Gateway of Bach Dang Estuary is funnel shaped with little fluctuation in morphology and structure of fish species. No primary sampling work to identify fish species was conduced for this EIA Study. Instead available data from the previous studies were used that was complimented with interview survey with fishermen and local people in Cat Hai market and Phu Long market.

The available data by Nguyen Nhat Thi (1991) showed that there are about 101 fish species in the Bach Dang Estuary and surrounding coastal water environment. In general, the fish species composition is quite rich. However, due to the fast moving characteristics of fish, the number of fish species which can be captured is not many, only about 20 species at a time during most previous surveys.

The fish variety in Bach Dang Estuary could be divided into 2 main groups:

(1) Fish species inhabiting the estuary: This is the group of species that has the ability to adapt to the very significant change in salinity and seasonal temperature, the characteristics peculiar to the Estuary. Fish species such as *Clupanodon, Thrissa, Coilia, Salanx acuticeps, Glossogobius, Hemiramphus itermedius* are representative ones belonging to this group.

(2) Offshore fish species using the estuary as breeding grounds in breeding season: In this group there are a lot of fish species with high economic value and their sizes are quite big. Such typical fish species of economic value caught by fishermen include *Scoliodon shorhachowah, Sardinella jussieu, Harengula nymphaea, Priacanthus tayenus, Caranx malabaricus, Selaroides leptopis, Lutianus, erythropterus, Nemipterus japanicus, Pomadaisys hasta, Upeneus moluccens, Rastrelligen kanagurta, Scomberomorus commersoni* and others.

f) Overall Ecological Status

Even though the approved EIA Report (2008) did not clearly make any overall ecological evaluation it is understood based on subsequent discussions conducted with HYMENET that the survey results including available results of pervious studies indicated there is no known existence of rare or endangered fauna or flora (marine biota) in the target project area for the port and its vicinity. This implies the target seabed areas for dredging and reclamation for the port development project are also not habitat for any rare or endangered marine biota. Accordingly, any short-term adverse effects due to dredging works on aquatic marine biota including the limited permanent loss of seabed area (in particular, as habitat of seabed benthos) consequent to the reclamation for the port terminals is evaluated as not that significant in consideration to the availability of vast similar unaffected seabed areas that would continue remain as habitat for marine biota including seabed benthos. This evaluation could also be made from past experience of similar works conducted for port development (and also for IWT navigation channels) both in Vietnam and other countries.

9.3 Social Environment

9.3.1 Socio Environmental Condition of the Proposed Port and Connecting Road and Bridge

Due to the physical and economical boundaries within the expected project area for the Lach Huyen port and Tan Vu-Lach Huyen Highway projects, the affected area would be categorized into six (6) zones (Figure 9.3.1)

(1) Hoan Chau Commune (south west end of the Cat Hai island)

(2) Nghia Lo Commune (west end of the Cat Hai island)

(3) Van Phong Commune (central and south end of the Cat Hai island)

(4) Dong Bai Commune (north east end of the Cat Hai island)

(5) Cat Hai TT (the central village and south east end of the Cat Hai island)

(6) Phu Long Commune (west end of Cat Ba island and facing the new port berths)

Figure 9.3.1 Potentially Affected Area for the Lach Huyen Gateway Port Project

General description of the potentially affected area is as follows:

1) Hoan Chau Commune, Cat Hai island

Hoan Chau commune is located at the south west end of the Cat Hai island. Primary occupation of this commune is aquaculture (180 out of 340 household) on the island and coastal fishing (70/340). Unlike other communes, there are only 5ha salt pan in the commune. Due to the limited job opportunities, most of the young people leave the commune to work in the cities and continue study in universities in major cities and work out side of the island. This commune will not be physically affected by either

the port or Tan Vu-Lach Huyen highway project. However, particularly, some fishermen would be directly affected by the port and sand control dike structures. Based on the discussion with commune officers and representative of the local people's committee, both port and highway projects are well noticed and accepted by both local authorities and people.

Seaweed on the Concrete Dike along the southern coast and Aquaculture Pond (right)

Interviewing with Officials

2) Nghia Lo Commune, Cat Hai island

Nghia Lo commune is located at the west end of the Cat Hai island where the Dinh Vu-Cat Hai ferry arrives. Primary occupation of this commune is salt production and aquaculture. Though this is the west gate of the Cat Hai island, there are not many business activities for tourists or other services except the salt production and aquaculture. As same as the other communes, most of the young people leave the island after the high school education due to lack of new job opportunities. This commune will not be physically affected by the port project but will be physically affected by the Tan Vu-Lach Huyen highway project. Based on the hearing with project affected people by the highway project, both port and highway projects are well noticed and welcomed as long as an adequate safeguard policy is applied for recovery of property and livelihood.

Ferry Terminal

Typical Salt Pan

3) Van Phong Commune, Cat Hai island

Van Phong commune is located at the south central of the Cat Hai island. Primary occupation of this commune is salt production and aquaculture. There are also some fishermen depending on coastal fishing only in coastal area with small boats. As same as the other communes, most of the young people leave the island after the high school education due to lack of new job opportunities. This commune will not be physically affected by either the port or Tan Vu-Lach Huyen highway project. However, particularly, some fishermen would be directly affected by the port and sand control dike

structures. Based on the hearing with the chief representative of the Van Phong commune, residents of the commune will appreciate the both port and highway projects and wish to contribute to the economic development of Hai Phong city and the nation.

Typical Salt Pan in Van Phong

Interviewing with the Head of Van Phong

4) Dong Bai Commune, Cat Hai island

Dong Bai commune is located at the north east end of the Cat Hai island. Primary occupation of this commune is salt production and aquaculture. There are also some fishermen using fishing net along the coast and coastal fishing. As same as the other communes, there are not many job opportunities except traditional salt, aquaculture, fish source (nước mắm) production. Dong Bai commune will not be physically affected by the port project but will be physically affected by the Tan Vu-Lach Huyen highway project. Some fishermen would be directly affected by the port and sand control dike structures. Based on the hearing with the commune officials and potentially resettled persons in the commune, residents of the commune are fully supportive for the both port and highway projects and expected to have better living standard and better job opportunities.

Fish net along the coast

Salt pan and Residence of Dong Bai

5) Cat Hai TT, Cat Hai island

Cat Hai TT (town) is the central area and located at the southeast end of the Cat Hai island. Occupation of Cat Hai TT varies such as the traditional salt production, aquaculture and coastal fishing and nontraditional in commerce and variety of services. However, as same as the other communes, there is lack of new job opportunities for young people. Cat Hai TT will be physically affected by either the port or Tan Vu-Lach Huyen highway project. Also, some fishermen would be directly affected by the port and sand control dike structures. In addition to the residents of Cat Hai TT, there are some immigrant fishermen living in Got harbor, the east gate of the Cat Hai island, who depend on the coastal and offshore (Ha Long bay and south of Cat Ba island) fishing and seasonally

go back to their hometown. Some immigrant fisherman conducting coastal fishing at the proposed site would be directly affected by the proposed port development project. Based on the public hearing in April 2010 at Cat Hai TT and EIA report, residents of the commune welcome both port and highway projects and are expecting good business and job opportunities.

Small fishing boats along the coast

Immigrant fishing boats in the Got harbor

6) Phu Long Commune, Cat Ba island

Phu Long is located as west end of Cat Ba island and is the only directly affected commune in Cat Ba island. Cat Ba island is one of the most famous islands in the region for the part of the Ha Long bay, the UNESCO world heritage. However, unlike the popular destination of the tourists and world heritage side of the island, the west coast of the Cat Ba island is very quit and hosts the traditional coastal fishing and aquaculture for the locals. As similar to the Cat Hai island, there are not many new job opportunities for young people in the community so that young people tend to go finding a job in central town in Cat Ba island or major cities. Phu Long commune will not be physically affected by either the port or Tan Vu-Lach Huyen highway project. However, some coastal fishermen would be directly affected by the port and sand control dike structures. Some fisherman are also using fishing net along the coat, which have already been banned for the preparation for the Lach Huyen port project and compensated for the loss of the net fishing right by the Cat Hai district. Based on the discussion with fishermen at a small port in Phu Long, they are generally supportive for the port development project and interested in the development of the regional economy. However, due to the inefficient information disclosure in the community, residents including potentially affected fishermen are not quite familiar with the project itself.

Coastal and offshore fishing boats at Phu Long harbor

Residence along the main street in Phu Long

9.3.2 Legal Updates after the Approval of the Lach Huyen Port EIA

Summary of the effective law and regulations are shown in section 9.1.2. Since the EIA of the Lach Huyen port was approved in 2008 and there are some changes in port design, MPMU II is likely to require additional EIA. In the case of the preparation of the additional EIA and land acquisition, which is additionally required due to the change in design, newer law and regulation might be applied. Followings are the legal updates relevant to the social environment.

1) Legal Updates Relevant to Law on Environmental Protection 2005

There are no updates relevant to the law on environmental protection so that it is not necessary to consider the applicability of the presently approved EIA and the upcoming additional EIA. Though MONRE has been working on an improvement of a guideline on law on environmental protection, it will not be applicable for the upcoming additional EIA due to the time gap between the effective date of a regulation and applicable date of the regulation.

2) Legal Updates Relevant to Land Law 2003

There are several key updates relevant to land law 2003. Followings are the list of the key updates that should be addressed to prepare the land acquisition plan.

- Decision No. 130/2010/QD-UBND on compensation on support & resettlement policy on Hai Phong City
- Circular No. 14/2009/TT-BTNMT detailing the compensation, support and resettlement and order of and procedures for land recovery, allocation and lease
- Decree No.69/2009/ND-CP to amend a number of provisions on land use planning land rental rates land reclamation and resettlement and compensation

Decision No.130/2010/QD-UBND of Hai Phong city was prepared to adapt and follow the requirement of Circular No.14/2009/TT-BTNMT, which requires municipal governments to prepare the locally adapted safeguard policy on resettlement and compensation. Decision No.130/2010/QD-UBND follows the most updated law and regulations and gives some local specifications such as land price. Circular No.14/2009/TT-BTNMT and Decree No.69/2009/ND-CP were developed and put into force to improve the practicability and applicability of previous regulations including the safeguard policy on involuntary resettlement, Decree No. 197/2004/ND-CP on compensation, support and resettlement when land is recovered by the State. Though Decree No. 197/2004/ND-CP is still effective, the latter circular and decree specify the applicable condition and repeal previous conditions to meet realistic needs and improve the safeguard policy close to international standards. Specifically, the involvement of the project affected people such as requirement of public hearing and improvement of the resettlement plan with the public opinions is clearly stated in Decree No.69/2009/ND-CP while Decree No.197/2004/ND-CP only required notification.

However, there are still some gap between the JBIC standards, which refers the World Bank's involuntary resentment policy (WB OP4.12), especially in the condition of eligibility and compensation. As stated in Article 1 of Decree No. 197/2004/ND-CP, the donors safeguard policies shall be applied in case such policies are different from Vietnamese and donors' policies and government of Vietnam agrees to apply the donors' policies. Therefore, the JBIC Guideline/WB OP4.12 is likely to be applied for the proposed Lach Huyen port project. As described in section 9.1.3 2) Compliance of the Approved Lach Huyen Port EIA with the JIBC Guideline, the safeguard policy of Northern Delta Transport Development Project, which adapted WB OP4.12, shall be referred for the Lach Huyen port due to the consistency of the ODA projects in the same region and same time.

9.3.3 Confirmation of the Impacts on Social Environment with the Checklist of JBIC Guideline

The result of the approve EIA review is summarized with the JBIC Guideline checklist below.

1. Permits and Explanation
(1) Explanation to the Public

- **Adequate explanation of project and its impact, public acceptance**

  Adequate explanation was given and opinion of the potentially affected people (PAP) was collected by both responsible local authorities and PAP's communities (fatherland front committee), which are required by Law and relevant regulations. In addition to the required public consultation by the Vietnamese law, the responsible implementation agency-MPMU II voluntary conducted a public consultation to have PAP understand the project further and encourage active participation of the project in April 2010. Record of the publish hearing is shown in Appendix 9-2

- **Proper responses made to comments from the public and regulatory authorities**

  The local authorities and communities' responses are recorded and mentioned in the approved EIA. The regulatory authorities' comments are also given in the approval letter of the project EIA. In general, projects are well supported by the potentially affected communities. In addition, Based on the public hearing in April, announcement of the project's concrete schedule and consideration for the coastal fishing were requested by the representatives of the Cat Hai TT. MPMU II agrees to provide the concrete schedule shortly and work together with responsible authorities for the consideration of the potentially affected fishermen

4. Social Environment
(1) Resettlement

- **Possibility of involuntary resettlement, any effort made to minimize the impacts**

  There is no resettlement required for the project. However, due to the change in design, land acquisition is required for public related facilities, which requires resettlement of toms and aquaculture ponds and land clearance of a community forest.

- **Adequate explanation on relocation and compensation given to affected persons prior to resettlement**

  Hai Phong city, Cat Hai district and commune authorities, who are responsible for the resettlement and land acquisition by law and regulation, have already consulted with project affected people (PAP) for fishpond and relatives of the toms and acquired general acceptance of the project and relocation.

- **Adequate resettlement plan, including proper compensation, restoration of livelihoods and living standards developed based on socioeconomic studies on resettlement**

  There are no resettlement plan available for the approved EIA due to the requirement of public own land at the original port development study. Due to the change in design to add public facilities, relevant authorities of Cat Hai district and MPMU II are preparing a resettlement plan/land acquisition plan, which is required by law and regulation to secure proper compensation and restoration of livelihoods and living standards.

- **Attention to vulnerable groups or persons, including women, children, the elderly, people below the poverty line, ethnic minorities, and indigenous peoples for the resettlement plan**

There are no vulnerable groups or persons in the affected area. However, special attention to immigrant fishermen coming from outside of the Cat Hai district and living on the boat might be needed. Responsible authorities and MPMU II are working on the safeguard policy on coastal fining activities, which is likely to include such affected fishermen.

- **Agreements with the affected persons obtained prior to resettlement**

Though the detailed condition will be settled in detail design stage, general agreements were given by the PAP through initial consultation by the local authorities.

- **Framework for proper implementation of resettlement, capability of resettlement and security of budget**

People's committee of Hai Phong city is responsible for the resettlement/land acquisition and has capability to implement the resettlement/land acquisition throughout the variety of resettlement activities in the area. The budget will be secured and transferred from the MOT, responsible ministry of the project owner, to Hai Phong city.

- **Availability of a monitoring plan for the impacts of resettlement**

Preparation of monitoring is mandate by law and monitoring will be included in the land acquisition plan, which is under the process of the preparation as of the end of April 2010.

(2) Living and Livelihood

- **Possibility to adversely affect the living conditions of inhabitants, adequate measures considered to reduce the impacts**

Any price including daily food and other commodities is likely to increase due to the project implementation and substantial business activities at and around the project site. Separation of the immigrant workers and local residence at the initial stage and gradual merger are proposed for local residence to adapt such price rise

- **Possibility of changes in water uses (including fisheries and recreational uses) in the surrounding areas due to project will adversely affect the livelihoods of inhabitants**

Proposed project will eliminate some part of coastal fishing area. Though the consideration for such fishermen was initially omitted due to the small scale of activities, this SAPROF study confirmed the regular fishing activities at the proposed project area. Result of the coastal fishing survey is described in section 9.3.4 Fishing Activities around the Proposed Project Site. Responsible authorities of Hai Phong city and MPMU II are working on the safeguard policy for such fishing activities as of the end of April 2010.

- **Possibility to adversely affect the existing water traffic and road traffic in the surrounding areas**

The sand control dike (7,600m long) is likely to prevent daily transport by small transport boats/fishing boats between Cat Hai and Cat Ba. However, such impacts will be minimal and traffic will be taken over by the existing water traffic between the God port, Cat Hai and Cat Ba with road transport naturally.

- **Possibility of diseases, including communicable diseases, such as HIV/AID introduced due to immigration of workers associated with the project, any considerations given to public health**

During the construction and operation stages, a large number of construction workers and

port workers may introduce some transmittable diseases such as HIV/AIDS, which are verified in Vietnam, in the communities. Not only for workers but also local communities, awareness education and prevention measures will be provided by the relevant authorities with the collaboration of local communities, contractors of the project and operator of the port. In addition, separation measures of immigrant workers and local residence, such as construction workers' temporally township, are recommended in the approved EIA. Detailed measures will be proposed in detail design stage.

(3) Heritage

- **Possibility of damaging the local archeological, historical, cultural, and religious heritage sites, Adequate measures considered to protect these sites in accordance with the country's laws**

  There are no heritage sites in the proposed sites.

(4) Landscape

- **Possibility to adversely affect the local landscape, and necessary measures taken**

  Though offshore land fill will significantly change the landscape of the local communities, the change will be rather considered as positive change in landscape. The change of the landscape could be considered as the symbol of the contemporary development area as categorized as Hai Phong development master plan.

(5) Ethnic Minorities and Indigenous Peoples

- **Complying with the country's laws for rights of ethnic minorities and indigenous peoples**

  Though there are no concerned people in the project area, the proposed project will fully comply with minority protection if it's necessary.

- **Considerations given to reduce the impacts on culture and lifestyle of ethnic minorities and indigenous peoples**

  There are no concerned communities in the project area.

5. Others

(1) Impacts during Construction

- **Adequate measures considered to reduce impacts during construction (e.g., noise, vibrations, turbid water, dust, exhaust gases, and wastes)**

  The necessary mitigation measures are examined in the EIA Report. The contractor shall be obligated to strictly adhere to EHS (environment, health and safety) aspects of the construction works in integral manner with due formulation and execution of EHS management and monitoring.

- **Adequate measures considered to reduce impacts for the natural environment (ecosystem)**

  With due EHS management and monitoring by contractor as above adverse effects could be mitigated.

- **Adequate measures considered to reduce impacts for social environment**

Adequate measures will be applied to prevent the adverse effects on the local communities for the construction period, especially consideration for local communities and immigrant workers communities. Temporally township for immigrant workers and occasional opportunities, such as meeting or festival, to bridge the gap between locals and immigrant workers are proposed by the responsible authorities.

- **Possibility of health and safety education (e.g., traffic safety, public health) provided for project personnel, including workers if they are necessary**

EHS management program and monitoring shall be implemented by construction contractors supervised by relevant authorities.

9.3.4 Fishing Activities around the Proposed Project Site

As a part of reviewing process, JICA SAPROF experts have consulted with HYMENET, the EIA consultant for the Lach Huyen Gateway Port Construction Project Study, and requested a sample survey to understand the actual status of the fishing activities at the proposed project site. HYMENET and the JICA SAPROF experts (Natural Environment and Socio-Environment) conducted two field surveys at the site from 24 to 27 November, 2009 and from 30 March to 2 April (Table 9.3.1).

Table 9.3.1 List of the Interviewed Stake holders and Field Survey

24 Nov. Haiphong	Planning Institute of Haiphong
	Institute of Marine Environment and Resources
25 Nov. TanVu-DinhVu	Nam Hai Commune Authority
	Dong Hai II Commune Authority
	Border Guard Post at Dong Hai II
	A Fisherman at Nam Hai
	Four Fisherman off shore south of DinhVu around proposed alignment area
26 Nov. CatBa & CatHai	Division for Agriculture and Rural Development, Cat Hai District
	A Fisherman at Phu Long, Cat Ba
	Four Fisherman at TT Cat Hai in the harbor, Cat Hai
27 Nov. CatHai	Hoang Chau Commune Authority, Cat Hai
	Van Phong Commune Authority, Cat Hai
30 Mar. Haiphong	Department of Agriculture and Rural Development, Haiphong City
	Department of Land Management, Haiphong City
31 Mar. Haiphong	Department of natural Resources and Environment (DONRE)
	Department of transport, Haiphong city
	Transport and Tourism Joint Stock Company
	Field survey (Tan-vu/Dinh-vu)
1 Apr. Cat Ba/Cat Hai	Division for Agriculture and Rural Development of Cat Hai District
	Field survey (Cat Ba & Cat Hai)
2 Apr. Cat Hai	Field survey

1) Summary of the Hearing with Local Authorities

a) Department of Agriculture and Rural Development, Haiphong City

- Total area of aquatic cultivation in Haiphong at the present is 13500 ha, from these:

Fresh water aquatic cultivation:	5000ha;
Brackish water aquatic cultivation:	8500ha;
Saltwater aquatic cultivation:	300ha;

- In addition to these, there are

  570 houseboats and 11500 float cage are used for aquatic cultivation;
  70 place for molluse cultivation.

- Total production of aquatic cultivation is 45600 tones, from these:

Fresh water aquatic cultivation:	21200 tones;
Brackish and saltwater cultivation:	24400 tones.

- Aquatic cultivation production of some major districts:

Cat Hai District:	6500 T/year;
Hai An District:	4100 T/year;
Thuy Nguyen District:	3392 T/year;
Duong Kinh District:	1000 T/year;
Do Son District:	2050 T/year;
Kien Thuy District:	1900 T/year;

- Number of fishing boats: 4090, from these:

Engine capacity less than 20 HP:	2850;
Engine capacity of 20 - 50 HP:	517;
Engine capacity of 50 - 90 HP:	390;
Engine capacity of 90 - 150 HP:	234;
Engine capacity of 150 - 250 HP:	83.

- Main fishing zones:

  Zone 1:
  From Ba Lat Estuary of the red river to Do Son. Fishing in this zone is forbidden from May to July because this period is breeding season.
  Zone 2:
  From Cat Ba to Long Chau island (around zero point).
  Zone 3:
  Around Bach Long Vi island. This zone is one of the most productive fishing zones in the North of Viet Nam.

- Fishing season

  There are two fishing season in a year.
  First season starts from November and ends in next year April. In this season fishing is mostly offshore and main product is surface fish.
  Second season starts from April and ends in November.

- Fishing duration

  In the past fishermen normally go to fishing only for one day because they do not have enough oil for longer time. At the present fish men can go to fishing for some days and months because offshore service is rather good organized. Fishermen can buy oil and other necessary goods (fresh water, food etc.) and sell their fishing products on sea at fishing place with reasonable price.

b) Division for Agriculture and Rural Development, Cat Hai District in Cat Ba island

- Clearance and compensation for the Lach Huyen port project: all coastal area has already been cleared and compensation for such clearance has already been granted since 2002.
- Owner of each rod net received 5 mill. VND for compensation to move the net from the project area.

- Proposed relocation places for people affected by the project: Tien Hai, Cai Vieng II, Phu Long communes
- Exception of the coastal fishing activities: due to the traditional practices, only coast along the east area of Dong Bai commune and a part of Phu Long commune are not cleared yet. Such are will be cleared when the actual project construction is started.
- Legal reference: Fishery law (1995?), Decree 128 on administrative fine on aquaculture
- Restriction of the fishing means: Fishing trap is restricted by regulation to protect the biological resources. Issue of the fishing trap along the coast has stopped since 2002.
- List of the licensees for the fishing trap: even after the ban on fishing trap in 2002, division for agriculture and rural development of Cat Hai district has been tracking the historical ownership and approximate location of the licensed traps. A list of the licensees was provided
- Salt production area: more than 100 Ha in Cat Hai district
- Production of salt: 10,000 t/year
- Sales price of salt: 1,000 VND/kg
- Aquaculture area: more than 500 Ha in Cat Hai district
- Average income of the aquaculture: 30 million VND/Ha-year
- Lease price of aquaculture pond: 1.0-1.5 million VND/Ha-year

Fishing Trap Along The Coast

Aquaculture Pond in Cat Ba

c) Nam Hai Commune Authority

- Area of Jurisdiction: 4,000 ha
- Population: 10,000
- Average income level: 600,000 VND/capita-year

2) Summary of the Hearing with Potentially Affected Fishermen

a) A Fisherman at Nam Hai

- Origin of residence: Quang Ninh Province and Thuy Nguyen District of Hai Phong
- Activities and number of boats: roughly 50 fishing boats in the TT Cat Hai harbor, mostly from Quang Ninh Province and Thuy Nguyen District of Hai Phong
- Fishing area: ZERO-LINE, roughly 18 miles from the shore line within Bac Bo Bay
- Fishing area of Cat Hai fishermen: close to shore line only
- Primary fishing product: shrimp, small fish, octopus with fishing trap
- Average net income/month-boat: 5-7 million VND/month-boat with two fishermen except fuel and other fishing relevant expenditure
- Cost of boat: 200 million VND/new fishing boat

- Any concern: only 30% of the fish yield in the recent years compared to previous average due to degradation of water quality, increase of fishing boats, better fishing traps
- Any wish for another job opportunity: Little idea due to no skill except fish
- Opinion for the new port: Rather neutral, but interested in schedule and project area


Fishing Port at Nam Hai


Interviewing with a Nam Hai Fisherman

b) Four Fisherman off shore south of Dinh Vu around proposed alignment area

- Origin of residence: Nam Hai
- Fishing area: Coastal area for fish trap, ZERO-LINE
- Primary fishing product: shrimp, small fish, octopus
- Fish sales: Shrimp: 18,000 VND/kg
  Small fish: 10,000 VND/kg
  Octopus: 100,000 VND/kg
- Average net income/month-boat: 6-7 million VND/month-boat with two fishermen except fuel and other fishing relevant expenditure
- Any concern: only 30 – 40% of the fish yield in the recent years compared to previous average after the coastal development activities
- Opinion for the new port: Rather neutral, but very limited idea about the project


Traditional Fishing net off shore Dinh Vu


Fish yield in the coastal area

c) A Fisherman at Phu Long, Cat Ba Island

- Origin of residence: Phu Long
- Fishing area: coastal are in Bac Bo Bay
- Primary fishing product: shrimp, small fish, octopus with fishing trap

- Average net income/month-boat: 10 million VND/month-boat with two fishermen except fuel and other fishing relevant expenditure
- Opinion for the new port: Rather supportive and expecting positive benefits from the economical development in the region, but very limited information about the project though radio and news paper only

Fishing Port at Phu Long, Cat Ba Island

Fresh Fish from Coastal Area

d) Four Fisherman at TT Cat Hai in the harbor, Cat Hai

- Origin of residence: Quang Ninh Province and Thuy Nguyen District of Hai Phong
- Activities and number of boats: roughly 50 fishing boats in the TT Cat Hai harbor, mostly from Quang Ninh Province and Thuy Nguyen District of Hai Phong
- Fishing area: ZERO-LINE, roughly 18 miles from the shore line within Bac Bo Bay
- Fishing area of Cat Hai fishermen: close to shore line only
- Primary fishing product: shrimp, small fish, octopus with fishing trap
- Average net income/month-boat: 5-7 million VND/month-boat with two fishermen except fuel and other fishing relevant expenditure
- Cost of boat: 200 million VND/new fishing boat
- Any concern: only 30% of the fish yield in the recent years compared to previous average due to degradation of water quality, increase of fishing boats, better fishing traps
- Any wish for another job opportunity: Little idea due to no skill except fish
- Opinion for the new port: Rather neutral, but concern about their possibility to adapt and benefit from the regional development due to the limited skills

Fishing Boat with Traps (front) and Coastal Fishing Boat (behind left)

Interviewing with Visiting Fishermen