## 14.2 Social Environment

### 14.2.1 Overview

Thua Thien - Hue Province is located at Central Vietnam. The provincial capital is Hue City which was the ancient capital of Vietnam. The area of the province is about 5,000 $km^2$ and its population is about 880,000. The length of the coastline is about 120 km. The seashore of the province has many lagoons and bays, including the Chan May Bay.

Thua Thien - Hue province has strategically very important position in the North of Central Vietnam. Chan May area has been planned to be one of main industrial development areas in Central Vietnam. The Chan May Deep Sea Port has been planned and proposed as one of gateways to the South China Sea of the northeast region of Thailand and Laos. The economy of Thua Thien - Hue Province is many-sided with large potentiality in the fields of mineral exploitation, construction materials production, tourism and services, as well as agriculture, forestry, aqua-culture and fishery.

The region of the Chan May Bay and the Thua Luu - Nuoc Ngot Plain locates in the south east of Thua Thien Province. In the north, this region is open to the South China Sea as shown Figure 14.2.1. The coast line stretches from the West Chan May Cape to East Chan May Cape. It is contiguous to Phuoc Tuong Pass in the west, to Phu Gia and Lang Co Passes in the east, in the south Trans Vietnam National Highway No.1, the Railway and the mountains with the height of tops from 800 m to 1,000 m.

The distances from the Chan May Bay to some important places of the central region are as follows:

| | |
|---|---|
| To Trans Vietnam National Highway 1A and the Railway | 5 km |
| To Phu Bai Airport | 36 km |
| To Hue City | 60 km |
| To Bach Ma peak | 24 km |
| To Lang Co | 12 km |
| To Thuan An Port | 53 km |
| To Lien Chieu Port | 22 km |
| To Dung Quat Port | 140 km |
| To Danang Airport | 45 km |
| To domestic navigation waterway | 25 km |
| To international navigation waterways | 170 km |

### 14.2.2 Socio-Economic Environment

The Chan May Bay belongs to Loc Vinh village and a part of Loc Tien and Loc Thuy villages, Phy Loc district.

Generally the plain behind the Chan May Bay is rather flat. The land in most part consists of tightly pressed sand and it has low productivity value for agriculture. This

region is relatively thinly populated and the houses are rather simple and primitive. In general, it is a favorable circumstance for people's resettlement, allocation and compensation.

**(1) Distribution and Composition of Local Communities and Residents**

According to an investigation, Loc Vinh and Loc Tien villages consist of 12 hamlets having a population of 12,380 (2,463 households) and an area of 8,152 ha as shown in Table 14.2.1. On the average, each household has 5.03 inhabitants. The number of male is 5,629 and female is 6,751. Loc Thuy has population of 4,325 and households of 758.

**Table 14.2.1 Distribution of Population in the two Villages in the Project Area**

| Village | Hamlet | Inhabitant | Households | Male | Female | Labor Force |
|---|---|---|---|---|---|---|
| Loc Vinh | | 5,059 | 1,027 | 2,327 | 2,732 | 2,508 |
| | Canh Duong | 1,544 | 289 | 708 | 832 | |
| | Dong An | 244 | 50 | 110 | 129 | |
| | Binh An | 2,326 | 499 | 1,067 | 1,252 | |
| | Phu Hai | 945 | 189 | 442 | 519 | |
| Loc Tien | | 7,321 | 1,436 | 3,302 | 4,019 | 2,800 |
| | Puoc An | 859 | 183 | 388 | 471 | |
| | Phuoc Loc | 1,020 | 202 | 459 | 560 | |
| | Thuy Duong | 806 | 150 | 365 | 442 | |
| | Thuy Tu | 738 | 145 | 332 | 405 | |
| | Trung Kien | 2,158 | 419 | 971 | 1,186 | |
| | Tho Son | 628 | 132 | 284 | 345 | |
| | Phu Gia | 706 | 137 | 319 | 387 | |
| | Tam Vi | 406 | 68 | 184 | 223 | |
| | Total | 12,380 | 2,463 | 5,629 | 6,751 | 5,308 |

Source : Report on Loc Vinh's People Committee and Loc Tien's People Committee - 1996

The distribution of population density between the villages are uneven The number of labor ages are low, which limit the development of agricultural production and other professions in order to increase living standard of the people.

**(2) Local Economic Conditions**

At present, the main profession in the area of two villages is agriculture as shown in Table 14.2.2. However, the land in most part is fine tightly pressed sand with low production output. The households engage in side jobs to earn their bread to support their family. Specifically, Loc Vinh is a coastal village which has many households making a living by fishing. Their income is not high due to lack of capital and technology. The other professions, including handicraft, trading, rock exploitation and animal breeding, are expected to be developed for the labor force, providing jobs and effectively exploiting the potential of this area.

**Table 14.2.2 The Current Status of Profession Structure at the Project Area**

| Village | Agriculture (%) | Fishery (%) | Handicraft (%) | Construction (%) | Trading (%) | Service (%) | Others (%) |
|---|---|---|---|---|---|---|---|
| Loc Vinh | 47.31 | 39.36 | 1.87 | 0.50 | 8.99 | 1.71 | 0.26 |
| Loc Tien | 66.92 | - | 5.95 | 0.69 | 8.57 | 0.89 | 16.98 |

Source : Report on Loc Vinh's People Committee and Loc Tien's People Committee - 1996

According to the survey at the two villages shown in Table 14.2.3, the average income of the inhabitants is about 582,500VND per capita per year.

The average income of Loc Vinh village: 665,000 VND/per year
The average income of Loc Tien village : 500,000 VND/ per year

**Table14.2.3 Average Income of Inhabitants in the Project Area**

(VND per capita / year)

| Village | Agriculture | Fishery | Handicraft | Construction | Trading | Service | Others |
|---|---|---|---|---|---|---|---|
| Loc Vinh | 515,829 | 587,900 | 418,972 | 472,500 | 813,800 | 617,663 | 985,575 |
| Loc Tien | 530,818 | | 510,500 | 430,000 | 875,000 | 603,333 | 966,600 |

Source : Report on Loc Vinh's People Committee and Loc Tien's People Committee - 1996

According to the investigation, the distribution of living standard is shown as in Table 14.2.4, many villagers of the project area live on agriculture. However, the land for farming is limited as well as agricultural output is low, which causes their income to be unfairly low. The part farming - part fishery - part other profession, households can earn more money than the others. More than 50% of households in Loc Tien village are farmers. They didn't make use of the other potential professions. Therefore, their income are lower than that of Loc Vinh village and some other villages in the area.

**Table 14.2.4 Living standard of the Population in Project Area**

(unit : %)

| The type of living standard | Loc Vinh | Loc Tien |
|---|---|---|
| Rich household | 12.29 | 5.00 |
| Passable household | 24.86 | 18.50 |
| Average household | 41.87 | 46.30 |
| Poor household | 20.98 | 30.20 |

Source : Data Collected by the Statistics of Direct Investigation - 1997

**(3) Land Use**

The area of the villages in the project area is in total 8,152 ha which consist of land for agriculture, forestry, house, etc. As the population in this area at present is 12,380 persons, per capita area is 0.66 ha/person.

**Table 14.2.5 Distribution of Land in two Villages**

(unit : ha)

| No. | The type of land | Loc Vinh | Loc Tien |
|---|---|---|---|
| 1 | Agriculture land | **266** | **497** |
| 2 | Indistrial plants land | - | **51** |
| 3 | Forestry land | **589** | **1,118** |
| | Natural forest | 464 | 785 |
| | Artificial forest | 125 | 333 |
| 4 | Using land | **40** | **166** |
| | Building land | 4 | 15 |
| | Transportation land | 15 | 29 |
| | Irrigation land | 1 | 8 |
| | Mineral Land | - | 14 |
| | Graveyards land | 20 | 100 |
| 5 | House land | **80** | **119** |
| 6 | Unused land | **1,829** | **3,402** |
| | Waste land | 20 | 258 |
| | Waste mountainous areas | 1,225 | 1,715 |
| | Waste water's face land | 2 | 12 |
| | River, stream | 57 | 79 |
| | Sand area | 525 | 1,338 |
| 7 | Fishery farming land | **75** | - |
| | *Total area of natural land* | **2,879** | **5,353** |

Source : Report on People Committee of Phu Loc District - 12/1994

Data on the land distribution in the two villages under survey shown in Table 14.2.5 tell that agriculture land is less 10% of total natural land, whereas forestry land is about 20% in which natural forest accounts for a high percentage of more than 70%. There is a great percentage of unused land, accounting for more than 60%, which means that the land resources have not been used fully.

**(4) Key Industries**

**1) Agriculture**

With the total agricultural area of 763 ha or 9.3% of the natural land in these two villages (average 0.31 ha/household), the land allocated for agriculture is just marginal. The two villages have about 50% of their households engaged in agricultural works. But, the land is mostly sandy and arid, and therefore agricultural output is low. In agriculture, the main crops are rice, other staple crops, and industrial plants of short life such as ground nut, maize, sweet potatoes, bean, chili, melon, etc.

All the processing facilities in Loc Vinh Cooperative have been now transferred to private enterprise. It is expected that the processing output can amount to 200 ton per year. In addition, there have been many processing workshops scattered in private households, with production amounting approximately to 250 ton per year.

There are now in the village about 145 boats of different types, of which 107 are motorized boats of capacity ranging from 6 - 22 CV. But, fishing is mainly performed near the seashore due to the shortage of capital and professional level. The output is therefore limited and all the strong points of the area have not brought in full play to raise the production and to assure high economic efficiency.

Though not bordering with the sea, Loc Tien village has already made full use of fresh water surface (river and lake) to undertake aquaculture. In the initial stage, they did not have much experience and did not invest much either. But, many families, undertaking floating - cage aquaculture, have achieved rather good output.

**2) Tourism**

Loc Vinh village has a 8 km coastline in the area of the Chan May Bay, connecting the West Chan May Cape and East Chan May Cape, thus giving it a great tourist potential. Up to now, a 5km seashore has been under use safely and great potentialities are likely affordable. Canh Duong Beach, located in the Chan May Bay, is a beautiful tourist landscape, very attractive with its clean, environment, and good environment, where an asphalted road runs to the sea. As the bay is sheltered from the east wind, waves are therefore usually not high and not perilous. It is nowadays an attractive tourist spot. The local authority has already encouraged the villagers to develop and diversify tourist services so to attract expatriates and local people to come to their two floating guest houses and many restaurants, and boutiques.

Much supportive efforts have been made to create favorable conditions to villagers to develop their tourist activities. However, there are still may restraints due to the rather long distance from the city center and also due to lack of significant investment. The tourist activities at the places have not brought into full play.

**3) Other Industries**

Stone exploitation for construction is a traditional occupation in Loc Tien with about 13% of households. In a past few years, this business developed thanks to the need in construction of the residents. Recently, due to decreased local demand and high transportation costs to other regions, the business has declined. However, for the development of infrastructure in the project area, this business should be paid attention and could serve the need of the project implementation.

Wood processing is another business with many workers. The carpenters, however, are not very skillful. Their skill was obtained through internship, not by vocational training. To employ them in future projects, there is a need to retrain them. Other occupations such as mechanics and electronics do exist, but there are about 20-30 people only.

It is to be noted that an occupation, which attracts relatively many people, is garment. This business did not develop in the project area, and around 350-400 people (from Loc Tien and Loc Thuy, Source: Village's Statistics) are now working in Ho Chi Minh City. It is learned from the survey that, most (if not all) of young people, working in other provinces, can not support their family on a monthly basis. They go home once a year on the New Year Holidays as their income is enough only for their life in the working place. (The newspapers in Ho Chi Minh City, however, reveal a different information, according to which migrant workers could save and send their family about VND 1,000,000 per year on the average). This situation should be taken into account when determining the industries to be first developed in the project area in order to use local labor force, as most of people want to live with or nearby their family.

**(5) Infrastructure and Public Services**

**1) Education**

The education system is now still poor and limited : primary school is most common. In general, budgets have been allocated by the district and provincial authorities to improve the school facilities, to increase teachers and eventually to raise the people's educational level, but the results are still limited.

**Table 14.2.6 Education Situation**

| Village | Kindergarten | | Primary school 1st level (1-5 grades) | | Elementary school 2nd level (6-9 grades) | |
|---|---|---|---|---|---|---|
| | Number of school | Number of pupils | Number of school | Number of pupils | Number of school | Number of pupils |
| Loc Vinh | 3 | 290 | 5 | 927 | 0 | - |
| Loc Tien | 1 | 184 | 8 | 1178 | 1 | 689 |

Source : Report on Loc Vinh's People Committee and Loc Tien's People Committee - 1997

As shown in Table 14.2.6 the number of schools and pupils are both small, though great efforts have been made by local authorities to maintain the number of pupils, to raise the number of the school branches and to improve the school facilities. It is worth noting that there is only one elementary school for 689 pupils and the figure shows that there is much dificulty in education facilities due to low living standards of the people.

In the whole area, there is no high school, or 3rd level school (10-12 grades). In case that children are able to study in the 3rd level school, their family should consider their affordability as children have to stay in town due to long distance from the village to school. Among randomly selected households in this area, there are few pupils now going to 3rd level school. This will be a problem for a project in labor recruitment and for the residents themselves in improving of their living standards by exploiting job opportunities provided by the project.

**2) Welfare**

In Loc Vinh village, there is one infirmary with 3 assistant doctors and one nurse and, in Loc Tien village, one infirmary with 2 doctors and 4 assistant doctors. However, the costs of medicine are unaffordable for most of the residents. Usually, they use traditional medicine and go to the medical post only when they are seriously sick.

As to hygienic standards, the water supply for domestic consumption is from open or bored wells. There are approximately 350 bored wells and 34 hygiene projects sponsored by the Rural Potable Water Program. But, these data are still low as compared to the total number of people in the area under survey.

**3) Communication**

In Loc Vinh village, there are 8 telephones and a post office at Chan May, and a generator station for electric supply for all hamlets in the village. In Loc Tien village, there are about 50 telephones, a village post - office and a post exchange for the whole area.

Availability of post offices and telephones help residents to communicate with other places. The number of telephones, however, is still small, mainly in the government offices or in trading/service households.

**4) Road Systems and Transportation**

Loc Tien and Loc Thuy are located along the National Road 1A that makes the transportation between the villages convenient. The transportation system within Loc Vinh is not developed yet, except a new road connecting the National Road 1A with the projected port Chan May is now under construction.

In Loc Vinh village, there are 5 km of asphalted road and 5 km of earthen village road. There are means of transportation, including one lam bretta (3-wheeled cab), 2 tractors and many motorbikes/ bicycles.

In Loc Tien village, there are 8 km of National Highway No. 1 A, 5 km of asphalt road from different hamlets in the village to Chan May, and 20 km of inter - communal roads. There are means of transportation, including one car, 3 tractors, 150 motorbikes and many bicycles. In the two villages, there is no public bus services accessible to people.

**5) Commerce (Market)**

In Loc Vinh village, there is no large market. In Loc Tien village, there is a small Market.

### 14.2.3 Resettlement

#### (1) Relocation of Residents and their Response

Loc Vinh village is the main area to be relocated in the plan of the construction of Chan May Port and Industrial Zone. It is envisaged in the plan that all Loc Vinh village will be moved to Loc Thuy village which is adjacent to it and has a natural land of 7,640 ha. Loc Tien is one village in the area under the survey for the project. Therefore, it will be also influenced by the subject of relocation and development in the future. These matters will also inflict various impacts on the local economy.

According to the survey by a specialist by means of direct interview with randomly sampled households, all of households interviewed agreed to move for the development project. Most of residents see the development project will positively affect their living conditions. Some households are optimistic, some are more cautious, but no household objects the project development. One of the reason, commonly agreed, is that traditional occupations could not help them make prosperous. With the project, they hope to change their job, and their children, who work in other provinces, have a chance to live in native place with family, so on and so forth. However, the survey also shows some issues that need to be seriously considered when inplementing the project.

When asked what job they would do after the project development, more than 60% of households do not know what they will do. This answer is found in households with one occupation and low income, or with combined occupations. This answer is also observed in households where there are either old/coming-to-old people, or children in schooling age. Mono-occupation households (25%) want to do the same job, as they do not know others.

In households with educated children ($2^{nd}$ / $3^{rd}$ level, vocational) are happy with the project, as they hope their children can find job in the new development area. Even some households with relatively high per capita income also hope that their children can change their traditional occupation, since it is hard, tough (agriculture), and dangerous (fishery).

The occupation preferred by the households, wanting to change their job (40%), is to work in development area. The second one is trading and services (35%) because of easiness and profitability. However, half of it is cautious as they do not have capital and experiences in trading in market conditions. 10% of households, tending to change their job, do not determine what they will do after project will take place.

With regard to relocation and compensation, most of the answers are to move with the other households in the village (70%). This comes from the close relationship and high community participation. The next form of relocation is to move with people of the same occupation. This is because they are scared of the discrimination between new and local communities in the new village, that might happen since the 'new' is the competitor to the local ones. In fact, the residents want to move together as they have lived for a long time.

Another concern of the residents is about the working conditions of the new area,

particularly those who are occupied with fishery and want to maintain the job. It is clear that fishery with simple boats need location with favorable weather conditions. In fact, in this area, there has almost been no marine accident, particularly since the border police always informs fishermen of the weather. Agricultural households, which do not know other jobs to change, are also, concerned of that problem.

Regarding the compensation, the answers to compensate fully in accordance with their assets.

The last subject is education and job providing as mentioned above. The education level of the residents in the area is low due mainly to the income level, partly to the poor education infrastructure in the area. One wish of the residents is to build up a 3rd level school to decrease the distance to school for children in the area. The second wish is that the government should have a policy, giving priority to local residents in training and recruiting to work in the project area.

**(2) Compensation Plans for the Residents**

The local authority already envisages some measures to be done:

- To register and check the inventory of all infrastructural assets, house, land, etc., so as to know accurately the present status and to formulate policies for the purpose.

- To solve the matter of population and specification of households. This is because the population is increasing and the households are likely to be divided into small ones as per the wishes of the villagers.

- The relocation of graveyards out of the area is also a problem due to traditional customs of the villagers who are not willing to do it at anytime. Therefore, there will be a detailed plan to be advised to the villagers so that a developer can have good cooperation with them. This is also closely related to environmental protection as it might pollute the area.

- There are also in the area revolutionary sanctuaries which are historic treasures and are worth consideration in Vietnam.

- The villagers educational level is still low. All the schools and related facilities have been deteriorating due to the effects of the wars and only rehabilitated after 1975 when the local community came back to shape. The aspirations of the villagers now is to have a stable life and to improve their living standards.

- There are in the area about 92.1% of the households who are willing to relocate, but there should be with decent support and appropriate measures.

Anyway, those are only the preliminary measures, giving guidance to a direction as mentioned above.

### 14.2.4 Historical Heritage and Cultural Properties

**(1) Loc Vinh Village :**

The village has four hamlets of Canh Duong, Dong An, Binh An and Phu Hai. They have the following heritages and relics.

**1) Canh Duong Hamlet**

- *Canh Duong temple* : built in the ancient time, collapsed in 1968. It was rebuilt in 1994 - 1995.

- *Bong Lai pagoda* : worshipped Madonna, built long time ago, collapsed in the war against French. It remains foundation and century - old trees.

- *Fisherman tomb* : built from - Bao Dai Dynasty (about over 50 years from now). Every year, ceremony sacrificing to "Whale" divinity is organized.

- *Church of Le Family* : built in the ancient time, rebuilt in 1993 - 1994.

- *Church of Bui Family* : built long time ago, rebuilt in 1993 - 1994.

**2) Dong An Hamlet**

- *Dong An Communal House* : built long time ago, collapsed in 1969

- *Dong An pagoda* : built long time ago, rebuilt now.

- *Fisherman tomb* : built long time ago, damaged, recently restored.

- *Forsaken Spirit Temple* : built a long time ago, restored after being damaged heavily. Every year, the lost soul worship of forsaken dead men in accidents.

**3) Binh An Hamlet**

- *Binh An Communal House* : built in 1968, destroyed in the war. It remains foundation.

- *Binh An pagoda* : built long time ago and restored now.

- *Catholic Church* : built in 1818, there are tombs of men dying of Dao.

- *Ong Ngu temple* : built long time ago. Every year, the ceremony sacrificing to Fisherman (Whale Divinity) is organized to pray for the peace in the sea.

- *Forsaken Spirit Temples* : scattered in the hamlets.

**4) Phu Hai Hamlet**

- *Phu Hai Communal House* (formerly called Xuan Yen) : started to build long time ago, from Nguyen Dynasty, by lime-sand stone, decorated by porcelain pieces with royal blue flowers into the shape of houses attending both sides of walls in front of the communal house. This communal house was destroyed by bombs in 1969 and now abandoned. In front, on the left of the communal house, there is a small temple built at the same time.

- *Ham Kinh shrine* : started to build long time ago by stone - brick - lime - sand at the foot of Da Kep mountain, group I (Phu Hai-Loc Vinh) . Now there are still wall and altars but broken a lot. Local inhabitants often burn incense to worship.

- *Dong Cay Dac* : shrine Started build long time ago by stone - brick - lime - sand, at the foot of the Paket mountain, group I (Phu Hai -Loc Vinh).

- *Dong Pho shrine* : started to build for a long time by lime - sand stone brick.

- *Tien Hien temple* : built long time ago, collapsed in the war against America. Recently, the small church was rebuilt on the old ground. Tien Hien has 12 genealogies of two families : Hac and Ho.

- *Fisherman temple* : built long time ago, collapsed, nowadays it is rebuilt. The whale divinity worship is celebrate to pray for the peace in the sea every year.

- *Nghia Tu* : built in the ancient time, collapsed now.

- *Church of Tran Family* : built in the ancient time. It was rebuilt in 1990.

**(2) Loc Tien Village :**

There are 8 hamlets under People's Committee of Loc Tien commune. Cultural and historical heritages are as follows :

- *Communal Houses* : : built 120 - 150 years ago ; most of them was destroyed in the war year of 1970 - 1973. Nowadays, they remain trace of ground and foundation, collapsed wall in the hamlets. Each hamlet has one communal house.

- *Pagodas* : built for one century. There are 2 pagodas lying in 2 hamlets. Both of them were restored or rebuilt in the old ground by local people. At present, the pagodas are still under operation. On the 15$^{th}$ day of every month (lunar), there are many people visiting the pagodas for praying to Buddha.

- *Catholic Church* : built long time ago, and restored. At present, christians always go to church for celebration.

In the areas, the hamlets still remain forsaken spirit temple's, old and new tombs. Every year, on the festival day on 5$^{th}$ of March (lunar month), or funeral day, the local people go there for lighting the incense and worshipping.

**(3) At Loc Thuy Village :**

- *Canh Thanh Duong Tinh pagoda* : build many years ago, about more than century, collapsed and has been rebuilt a few years ago. The pagoda is at Phu Xuyen hamlet.

- *Fresh Water pagoda* : built by Mr. Nguyen Van Kinh half a century ago, has been repaired lately. The pagoda is at Phu Cuong hamlet, near high way 1A.

- *Catholic Church* : belonging to Phu Xuyen hamlet, started to build nearly a century, The church was collapsed, now there are still foundations and two poles used as an entrance gate. Near the church, there is a prayer house (preaching house) which was built at the same time, and it has been repaired and used as a church for christians.

- *Catholic Church* : of Phuoc Hung hamlet built in 1936. The church still mainains the former shape, many places were damaged. Near the church, there is a prayer house (also called preaching house). Roofs were damaged. A part of them were roofed and repaired and now used as an elementary school and classes.

- *Phu Cuong Communal House* : started to build many years ago, collapsed and rebuilt a few years ago, now used as the headquarters of the People' s Committee of Loc Thuy Commune.

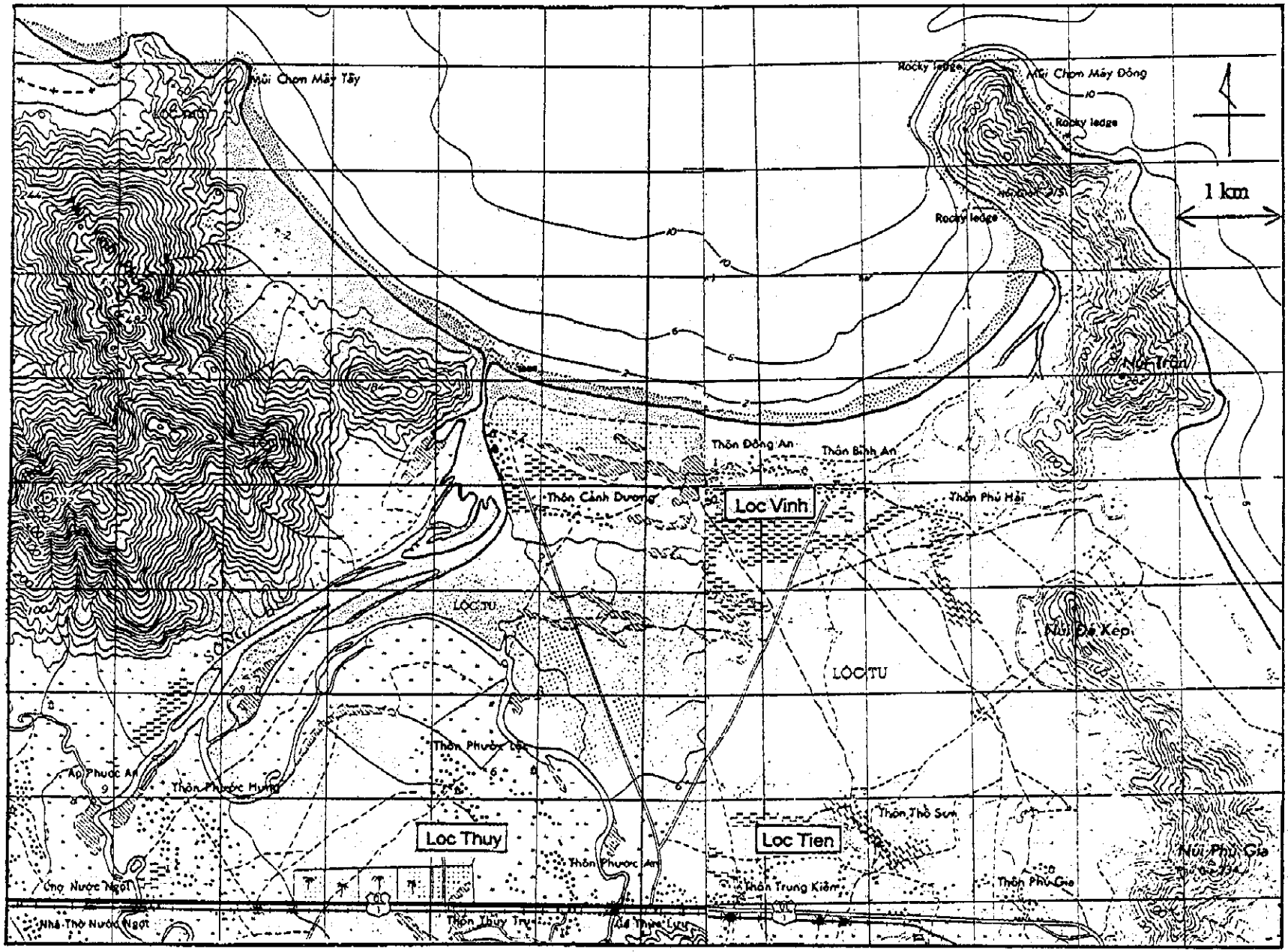


**Figure 14.2.1 Location of Villages and Communes at Chan May, Thua Thien- Hue**

## 14.3 IEE Checklist

The law on Environmental Protection was passed by the National Assembly of Vietnam in December 1993 and came into force in 1994. Consequently, most of large projects such as the development of Chan May are subject to EIA studies. The law requires the investors, project managers or directors of the offices to conduct the assessment of environmental impact (Article 9). Article 11 of the law defines that the EIA shall be conducted in two phases, namely preliminary and detailed. Appraising power is given to the Ministry of Science, Technology and Environment (MOSTE) for large projects and to the provincial Department of Science, Technology and Environment for others. In case of the development of ports, all projects which may handle more than 500,000 m3 per year need to be appraised by MOSTE.

Major sources of adverse effects of port development can be categorized into three types: (a) location of port; (b) construction; and (c) port operation, including ship traffic and discharges, cargo handling and storage, and land transport. Location of port connotes the existence of structures or landfills, and the position of the development site. Construction implies construction activities in the sea and on land, dredging, disposal of dredged materials, and transport of construction materials. Port operation includes ship-related factors such as vessel traffic, ship discharges and emissions, spills and leakage from ships; and cargo-related factors such as cargo handling and storage, handling equipment, hazardous materials, waterfront industry discharges, and land transport to and from the port.

Environmental facets to be considered in relation to the development of the new port of Chan May are categorized into nine groups: (a) water quality; (b) coastal hydrology; (c) bottom contamination; (d) marine and coastal ecology; (e) air quality; (f) noise and vibration; (g) waste management; (h) visual quality; and (i) socio-cultural impacts.

Checklists of adverse effects of port development for IEE have been compiled by several organizations including the World Bank, the Asian Development Bank, the International Association of Ports and Harbors and Japan International Cooperation Agency. Based on the these checklists potential adverse effects are checked as listed in Table 14.3.1.

**TABLE 14.3.1 Initial Environmental Examination Check List (Chan May)**

| Factors | Impacts |
|---|---|
| **(1) WATER-RELATED ITEMS** | |
| **a. Dredging** | |
| 1) Toxic, harmful substances in water column; Sunlight penetration; Smothering bottom biota | Dredging will stir up bottom muds/sands. This will temporarily reduce sunlight penetration and smother some of the local bottom biota, but bottom habitat of particular high value/importance have not been detected. |
| 2) Influence on tidal flows; Accelerated natural sediment deposition; Attraction of desirable or undesirable fisheries; Altered bottom biota | Dredging will alter bottom biota locally and may result in loss of fishery in the limited area of Chan May Bay. Influence on tidal flow and sediment deposition to be studied in EIA |
| 3) Change in current patterns; Shorezone and beach erosion; Accelerated sediment deposition shoaling | Impact of the reclamation and submersed structures to be studied in EIA |
| 4) Loss of bottom habitat, shellfisheries, fishery food resources | Bottom habitat of particular high value/importance have not been detected. |
| 5) Salt water intrusion; Accelerated groundwater flow to estuary | No dredging planned in river area |
| **b. Dredged Material Disposal** | |
| 1) Selection of appropriate disposal site; Methods of dredging and dredged material transfer and related disposal impacts | Dumping site located offshore well away from known fishing areas and coral reefs. |
| 2) Characteristics of dredged material | Sand and sandy silt |
| 3) Disposal methods (Potential or requirements for capping; Alteration of current patterns; Accelerated shoaling) | Dredged material will be used for land reclamation as much as possible. Limited volume of marine dumping will take place at offshore disposal site carefully selected. |
| **c. Landfills and Construction of Breakwaters** | |
| 1) Loss or displacement of shellfisheries, fishery food resources lost or displaced | Although there will be adverse effects on coral reefs at Chan May, these reefs which are generally in poor condition are unlikely to be important/valuable shellfisheries or fishery food resources. |

| | |
|---|---|
| 2) Desirable, undesirable species formed by structures (especially pilings and breakwaters) | Not detected in the past |
| 3) Alter currents; Sediment deposition accelerated; Change required in harbor maintenance dredging practices | Changes in currents to be simulated. |
| 4) Dispersal of suspended sediments | Areas likely to be adversely affected by dispersal of suspended sediments from landfills and breakwater construction do not contain any habitat or fisheries of particularly high value/importance, although these sediments are likely to adversely affect the corals |
| **d. Alteration of Harbor/Port Ship Traffic Patterns** | |
| 1) Relocation of navigation markers, moorings | Not required |
| **e. Ship Discharges, Oily Ballast; Bilge Water; Sewage** | |
| 1) Regulations controlling cleaning procedures; Limitations on release of cargo and machinery space residues (Discharge limitations); Need for facilities to receive waste from ships; Means of storage and ultimate disposal of residual wastes | Potential impacts will be mitigated by developing site-specific waste management procedures to be employed at each site for collection, handling, treatment and disposal of cleaning wastes, including wash-waters and residues. |
| 2) Importance to fishery resources; Water quality of rivers, bays, harbors | Monitoring is ongoing. Change in Water quality to be studied |
| 3) Shore facilities for receiving ship generated sewage and garbage waste; Sanitary treatment facilities (Connection to special or municipal systems); Transfer and pumping facilities | Port Design will include on-shore sewage and garbage waste handling, storage and disposal facilities for ship-board wastes. |
| **f. Detection and Clean-up of Spills** | |
| 1) Type of spills (oils, lubricants, hydraulic oils, fuels, liquid and solid chemicals); Frequent spill sources | Potential types of spills and assessment of spill risk will be identified during detailed port design phase. |

| | |
|---|---|
| 2) Spill clean-up measures (regulations, clean-up equipment available); Spill detection routines; Contingency plan | Oil berth to be equipped with oil fences. Site-specific spill clean-up measures will be developed, including management procedures, equipment requirements, spill detection system and emergency response procedures as part of the site contingency plan. |
| 3) Dry cargo releases (fugitive emissions, dust control, smoke density and effects) | Bulk (mining products, coal, clinker and others) operations will have little dust emission. Site-specific dust control measures will be adopted during detailed port design phase. |
| **g. Waterfront Industry Discharges** | |
| 1) Sanitary wastes (sources, volumes, special contaminants)<br><br>- Sanitary treatment facilities (existing, planned, proposed, capacity of each locations, discharge water quality, ability to handle shipping) | Direct discharges of sanitary wastes into port waters are not planned in Chan May. Sanitary treatment facilities and appropriate mitigation to be designed in the construction stage of waterfront industry. |
| 2) Non-sanitary wastes (sources, volumes, toxins)<br>- Discharge/treatment procedures (capacities, discharge points, limitations, residuals)<br>- Discharges reaching harbor/river waters; Dispersion; Settling tendencies | Any requirements for non-sanitary waste discharge treatment facilities will be addressed in the site-specific design stage. |
| - Non-sanitary spillage from non-ship related activities (types of spills, frequency, volumes, how handled, retention/recovery systems) | Risk of non-sanitary spillage from non-ship related activities to be assessed during site-specific study |
| 3) Heated process water discharges (electricity generation, industrial processes, LNG condensation) | Heated water discharges not detected |
| **(2) LAND-RELATED ITEMS** | |
| **h. Excavation for Fill** | |
| 1) Shore sand/gravel excavation; Dust (fugitive emissions); Blasting | Gravel extraction areas and potential impacts associated with gravel extraction process and appropriate mitigation methods for these will be identified in the site-specific study. |

| | |
|---|---|
| 2) Transportation to construction site | Potential environmental impacts from the transportation of fill materials will be identified and addressed with appropriate mitigation measures in the site-specific study. |
| **i. Wetland Damage and Filling** | |
| 1) Ecological value of wetlands (use by domestic animals, use by other fauna, unique vegetation, irrigation water source, damage to flora) | Dam Cau Hai Lagoon is located 10 km west of the planned development site. Potential impacts on the large lagoon would need further study to plan impact mitigation and protection measures during the site-specific study. |
| 2) Runoff from ports and harbor facilities, Existing contamination input | Runoff collection and control measures will be designed at the detailed design stage with a view to minimizing the risk of future contamination of port and harbor waters. |
| **j. Loss of Usable Uplands** | |
| 1) Types of land areas likely lost to waterfront use (residential areas, market centers, commercial areas) | The areas likely to be lost to waterfront use are currently low value, low productivity agricultural land. |
| 2) Residential relocation; Replacement farmlands; Other replacement/relocation needs | Residential relocation of a few low quality houses and garden/farm land will be required at Chan May. Replacement of fishing village also required. |
| **k. Noise from ports and harborside industry:** | |
| 1) Location of noise sources; Background noise level | Noise from port activities is limited. Port related traffic which would be sources of noise needs further study to plan impact mitigation along the main transportation routes. |
| **l. Dust and Other Airborne Emissions** | |
| 1) Sources (industrial, construction), Raw material storage | Sources of dust and other airborne emissions will be identified and appropriate mitigation measures planned on a site-specific basis. |
| 2) Smoke and other combustion products (ships, traffic, industry) | Port activities in Chan May area will generate no significant volume of smoke and other combustion products. Smoke from ship will be seen temporarily. |

| | |
|---|---|
| **m. Traffic related items** | |
| 1) Existing traffic load (roadway network, traffic load, accident data) | Route No.1 is the major existing road and port-related traffic load will be studied in the site-specific investigation. |
| 2) Projected traffic increases (roadway additions/improvements, important routes) | Port related road traffic will be identified and impact mitigation planned in the site-specific study. |
| **n. Handling and Disposal of Solid Shore Generated Wastes** | |
| 1) Important sources (ships, waterfront industrial areas, residential areas) | Collection, handling and disposal of solid wastes generated from ships and port activities will be managed by port authorities and municipal agencies. |
| 2) Means of transport/transfer (ship-to-shore, onshore) | Ship to shore transfer of ship generated wastes and onshore transport of these to treatment/disposal sites in an environmentally safe and secure manner will be carried out in accordance with the direction of port authority. |
| 3) Disposal methods (incineration, landfills) | To be carried out in accordance with the direction of municipal agencies. |
| **o. Runoff from Raw Material Storage** | |
| 1) Nature of materials (salt, sulfur, metal ores, refined concentrates) | Bulk cargo would be a potential runoff source. Preventive measures will be designed in the site-specific design stage. |
| 2) Typical storage conditions, locations, storage time, health menace to workforce) | Storage of raw materials will be designed in the site-specific design stage with a view to reducing health menace to port workers. |
| **p. Visual impacts** | |
| Structure; Painting; Lighting; Attempts to blend with surroundings | Visual impact mitigation measures will be incorporated into the site development plans where this is practicable and warranted. |

| | |
|---|---|
| **(3) AIR-RELATED ITEMS** | |
| **q. Background information** | |
| 1) Meteorological data (prevailing winds, seasonal weather patterns, storm tracks, frequency and severity, rainfall records, wind rose data) | Available in this report |
| 2) Identify sensitive areas | None detected in Chan May area |
| **r. Gases, Smoke, and Fumes** | |
| 1) Sources, components, controls (industrial contributions, ships, residential background, vehicle emissions, background from other areas) | Impact of the emission from ships and port-related vehicles will be examined in the site-specific study. |
| **(4) HAZARDOUS MATERIALS/CARGOES** | |
| **s. Categories Gases, Liquids, Solids** | |
| 1) How stored; Location of storage areas; Shipping and handling procedures; Disposal of any hazardous wastes generated | Site-specific hazardous materials/cargoes management practices, including location and design of storage areas, handling procedures and collection/treatment/disposal of any hazardous wastes will be developed in the site-specific detailed design stage. These cargoes will be handled in a restricted area of the Port. |
| **(5) SOCIO-CULTURAL ITEMS** | |
| Tribal, cultural, ethnic, historical, religious aspects likely impacted by changes, including consequences of modernisation and industrialisation Preserving traditions with minimum loss and disturbance; Removal of graveyards, churches, etc. | Socio-cultural situation of Chan May area were studied and information is available in Chapter 14.2 of this report. Population to be relocated will be identified and assessed in the site-specific study. |

## 15. Conclusions and Recommendations

### 15.1 Conclusions

(Findings on the region)

Central region of Vietnam is not enjoying the economic boom prevailing in the south and north region. To cope with this situation, the national government proposed or approved several projects in the region including the East West Transport Corridor, Dung Quat oil refinery, the South North Highway through Hai Van tunnel and industrial zone development as well as agricultural development. Transportation infrastructures including port facilities are in poor condition in the region to serve for the economic development.

(Port of Danang)

Port of Danang consists of two ports, i.e. Song Han port at the mouth of Han River and Tien Sa port on the west coast of Son Tra peninsula. Cargo throughput of Danang port was 870,000 tons in 1997, of which 70-80 % was handled at Tien Sa port. Existing two piers in Tien Sa port are deteriorated and require rehabilitation of its pile structure. Nguyen Van Troi bridge is used for port access, however, it allows only traffic under a weight of 13 tons. Upgrade of the bridge is also in urgently required.

(East West Transport Corridor)

East-West Transport Corridor Project is studied by ADB and regional countries. The route No.9 and the second Thai-Lao Mekong bridge were selected for early implementation. This report assumed that R9 will be developed firstly followed by R18. R16 will have a low priority.

(International Transit Cargo)

Southern provinces of Lao PDR and northeast Thailand are deemed as the hinterland of the new port subject to the completion of R9 and Route R16/R18 of the East West Transport Corridor project. Projected cargo volumes in 2020 are 646,000 tons through R9 and 822,000 tons through R16/18. It is assumed that R9 will be developed firstly followed by R18. R16 is deemed to have a low development priority

(Natural Conditions)

Wind observations were also carried out in each project area throughout a year. The most frequent wind directions are N and SE in Chan May

Offshore waves were observed at two points on the coast of the central region. One ultrasonic wave recorder was placed on the seabed in the mouth of Danang Bay and the other one was positioned off the Ky Ha Cape in Quang Nam Province. The maximum waves observed were 5.7[1/] m at the Danang Bay mouth and 5.1[2/] m at the Ky Ha offshore observation point.

Based on the observations and statistical analysis of 30 historical typhoons, offshore wave height for the return period of 50 years was estimated at 9.7[3/] m in the deep sea off the Danang Bay and Chan May Cape, and at 8.8[3/] m in the deep sea off Dung Quat Bay. Design wave height for the main breakwater is 7.4[3/] m in Chan May.

(Seabed Soil Conditions)

Soil boring investigations revealed that a thick clay/clayey sand layer exists in Chan May. A stratum of fine sand was identified at the depth of -20 to -35 m in Chan.

(Demand Forecast)

A considerable increase in cargo throughput is envisaged in the central region owing to the economic growth and industrial development. Projected seaborne dry cargo from/to the central region will reach to 10-20[4/] million tons in the year 2020. Expected cargo throughput in 2020 is about 5.4 million tons at Chan May port.

(Capacity of the Present Port)

The capacity of Tien Sa port is assessed using a numerical simulation model, POSIM, assuming irregular ship arrivals and cargo capacities. In case that No.1-4 berths are rehabilitated and utilized, the port capacity is estimated at about 1.7 million tons and at about 2.2 million tons after the completion of Berth No.5. If Tien Sa No.6 berth were developed, the port capacity would reach 3.1-3.3 million tons. The capacity of Song Han port is deemed to remain at the present level, i.e. about 200,000 tons.

(Master Plan for Chan May)

Requirements for new berths in Chan May are estimated at one multi-purpose berth for container cargo vessels and general cargo trampers; one deep draft conventional berth for car carriers, passenger ships and general cargo trampers; three conventional berths for general cargo and bulk cargo; and 2 berths for product oil tankers. The main

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[1/] This height is the significant wave height ($H_{1/3}$), which is 9.0 m in the maximum wave height ($H_{max}$), caused by Typhoon Friz on 25 September 1997

[2/] $H_{1/3}$, $H_{max}$ is 7.9 m, caused by Typhoon Friz

[3/] $H_{1/3}$

[4/] exclude crude oil and oil products

breakwater has a length of 1,290 m to shelter the port waters, and dredging of 4 million $m^3$ is required for the approach channel and turning basin with a depth of -13[5/] m. Land reclamation is planned for the wharves of 49 ha.

(Initial Stage Development Plan)

The development of Chan May Port is possible if industrial development of the hinterland is realized and the demand for a new port is confirmed. Since a new port development generally requires a large initial investment in breakwater and/or channel dredging at the first stage, a proper size of development is necessary to be a feasible project. ISP is proposed as a package plan for the first stage of development in Chan May. It will become necessary to develop a multi-purpose berth with a provisional alongside depth of –12 m (to be deepened to –13 m in the future) and two conventional berths with an alongside depth of –8 m, if Chan May Industrial Park is realized.

(Port Facility Design)

After comparing several designs of breakwater and quaywall, it was concluded that composite gravity type structure with hybrid caisson will be appropriate for deep sea breakwater and quaywall from the viewpoint of technical and economical aspects. In particular, the proposed structure will be suitable for the marine structure with high design wave heights and soft foundations.

(Cost Estimates for Chan May)

The costs of implementing the Master Plan are estimated at US$258 million in which the costs for ISP is US$151 million. Breakdowns are summarized in the table below.

| (US$ million) | Cost of MP | ISP |
|---|---|---|
| Breakwaters, seawalls, groins and others: | 66.8 | 51.6 |
| Quaywalls and yard pavement: | 91.5 | 50.1 |
| Dredging: | 19.8 | 6.4 |
| Road and other utilities: | 7.9 | 7.9 |
| Cargo handling equipment and navigation aids: | 17.1 | 4.7 |
| Engineering services, contingencies and tax: | 54.6 | 30.2 |
| Total: | 257.6 | 150.9 |

[5/] All depths indicated here are the depth under CDL

(Economic Analysis)

The results of the economic analysis indicate that port development projects of Chan May are viable from the viewpoint of national economy of Vietnam. Economic Internal Rate of Return of ISP is shown below including sensitivity tests.

| | EIRR of ISP | Sensitivity tests[6/] |
|---|---|---|
| Chan May: | 17.2 % | 14.7 % |

(Port Administration and Operations)

Although several port administration and management bodies are identified in Vietnam, such as Vinamarine, Vinalines, local government and the military, Vinamarine will be an adequate body for the development of the new commercial port in the central region.

(Environmental Survey)

Field surveys covered waves, currents, water pollution, shoreline sediments, terrestrial flora and fauna, and local residents and cultural assets. Although coral reefs were found near the project area, their location is limited and generally in poor condition. Bottom habitat of particular high value/importance has not been detected. The hinterland is unfertile, low productivity farm land and the area likely to be lost to waterfront use is currently low value, low populated land.

(Initial Environmental Examination for Chan May Port)

Initial environmental examination indicated the need for a EIA study on changes in current patterns, disposal of dredged material, impacts on water quality, shoreline change, traffic load on access roads and relocation of inhabitants.

(Overall Evaluation of the Project)

Maritime transportation borne by the port development will greatly contribute to the development of the central region in terms of foreign currency earnings, job opportunities, trade promotion and industrial development. However, the development of a new port requires a fairly large capital investment in breakwaters and reclamation work in the deep sea area, so that financial feasibility is very critical in connection with construction cost and port revenues. As seen from EIRR, the port development projects in Chan May are economically effective and will have no particular difficulty in technical, environmental aspects. However, the timing of the development of Chan May Port should be carefully decided in implementing the planned industrial development.

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[6/] subject to 10% increase in development costs and 10% decrease in economic benefits

## 15.2 Recommendations

### 15.2.1 Basic Strategies on Development of the Key Area of the Central Region

As already recommended in the Study on the Integrated Regional Socio-Economic Development Master Plan for the Central Region of the Socialist Republic of Vietnam prepared by the JICA study team in March 1997, the Central Region has significant roles and development needs in the international, national, and regional context under the general understanding that accelerating economic growth of the Central Region is important for the economic unification of the country.

In the international context, the Central Region should form an economic network with inland countries and regions in the Greater Mekong Sub-region and become a trade processing center of the Sub-region. In the national context, it should achieve an accelerated economic growth to mitigate widening economic disparities among regions, thus contributing to the economic unification of the country. In the regional context, it should pursue development quality, which is socially and economically balanced and environmentally sustainable development.

While the above recommended concept is considered generally applicable to port development planning in the Central Region, following points need to be carefully considered to secure sound, steady and practical development.

(1) In order to avoid possible adverse impacts of drastic and random development, the target projects and their location need to be critically selected under careful coordination with the parties concerned.

(2) Development schedule should be appropriately controlled to be harmonized with local life and culture.

(3) Initial scale of the target projects should be down-sized as far as possible so as not to jeopardize national and regional financial soundness.

(4) Private sector participation in the development schemes is desirable in principle but needs to be controlled carefully to mitigate its adverse effects on the national and regional economy and society.

(5) Experiences in most advanced countries show that drastic industrialization is often harmful, if not properly controlled, to sound development. Vietnam should take advantage of its "latecomer" position and avoid the mistakes made by other countries.

### 15.2.2 Objectives and Basic Framework of Port Planning for the Area

While the detailed objectives of port planning vary widely depending on their type, coverage, time span, target facility and so on, the overall objectives of port planning for the region can be summarized as follows:

(1) to be a guideline for long-term investment and operational improvement schemes of the target ports.

(2) to be a base for short-term/urgent development plan of which contents are required to be consistent with total development scheme.

(3) to provide port users, investors, and other business entities concerned with the future prospect of a business environment and thus to guide the business behavior of the private sector in a proper direction consistent with the port development.

(4) to promote harmonized development of other infrastructures necessary to realize the proposed port development schemes.

(5) to be a component of the national port plan so that the port development of the Area can be appropriately coordinated with the overall concept of national port development.

(6) to be a base for consideration of various financing agencies in their investment or financial plan.

In order to achieve the above objectives and to satisfy various requirements of the Study, the port planning framework is designed as follows:

(1) Master Plan (MP) for port development in the three key areas with target year of 2020.

(2) Initial Stage Plan (ISP) of port construction for each site of the three key areas within the framework of the Master Plan.

(3) Feasibility Study (FS) on short-term port development plan for a selected site with target year of 2010

Among the above three types of planning, ISP has a unique function in particular to cope with the potential port development demand expected in the three sites, namely Chan May, Danang and Dung Quat. The objective of ISP is to propose a minimum reasonable package of port facilities to be developed at the initial stage of total development scheme under the proposed master plan for the ports. In an ISP, the schedule of port development including commencement timing and final target year is normally not indicated. ISP is, therefore, an appropriate way of planning for such a case as when confirmation of the exact timing and volume of potential cargo traffic is considered difficult due to the uncertain situation of background factors such as industrial location, public acceptance of the project, and so on. In case of Danang Port, ISP is identical to the short term development plan of which development schedule is clearly defined for the feasibility analyses in the study. On the other hand, only ISPs are proposed for Chan May

Port and Dung Quat Port, mainly because of the reasons stated in the above paragraphs. In any case, ISP is useful enough for further study for the projects.

### 15.2.3 Port Development Strategy for the Three Key Sites

The final goal is to realize well balanced national development by creating a third social and economic core of the country following the other two advanced areas, namely Hanoi and Ho Chi Minh City. For successful achievement of the above objectives, each of the ports to be developed in the three target sites namely Chan May, Danang, and Dung Quat, needs to have a clearly defined function, scale and development timing which is conceived to fit the original character of each development site. In this regard, the following are the most important points in developing ports in the region:

(1) With the view to avoiding possible unproductive competition among the ports, duplication of functions and facilities should be strictly checked. This is especially important for international container handling facilities at the initial stage of the project when the actual cargo demand of the region is relatively small and inadequate to attract the major container lines.

(2) Construction of port facilities for industrial cargoes to be originated mainly from the direct hinterland of the port should be started upon confirmation of actual location of planned industries in the site.

(3) Considering the severe financial position of Vietnam, the initial stage investment for the ports should be minimized to the extent possible.

(4) On the other hand, the full scale potential port development concepts need to be appropriately planned and authorized with a view to promoting overall regional development and attracting private sector investment in the hinterland of the ports.

(5) Financial resources for public port development should be diversified to promote participation not only of domestic/foreign private sector but of the relevant local provinces so that the port development concepts could reflect their will and desire in particular.

### 15.2.4 Functional Allotment to Ports in the Area

Functional allotment to ports in and around the area is proposed in the Conclusion of this Chapter. In connection with the proposed allotment, the following points are recommended:

(1) An international commercial hub port must be able to accommodate at least Panamax size container ships and have a large volume of cargo to enable shipping lines to make frequent calls at the port. When shipping lines call a port frequently, users generally enjoy such benefits as reasonable shipping freight rates, more options in selecting favorite shipping services, overall scale merit of cargo handling and so on. In this context, it is recommended that utmost efforts of the country should be concentrated in developing

commercial port functions with international standard container terminals at Danag Port Complex, which has historically served as a commercial port and is strategically located to become a transport junction. The port could attract an adequate number of ship calls as a hub port of the country and this may be very effective not only in attracting international transit cargoes from/to the neighboring countries, but in accelerating development of the industrial zone behind the site, through stimulating investment in various related infrastructures including the road network to the hinterland.

(2) In the long term, Chan May has the potential to be a multi-functional port due to its advantageous location, moderate natural conditions locally, prioritized industrial development schemes and active promotion policy of the province. In the short term, however, immediate and large scale commercial port development in this site may be relatively risky mainly due to the existence of Danang Port Complex, uncertain status of commercial cargo demand for the port, and the fact that industrial development in the hinterland is in the initial stage. Considering the above situation, the first stage of the development of this site shall be focused on promotion of industrial location of appropriate scale at the industrial park behind the Chan May Bay with timely construction of a feeder port for the province. Since the People's Committee of Thua Thien-Hue has designated development of the Chan May Port as a top priority project in the province as a means to raise living standards in this area, it is recommendable that the central government should consider to support, if possible and appropriate, the project financially or institutionally, because it could also have a vital role for future national economic development, provided that the project scale and construction timing are reasonably planned and selected.

(3) A large industrial zone with a full scale oil refinery is to be developed in the direct hinterland of Dung Quat Bay, which means that the expected major function of the port is to serve industrial cargoes from/to the industrial zone. While public port functions may be required in the long term, the initial development components of the port should be focused on such industry related facilities. Port development schedule of this site should accordingly be coordinated with the planned industrial development, so that timely construction and reasonable scale of the port facilities concerned can be secured.

### 15.2.5 Port Administration, Management and Operation

Chapter 13 of the Report illustrates the present system of Vietnamese port administration, management and operation which is formed mainly under domestic administrative requirements and considerations. While it is natural that an administration system of a certain sector of a country is established for her own benefit and convenience under the political and social system of the country, international requirements are an

important factor as well for the port sector administration concerned in particular. This is because the port facilities and its service activities should be designed and provided for the port users who have their own requirements for the benefit of their international business and global shipping economy. The port users, whether they are shippers, shipping lines and other port related entities, want to use a port which is managed and operated well under a simple and transparent administration system, so that they can coordinate their business activities easily with the direction of port sector development and management policy of the government. In this context, the current system of port administration of this country may need to be simplified under well coordinated institutional systems. Some suggestions in this regard are as follows.

(1) Generally speaking, the basic port sector development policy and nation wide port administration are to be under MOT for all commercial ports.

(2) While VINAMARINE is responsible for overall regulatory functions in the maritime sector and for some ship, port and shipyard operational management functions under MOT, VINALINES is engaged in comprehensive shipping and maritime related activities including the management and operation of Saigon Port, Haiphong Port and Cai Lan Port under direct supervision of the Prime Minister's office. This kind of administration may jeopardize consistent policy decision making in port sector affairs and effective utilization of maritime human resources. If the two organizations can not be amalgamated for some reason, further coordination by MOT may be required. Full privatization of the operation and management functions of VINALINES may be another alternative to promote overall economic efficiency of the major ports.

(3) If the situation allows, the administration of river ports should be simplified. Too many administrative organizations are involved in the river port affairs, which makes it difficult to keep a consistent and comprehensive port policy. Since the function of Vietnamese river ports is mainly limited to related local areas, it may be reasonable to let the local communities manage them under the overall supervision of MOT and/or IWB.

### 15.2.6 Procurement of Financing Source for Port Development and Private Sector Participation

Procurement strategy of financial resources is always one of the critical issues for successful port development which normally requires a large amount of investment. There may be several ways to procure funds for a port project. In recent years, it can be often observed in many developing countries that construction funds from private sector are

mobilized through privatization of a core function of a port. This selection, however, is not always successful nor appropriate from the public port development concept point of view. If the purpose of privatization is to improve efficiency of port operation through competition, this selection may be justified generally for any type of port development including a port of highly public function like the target port development of the Study. However, if the government wants (mainly because of heavy shortage of original funds) instant money for the project by simply selling to the private sector a vital part of the potential port development site and/or its function, such a policy should not be applied. Considering the aspect pointed out in the above paragraph, it may be better for the government to use its own funds for the projects (at least for the initial stage of the projects) including utilization of possible soft foreign loan or combination of public and private financing sources.

### 15.2.7 Attraction of International Transit Cargo

The potential international transit cargo traffic from/to the neighboring countries through the project ports can not be realized simply by increasing the cargo handling capacity of the ports. Several critical conditions as shown in the following paragraphs need to be satisfied. The most important and basic requirements are to provide fast, reliable and efficient services at a reasonable price, which is not easy to achieve, particularly for a newly developed port. Moreover, in order to compete successfully with other ports for such transit cargo, overall performance of total transit corridor from origin to destination including road network, cross border services, port and shipping performance should be sufficiently competitive.

(1) For the project ports in the Central Region, the international cross border facilities, custom clearance and documentation need to be improved and simplified in particular.

(2) Since scale merit on cost performance of cargo handling operation and shipping is significant the international container traffic, the newly developed container port in the Region should attract as many ship calls as possible, so that the port can establish its position as a international container hub port. This can be achieved by developing the relevant infrastructures and institutional systems of the port under coherent overall policy.

(3) Service level and tariff policy of the rival ports need to be studied and analyzed, so that overall performance of the corridor can be sufficiently competitive through constant improvement of service and careful adjustment of the tariff and charges of the port.

### 15.2.8 Engineering Surveys and Studies

Considering Vietnam's lack of experience in constructing large scale seaports with long and deep breakwaters and quays, it is important to collect the basic engineering data and information necessary for economical design and construction. To this end, following items are recommended to be included as apart of the engineering analyses.

(1) Wave observation over a period of at least three years at the appropriate offshore point of the project is essential for the analyses of anomalous high wave (for selection of design wave), and normal wave (for the study on calmness of sheltered water, sand drift, construction planning and so on).

(2) Annual shoreline survey and sounding at the project sites to check long term effect of possible topographic changes on shoreline and sea bottom is vital for assessing the impact of the completed project structures and for determining if countermeasures are necessary.

(3) The sedimentation/siltation phenomenon is still one of the difficult themes in port and coastal engineering. Discussions on this subject have been made at Lien Chieu in the Study within the limit of the Scope of Work which is in detail enough as an analyses for planning stage. In order to confirm the results of the Study and improve its accuracy, in particular on prediction of sedimentation volume in the approach channel and basins, however, it is recommended that the Study should be followed, if possible, by deeper survey and analyses, for example, measurement of salt water wedge, full scale computer simulation and site experiment by test pits. These data are also useful for control or improvement of safety and efficiency of ship navigation and berthing performance in a port.

### 15.2.9 Detail Design and Cost Estimates of the Project Structures

For the detail design of the project structures, following points need to be examined:

(1) In order to cope with the soft foundations observed at the construction sites of Lien Chieu and Chan May in particular, confirmation of stability of the structures, estimation of consolidation settlement of the reclaimed land and selection of effective countermeasures need to be carefully examined based on an adequate number of borings and minute sample testing.

(2) Since the design condition of wave protection facilities is quite severe due to the considerably high waves observed at the offshore points of the project sites, the project

breakwaters should carefully be designed referring to advanced technology and experiences of foreign countries.

(3) Type of the end section (final or temporary) of sea-wall or breakwater at the final stage of ISP needs to be carefully selected depending on the next stage construction schedule of the structures.

(4) In reviewing the proposed cost estimation of the projects, it is important to consider possible future inflation of price and changes in taxation policy.

### 15.2.10 Implementation of Port Construction Works

Following actions and cares are essential for safe, economical and efficient construction of the project structures under severe natural conditions and financial constraints.

(1) Careful construction planning and supervision are essential in preventing possible accidents and disasters due to the high waves during construction works. To this end, it is highly recommended to carry out the detailed weather and wave forecasts based on recorded observation of air pressure, wind velocity and wave height at the construction site.

(2) The offshore structures under construction are not strong enough against high waves. To avoid possible disaster by high waves, it is recommended to complete the structures leave the structures before the typhoon and north-east monsoon season.

(3) Since soft subsoil conditions are observed at the construction site in Lien Chieu and Chan May, removal and replacement of soft foundation and reclamation should carefully be executed on the basis of the deformation monitoring of the foundation.

(4) Since this is the first time for Vietnam to construct a deep sea port in the open sea area, it is recommendable to confirm any shoreline changes or channel siltation through parallel observation with actual progress of the construction works. If any countermeasures would be necessary, appropriate actions should be taken accordingly.

(5) The Study recommends a large scale caisson structure for construction of the breakwaters and wharves. In this case, it is important to prepare an appropriate base for construction works of such a large caisson, considering various factors including construction method of caisson, workability and economy.

### 15.2.11 Periodical Review of Port Plans

Periodical review of port plans is always required for proper promotion of port development, particularly under highly sensitive or unstable economic or social conditions. As already pointed out, cargo traffic demand in the region is expected to increase depending on economic development not only of the region but of the inland neighboring countries, and also on industrial location expected at the hinterland of the target ports. On the other hand, recent economic trend of the major Asian countries including Vietnam implies unstable/uncertain position of the total cargo flow demand to be generated by such sensitive situation of the regional economy. It should be clearly understood, therefore, that a certain level of uncertainty may creep into cargo traffic forecasts, and that there may be a certain gap between estimated potential cargo traffic demand and actual future cargo traffic to be served by the project port facilities.

Considering the above point, it is important to understand that the original plan might lead the development policy of the ports in an undesirable direction. In this sense, constant review and adjustment of the plans are essential to meet any contingency in the surrounding situation. For the three target ports in the Central Region, the recommended master plans should be carefully reviewed and adjusted, say, at least every five years.

### 15.2.12 Authorization of the Recommended Plans

How to realize the recommended development plan of the ports is another important point for effective implementation of the projects. There are many cases observed in developing countries where the project development as recommended in the studies fails to be successfully realized. The major reasons (apart from apparent failure in planning) for this type of failure can be summarized as follows:

(1) Lack of practicability, applicability or flexibility in proposed schemes
(2) Basic change in the government's policy for the target port development
(3) Shortage of funds for the development
(4) Failure in developing other port related infrastructure and facilities
(5) Lack of proper control by the government of related private sector activities.

In order to avoid the above mentioned failures, the plans should officially be authorized through proper procedure by laws, regulations or any other form applicable to the country concerned. This is particularly effective in securing public expenditure on a long-term basis for the projects themselves as well for other public works necessary for the projects. The plan also needs to be open to the public so that business activities concerned could be properly coordinated.

### 15.2.13 Human Resources Development Policy for Port Sector Development

The Vietnamese institutional and organizational structure and capability for port sector administration have been generally well developed so far. Considering the dramatic changes in various requirements of port sector administration and engineering in future, however, there would be substantial shortage and weakness in staff resources. Therefore, a systematic training strategy for port administration and management/operation staff and engineers should be established.

While on-the-job training is always one of the best ways to train the staff, this is not considered effective when they need to acquire special knowledge or capability for an advanced concept and technology or newly developed engineering systems. In this case, the government should organize specially designed training courses or promote positive participation in an appropriate ODA based technology transfer classes prepared by advanced foreign countries. Exchange of government officials among the other different ministries or agencies is another effective way to give the staff wider knowledge and experience which is considered vital for higher level administrative staff of the sector. Considering current and future administrative and engineering requirements, following subjects may be most recommendable for the Vietnamese port staff training.

(1) Overall mental attitude as public service personnel
(2) Instilling cost consciousness in the management and operation staff
(3) Coastal/port engineering and structural design for a river mouth and deep sea area (deep sea break water, quay, navigation channel/basin, and coastal protection etc.)
(4) Oceanographic surveys and analyses on wave, current, sand drift and so on
(5) Investment planning , legal and safety inspection for port operation staff
(6) Privatization policy and practice for headquarters staff
(7) Computerized operation for cargo handling, accounting, and statistics

### 15.2.14 Improvement of Port Statistics

Accurate and reliable port statistics including cargo handling volume, number of ships calling, port operation performances and other data/information are essential as a base of port planning, administration, management and operation. Although some port related data and statistics in Vietnam are well collected and compiled, following suggestions may be useful for further improvement of the port statistic system of the country.

(1) Since port statistics are recognized by major countries of the world as one of the most basic data sources not only for the port sector development but the national economic

development policy making, the total systems for the statistics have been improved accordingly under the responsible government agencies. While it may be a difficult task to establish a complete port statistics system, which may sometimes be expensive, it is recommended to make further efforts for upgrading accuracy, reliability, consistency, coverage and contents of the statistics.

(2) With a view to achieving the above mentioned objectives, standardization of statistics forms under jurisdiction of MOT need to be established, which may require a practical proposal supported by an intensive study on the subject.

### 15.2.15 Natural and Social Environment Conservation

Based on the overall assessment conducted under the Study, it can be understood that development of port function itself does not generally have any serious adverse effects on the existing environment of the area. The possible increase of population with corresponding economic activities as a result of port development may, however, cause general increase of the basic load on the environment system. Under the situation, following suggestions may be useful for effective conservation and/or even upgrading of the environmental quality of the area:

(1) While the detailed environmental impact assessment is supposed to be officially conducted before commencement of the construction works, under the regulations concerned of the government, by the executing agency of the project for MOSTE approval, this procedure should not be considered as an objective of the port sector environment administration. It is more important, in this context, to understand that the final objective is to secure better quality of environment for the residents, workers and visitors of the port so all people can fully accept and enjoy the existence of the port and its activities.

(2) In order to achieve the above objective, it is essential to establish an environmental policy in respect to port development and institutional and organizational arrangements for effective port sector environmental administration. Preparation of an action program for environment conservation activities and provision of appropriate level of budget for execution of the policy are also vital accordingly.

(3) At the actual implementation stage of the project, following items needs to be considered:

1) Tracing surveys on the impact to water quality and marine life as a result of construction works need to be conducted throughout the construction period of the project facilities.

2) For the environmental factors such as water quality, heavy metal in the bottom materials and other hazardous materials, which may have some effects on human and marine life, need to be carefully checked in EIA not only at the port development sites but across wider areas including the industrial zones, urbanized areas and upstream lands of the rivers, so that a comparative assessment could be made among the different types of the areas.

3) Regarding relocation of residents in and around the project sites, it is important to pay maximum attention to their quality of life through appropriate measures including adequate compensation, creation of job opportunities, and so on.

### 15.2.16 Financial Status of Danang Port Development Project

As illustrated in Conclusion of the Report, the short term development plan of Lien Chieu area is considered financially viable although the calculated value of FIRR under the worst case (10% increase for the cost and 10% decrease for the income) is only slightly over the possible lowest interest rate of available funds for the project. While it appears that the financial position of the project may not be adequately sound under this estimation, this does not necessarily mean that the project would be financially risky, because some potential income sources and cost saving factors were not fully counted in the calculation under the principle of being on safe side. In this context, however, following suggestions may be useful in further strengthening the financial status of the project:

(1) EIRR of the project is substantially higher than the FIRR. This means that there may be considerable amount of external economy of the project, which could be internalized, for instance, by collecting a kind of special tax or charge from the direct external beneficiaries such as local port related industries and general private entities in a certain zone of Danang city. For the nation wide benefit of the project, it may sometimes be justified, if the situations allow, that an appropriate portion of the general income tax be used for a new port project at the initial stage of development in particular, when the financial position is normally weak and tight.

(2) With a view to increase the project income, one possible scheme is to rent for general commercial use a part of the available land and space created as a result of construction of the major project facilities. While the potential income from such an operation is not included in calculating the FIRR of the project in the Study, the executing agency of the project could enjoy substantial benefits depending on its devises and will.

(3) While the cost estimates of the project are reasonably proposed in the Study, potential cost saving factors may still be found in the detail design and construction stage. Utmost efforts in this regard should be made in economic design, bidding process and procurement of construction materials.

### 15.2.17 Basic Development Concept of Chan May Port

As stated in the item (2) under "Functional Allotment of Ports in the Area", the large scale port development at this site should be prudent enough mainly due to its premature status of industrial location in its direct hinterland. In this connection, it is recommended to refer to following points for maximization of total development benefit of the project for the region.

(1) The economic conditions of Thua Thien-Hue provinces, which suffered heavily in the war against America, is still quite severe and the average income of the people in the region is substandard under scarce job opportunities. On the other hand, the region has many historical monuments and valuable heritage attracting a number of tourists, and is blessed with rich agricultural land and natural resources such as rare metals and construction materials. The coastal areas of the provinces are rich in tropical beauty and in natural marine resources for tourism, fishing and boating.

(2) Under the above mentioned conditions, general direction of the regional development may be suggested as follows:

1) In general, the region development of the provinces should be conducted at a relatively slow and steady pace compared with the other advanced regions which have already suffered the adverse effects of drastic and random industrialization so that Thua Thien-Hue provinces could maintain their advantageous potential development resources for sustainable benefit and concentrate efforts on generating more jobs, for instance in the agricultural sector and/or tourism industries by less expensive development schemes.

2) As for the port function necessary to support commercial and industrial activities expected in the planned industrial park, it is considered wiser and more economical to utilize Danang Port as an out-port of Hue province for the time being by using Hai Van tunnel which is to be constructed with in a few years. There are historical precedents for such a policy. In Japan, commercial/industrial activities and the everyday life of the citizens of Tokyo had been dependent on the port of Yokohama for long time until it became sufficiently competitive with the port of Yokohama.

3) In summarizing the above consideration, immediate development of a large scale port at Chan May area should be suspended for a while mainly for confirming the short term cargo traffic demand and for mitigating current economic burden of the country and the province. At the same time, however, the proposed development plan of the port will lead to great benefits in the future and should thus be maintained.

# APPENDIX

## List of Tables

## List of Figures

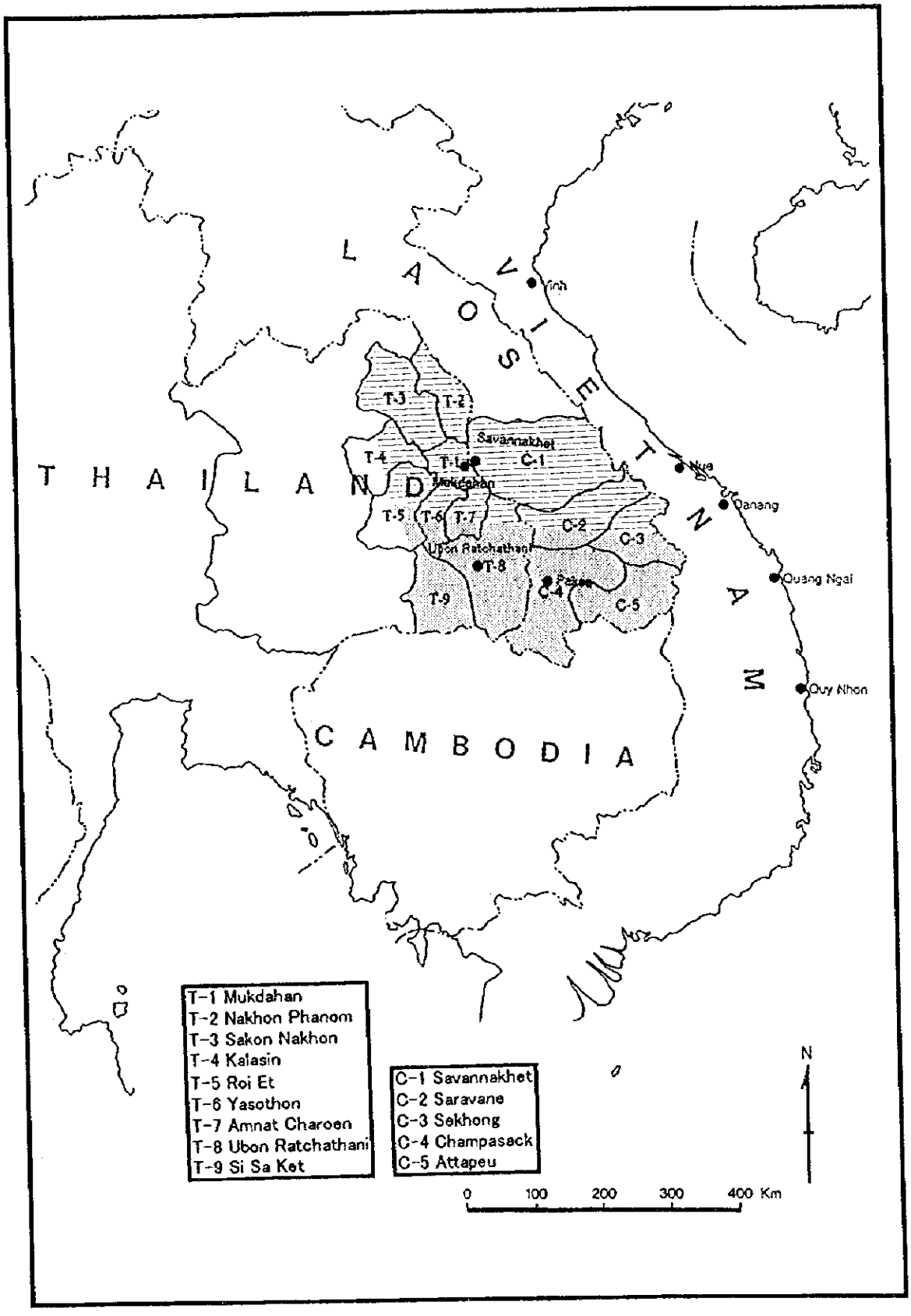



**Figure A 2.2.2 Southern Lao and Northeast Thailand**

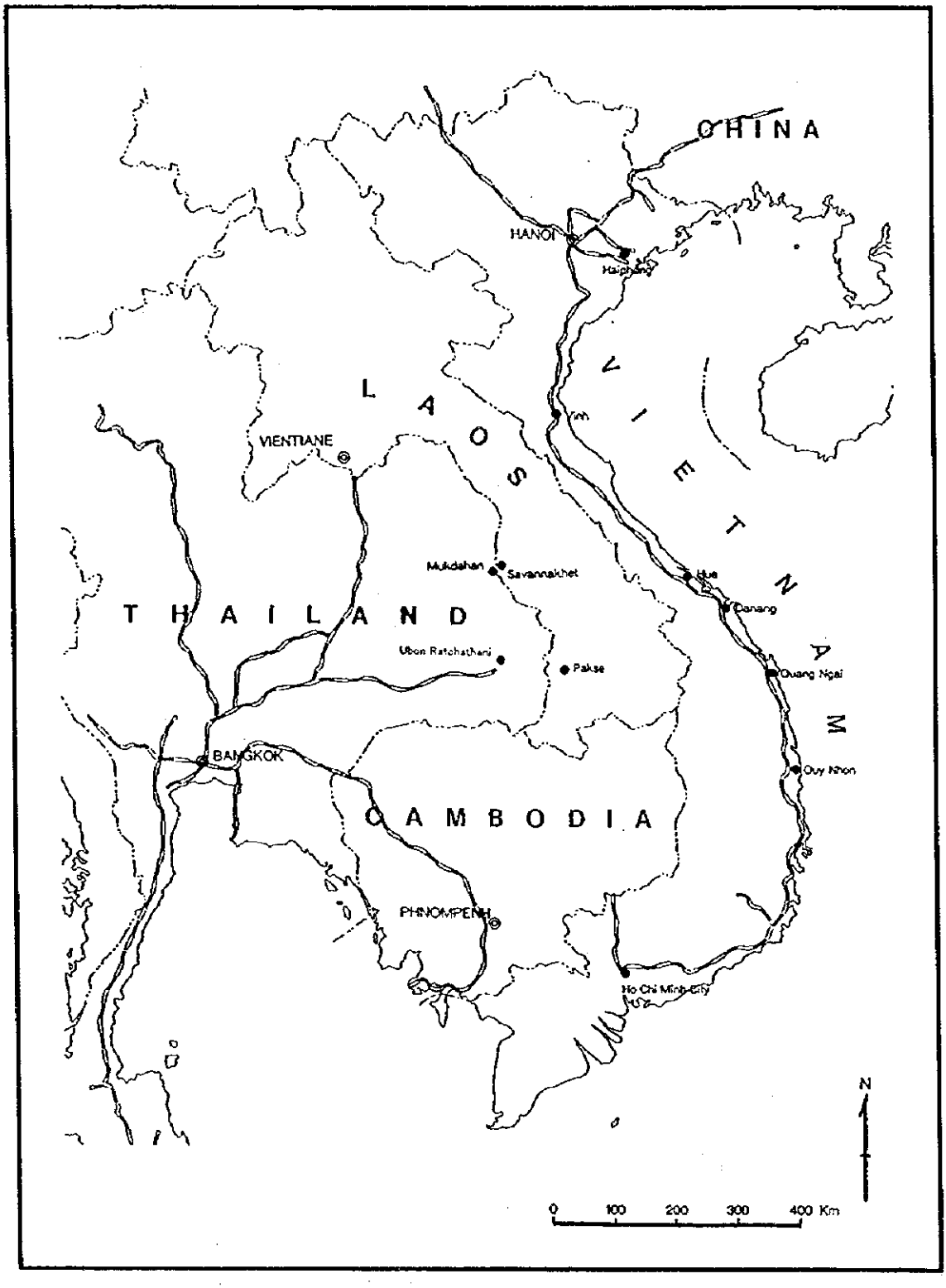
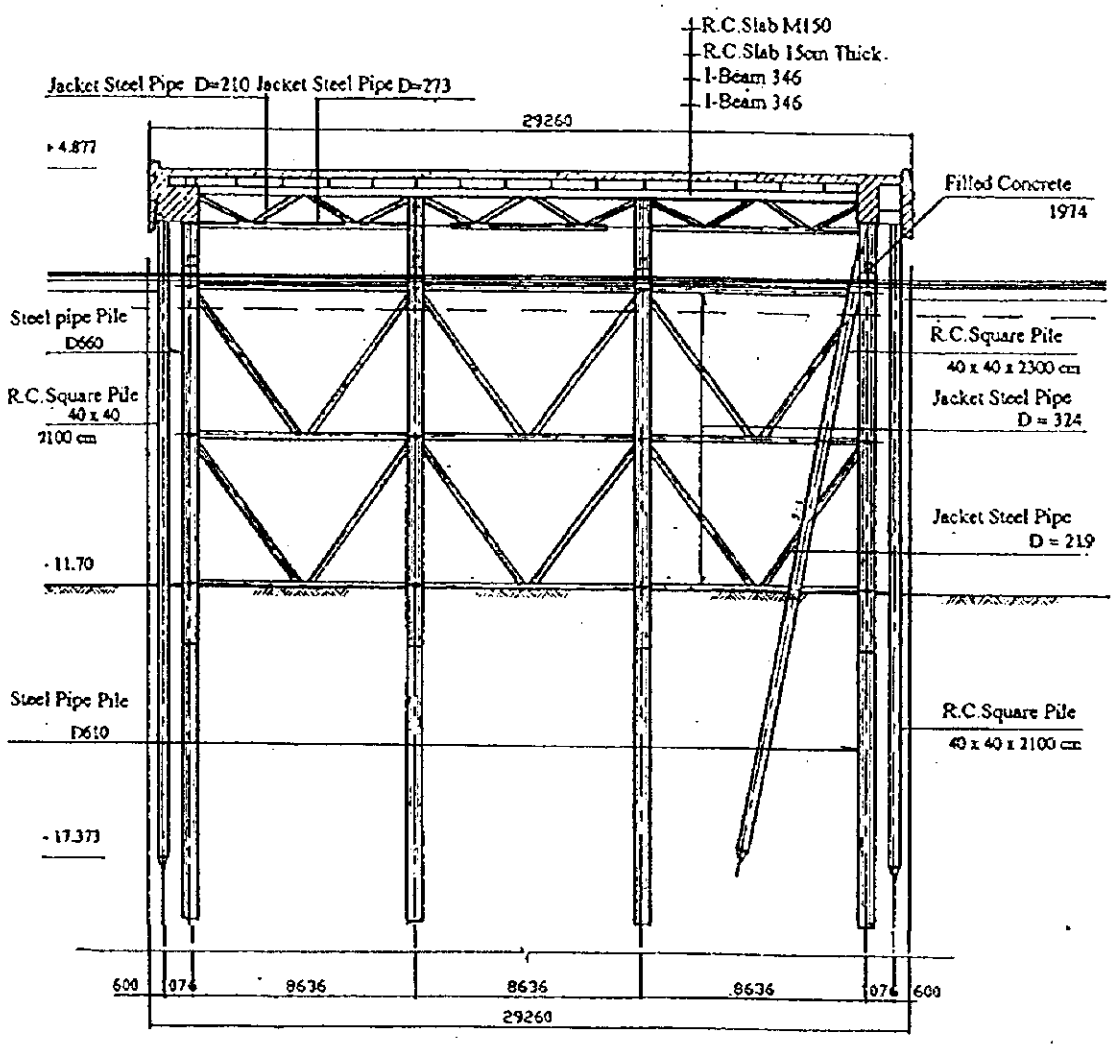
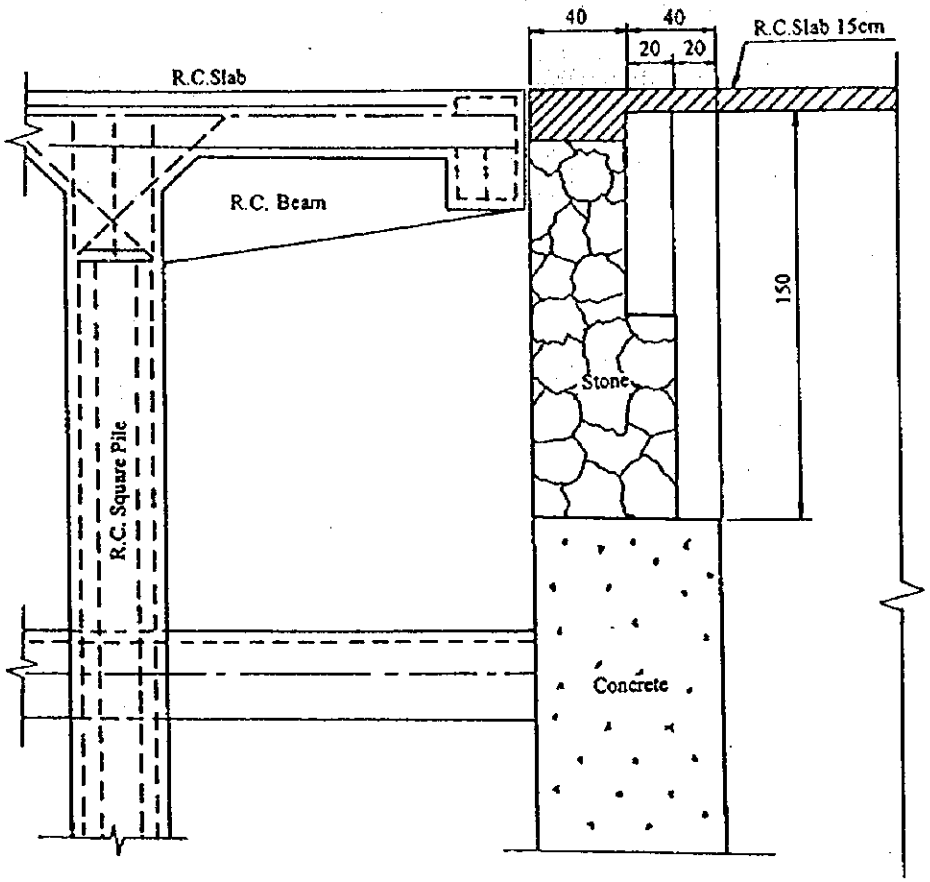



**Figure A 2.3.3 Railway Map of Vietnam**




Source: Marine Engineering in Hai Phong

**Figure A3.1.1 The Typical Cross Section of No.1 and No.2 Jetty Piers**




Source: Danang Port

**Figure A3.1.2 Typical Cross Section of Wharf in Song Han Port**

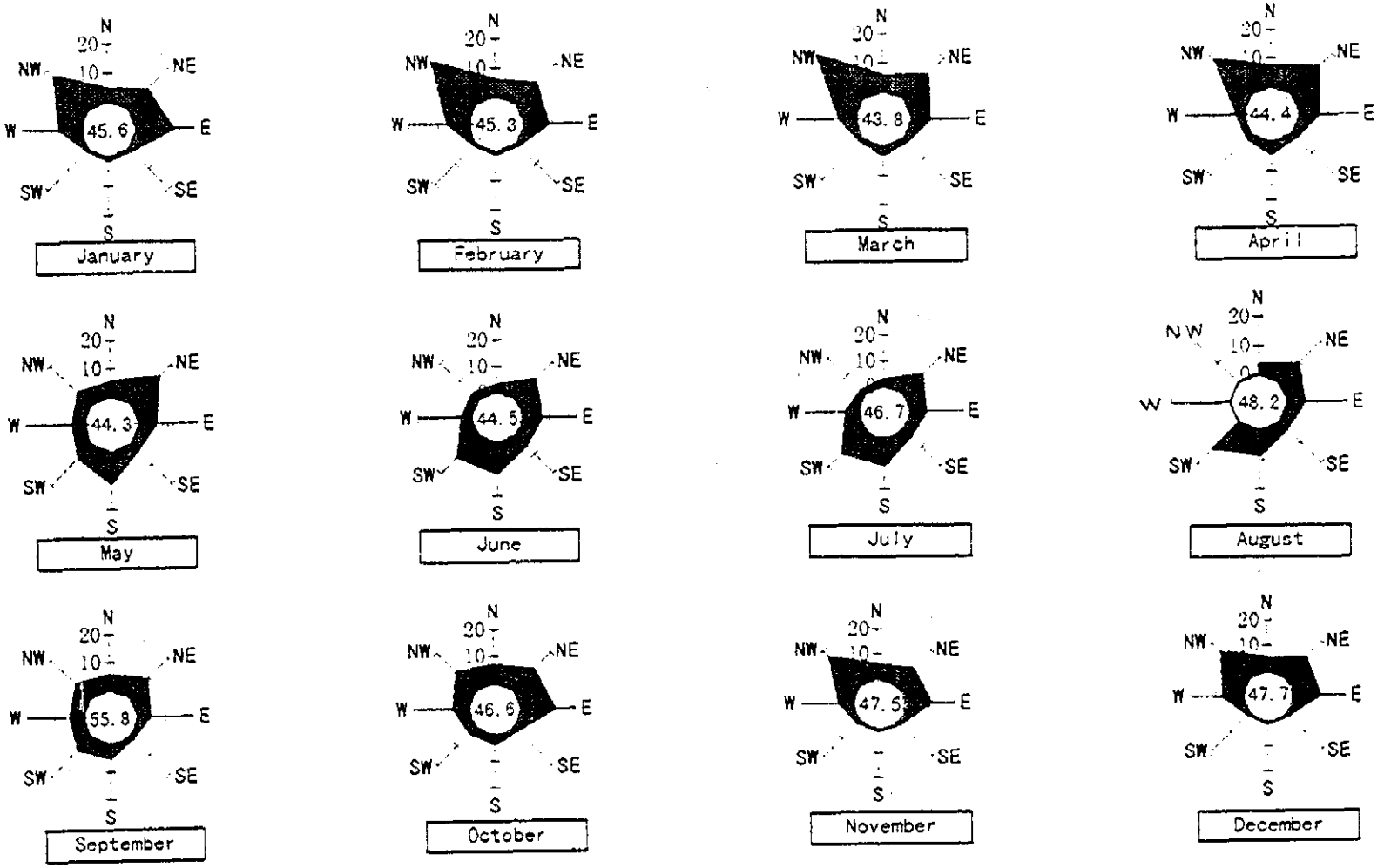
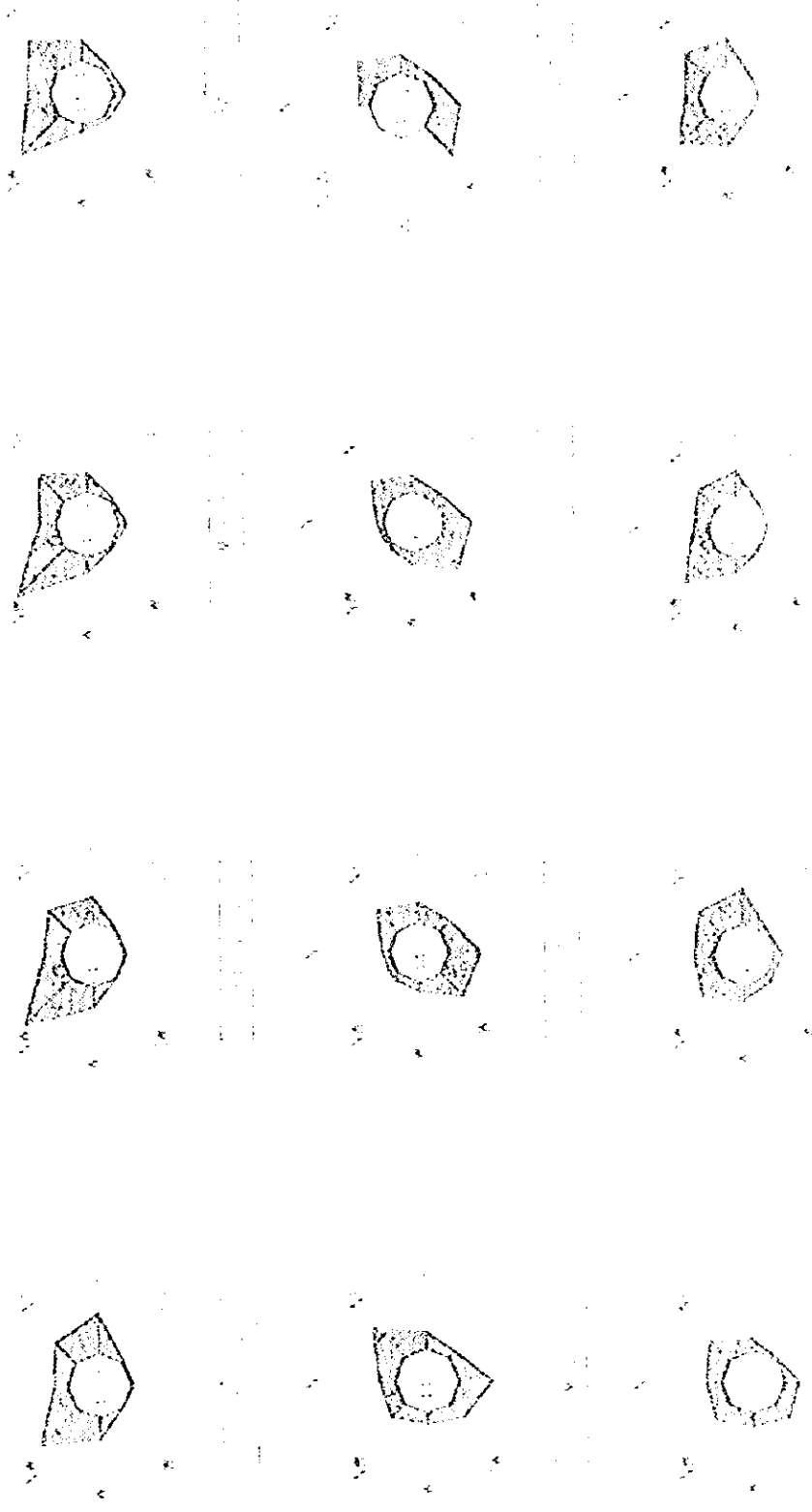



**Figure A 4.2.1 Wind Roses at Observatories on the Land (1) Hue Observatory**

Data source: Institute of Meteorology and Hydrology



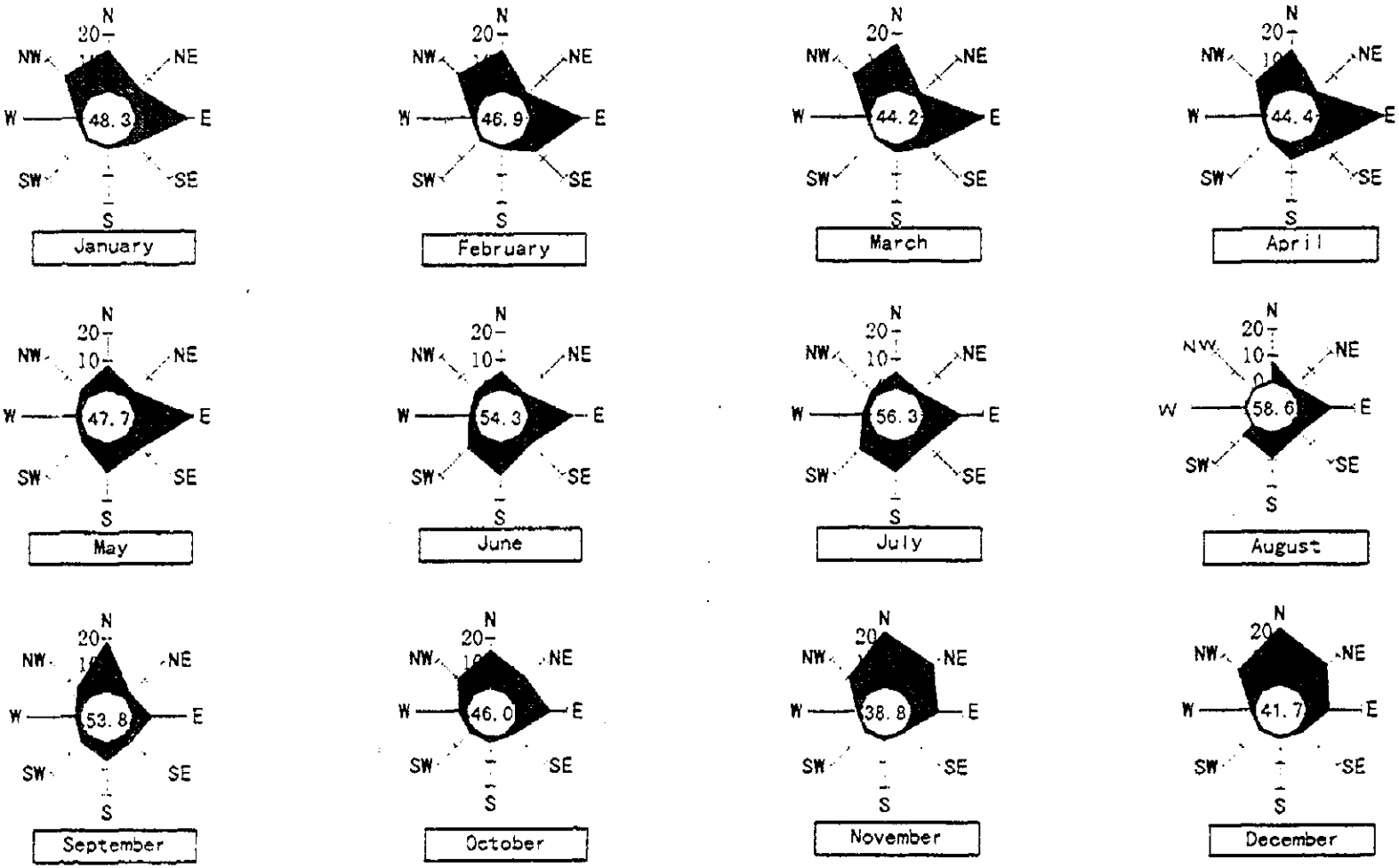



**Figure A. 4.2.1 Wind Roses at Observatories on the Land (2) Da Nang Observatory**

Data source: Institute of Meteorology and Hydrology

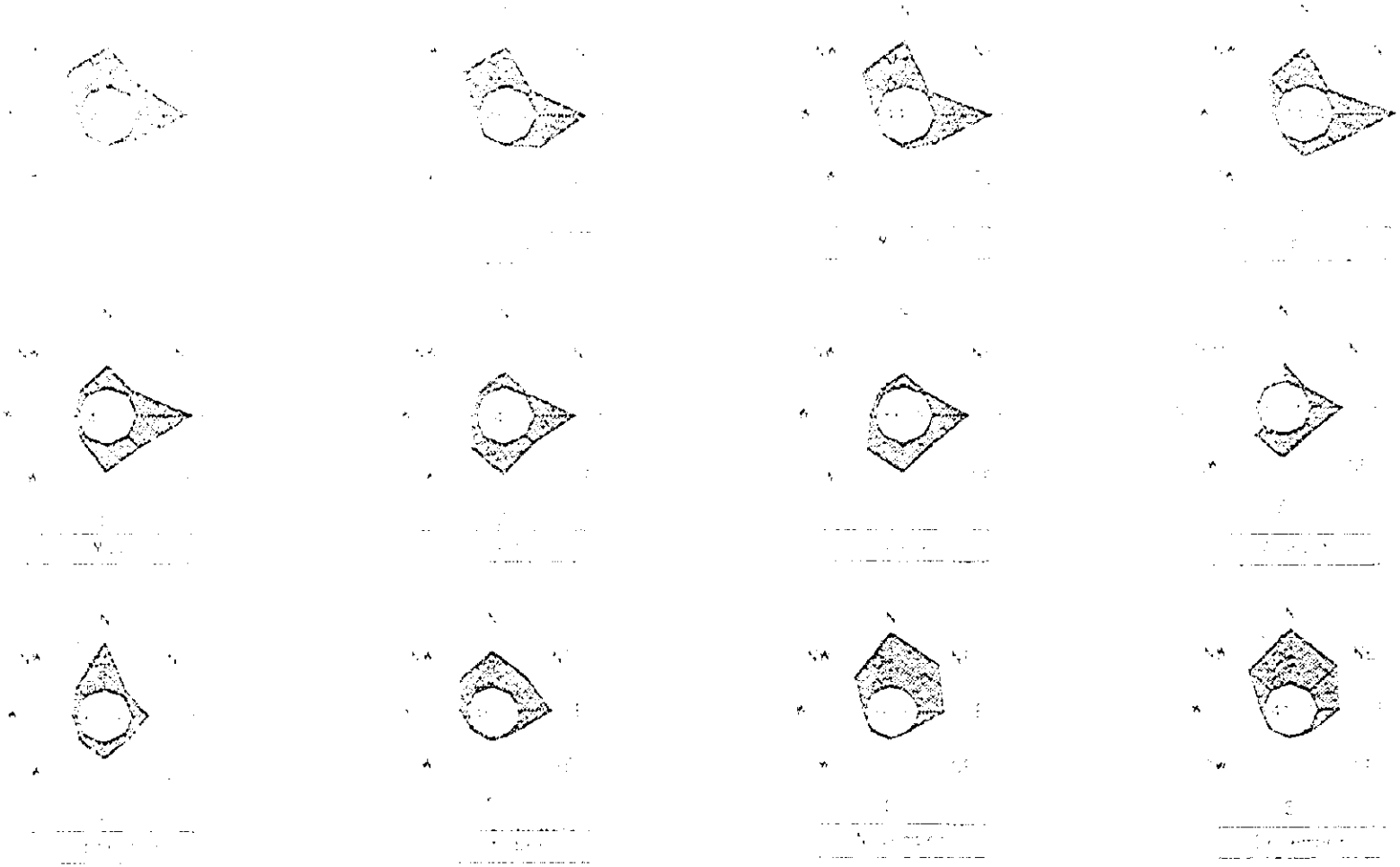


Figure V.4.2.1 Wind Roses at Observatories on the Land (2) Da Nang Observatory

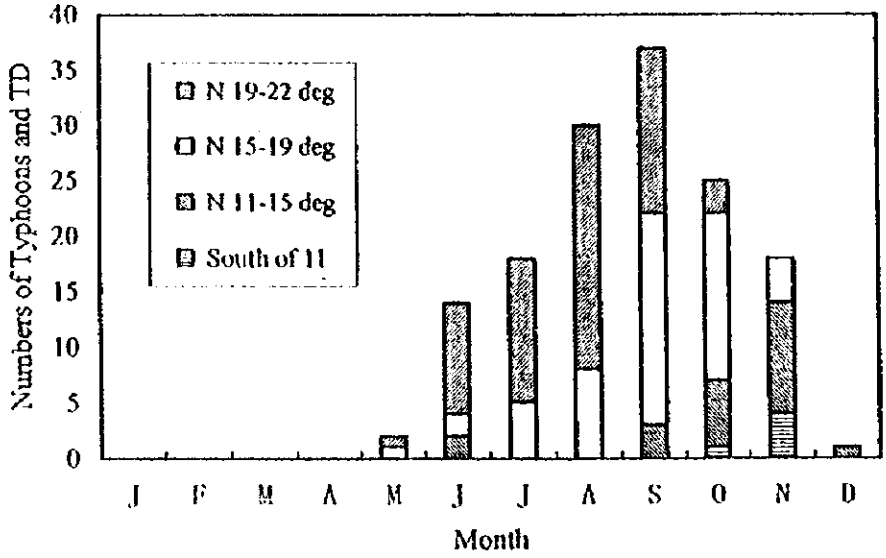



**Figure A 4.2.2 Number of Typhoons by Region of Vietnam (1954-1980)**

Data Source: MHMC "Report on Storm Characteristics" 1995

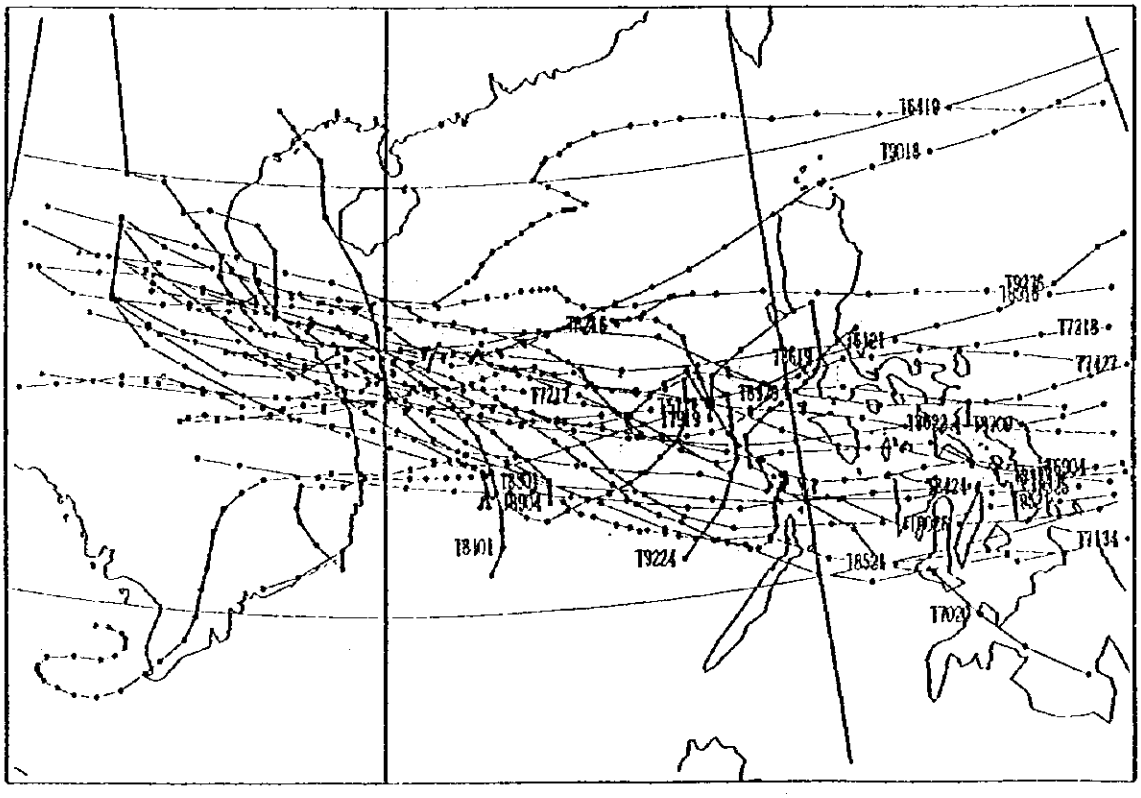


**Figure A 4.2.3 Tracks of Typical Typhoons affected Central Vietnam**

## Table A 4.2.2 Typhoons Most Affected the Central Coast of Viet Nam (1961-1997)

| No. | Typhoon No. | Name | Approach direction | Place landed** | Date landed | Pc* (hPa) | Wind* | | Speed* U (km/hr) |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | V (m/sec) | Direction | |
| 1 | 9721 | Fritz | E | DN-QN | 25-Sep-97 | 980 | 24 | NE | 12 |
| 2 | 9622 | Beth | ENE | DN-QN | 22-Oct-96 | 1006 | 12 | N | 20 |
| 3 | 9521 | **Zack** | E | South QN | 1-Nov-95 | 965 | 34 | N | 13 |
| 4 | 9325 | **Kyle** | E | South QN | 23-Nov-93 | 960 | 44 | NE | 28 |
| 5 | 9226 | Colleen | ESE | South QN | 28-Oct-92 | 980 | 24 | NNW | 29 |
| 6 | 9224 | Angela | NE | South QN | 23-Oct-92 | 990 | 30 | NW | 10 |
| 7 | 9025 | **Mike** | ESE | Offshore | 16-Nov-90 | 970 | 20 | NNE | 12 |
| 8 | 9018 | **Ed** | E, SE | Offshore | 19-Sep-90 | 980 | 31 | NNE | 13 |
| 9 | 8926 | **Dan** | ESE | North HU | 13-Oct-89 | 965 | 40 | - | 25 |
| 10 | 8904 | **Cecil** | E | DN-QN | 24-May-89 | 980 | 22 | - | 12 |
| 11 | 8829 | Skip | E, N | Offshore | 12-Nov-88 | 995 | 16 | NNW | 10 |
| 12 | 8709 | **Betty** | ESE | North HU | 16-Aug-87 | 950 | >40 | NNE | 18 |
| 13 | 8622 | Georgia | ESE | South QN | 22-Oct-86 | 990 | 20 | - | 18 |
| 14 | 8619 | Dom | E | North HU | 11-Oct-86 | 998 | 24 | NNW | 16 |
| 15 | 8521 | **Cecil** | ESE | North HU | 15-Oct-85 | 970 | 35 | - | 23 |
| 16 | 8424 | **Agnes** | ESE | South QN | 7-Nov-84 | 975 | 40 | - | 31 |
| 17 | 8401 | Vernon | ESE | DN-QN | 10-Jun-84 | 996 | 16 | - | 19 |
| 18 | 8316 | Lex | E | North HU | 26-Oct-83 | 985 | 40 | - | 20 |
| 19 | 8301 | Sarah | SE | North HU | 25-Jun-83 | 1000 | 14 | - | 15 |
| 20 | 8216 | **Hode** | E | DN-QN | 6-Sep-82 | 980 | 20 | - | 24 |
| 21 | 7919 | Sarah | E | South QN | 14-Oct-79 | 965 | 22 | - | 9 |
| 22 | 7427 | **Faye** | E | South QN | 4-Nov-74 | 992 | 26 | - | 23 |
| 23 | 7218 | **Elsie** | NE | South QN | 4-Nov-72 | 995 | 31 | - | 6 |
| 24 | 7217 | Flossie | ENE | South QN | 15-Sep-72 | 995 | 26 | - | 9 |
| 25 | 7134 | **Hester** | SE | DN-QN | 23-Oct-71 | 970 | 40 | - | 26 |
| 26 | 7112 | **Harriot** | E | North HU | 6-Jul-71 | 985 | 28 | - | 25 |
| 27 | 7020 | Kate | E | DN-QN | 25-Oct-70 | 990 | 33 | - | 19 |
| 28 | 6904 | Tess | ESE | North HU | 11-Jul-69 | 990 | 28 | - | 22 |
| 29 | 6419 | Tilda | E | North HU | 22-Sep-64 | 990 | 38 | - | 14 |
| 30 | 6121 | Ruby | ESE | North HU | 24-Sep-61 | 992 | 28 | - | 33 |

* Figures of wind are at the nearest in-land station. Pc, wind and speed are when the typhoon landed on the coast. Wind are maximum (gust) wind. (-) are lost data.

** DN-QN : Landed between Da Nang and Quang Ngai
South QN : Landed at south of Quang Ngai
North HU : Landed at north of Hue
Offshore : Passed offshore (not landed)

Data Source: Institute of Meteorogy and Hydrology, 1997

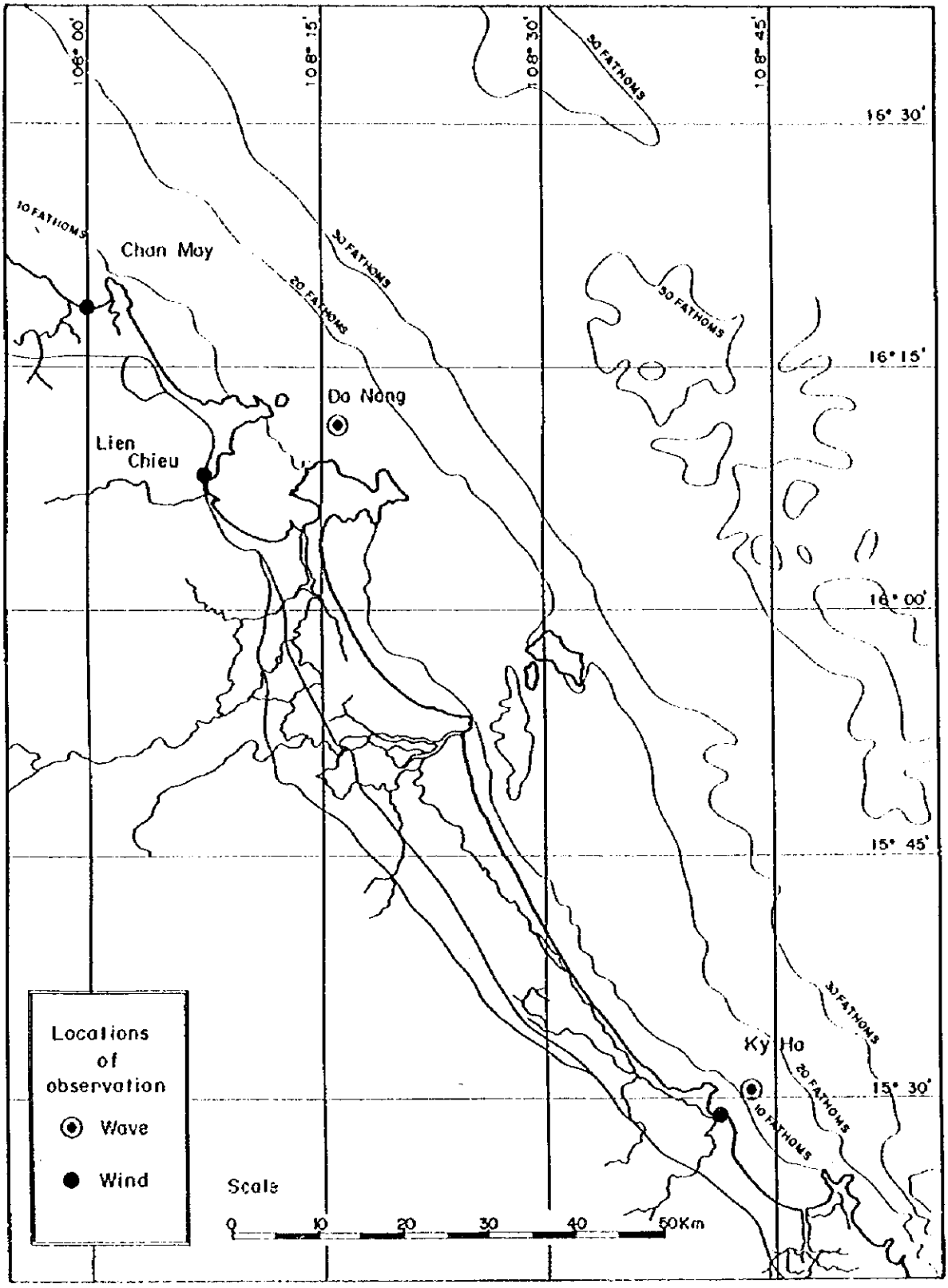
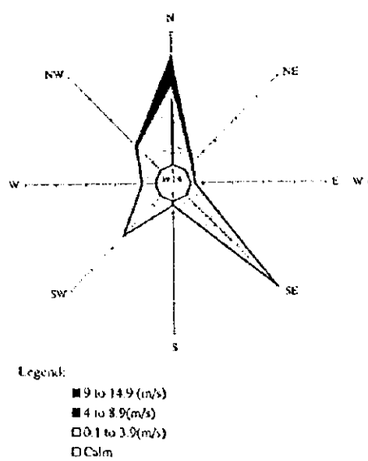
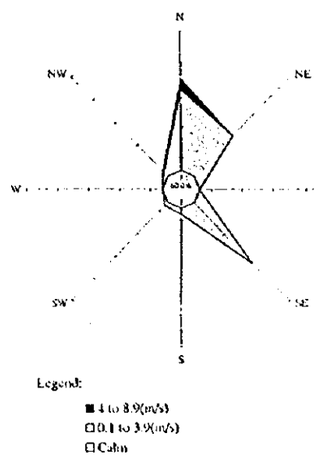



Figure A 4.2.4 Locations of Wind and Wave Observation by the JICA Study Team

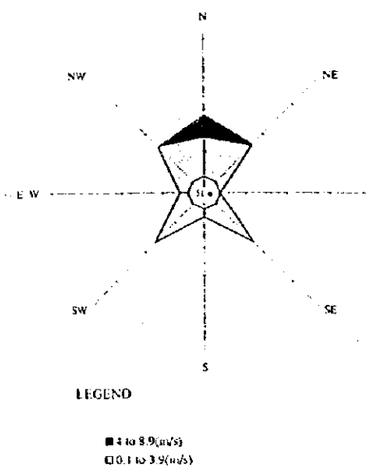
April/1997



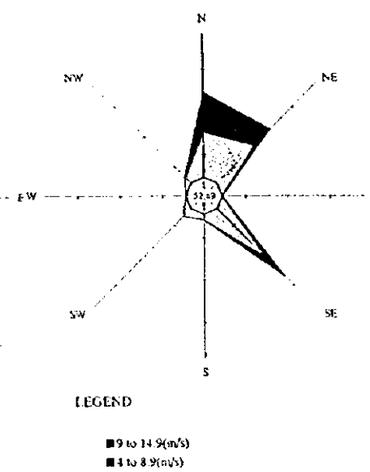

June/1997




August/1997




October/1997

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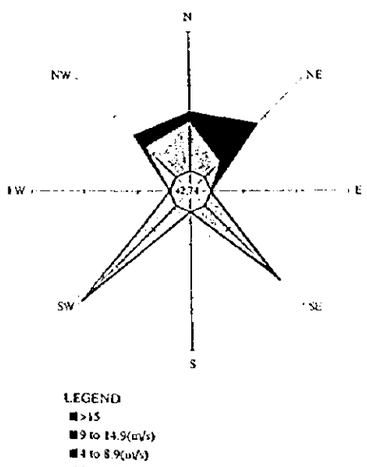
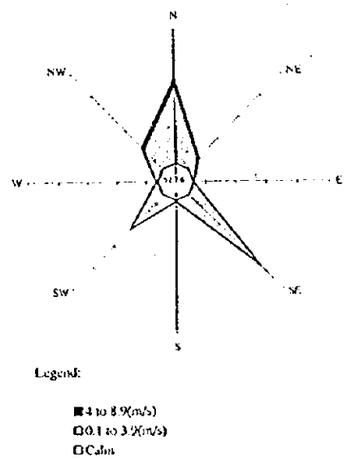
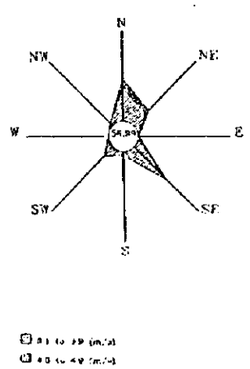


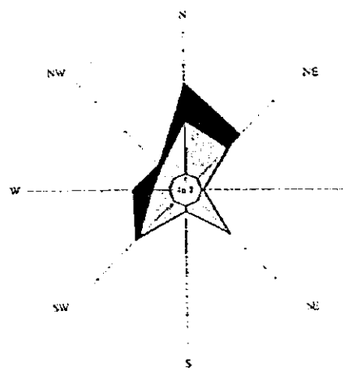

May/1997




July/1997




September/1997




November/1997

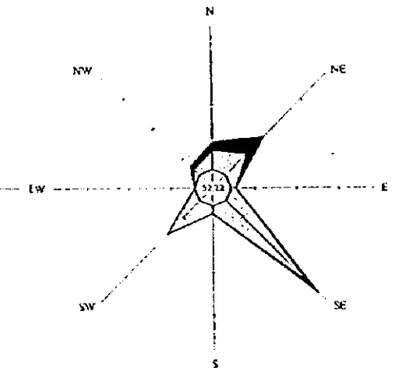



**Figure A 4.2.5 Wind Observed at Chan May by the Study Team**

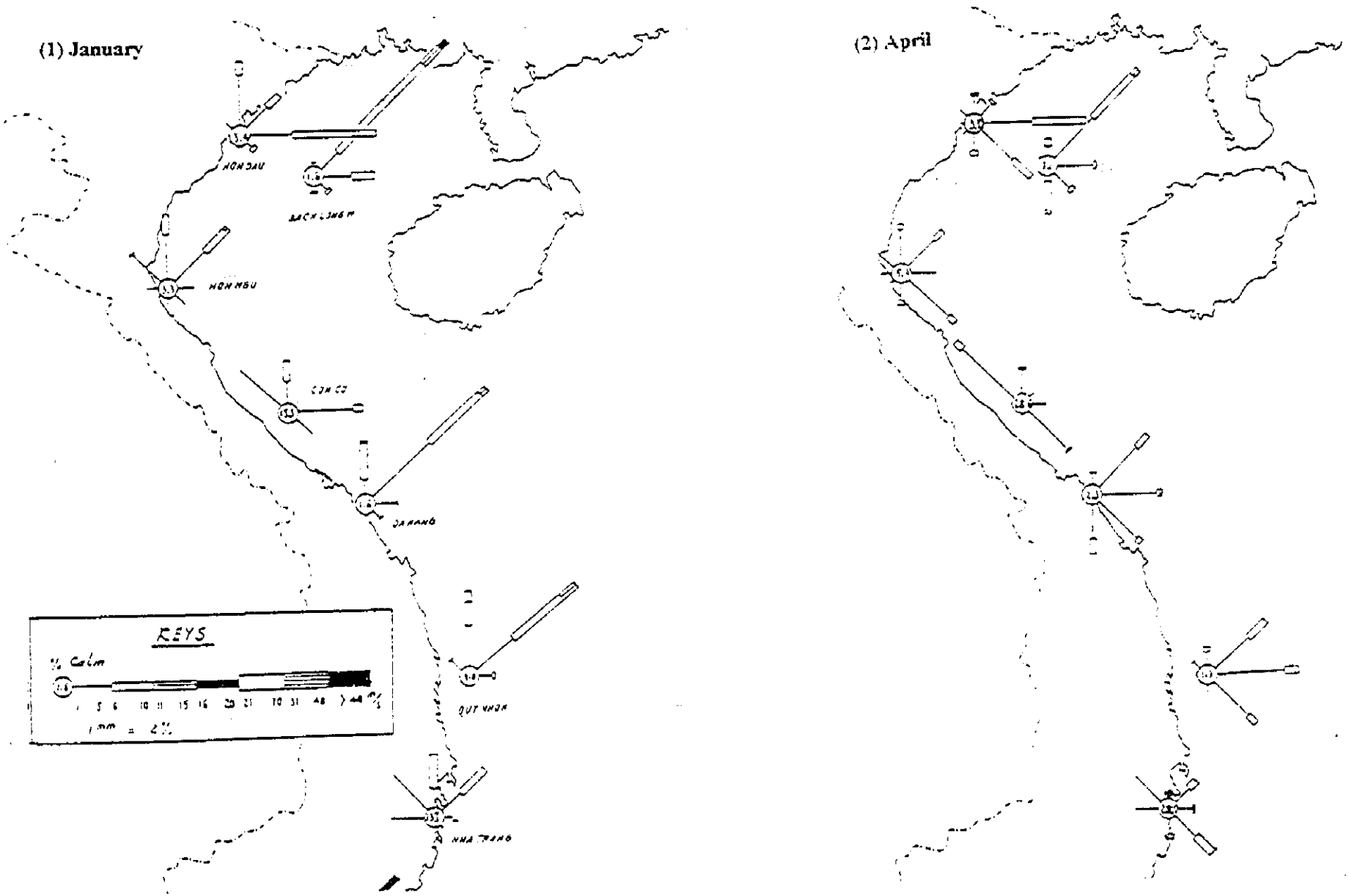



Figure A 4.3.1 Wave Roses at Northern and Central Stations on the Coast (1)

Source: MHMC "Report on Wave Statistics", July 1995

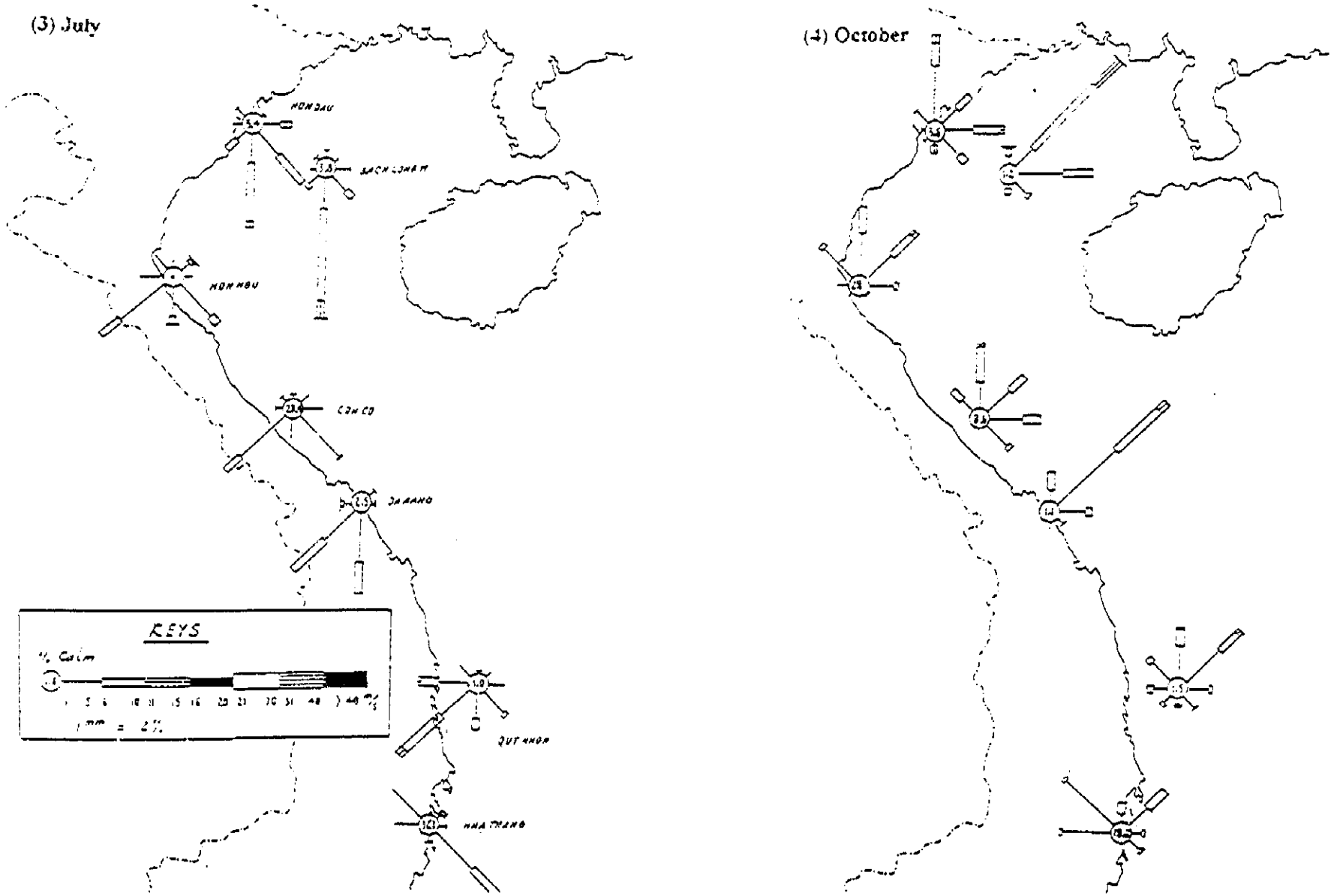



**Figure A4.3.1 Wave Roses at Northern and Central Stations on the Coast (2)**

Source: MHMC "Report on Wave Statistics", July 1995

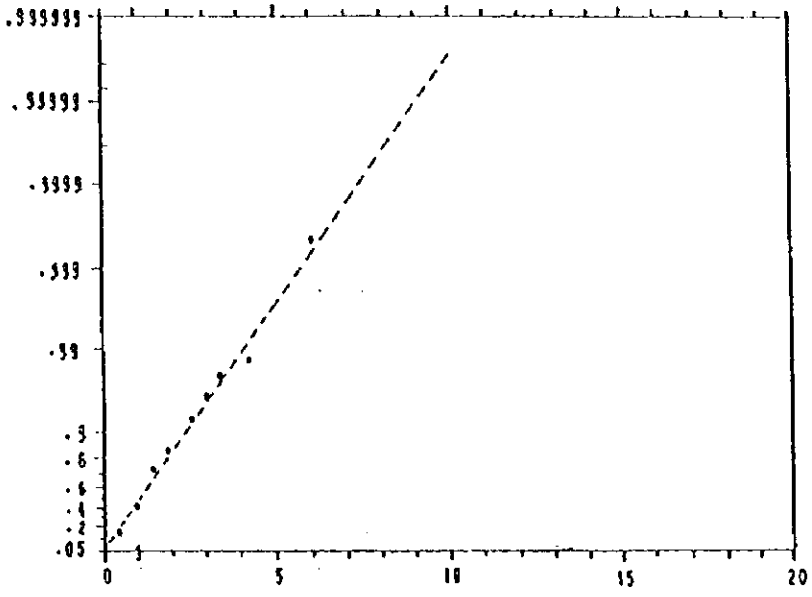



**Figure A 4.3.2 Probability Distribution of Wave Height at Son Tra, Danang**

* Source: MHMC "Report on Wave Characteristics", July 1995

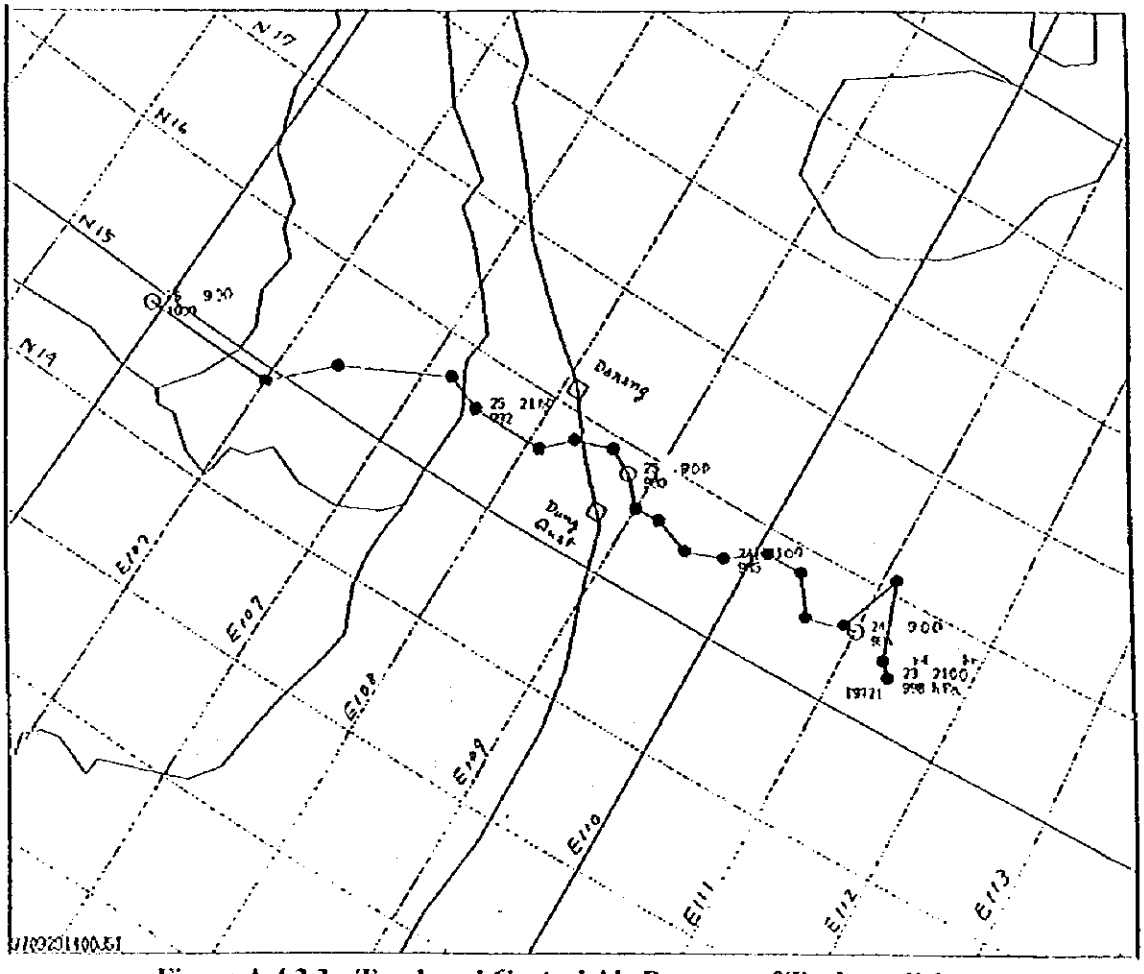



**Figure A 4.3.3 Track and Central Air Pressure of Typhoon Fritz**

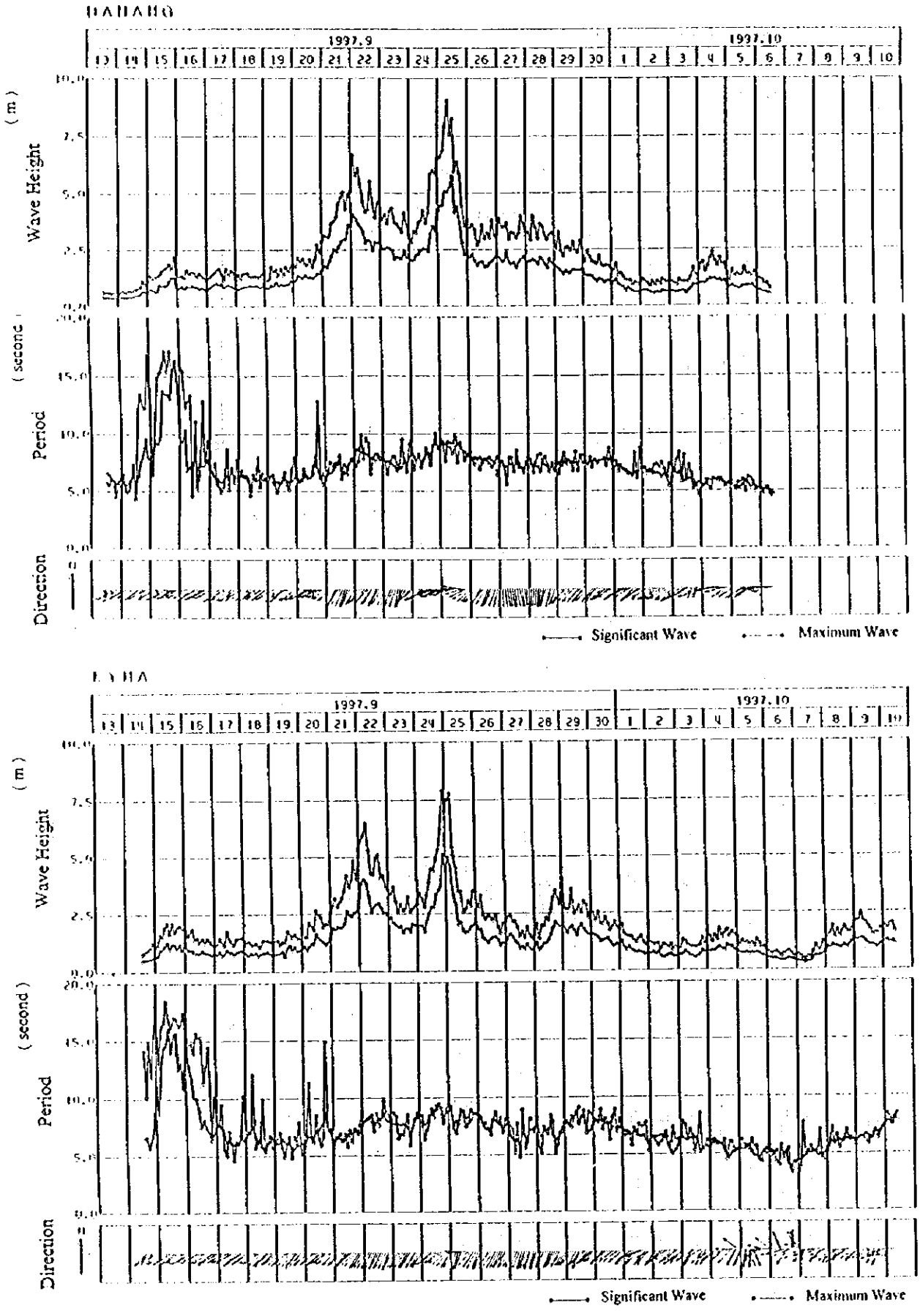



**Figure A 4.3.4 Time Series of Wave Records at Danang and Ky Ha**

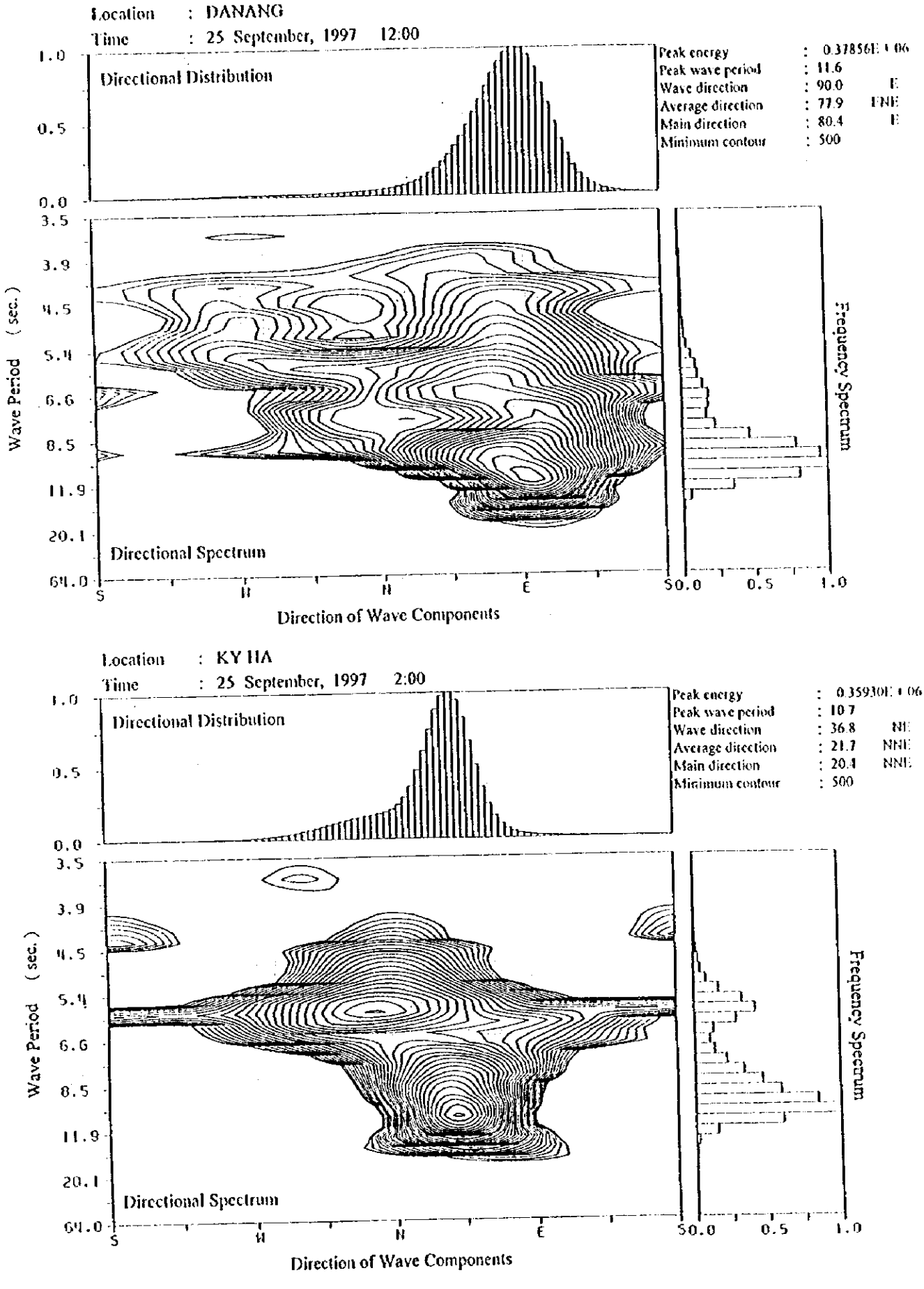



**Figure A 4.3.5 Directional Spectra of Waves Generated by Typhoon Fritz**

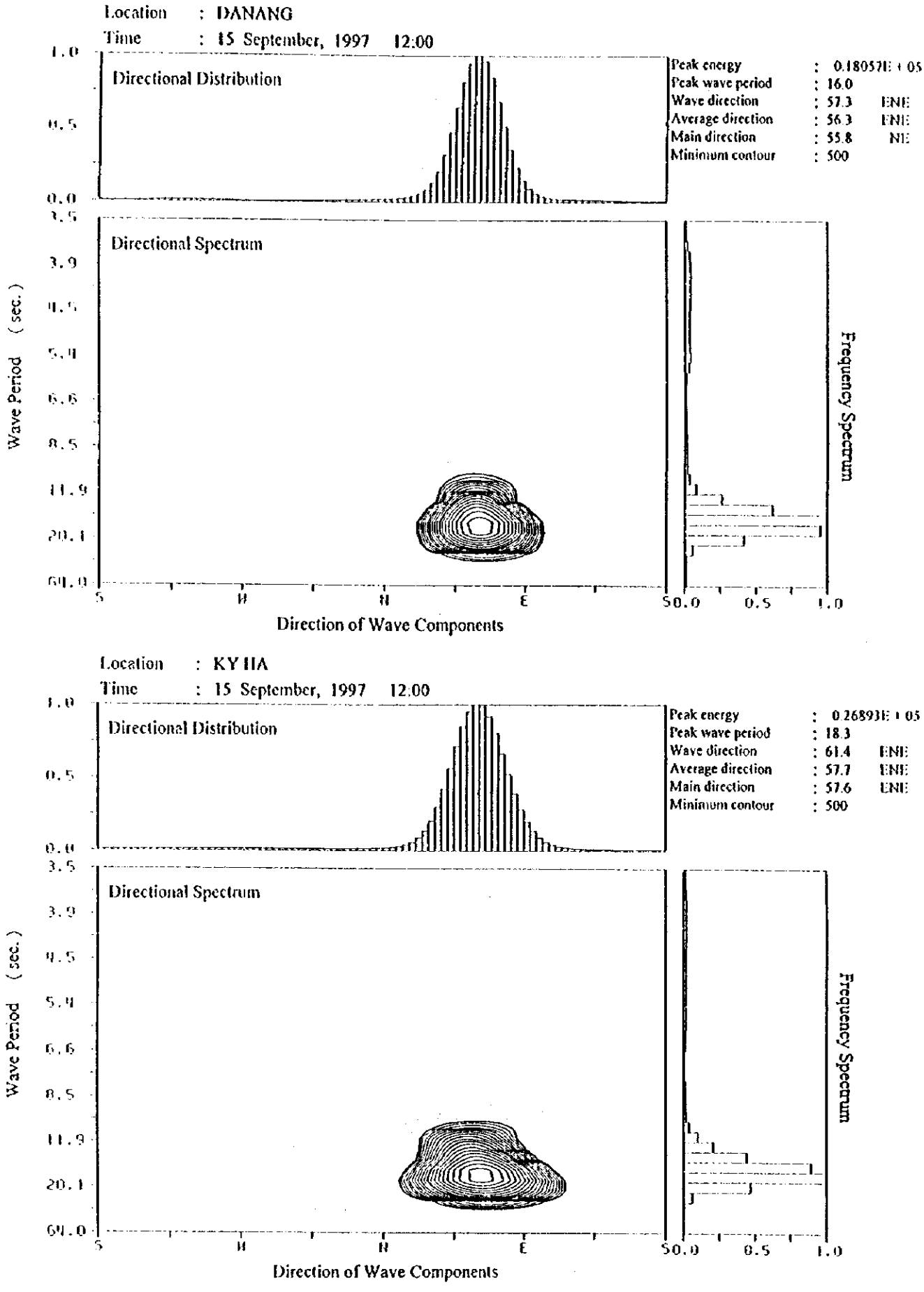
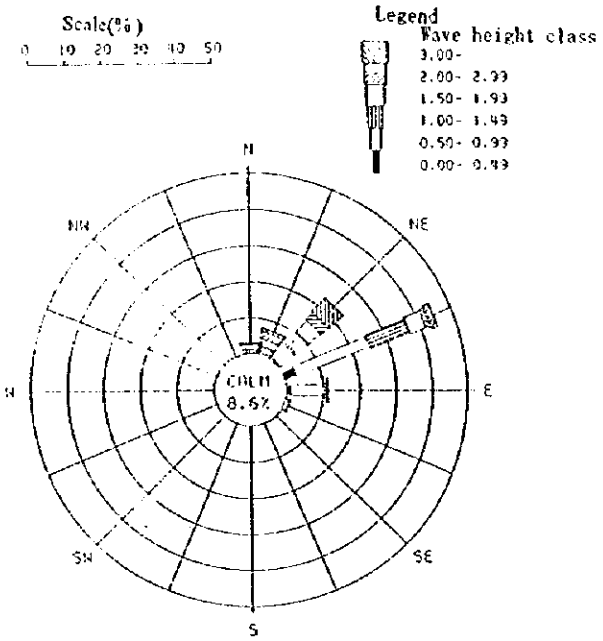
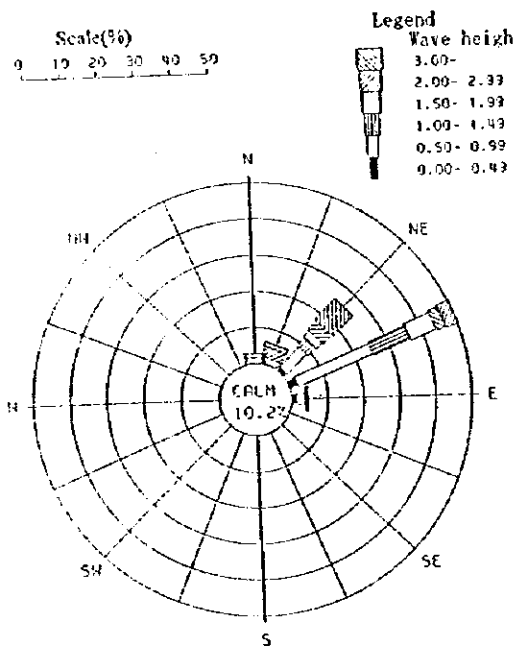


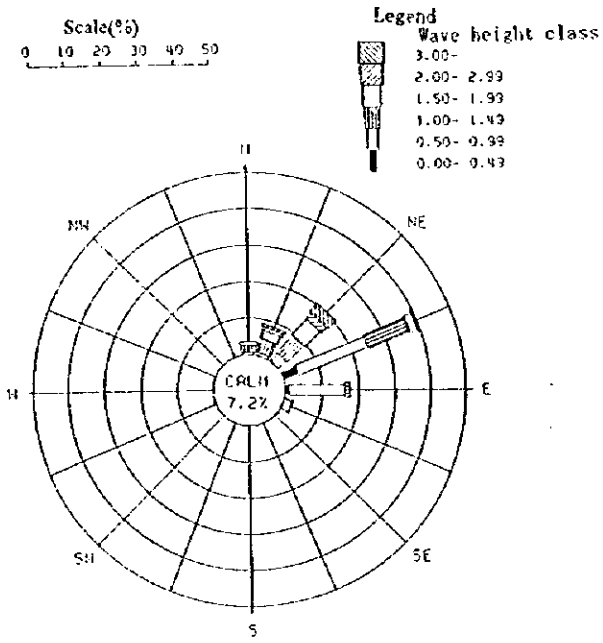

**Figure A 4.3.6 Directional Spectra of Swells Propagated from Remote Typhoon**




All period ( Sep. 1997 ~ Feb. 1998 )

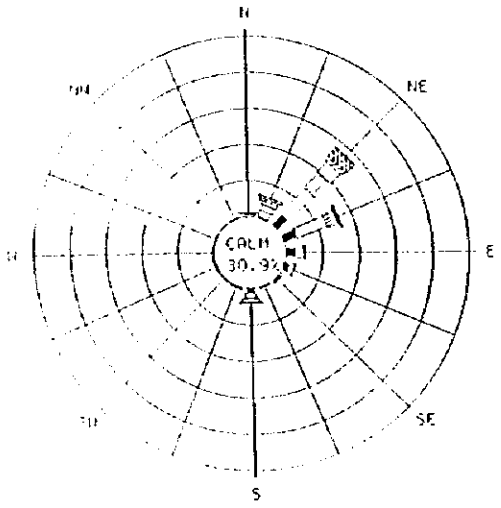



From Sep. to Nov. 1997

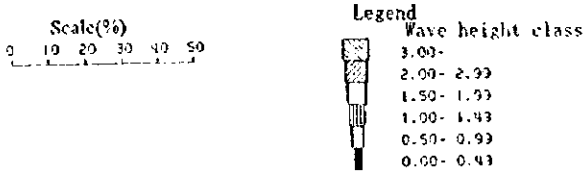


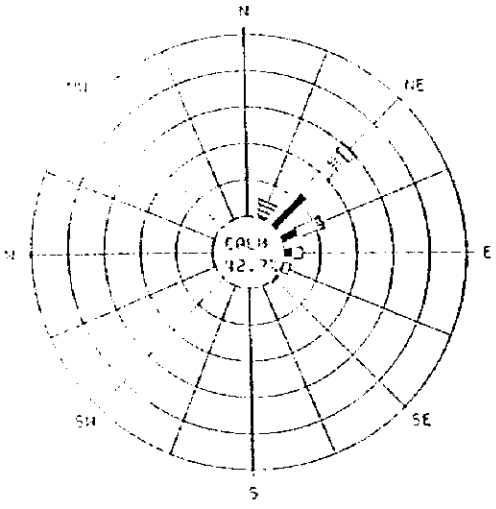

From Dec. 1997 to Feb. 1998

**Figure A 4.3.7 Wave Roses of Observed Waves (1) Danang**

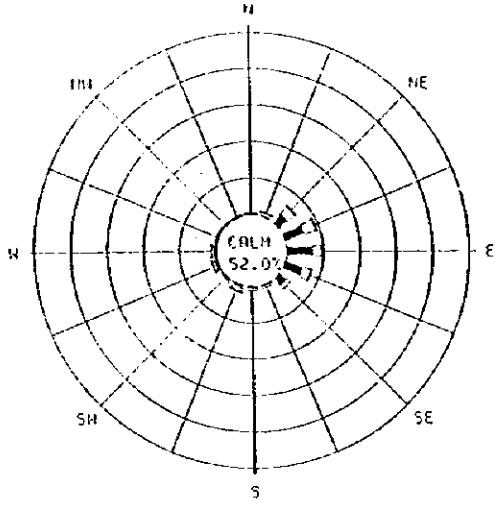



All period ( Apr. 1997 ~ Feb. 1998)

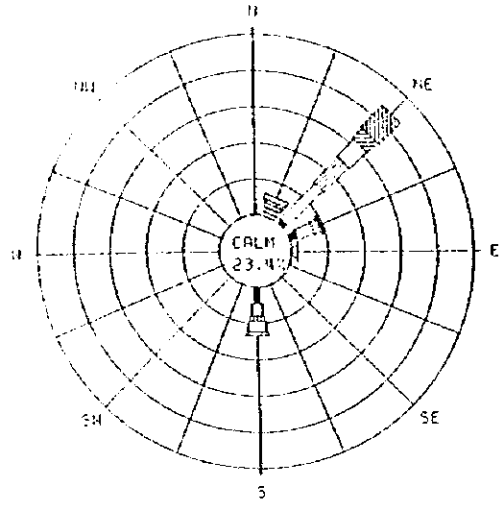


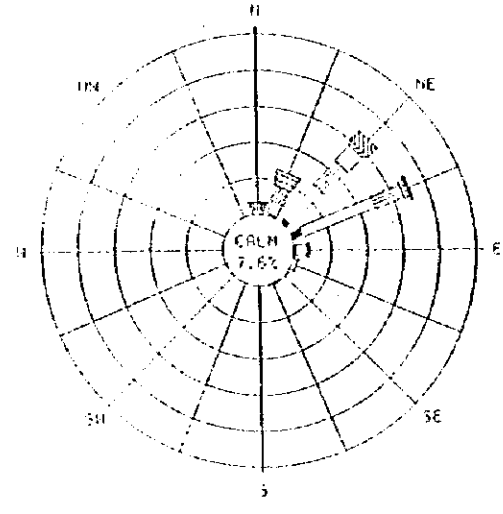

From Apr. to May. 1997




From Jun. To Aug. 1997




From Sept. to Nov. 1997




From Dec. 1997 to Feb. 1998

**Figure A 4.3.7 Wave Roses of Observed Waves (2) Ky Ha**

## Table A 4.3.2 Frequency Distribution of Observed Waves by JICA Study Team

**(1) Location : Mouth of Danang Bay**

Total no. of data: 1,731 % of successful observation: 79.7 %

Unit: %

| Height (m) | N | NNE | NE | ENE | E | ESE | SE | SSE | S | SSW | SW | WSW | W | WNW | NW | NNW | Calm* | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0.00- | | | | | | | | | | | | | | | | | | 0.0 |
| 0.25- | 0.1 | | 0.6 | 3.4 | 1.3 | | | | | | | | | | | | 2.8 | 8.2 |
| 0.50- | | 0.1 | 2.2 | 11.4 | 6.4 | 1.0 | 0.1 | | | | | | | | | | 5.0 | 26.2 |
| 0.75- | 0.3 | 0.5 | 2.9 | 10.1 | 2.5 | 0.2 | | | | | | | | | | | 0.8 | 17.3 |
| 1.00- | 0.6 | 0.6 | 2.5 | 6.5 | 0.9 | 0.1 | | | | | | | | | | | | 11.2 |
| 1.25- | 0.4 | 1.4 | 2.3 | 5.3 | 0.1 | | | | | | | | | | | | | 9.5 |
| 1.50- | 0.3 | 1.2 | 2.3 | 3.2 | | | | | | | | | | | | 0.1 | | 7.1 |
| 1.75- | 1.0 | 0.8 | 1.8 | 1.6 | | | | | | | | | | | | | | 5.2 |
| 2.00- | 0.4 | 0.9 | 1.6 | 0.9 | | | | | | | | | | | | | | 3.8 |
| 2.25- | 0.1 | 1.1 | 1.2 | 0.5 | | | | | | | | | | | | | | 2.9 |
| 2.50- | 0.1 | 0.9 | 5.4 | 1.8 | 0.2 | | | | | | | | | | | | | 8.4 |
| Total | 3.3 | 7.5 | 22.8 | 44.7 | 11.4 | 1.3 | 0.1 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 8.6 | 100.0 |

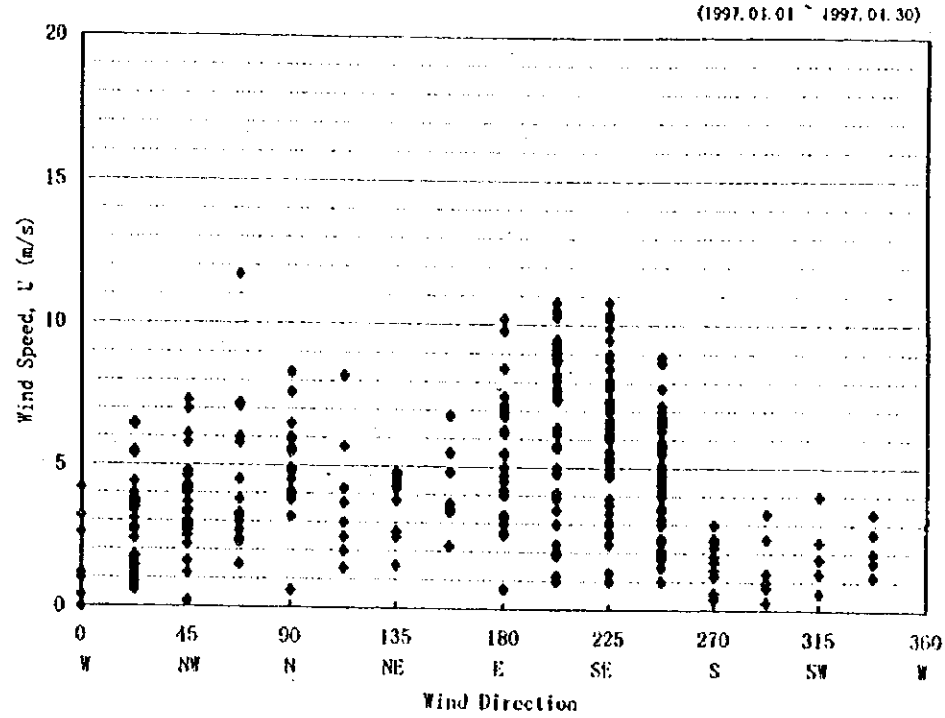
**(2) Location : Ky Ha**

Total no. of data: 3,794 % of successful observation: 94.8 %

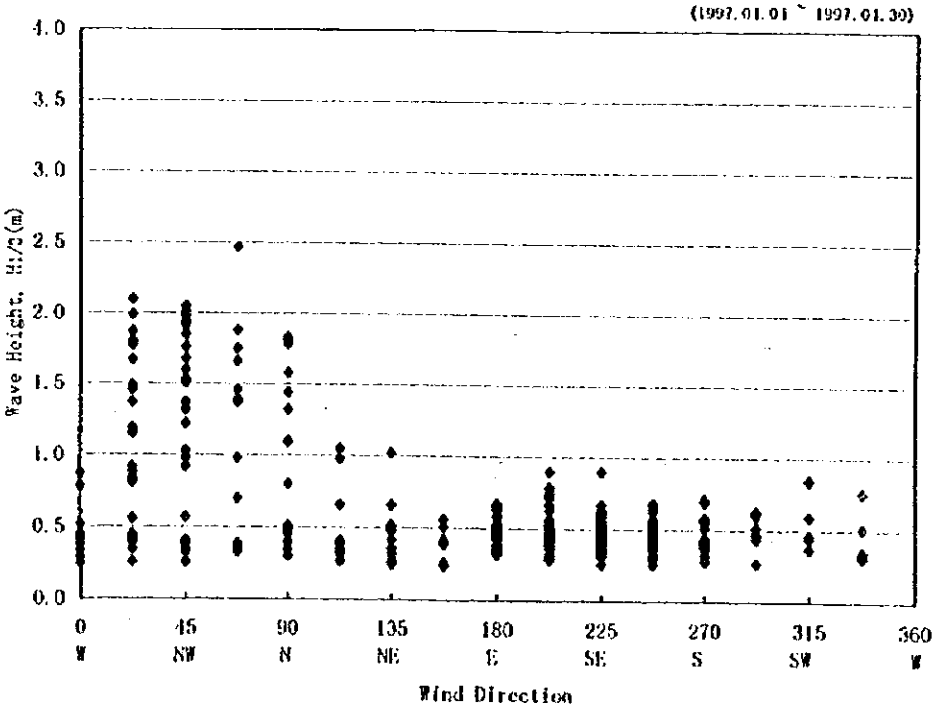
Unit: %

| Height (m) | N | NNE | NE | ENE | E | ESE | SE | SSE | S | SSW | SW | WSW | W | WNW | NW | NNW | Calm* | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0.00- | | | | 0.1 | 0.1 | 0.0 | | | 0.0 | | | | | | | | 2.2 | 2.4 |
| 0.25- | 0.1 | 0.5 | 3.9 | 3.8 | 2.4 | 1.5 | 0.8 | 0.2 | 1.4 | 0.2 | 0.2 | 0.2 | 0.2 | 0.1 | | 0.2 | 23.0 | 38.7 |
| 0.50- | 0.3 | 0.9 | 4.9 | 5.6 | 1.9 | 1.3 | 0.5 | 0.3 | 0.7 | 0.2 | 0.1 | 0.2 | 0.1 | 0.0 | 0.0 | 0.2 | 4.8 | 22.0 |
| 0.75- | 0.3 | 0.8 | 5.0 | 3.3 | 0.6 | 0.1 | 0.1 | 0.0 | 0.5 | 0.1 | 0.1 | 0.1 | 0.1 | 0.0 | 0.1 | | 0.7 | 11.9 |
| 1.00- | 0.3 | 0.9 | 3.1 | 2.5 | 0.1 | 0.1 | | | 0.2 | 0.1 | | 0.1 | 0.0 | 0.0 | 0.0 | | 0.2 | 7.6 |
| 1.25- | 0.2 | 1.0 | 2.7 | 0.6 | 0.1 | | | | 0.2 | | | | | | | | | 4.8 |
| 1.50- | | 0.4 | 1.8 | 0.3 | | | | | 0.4 | | | | | | | | | 2.9 |
| 1.75- | | 0.5 | 1.9 | 0.1 | 0.0 | | | | 0.4 | | | | | | | | | 2.9 |
| 2.00- | 0.1 | 0.5 | 0.8 | 0.1 | 0.0 | | | | 0.2 | | | | | | | | | 1.7 |
| 2.25- | 0.1 | 0.2 | 0.6 | 0.1 | | | | | 0.1 | | | | | | | | | 1.1 |
| 2.50- | | 0.7 | 3.3 | 0.1 | | | | | 0.1 | | | | | | | | | 4.2 |
| Total | 1.4 | 6.4 | 28.0 | 16.6 | 5.2 | 3.0 | 1.4 | 0.5 | 4.2 | 0.6 | 0.4 | 0.6 | 0.4 | 0.1 | 0.1 | 0.4 | 30.9 | 100.0 |

* "Calm" is defined by waves of which wave period is less than 5 seconds.




**(1) Correlation between Wind Direction and Wind Speed**




**(2) Correlation Between Wind Direction and Wave Height**

**Figure A 4.3.8 Correlation of Wind and Waves observed at Ky Ha by JICA Study Team**

## Table A 4.3.3 Frequency Distribution of Hindcast Usual Wave Height by Direction (1993-1994)

**(1) Location : N17.5 deg. E107.5 deg.**

Total no. of data: 2,920
Unit: %

| Height (m) | N | NNE | NE | ENE | E | ESE | SE | SSE | S | SSW | SW | WSW | W | WNW | NW | NNW | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0.0 - | | | | 0.5 | 0.9 | | | 0.0 | | | | | | | | | 1.4 |
| 0.5 - | 0.1 | 0.0 | 0.2 | 22.3 | 13.1 | 1.0 | 2.8 | 1.6 | 1.3 | 1.9 | 2.0 | 0.3 | 0.1 | | 0.0 | 0.0 | 46.7 |
| 1.0 - | 0.5 | 0.3 | 0.3 | 18.7 | 3.7 | 2.1 | 2.6 | 0.3 | 0.1 | 0.3 | 1.9 | 1.5 | 0.1 | | 0.0 | 0.2 | 32.5 |
| 1.5 - | 0.6 | 0.3 | 0.0 | 5.8 | 3.2 | 0.1 | 0.1 | | 0.0 | 0.1 | 0.1 | 0.2 | | | | | 10.7 |
| 2.0 - | | 0.3 | | 2.2 | 2.7 | | | | | | | | | | | 0.0 | 5.2 |
| 2.5 - | 0.1 | 0.1 | | 0.8 | 1.6 | | | | | | | | | | | | 2.6 |
| 3.0 - | 0.0 | | | 0.5 | 0.5 | | | | | | | | | | | | 1.0 |
| 4.0 - | | | | | | | | | | | | | | | | | 0.0 |
| 5.0 - | | | | | | | | | | | | | | | | | 0.0 |
| Total | 1.2 | 1.1 | 0.6 | 50.7 | 25.7 | 3.2 | 5.6 | 1.9 | 1.4 | 2.2 | 4.0 | 1.9 | 0.2 | 0.0 | 0.1 | 0.2 | 100.0 |

**(2) Location : N15.0 deg. E110.0 deg.**

Total no. of data: 2,920
Unit: %

| Height (m) | N | NNE | NE | ENE | E | ESE | SE | SSE | S | SSW | SW | WSW | W | WNW | NW | NNW | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0.0 - | | | | 0.1 | | 0.0 | | | | | | | | | | | 0.1 |
| 0.5 - | | 0.3 | 1.4 | 21.3 | 0.1 | 0.1 | 1.4 | 4.0 | 5.0 | 2.3 | 1.3 | 0.1 | 0.1 | 0.0 | 0.0 | 0.0 | 37.6 |
| 1.0 - | 0.3 | 2.0 | 5.0 | 15.9 | 0.1 | 0.1 | 1.0 | 6.3 | 5.5 | 2.4 | 1.5 | 0.3 | | | 0.1 | 0.1 | 40.5 |
| 1.5 - | 0.6 | 2.0 | 2.3 | 5.7 | 0.1 | | 0.1 | 0.5 | 0.3 | 0.1 | 0.3 | 0.0 | | | 0.0 | 0.1 | 12.2 |
| 2.0 - | 0.6 | 1.2 | 0.9 | 1.5 | 0.1 | | | 0.0 | 0.0 | 0.0 | | | | | | | 4.3 |
| 2.5 - | 0.3 | 1.1 | 0.3 | 0.9 | 0.1 | | | | | | | | | | | | 2.8 |
| 3.0 - | 0.3 | 1.0 | 0.2 | 0.8 | 0.0 | | | | | | | | | | | | 2.3 |
| 4.0 - | 0.2 | 0.0 | | 0.0 | | | | | | | | | | | | | 0.2 |
| 5.0 - | | | | | | | | | | | | | | | | | 0.0 |
| Total | 2.3 | 7.6 | 10.1 | 46.3 | 0.5 | 0.2 | 2.5 | 10.9 | 10.8 | 4.9 | 3.1 | 0.4 | 0.1 | 0.0 | 0.1 | 0.2 | 100.0 |

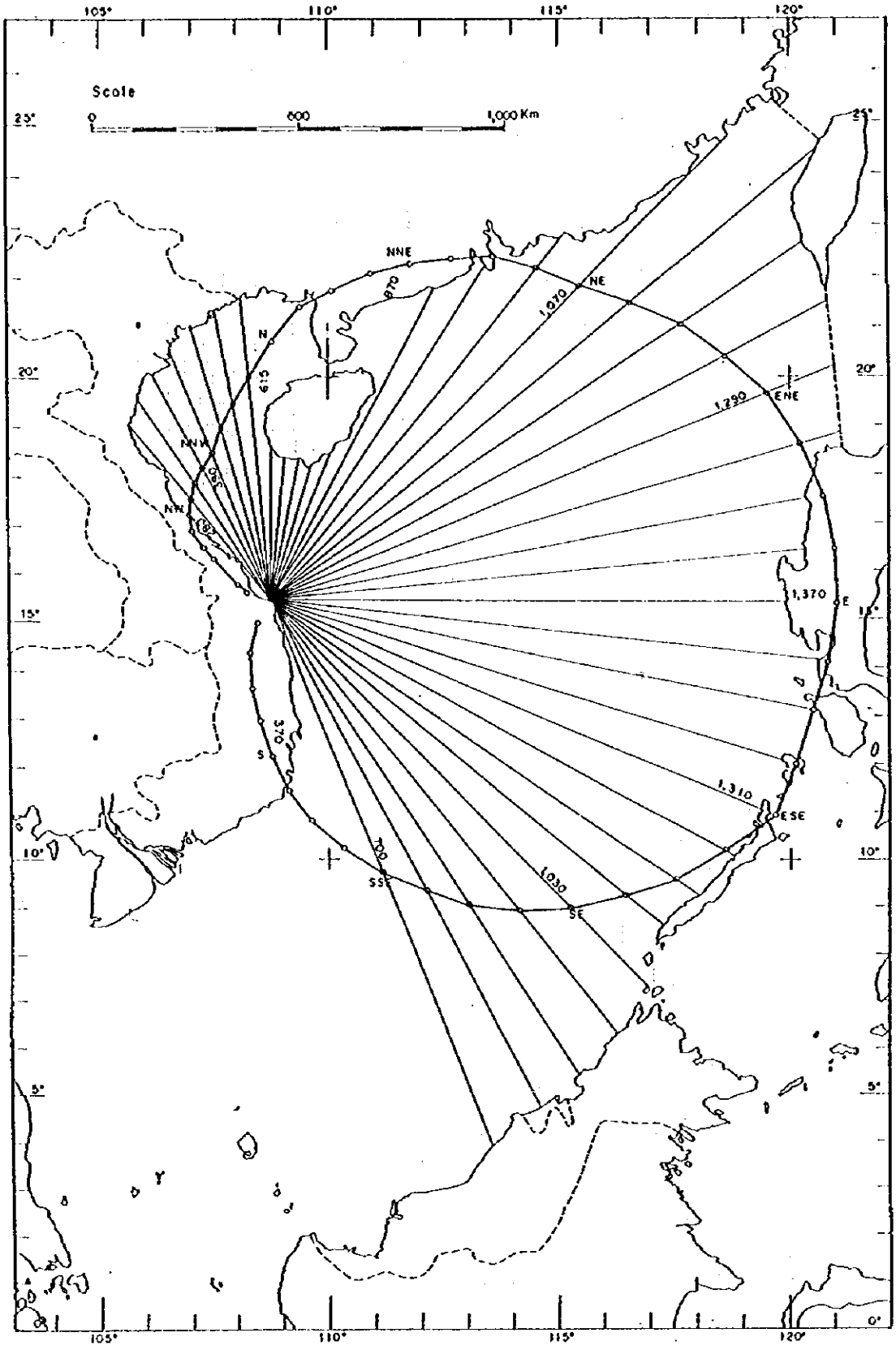
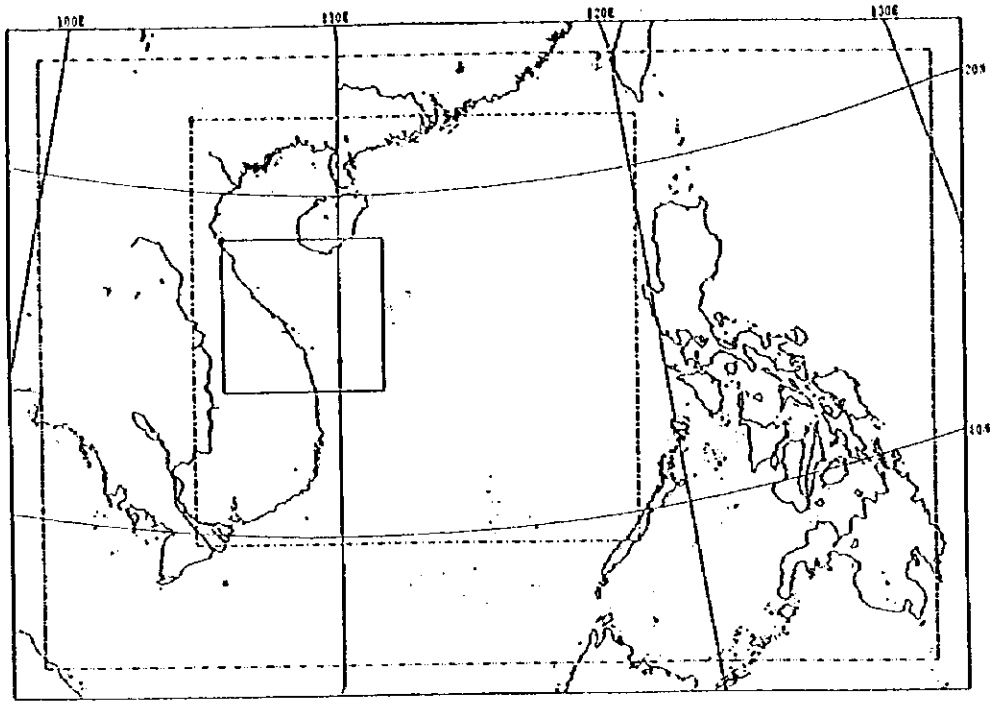



**Figure A 4.3.9 Effective Fetch at Ky Ha / Dung Quat (Unit: km)**

Source: JICA Study Team



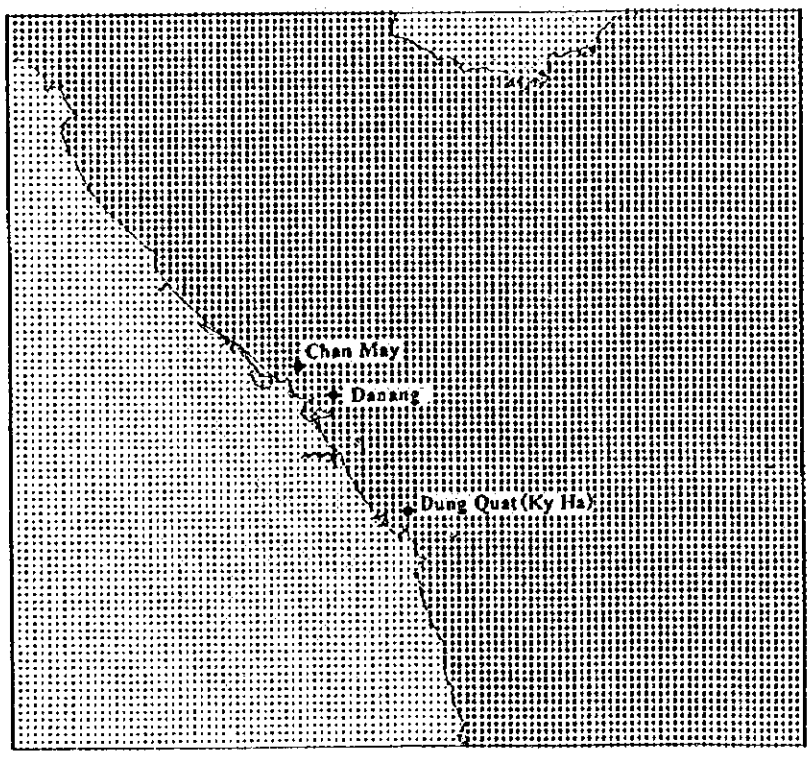
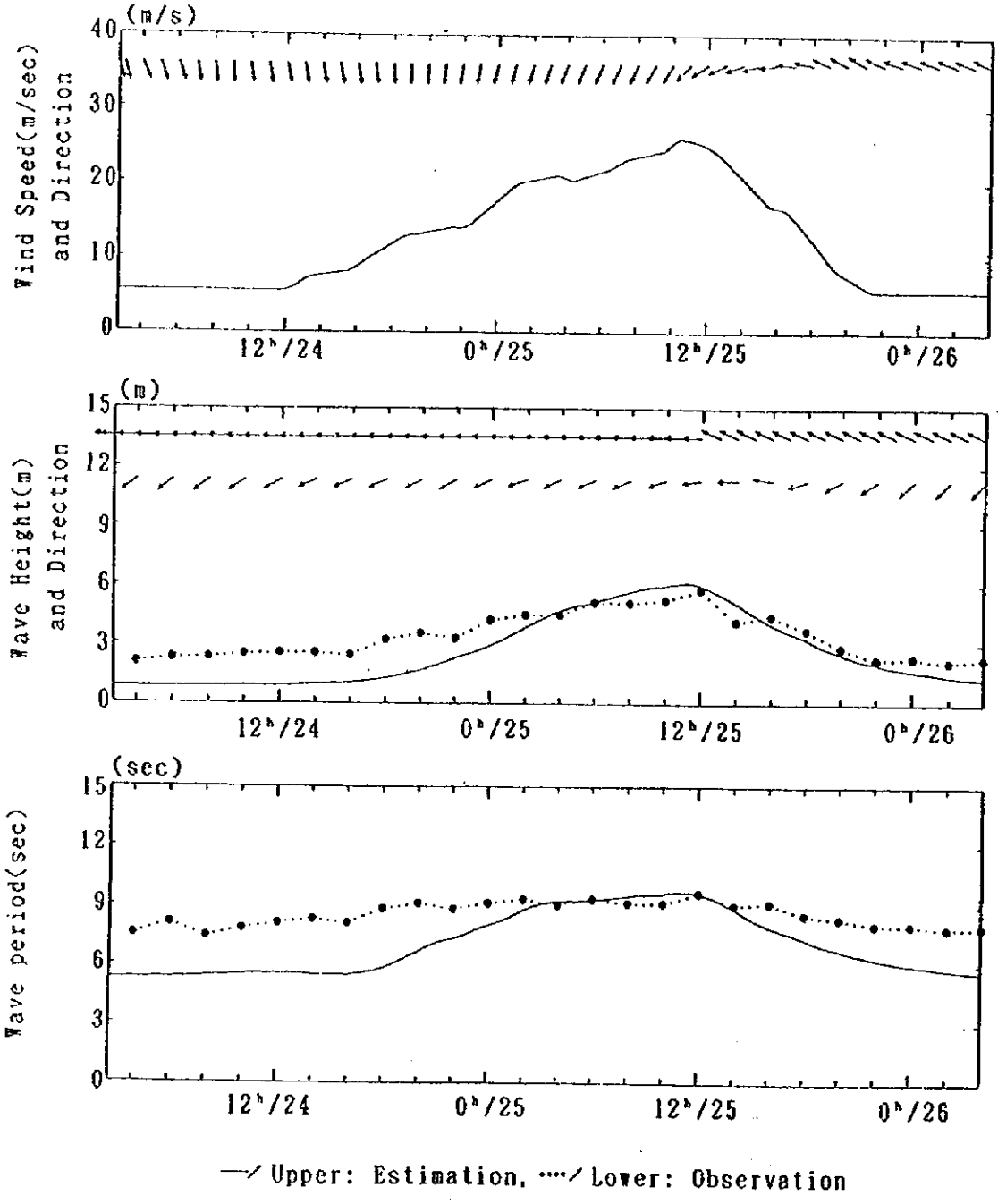


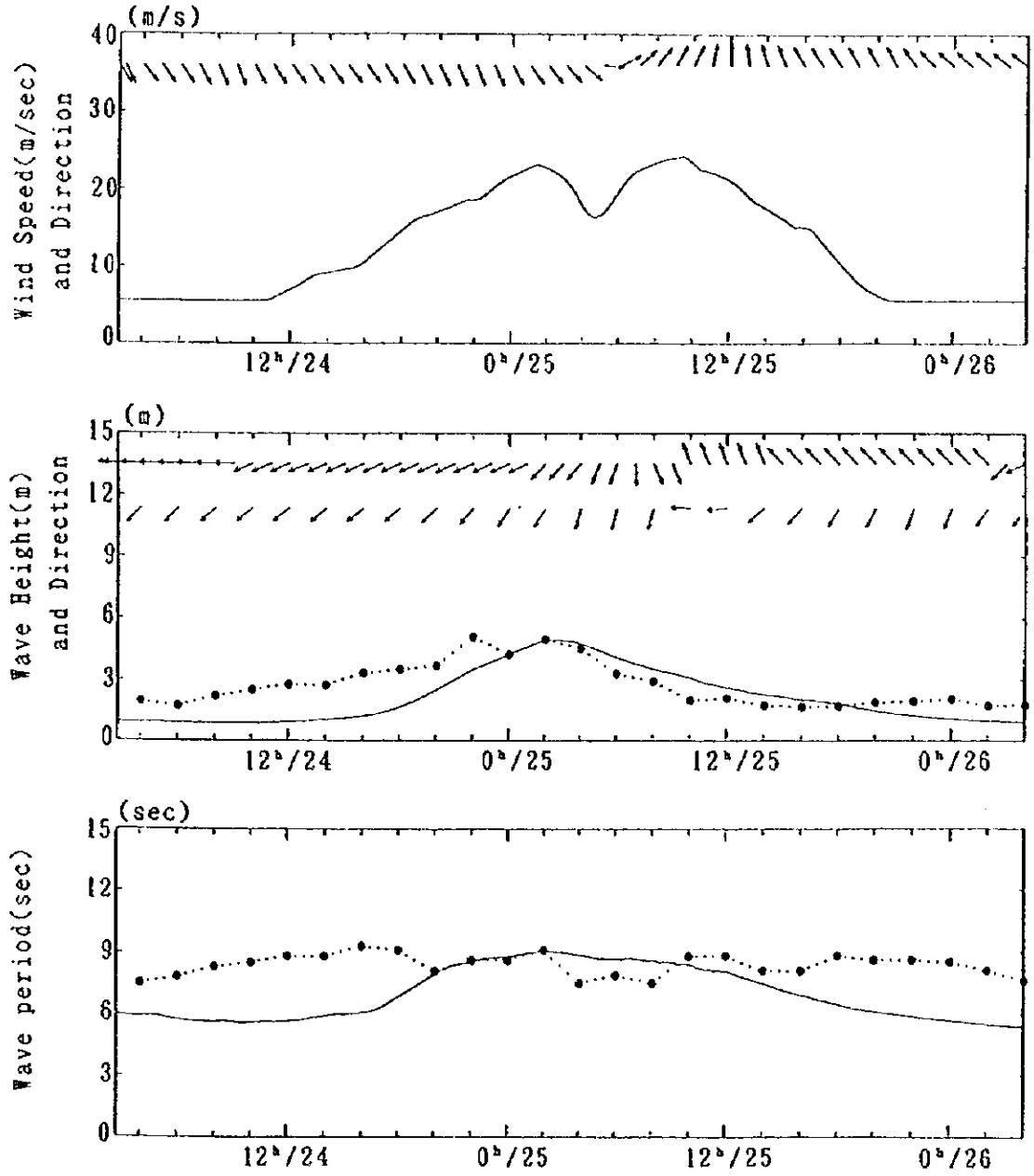

**Figure A 4.3.10 Fields and Points of Wave Hindcast Calculation**




| Maximum Values | | | | | |
|---|---|---|---|---|---|
| | Wind | | Wave | | |
| | Speed (m/s) | Direction | Height (m) | Period (sec) | Direction |
| Estimated | 25.9 | NE | 6.1 | 9.7 | E |
| Obseeved | – | – | 5.7 | 9.7 | E |

**Figure A 4.3.11 Comparison of Estimated and Observed Waves due to Typhoon Fritz**

**(1) Danang from 02:42 24 Sept. to 04:00 26 Sept., 1997**




| Maximum Values | | | | | |
|---|---|---|---|---|---|
| | Wind | | Wave | | |
| | Speed (m/s) | Direction | Height (m) | Period (sec) | Direction |
| Estimated | 24.4 | SSW | 5.0 | 9.1 | NE |
| Obseeved | — | — | 5.1 | 8.7 | NE |

**Figure A 4.3.11 Comparison of Estimated and Observed Waves due to Typhoon Fritz**

**(2) Dung Quat (Ky Ha) from 02:42 24 Sept. to 04:00 26 Sept., 1997**