PART 2

MASTER PLAN
ON NATIONWIDE FERRY SERVICE

Photograph of Mokmer

Chapter 1 Basic Ideas for Ferry Service Development Plan

1-1 Basic Concept of Ferry Service Development

1-1-1 Basic Requirements of Ferry Service

1. The following factors are generally proposed for basic requirements of ferry service, and they can also be recommended in the development of ferry service in Indonesia.

(1) Frequent Shuttle Service

2. Regardless of passenger or cargo, users of ferry transportation naturally want to have the service without waiting long at the terminal when they use it. It is one of the principal requirements peculiar to ferry service, compared with those of conventional sea transportation service. Consequently, frequent shuttle service will be very important for ferry transportation.

For short-distance routes, daily or more frequent service with a moderate sized boats should preferably be introduced although ferry operating bodies tend to pursue operating efficiency by using bigger boats.

(2) Conveniently Scheduled Sailing Service

3. Sailing schedule should be planned according to the characteristic or the role of each route. It should be carefully determined depending on whether departure and/or arrival time is to be set in the morning, in the evening or in the night.

For example, in case of a short-distance route, local people usually want to have the ferry service to go to their destination "early in the morning", and come back to their home town "in the evening".

On the other hand, in case of a long-distance route, users do not want to spend so much time tediously on board in the daytime and rather prefer to travel in the nighttime.

Time schedule of ferry service, therefore, should be set considering users' purpose and favorable schedule for passengers'/cargoes' transportation.

(3) Regular Service

4. Ferry transportation users, as a matter of course, expect regularity of service. The ferry operating body should comply with this request by providing daily or weekly scheduled service for instance.

In case of a daily service route, departure and arrival time should respectively be fixed at the same time every day and should not be irregularly or arbitrarily changed. In case of a weekly service route, departure and arrival days should be set on the same day of the week rather than on different days of the week.

(4) Punctuality of Service

5. Ferry users expect to have a quick and on-time door-to-door cargo transportation service provided by taking advantage of role-on role-off system of ferry service, with which they can transport cargoes to any destination without wasting time for cargo handling at ports. Therefore, punctuality of ferry service is an essential requirement for users. For this reason, introduction of a ferry boat with sufficient capacity which ensures a steady navigation regardless of weather or sea condition, such as wind, wave, or current, is very important.

(5) Comfortable and Safe Sailing

6. On most of the study routes, passengers will be the main object of transportation and the route distances are relatively long. Comfort and safety of sailing is an essential requirement. Special attention should be paid to the condition of ferry accommodations in case of nighttime service route.

(6) Moderate(Low)-Priced Service

7. Compared with conventional sea transportation means, ferry transportation has the advantage of enabling door-to-door service on time, but on the other hand, there is a disadvantage peculiar to ferry transportation. That is the transportation capacity of ferry boats, which is usually smaller than that of conventional ships. Accordingly, the fare and freight rate of ferry transportation tend to be set higher. In most cases of the study routes, ferry service is requested to be introduced as a basic means of the regional transportation for

local inhabitants. To play this role, the price of ferry service should preferably be offered at a moderate level. For this reason, there might be the need for the government to subsidize ferry operations to some extent, when necessary.

(7) Accessibility to Ferry Terminal

8. To ensure really convenient door-to-door transportation, the location of the ferry terminal is a very important factor. Generally speaking, a ferry terminal should be located at the point closest to the center of the origin/destination of the transportation demand. By planning the ferry terminal in this way, total transportation time can be saved and convenience of the trip can also be improved.

1-1-2 Roles of Public and Private Sector in Ferry Service

(1) Present Ferry Operation

9. As the present conditions of ferry operations are mentioned in Chapter 1 of Part 1, it will be simply touched on in this chapter. At present, the shipping operations are performed by the Perum ASDP(public corporation) and 15 private companies. On the other hand, the management and operation of ports are performed either by MOC or by the Perum ASDP. The construction of ferry port terminal facilities are under the responsibility of MOC. Ten ferry ports now operated by the Perum ASDP are the assets that have been transferred from MOC without compensation.

(2) Shipping Operation

1) Increase of Ferry Service Companies

10. Ferry transportation was initiated as an ASDF project in 1973. Two private companies were permitted to operate the ferry boats for the first time in 1976. Permission to establish private shipping companies has been gradually increasing since 1976. The average rate of increase was one company per year as shown in Fig. 1-1-1A. Also, ASDF's project was transferred to the public corporation(Perum ASDP) in 1986. At present, 16 shipping companies including the Perum ASDP operate ferry boats.

2) Passengers transported by the Perum ASDP and Private Companies

11. Since private companies have participated in the comparatively profitable routes, the number of passengers transported by private shipping companies already exceeds twice of that transported by the Perum ASDP as shown in Fig. 1-1-2A. This shows that the private companies are playing the important roles in the ferry service. The reason the number of passengers transported by the private companies in 1989 did not increase more compared with the previous year seems to be that no private company could obtain a permission to establish a shipping company in 1989 as shown in Fig. 1-1-1A.

12. On the other hand, the number of passengers transported by the Perum ASDP is increasing, although the operating area of the Perum ASDP is not the same as that of private companies. This implies that the demand for ferry transportation is increasing across the board.

13. In the case of the existing routes, although a participating private company will have to run business in competition with the Perum ASDP and/or other private companies, it is important for the government to give permission to the private company to introduce private funds to this field as much as possible.

3) Role and Task of the Perum ASDP

14. In Indonesia, the development of ferry transportation is considered as a extended part of road transportation, and is given a position as one of the important infrastructures. Especially, the development of ferry transportation in eastern Indonesia has a role to promote rectifying the unbalanced living standard between the eastern and the western part of Indonesia, thus becoming an important government policy. The Perum ASDP, as a public corporation, assumes a task of spearheading the government policy. Granting this role of the Perum ASDP, the government regularly gives ferry boats to the Perum ASDP without charge. It is considered that this kind of government aid will and should continue.

15. To ensure necessary funds to achieve the appointed task of developing pioneer routes, the Perum ASDP should continue to operate on commercial (profitable) routes with reasonable profits as a public corporation.

16. The Perum ASDP has another role as coordinator of any kind of problems that arise among companies and so on. Though the Perum ASDP is an organization of public nature, the Perum ASDP as a company is undoubtedly the leader among ferry operating companies. Therefore, it is strongly required that the Perum ASDP conducts fairly his task to meet and coordinate requests from/to regional governments and the central government as a mediator of ferry companies.

(3) Construction and Operation of Ferry Port

1) Construction of Ferry Port

17. As mentioned above, all the ferry ports are constructed by the government(MOC). In a country like Indonesia comprising innumerable islands, because the supply of ferry boats tends to insufficiently meet the demand, the selection and prioritization of port construction sites is a matter of prime importance. This is an important task of the central government in the course of developing the ferry transportation network in the nation.

18. In the development of ferry transportation in the future, it will be required to promote it taking much more account of the improvement in the living standards and security of local inhabitants. In this sense, the government's role is becoming more and more important.

19. Since profitability will not be naturally expected in shipping operation on those regional routes, the government needs to coordinate carefully the setting of tariff and other charges with the Perum ASDP when putting those new routes in operation. These arrangements are also important for the development of the related regions in the future.

2) Management and Operation of Ferry Port

20. Most of the ferry ports are managed and operated by MOC, and the others are managed and operated by the Perum ASDP. The tariff for the ports of MOC is determined lower than tariffs for the ports of the Perum ASDP in most cases. This is meaningful in that the lower tariff is regarded as a kind of financial aid for shipping companies.

21. At present, the Perum ASDP manages and operates ten ports transferred from the government. And, staff of MOC are also transferred to the Perum ASDP. Although it looks like the privatization of government-operated ports, the ports transferred to the Perum ASDP were only profitable ones. In this sense, it is regarded as a kind of government assistance to the Perum ASDP at the present stage.

22. The roles of MOC in the future are to promote the development of new pioneer routes in cooperation with the Perum ASDP and provision of port facilities at a lower tariff. Those policies should, however, be implemented carefully taking into consideration a reasonable level of financial arrangements.

1-2 Basic Concept of Ferry Service

1-2-1 Basic Concept of Ferry Network

23. The DGLT has a magnificent plan to form a nation-wide transportation network for the automobile/passenger traffic by connecting the existing regional or insular road networks with ferry lines, which total thirty-five routes in operation at present. The ferry service has been provided so far mainly in the area from Sumatra Is. into Flores/Timor Is. through Jawa Is. while long-haul ferry lines connecting each of main islands together - inter-regional ferry service - do not exist at present. In that sense, the real nation-wide network has not yet been realized. The nine ferry routes proposed for the study are to expand and strengthen some of the above-mentioned regional networks mainly focusing on the eastern region of the nation.

24. Judging from the existence of substantial automobile/passenger traffic flowing continuously through the existing network, the most active regional network is the one which connects each of the islands in series from Sumatra to Timor extending over around five-thousand kilometers. This is because the network connects the Island of Jawa which is the political and economic center of the nation with many of the other major cities and tourist spots from west to east, and because the islands on the network with relatively well developed national highways are located in a row with relatively short distance between each other. In this sense, this network is considered the most appropriate to

make the best use of the ferry service from the viewpoint of social and economic development of the nation.

25. The other networks located in the regions of Kalimantan, Sulawesi, Maluku and Irian Jaya have not yet been developed sufficiently and are in a less active state compared with the above-mentioned network in terms of the volume of automobile/passenger traffic. Viewed from the geographical condition and the distribution of social/economic activities to those regions, the expansion and strengthening of the regional networks should be stressed especially in the eastern regions such as Sulawesi, Maluku and Irian Jaya which have rather been left behind in the social/economic development. In those regions the ferry service should also be provided to surrounding small islands to solve the problem of isolation. The Kalimantan region, different from other regions, does not seem to have much more specific requirement to develop the regional ferry lines except, for example, the area around the estuary of large rivers because of its geographical condition.

26. When considering the inter-regional long-haul ferry service, what should be taken into account is the inter-regional traffic demand especially in terms of passenger/cargo traffic with vehicles. According to the O-D survey conducted by MOC in 1988, the volume of inter-regional passenger traffic carried by airplane, conventional passenger boat and ferry boat was largest on the route of Jawa-Sumatra followed by Jawa-Bali & Nusa Tenggara, Jawa-Kalimantan and Jawa-Sulawesi, all originated from or destined to Jawa. The volume of other inter-regional passenger traffic on the routes such as Sumatra-Kalimantan, Kalimantan-Sulawesi, Sulawesi-Maluku & Irian Jaya etc. was very small with ratios of less than five-percent of the traffic volume on the route of Jawa-Sumatra. The same survey shows that the volume of inter-regional cargo traffic carried by conventional cargo boat and ferry boat was largest also on the route of Jawa-Sumatra followed by Jawa-Kalimantan and Kalimantan-Sulawesi. Different from the passenger traffic, the inter-regional cargo traffic on the routes excluding Jawa such as Sumatra-Kalimantan, Kalimantan-Sulawesi, Sulawesi-Maluku & Irian Jaya can not be overlooked with ratios of 7 to 15% of the traffic volume on the route of Jawa-Sumatra. From the above-observed facts, a triangular network formed by connecting Jawa, Kalimantan and Sulawesi should be given priority with comparatively less importance on the route of Kalimantan-Sulawesi in terms of providing inter-regional ferry service. The

necessity of providing ferry service on the other inter-regional routes might barely come out at the time when respective regional economies and road networks are much more improved.

27. The characteristics of ferry service are enabling quick delivery of cargoes and willful travel of passengers. From this viewpoint, the long-haul ferry service should be launched only after careful examination of real demand for passenger and cargo traffic considering the existing services provided by conventional type of vessels for passenger and cargo traffic without vehicles. Leaving aside the ferry service in the above-category, there might be sea-highway type of ferry routes which will contribute to decreasing the traffic burden to existing highways. The ferry routes connecting Berawan, Palembang, Jakarta and Surabaya would be worth considering in future.

1-2-2 Classification of Ferry Route

28. Although each existing ferry route constitutes an element of the nation-wide transportation network, there are conspicuous differences among functional characteristics of the routes depending on its geographical location, the social/economic circumstances of the serving areas, the accessibility to national/regional trunk routes and so forth. When trying to classify the existing ferry routes, factors that should be taken into consideration could be the importance of the route on the national/regional transportation policy and the expected traffic demand on the route. Since those characteristics of the route should be reflected in the kind/scale of facilities and equipment, and operation method needed for the provision of ferry services, this idea for classification would be helpful for the planning of new ferry services in future.

29. Classification of ferry route according to functional characteristics:

1) Accessibility to Provincial Capital

A) National Route:

A ferry route located on the route having direct accessibility to provincial capitals on both ends

B) Regional Trunk Route:

A ferry route located on the route having direct accessibility to a provincial capital on one end

C) Regional Route:

A ferry route located on the route having no direct accessibility to provincial capitals

2) Demand Level

I) High Demand Route:

A ferry route providing service of more than six trips/day in terms of 300-500 GRT boat

II) Medium Demand Route:

A ferry route providing service between two and six trips/day in terms of 300-500 GRT boat

III) Low Demand Route:

A ferry route providing service of less than two trips/day in terms of 300-500 GRT boat

30. Classification of each route can be obtained by combining classification 1) and 2). National routes would be expected to form a nation-wide trunk network in the future. Regional trunk routes would contribute to the social/economic development of the region in cooperation with the national routes. Regional routes would be necessary mainly to break the isolation of remote islands. Inter-regional long-haul routes which will be mentioned below, when put into operation, should be classified as a national route in view of its importance in increasing the coverage of a nation-wide trunk network.

31. Classification of Ferry Route According to Geographical Characteristic:

Aside from the above classification, a different kind of classification would be possible as follows based on the geographical location of the route.

1) Inter-regional Route Connecting Main Islands:

A route connecting main island, which tends to be a long-haul route, i.e. Java-Kalimantan, Java-Sulawesi etc.

2) Inter-island Route:

A route connecting different islands within a region, which includes a route serving remote islands

3) Inland Route:

A route located in the inland area, which serves to cross rivers and lakes

4) Short-cut Route:

A route which helps to shorten a land transportation distance, which are expected to be developed more in Sulawesi and Halmahera, i.e. Bajoe-Kolaka

1-2-3 Characteristics and Roles of Ferry Service on the Study Routes

32. The nine study routes are practically divided into 13 individual routes and their general characterization is presented in Table 1-2-1A, in which three kinds of characterization are shown. The first one "A" is based on the functional characteristics of each route as analyzed in section 1-2-2. The second one "B" is the classification simply based on the length of the route. And, the third classification "C" is concerning transportation demand on the route.

33. According to the above characterization, Kolaka-Bajoe Route(Route 8) is classified as a "National Route". This route is located on the route between two provincial capitals, namely Kendari of South-East Sulawesi Province and Ujung Pandang of South Sulawesi Province. Between Kendari and Ujung Pandang, there are no sufficient road connections for automobile traffic, thus this route is geographically classified as a "short-cut route". Due to such a situation, this route plays an essential role in cargo/passenger transportation within the concerned regions at present and will continue to play an important role in the social/economic development of the region in the future.

34. Hunimua-Waipirit route(Route 1) and Palembang-Bangka Island route (Route 9-1) are classified under "Regional Trunk Route".

Route 1 connects Seram Isl. with the provincial capital city, Ambon. It is a short distance route with a distance of 11 miles, then people in Seram Isl. can easily visit Ambon city and come back in one day. So, one-day trip demand will be dominant on this route in the future.

Route 9-1 connects Bangka Isl. to the provincial capital city, Palembang, with a distance of 74 miles. Due to the unfavorable tidal condition at Kayuarang in Bangka Isl., the present ferry service can not fully comply with the transportation demand. For this reason, shifting terminal from Kayuarang to Muntok should be carried out to solve the problem, thus enabling the ferry service on this route to play the expected fundamental role of providing regional transportation.

35. Except for three routes mentioned above, the other ten routes are categorized under "Regional Route". Among these routes, Yapen Isl.- Irian Jaya(Nabire) route (Route 2-2), Flores Isl.(Larantuka)-Alor Isl. (Kalabahi) route (Route 3-3) and Bangka Isl.-Belitung Isl. routes (Route 9-2) are relatively long routes. These routes will be "Nighttime Service" routes.

The seven routes are short distance routes, thus their service will be provided in "Daytime". In the future transportation demand of the route connecting Flores Isl.(Larantuka), Adonara Isl. and Lomblem Isl.(Route 3-1), there will also be included the demand which is originated from and destined to the provincial capital city, Kupang.

Chapter 2 Development Ideas for the Study Ferry Routes and the Evaluation of the Alternatives for Ferry Terminal Sites

2-1 Ambon-Seram Route

2-1-1 Evaluation of the Existing Ferry Route

1. The existing route is located with the shortest section between Ambon Island and Seram Island. Improvement of the roads from Waipirit to the inland area is now in progress; paving of road is almost completed in the section from Waipirit to the principal towns in the island such as Amahai, Tehoru, and Piru.

2. The transportation volume on the route is steadily increasing at a higher rate than those of the conventional transportation services between the two islands, as shown in Fig. 2-1-2A of Part 1. Considering this situation, the ferry service of this route should continue to comply with the increasing demand in future. Some improvement, for example, in the existing shallow basin should be made.

2-1-2 Terminal Site Study

(1) Natural Conditions of the Terminal Sites

1) Hunimua (Ambon) Site

3. Oceanographic Conditions

* During December to March, the max. wave of 0.5m high attacks from N or W direction but this does not pose any problem for ferry service.
* The difference between HWS and LWS is 2.20m and the tide is mixed semi-diurnal.

4. Topographic Conditions

* The existing berthing facilities are located at the coral sandy beach, where the slope becomes deep suddenly.
* The land in the vicinity of the terminal is flat with a highland of approx. 30m high behind it.

5. Land Use Conditions

* The land behind the terminal area is owned by the air force.
* There are houses used for air force personnel on the highland and no houses around terminal.
* Existing terminal area is 2.5ha, and will be expanded to 5.0ha in the near future.

6. Other Conditions

* Water is not available at the terminal site.
* All rubber fenders on breasting dolphins have disappeared.

2) Waipirit (Seram) Site

7. Oceanographic Conditions

* During December to March, a max. wave of 1.0m high attacks from W direction which makes right angle to ship hull and will cause serious problem of ship rolling during the time mooring and loading/unloading.
* Tide is the same as in Hunimua.
* A max. three knots of stream is observed.
* Littoral drift to southern direction is predominant and the sedimentation with a thickness of 1.5m has occurred at the berthing basin during the last five years. Maintenance dredging is necessary as early as possible.

8. Topographic Conditions

* The coast is sandy beach and the existing ferry berth is located 150m off the coast line, where the original water depth was 3.5 m below LWS. And present water depth is 1.85m below LWS.
* The land around the terminal is flat and covered with grass and trees

9. Land Use Conditions

* Of the land of five ha already reserved for future development, only 1.0ha is utilized at present for terminal use.
* Behind the terminal area, many houses of village people are standing along the access road.

10. Other Conditions

* Water supply by private company is available and public water supply is requested.
* Electric power is available.

2-2 Biak-Yapen-Irian Jaya Route

2-2-1 Ferry Network Alternatives

11. Some ferry network alternatives are proposed considering the unique location of the islands and the study area. The topographic characteristics of the area are as follows;

* Biak Island, Yapen Island and Nabire(Irian Jaya) are located close to each other in a line from north to south.
* The shape of Yapen Island is slender stretching from east to west, just in the middle of Biak Island and Nabire.
* The main city of Yapen Island, Serui, is located on the south side of the island.
* Due to this topography, the direct sea connection from Biak to Serui have to be a long route with the detour around the west end of Yapen Island.

12. Considering the locations of the islands and the study area, the two alternatives for the future ferry networks are proposed based on the following conditions:

* Case-1: One ferry terminal in Yapen Island, at Serui or somewhere on the northern coast of the Island.
* Case-2: Two ferry terminals in Yapen Island, one is at Serui and the other, on the northern coast of the Island.

13. The role of each terminal will be given according to the following ferry-network alternatives, and are shown in Fig. 2-2-1A.

* Alternative-1: "Network Connecting Two Islands(Areas)"

  This network strengthens the social/economic relationship mainly with Biak island which functions now as a sort of economic center in the region. In this case, the network will be formed with a route between Biak island and Yapen island, and a route between Biak island and Nabire area.

  In this case, three ferry terminals are required.

In Yapen island, one terminal is required and its location will be at Serui or somewhere on the northern coast of the island.

* Alternative-2: "Network Connecting Three Islands(Areas)"

  This network will strengthen the social/economic relationship not only with Biak island but also with other islands(areas). In this case, the network will be formed with two routes, one is between Biak Island and Yapen Island, and the other, between Yapen Island and Nabire.

  The people of Yapen Island can go to both Biak Island and Nabire area using either of the two routes, and the people of Biak Island(or Nabire) also can go to Nabire(or Biak Island) through Yapen Island.

  In Yapen island, it is required to provide at least one terminal at Serui. The provision of another ferry terminal is requested on the northern coast of Yapen island.

14. The Team would recommend to choose Alternative-2 in formulating the Master Plan, because the Alternative-2 would be more effective than the Alternative-1 in view of promoting regional development.

2-2-2 Terminal Site Study

(1) The Natural Conditions of Terminal Site Alternatives

1) Mokmer (Biak) Site

15. Oceanographic Conditions

* This site is opened to SW waves. The max. height of wave is assumed to be about two meters, since the max. wave height of 1.25m has been reported at the port of DGSC which is protected by the ideal natural breakwater of coral reef.
* The tidal range is 1.55m, and the tide is mixed semi-diurnal.
* The max. current of 6 knot setting east direction occurs during September to December.

16. Topographic Conditions

* This site is located on the coral beach and deep water appears approx. 50m off the coast line.
* Seabed material is coral rock.
* The land between coast line and access road is flat with a cliff behind the road.
* The land material under the surface mud is coral rock.

17. Land Use Conditions

* There are houses, a garden and fish ponds on the land between the coast and the access road.
* This land is owned by the people of the village.

18. Other Conditions

* Along this coast, the port facilities exist and were used by the Japanese army during World War II.
* Water and electric power supplies are available.

2) Parai (Biak) Site

19. Oceanographic Conditions

* Almost same as Mokmer site.

20. Topographic Conditions

* This coast is widely covered by coral reef and deep water appears around 200m off shoreline.
* There is a steep cliff just behind the coast, and the land along the shore is covered by rock and big trees. There is no flat land here.

21. Land Use Conditions

* No houses exist in this area.

* This land is owned by the local people.
* The land beside this site is relatively low and flat, and aleady planned to be used for a hotel.

22. Other Conditions

* Water and electric power supplies are available.

3) Mandon (Biak) Site

23. Oceanographic Conditions

* Same as Paray site

24. Topographic Conditions

* This coast is also widely covered by coral reef and deep water appears 300m off the shore line.
* The land behind the coast is low and flat and thickly covered by trees.

25. Land Use Conditions

* Paved road runs approx. 350m inward of the shore line. There are no houses between the road and the shore.
* This site is owned by local peoples, and an area of 100m x 350m is owned privately by a single person.

26. Other Conditions

* According to the information of BAPPEDA, this area is planned to be a tourism center of Biak in future.
* Electric power supply will be available soon, and water supply is not available now.
* At around one km to the west of the site, there is a small ship repairing yard where the work is done in the basin protected by a rubble mound jetty/break water.

4) Yobi (Yapen) Site

27. Oceanographic Conditions

* This site is opened to N to W, then, waves would be high during December to March.
* The tidal range is 1.60m and tide is mixed semi-diurnal.
* There is a possibility of sedimentation in this site due to the littoral drift.

28. Topographic Conditions

* This coast is sandy beach. The slope of the sea bottom is gentle with many rocks on the seabed.
* There is a small river at the root of the nearby cape .
* The land behind the coast is flat.

29. Land Use Conditions

* There is a small village surrounded by jungle close to the site. No vehicle roads exist.

5) Saubeba (Yapen) Site

30. Oceanographic Conditions

* This site is opened from E to N and protected against westerly waves by a cape. Easterly swells enter directly.
* Tidal condition is the same as Yobi site.
* This site has a tendency of erosion.

31. Topographic Conditions

* There is no sandy beach and the slope of the sea bottom is steep.
* There is no flat low land along the coast with mountains, covered thickly by trees.

32. Land Use Conditions

* No people are living in this area
* A road connecting this site and Serui is now under construction.

33. Others

* The team was told at Yobi that all villagers will move to Saueba when trans-island road is completed.

6) Turu (Yapen) Site

34. Oceanographic Conditions

* This site is on the east coast of Serui bay, and protected against waves from all direction except SE direction. The max. SE waves reach two to three meters in the months during December to February.
* The tidal range is 2.80m and tide is mixed semi-diurnal.
* The tidal current is two to three knots.

35. Topographic Conditions

* Along the coast, there is a narrow sandy beach, and many rocks are scattered on the seabed.
* The slope of the sea bed is not gentle.
* There is low flat land of approx. 50m wide along the coast with a rocky mountain behind it.

36. Land Use Conditions

* There are several fishing boats on the beach.
* The flat land is occupied by fishermen's houses.

37. Others

* The small passenger boats connecting with nearby islands are using the beach near this site.

7) Kabuaena (Yapen) Site

38. Oceanographic Conditions

* There is a cape to the west and a big island in front of the site, providing a calm sea area.
* The tide is almost the same as Turu site.

39. Topographic Conditions

* This coast is sandy beach and a small river flows into the sea near here.
* Within 100m off the coast, -5m of water depth is obtained.
* The land of 100m-wide along the coast is flat with a steep mountain lies behind.

40. Land Use Conditions

* The flat land is used for houses and a coconut field. The mountain is covered with a jungle.

41. Others

* The scenery here is very beautiful.

8) Pasar Ikan (Yapen) Site

42. Oceanographic Conditions

* The existing coast is protected by a cape against the strong waves from SE direction. It is necessary to extend the jetty to obtain sufficient water depth. The wave condition at the berth will be the same as Turu site.
* The tide and the current are the same as Turu site.

43. Topographic Conditions

* The slope of the sea bed is very gentle and the sea bottom material is coral rock.
* There is a small river beside the fish market.
* The land around the market is flat with a small mountain beyond the river.

44. Land Use Conditions

* There are many fishermen's houses along the coast.
* On the mountain, there are no houses.

9) Nabire (Irian Jaya) Site

45. Oceanographic Conditions

* The site faces W and opens from SW to NE, and high waves can break on the beach.
* The tidal range is 2.12 m and tide is mixed semi-diurnal.

46. Topographic Conditions

* There is an open space of 100m x 70m along the coast and a bus/taxi terminal is located behind it.
* This open space is owned by the local Government.

47. Others

* There is a heavily-damaged wood jetty at the site.
* The oil jetty of PERTAMINA is located approx. one km to the north.

10) Kimi (Irian Jaya) Site

48. Oceanographic Conditions

* This site is situated in the inner part of Kim bay which opens to NW direction. Only NW waves will enter and the wave height will be less than 1.0m.

49. Topographic Conditions

* There are two rivers on the north and south sides of the site. There is a large quantity of sand drift from the southern river that will probably move to the site.
* The coast is sandy beach and the slope of sea bottom is gentle.
* The land behind the coast is flat.

50. Land Use Conditions

* There are several houses along the coast and other area is a forest.
* There is a sea port of DGSC at the northern part of this bay.

(2) Terminal Sites Evaluation/Selection

1) Biak Island

51. There are three alternative proposals for the terminal site as follows. Their locations are shown in Fig. 2-2-2A;

A(Alternative)-1. Mokmer
A-2. Parai
A-3. Mandon

52. The evaluation of the alternatives are as follows;

"A": Good
"B": Fair
"C": Poor

A-1. Mokmer: "A"

a. Accessibility: "A"

* Among the three alternatives, Mokmer is the closest to the center of Biak, with a distance of about 7km.

b. Land Conditions: "B"

* Local inhabitants have their own houses along the sea side, then, purchasing of the land for the terminal is required.
* Among the three alternatives, this site has the narrowest tidal flat of coral reef with the width of about 160m along the existing road and the water depth of -5m on its sea side edge. Then, this site offers minimum necessity of reclamation.

c. Sea Conditions: "B"

* There is no protection against waves. (The three alternatives have almost same conditions concerning waves.)

A-2. Parai: "B"

a. Accessibility: "B"

* This site is located a little farther from the center of Biak City compared with Mokmer, with a distance of 14km.

b. Land Conditions: "C"

* There is a jungle between the existing road and the sea side with a hill behind it.
* The land is privately owned with no people living here.
* There is a wider tidal flat of coral reef, compared with the case A-1.

c. Sea Conditions: "B"

* The site has almost the same sea conditions as the other alternatives.

A-3. Mandon: "C"

a. Accessibility: "C"

* The site is located farthest from the center of

Biak City among the three alternatives, with a distance of 18km.

b. Land Conditions: "C"

* There is a jungle between the road and the sea side.
* The land here is privately owned, with no people living here.
* The site has the widest tidal flat, with the width of 300-400m, along the road.

c. Sea Condition: "B"

* The site has almost the same sea conditions as the other alternatives.

2) The North Side of Yapen Island

53. There are two alternatives proposals for the terminal sites as follows, and their locations are shown in Fig. 2-2-3A.

A-1. Yobi
A-2. Saubeba

54. The evaluation of the alternatives are as follows;

A-1. Yobi: "C"

a. Accessibility: "C"

* The site is 50km away from Serui.
* A Road is under construction, between Saubeba and Serui, for a road length of about 34km.

b. Land Conditions: "B"

* There is a jungle along the coast, and local inhabitants live near the site.

c. Sea Conditions: "C"

* The site has no protection against high waves from N and W.

A-2. Saubeba: "B"

a. Accessibility: "B"

* The site is 34km away from Serui.
* The road is under construction, for a road length of about 25km.

b. Land Conditions: "A"

* There are mountains just behind the site, however there is sufficent flat area for femrry terminal.

c. Sea Condition: "B"

* The site has no protection against high waves from N.

3) Serui: The South Side of the Yapen Island

55. There are three alternative proposals for the terminal site as follows and their locations are shown in the Fig. 2-2-3A.

A-1. Turu
A-2. Kabuaena
A-3. Pasar Ikan

56. The evaluation of the alternatives are as follows;

A-1. Turu: "B"

a. Accessibility: "A"

* The site is located very close to the center of Serui, with a distance of 1km. The existing access road is very narrow and located on the slope of the mountain.

b. Land Conditions: "C"

* There are three mountains just behind the site.
* Local inhabitants live along the sea-side, and there is no open space around here.

c. Sea Conditions: "B"

* The site has the insufficient protection against waves from W

A-2. Kabuaena: "A"

a. Accessibility: "B"

* The site is located about 5km away from the center of Serui

b. Land Conditions: "B"

* Local inhabitants live along the sea-side in close proximity to the site.

c. Sea Conditions: "A"

* The site has the sufficient protection against waves due to the existence of an island and a peninsula

A-3. Pasar Ikan: "C"

a. Accessibility: "A"

* The site is located just in front of the "City Market"

b. Land Conditions: "C"

* It is difficult to obtain an area for the terminal just behind the beach, due to the existence of a very wide tidal flat. Need of reclamation.

c. Sea Conditions: "B"

* The site has the insufficient protection against waves in a water area of the required water depth.

4) Nabire

57. There are two alternative proposals for the terminal sites as follows. And their locations are shown in the Fig. 2-2-4A.

A-1. Kimi

A-2. Nabire

58. The evaluation of the alternatives are as follows;

A-1. Kimi: "A"

a. Accessibility: "B"

* The site is located a 24Km away from Nabire City

b. Land Conditions: "B"

* Not many people local inhabitants live in the site area

c. Sea Conditions: "A"

* The site has a good protection against waves

A-2. Nabire: "C"

a. Accessibility: "A"

* The site is located in the center of Nabire

b. Land Conditions: "B"

* There is an open space just behind the sea
* The site is now used for a marine recreation zone for the local inhabitants at present.

c. Sea Conditions: "C"

* The site has no protection against waves from North and West

2-3 Flores-Alor Route

2-3-1 Ferry Network Alternatives

59. Two alternative routes are proposed, as shown in Fig. 2-3-1A.

* Alternative-1: "Direct Route"
  This connects Larantuka with Kalabahi directly.

* Alternative-2: "Islands Connecting Route"
  This not only connects Larantuka with Kalabahi, but also provides connections of Larantuka and Kalabahi with Adonara, Lomblen, and Pantar islands.

60. The concepts of the two Alternatives are as follows, and their locations are shown in Fig. 2-3-2.

* Alternative-1: The National Routes connecting Sumatra, Jawa, Bali and etc, in series will extend down to Timor island via Alor island, which are shown as "A" in Fig. 2-3-2A.

* Alternative-2: The National Routes will extend down to Timor island via Flores island, by strengthening the existing routes between Kupang and Ende or Larantuka, without providing trunk route between Flores and Alor islands. The suggested routes are shown as "B" in Fig. 2-3-2A.
  In this case, the route between Alor island and Flores island is provided as a "Regional" route, serving local inhabitants.

61. The Team would recommend Alternative-2 based on the present situation and future prospect of the distribution of social/economic activities in the region.

2-3-2 Terminal Site Study

62. The terminal site study for this network was conducted according to the concept of Alternative-2 mentioned above.

In Larantuka, there is already a ferry terminal owned by DGLT. In Kalabahi, a new DGLT's ferry terminal is going to be constructed from 1992. The terminal site alternatives, therefore, are selected from among those islands of Adonara, Lomblen and Pantar. The candidates are as follows, and their locations are shown in the Fig. 2-3-3A.

The Adonara Island;

- Alternative-Adonara-1: Waiwerang(Old Jetty)
- A-A-2: Terong
- A-A-3: Wailebe
- A-A-4: Riangderi

The Lomblen Island;

- Alternative-Lomblen-1: Lewoleba
- A-L-2: Balauring
- A-L-3: Wairiang

The Pantar Island

- Alternative-Pantar-1: Baranusa

(1) The Natural Conditions of the Terminal Site Alternatives

1) Larantuka (Flores) Site

63. Oceanographic Conditions

* This site faces the enclosed sea area surrounded by Flores island, Adonara island and Solor island. In addition to this, there is Waibaron island in front of this terminal site. Therefore, the calmness factor for wave is very high at this site.
* The tidal range is 2.20m and the tide is mixed semi-diurnal.

64. Topographic Conditions

* There is no sand beach, and shore is protected by revetments.

* The slope of sea bed is steep and the water depth of 5m below LWS is obtained 70m off the shore.
* The land of about 100m wide between coast and main road inclines gently and there is a mountain beyond the main road.

65. Land Use Condition

* The land of approx. 100m x 100m is utilized for the facilities of ferry terminal.
* The berthing facilities for ferry of 500GRT are situated 70m off the shore.

66. Others

* In Save sea between Larantuka and Kupang, waves are rough during October to March and small ships are impossible to sail.

2) Wailebe (Adonara) Site

67. Oceanographic Conditions

* This site is situated in the Flores strait and waves are small and the current does not adversely affect navigation.
* The tidal range is 2.20m and tide is mixed semi-diurnal.

68. Topographic Conditions

* This coast consists of sand and cobble stone.
* There is a small river at the site and its bed load is moved and sedimentation is seen on eastern side.
* There are mangroves on eastern coast and big rocks on western coast.
* The land elevation is about 3m higher than the beach and the ground is also rocky.

69. Land Use Condition

* This coast is not utilized.

* There are houses along the road around 200m from the shore.
* The land behind the road is used for farming.

70. Others

* There is a small broken rubble mound jetty at the site.

3) Terong Waiwerang (Adonara) Site

71. Oceanographic Conditions

* This site is located in the strait between Adonara and Solon islands and there is no problem with waves.
* The current does not adversely affect navigation.
* The tidal range is 2.95m and the tide is mixed semi-diurnal.

72. Topographic Conditions

* This coast is sand beach and the slope of sea bed is steep. The water depth of 5m below LWS is 30m from the shore.
* The main road lies around 60m from the coast and the land in front of the road is flat but a small mountain stands behind the road.
* Underground material will be rock on land and in the sea.

73. Land Use Conditions

* There is a new concrete wharf and reclaimed land of DGSC and it is used by cargo ships.
* There are no houses on land in the vicinity and the land is covered by wild grass.

74. Others

* DGLT has a plan to build a new ferry terminal near here.

4) Dermaga Lama Waiwerang (Adonara) Site

75. Oceanographic Conditions

* The oceanographic conditions are the same as Terong Waiwerang Site, although waves here might be higher that those in Terong.

76. Topographic Conditions

* There is a gravity type concrete jetty of about 70m long. The water depth is 0.0m (LWS) at the tip of jetty.
* The water depth of 5m below LWS is obtained 30m from the tip of the jetty.
* There is more sand on the eastern coast than on the western coast.
* The land elevation is about 6m at the coast and the land behind the coast is sloped gently.

77. Land Use Conditions

* The coast and front water is used by small fishing boats for mooring and fishing.
* There are many houses along the coast and along the main road about 30m behind the coast. And there is no open space in the vicinity.
* This jetty is used by traditional passenger boats and the ferry of DGLT at present.

5) Riangderi (Adonara) Site

78. Oceanographic Conditions

* This site is located in the Lamakera strait and the sea is calm.
* The tide range is 2.14m and the tide is mixed semi-diurnal.
* The current does not adversely affect navigation.

79. Topographic Conditions

* This coast is sand beach and the slope of seabed is relatively steep.
* The land behind the coast is flat and rocky.

80. Land Use Conditions

* The beach is not used for any purpose.
* The land is used for the farming of corn.
* The houses are situated around 1km south of the site.

6) Lewoleba (Lomblen) Site

81. Oceanographic Conditions

* The oceanographic conditions are similar to Riangderi site.

82. Topographic Conditions

* This coast is sand beach and the slope of seabed is steep. The water depth of 5m below LWS is obtained 20m to 50m from the shore.
* The land behind the coast is flat and sandy.

83. Land Use Conditions

* The beach and front water is used by large fishing boats for mooring and fishing.
* There are many fishermen's houses along the beach.
* The land behind the houses is covered by coconut trees and wild grass.
* At the western side of the village, the open space for ferry terminal is reserved by the local Government.

84. Others

* There is a concrete wharf of DGSC around 1.0km east from the site.

7) Balauring (Lomblen) Site

85. Oceanographic Conditions

* This site is situated in the Balauring bay and the calmness of wave is very high.

* The tidal range is about 2.60m and the tide is mixed semidiurnal.

86. Topographic Conditions

* This coast is sand beach and the slope of seabed becomes steep below 0.0m (LWS). The water depth of 5m below LWS is around 30m from the shore line.
* There are many rocks and a developed reef on the sea bottom. Therefore, care is required in navigation.
* There is a river approx. 2km to the west.
* The land behind the coast is flat and 300 to 400m wide.

87. Land Use Conditions

* The beach and front water of east side are used by fishing boats and traditional ships.
* There are many houses on the water along the eastern coast.
* Along the road behind the coast, there are many houses.

88. Others

* There is a concrete wharf of DGSC at the center of village.

8) Wairiang (Lomblen) Site

89. Oceanographic Conditions

* This site faces the open sea but there are reeves in off-shore, which act as break water. Therefore the navigable waterway is narrow but waves at site are not high.
* The tidal range is about 2.60m and the tide is mixed semidivine.

90. Topographic Conditions

* This coast is rocky and the slope of seabed is steep.
* There is no flat land along the coast at site and the mountainous land is also rocky.
* The village is situated approx. 500m west of the site.

91. Land Use Conditions

* At the western coast near the village, there are many fishing boats.
* One wooden jetty is now under construction at the site by local Government.
* The land in the vicinity of site is not developed yet.

92. Others

* There is another wooden jetty owned by a private company approx. 2km west from the site.

9) Baranusa (Pantar) Site

93. Oceanographic Conditions

* This site is located in the branched small bay of the Tangerang bay. Therefore, wave condition is very calm.
* The tidal range is 2.60m and the tide is mixed semi-diurnal.

94. Topographic Conditions

* This coast is sand beach and the water depth of 5 m below LWS is obtained 40m off the shore.
* The land behind the coast is sloped gently.

95. Land Use Conditions

* This coast is used by small passenger boats for landing.
* There are houses along the road behind the coast and the land behind the houses is used for farming.
* The land in this site is owned by the local people.

96. Others

* At present, a concrete with steel pile wharf is under construction in the vicinity of site by DGSC.

10) Kalabahi (Alor) Site

97. Oceanographic Conditions

* This site is located near the existing fishing port in the Kebora bay. Therefore, wave condition is good.
* The tide range is 2.55m and the tide is mixed semi-diurnal.

98. Topographic Conditions

* There is little sand on the beach and seabed slope is steep. The water depth of 5m below LWS is 40m off shore.
* The land of 50m wide between coast and road is flat and a gentle hill lies behind.

99. Land Use Conditions

* This site had been used for frog nursery, but is not used now.
* There are houses behind the road.

100. Others

* The land of 1.26ha for ferry terminal is already arranged by the local Government. DGLT has decided to commence the construction work of new ferry terminal in this fiscal year.

(2) Terminal Sites Evaluation/Selection

101. To meet the transportation demand of a region consisting several islands, it is necessary to provide an efficient ferry network servicing each of islands, with a limited sum of investment. For this purpose, the number of terminals should be limited, to some extent.

In this case, it will be proper to provide each small island with one ferry terminal, and to choose the terminal site near or in the center of the demand core of the island.

102. In Adonara Island, there is no open space for terminal in the existing

passengers terminal zone. So, a place close to the DGSC's new sea port, which is located close to the center of the town "Waiwerang", is recommended for the ferry terminal site. Other alternatives sites are located farther from the center of the traffic demand.

103. In Lomblen Island, Lewoleba is recommended for a terminal site. Other places are far from the center of the traffic demand and the wave conditions are not as good as at Lewoleba.

104. In Pantar Island, Baranusa is recommended for the terminal site, as it is the center of the traffic demand and has a good wave condition.

2-4 Southeast Sulawesi-West Kabaena

2-4-1 Ferry Network Alternatives

105. As mentioned already, ferry services exist between the main island of Southeast Sulawesi and Muna Island and also between Muna Island and Buton Island; Kabaena Island currently remains disconnected with any other island by ferry service. There are two alternatives to provide a ferry route connecting with the main island; one is from the west coast and the other is from the east coast. Furthermore, there are two other alternatives to connect indirectly with main island, one is through Muna Island, and the other, through Buton Island.

106. Considering the existing sea communication, the possible alternatives are as follows:

(1) Sikeli-Bambaea, Bupinang or Kasipute

(2) Dongkala or Toli Toli-Bambaea, Bupinang or Kasipute

(3) Sikeli-Bau Bau

(4) Dongkala or Toli Toli-Mawasangka

107. Considering that lots of cargoes transported to Kabaena Island originate in Ujung Pandang, and that Bajoe-Kolaka ferry route will continue to increase its cargo transportation, it is necessary to connect Kabaena Island directly with the main island in the first stage of the plan. Among the four alternatives, (1) and (2) are the ferry routes directly connected with the main island. For the same reason mentioned above about the relationship with Ujung Pandang, Kasipute is not convenient.

In Bupinang, there is a seaport. Wave conditions are unknown, but the port is protected from westerly waves by shoals existing to the west of the port. The coast around the port is almost fully occupied by residents with the exception of the entrance to the jetty of the sea port. Under these circumstances, it seems difficult to construct a new jetty specialized for ferry boats without utilizing the sea port facilities. Terminal facilities should be prepared by reclamation.

108. Judging from the above information and upon learning that in Bambaea there is an appropriate site with a water depth of more than -5m and reefs covering the inner part, Bambaea has been selected based on the natural condition survey. Sikeli has been selected for a candidate terminal site, because it is the shortest to connect with a ferry route from Bambaea, and also for the reason that this region has a high potential for cargo transportation (Fig 2-4-1A).

2-4-2 Terminal Site Study

(1) The Natural Conditions of the Terminal Site Alternatives

1) Banbaea (Sulawesi) Site

109. Oceanographic Conditions

* This site is located in a wide bay which opens to the sea. During the wet season in February, westerly waves reach 1.5m high, while during the dry season in September, southerly waves of 2.0m can be expected.
* The tidal range is 2.80m.
* The littoral drift is predominantly from E direction in the wet season, and in W direction in the dry season.

110. Topographic Conditions

* Beside the site there is the Bambaea river(30m wide), the mouth of which used to be closed due to the littoral drift sand.
* This coast is sandy beach with a very gentle slope. A water depth of 5m below LWL obtained approx. 500m offshore.
* The land is flat and only slightly elevated, floods caused by river flow will occur every 2 to 3 years.

111. Land Use Conditions

* The coast land of approx. 100m wide belongs to the local Government.
* On the land behind the coastline, many houses stand along the road.
* The main road between Kolaka and Kendari runs for about 1km behind the coast.

2) Pulemo (Sulawesi) Site

112. Oceanographic Conditions

* This site is situated in the wide bay which opens to SW. There is a 500m long natural breakwater of coral reef about 500m off the shore. Therefore, this site is well protected against waves in general, but there is a possibility that westerly waves may invade in February.
* Tide is the same as Banbaea site.

113. Topographic Condition

* At the site, there is a broken wooden jetty of 100m long which was constructed by local people in 1983.
* This coast is sandy beach with normal slope and the water depth of 5m below LWL is found 130m off-shore.
* The land of 150m wide between the coast and the village road is flat.

114. Land Use Conditions

* This beach is scarcely used by fishermen.
* The land is used for a coconut field and there are few houses, additionally there is a small graveyard at west coast near the site.
* This land is owned by local people.

115. Others

* The broken jetty had been used by ships up to 350tons.

3) Sikeli (Kabaena) Site

116. Oceanographic Conditions

* This site is protected against waves by a large coral reef and the sea is very calm.
* The tidal range is 2.4m and the tide is mixed semi-diurnal.
* The tidal current is negligibly small.

117. Topographic Conditions

* Due to a large coral reef,it is necessaly to plot a circuitous course to reach Sulawesi.
* The coast is a narrow sandy beach and the sea bottom is coral rocks.
* The water depth becomes suddenly increase about 85m off- shore.
* Lakmbulah river flows into the sea approx. 2km to the southwest of this site.
* The coastal land is low and flat.

118. Land Use Conditions.

* The land behind the coast road is a town center and occupied by houses and markets.
* Two pieces of open space of around 1.0ha are available in the site for the ferry terminal.

119. Others

* The wood jetty of DGSC is situated 150m to the southwest of the site.

(2) Terminal Site Evaluation/Selection

120. The natural conditions survey at Pulemo shows:

a) The coast is mostly protected from waves by coral reefs with 500m wide. The inner part is calm, except in February when westerly waves with maximum height of 1.5m will invade,

b) The water depth appropriate for mooring facilities is obtained only 130m off the shore line, this is convenient to build a short jetty,

c) It seems easy to obtain the land for ferry terminal facilities. For the reasons mentioned above, Pulemo is recommended for the terminal site on the main island side of this route.

The natural condition survey at Sikeli shows:

a) The coast is protected against waves by coral reefs and islands, and is very calm all year round.

b) The point with sufficient water depth appropriate for mooring facilities appears less than 100m off the coastal line,

c) There is a sea port near the site, which has played an important role in sea transportation of cargoes and passengers.From this fact it is known that the navigation around Sikeli is safe,

d) It seems easy to obtain the land for ferry terminal facilities in the area behind the site.

For the reasons mentioned above, Sikeli is recommended for the terminal site on the Kabaena island side.

2-5 East Kabaena-Muna

2-5-1 Ferry Network Alternatives

121. Regarding the development of the ferry network in Kabaena island,it is necessary, at first,to establish a route that connect with the main island, as described in 4-4-1. There are two alternatives to connect Kabaena island with neighboring islands, one is with the Muna island(for example with Mawasangka), the other with the Buton island (for example, with Bau Bau which is the largest city in these areas). The trip time from Bau Bau is estimated as follows:

Bau Bau--(directly by ferry)--East Kabaena 6 hours

Bau Bau--ferry--car--ferry--East Kabaena 4 hours[1)]

1) excluding the time for transfer

122. It is necessary to take account of the cargo/passengers transport demand not only from Mawasangka, Raha but also from Kendari. And the size of the ferry boat of Bau Bau- East Kabaena route should be larger than that of Mawasangka-East Kabaena route. Taking the above things into considerations, Mawasangka has been chosen as the study terminal site to be connected with East Kabaena.

2-5-2 Terminal Site Study

(1) The Natural Conditions of the Terminal Site Alternatives

1) Toli-Toli (Kabaena) Site

123. Oceanographic Conditions

* The site is situated in the inner part of the bay which opens to the E direction, a developed coral reef is situated at the SE side of the bay. Therefore, no large waves will enter this site.
* The tidal range is 2.40m and the tide is mixed semi-diurnal.

124. Topographic Conditions

* There is sand on the sea bed up to the elevation of LWS and corals is observed below LWS. The slope of sea bed is very gentle up to 1.0m bellow LWS, and it becomes suddenly steep from there. The water depth of 5m below LWS is found 400m off the shore.
* Two rivers flow into the bay in the north and northeast.
* There is no flat land on the coast, and a steeply sloped mountain lies along the coast.

125. Land Use Conditions

* There are houses on the water along the shore line due to the lack of flat land.
* The mountain, apparently rocky, has no trees, partly covered with the grass.

126. Others

* There is a rubble mound jetty of about 100m long at the site, but it is only available during high tide.

2) Dongkala (Kabaena) Site

127. Oceanographic Conditions

* There are Small Damalawa and Big Damalawa Islands in front of the site. Therefore, the sea is very calm.
* Tide is the same as Toli-Toli site.

128. Topographic Conditions

* There is a rubble mound jetty of around 200m long, and the water depth is 1.5m below LWS at the tip of jetty.
* There is a wide sandy beach on the south coast,but no sandy beach on the north coast. It is probably the result of the drift sand from South having been barred by the jetty.

* The land behind the coast is flat for several hundred meters from the shore line.

129. Land Use Conditions

* On the south of the jetty, along the beach there are many houses along the road.
* On the north of the jetty, many houses are standing on the water.

130. Others

* Part of the existing jetty was built during the era ruled by Netherlands.
* The jetty is now under repair by local government and will be expanded and used by DGSC in the near future.

3) Mawasangka (Muna) Site

131. Oceanographic Conditions

* Since this site is located in the Muna strait, no high waves theaten this site. However, SW waves reach 1.5m high in bad weather.
* The tidal range is 2.40m and the tide is mixed semi-diurnal.

132. Topographic Conditions

* There is a rubble mound jetty of about 500m long, which was built by the local government in 1990, but the sea bed elevation at the tip of the jetty is 0.5m above LWS. Therefore, this jetty is only available during high water.
* The waterfront is sandy beach and the slope of seabed is very gentle. The water depth of 5m below LWS is obtained at 1,200m off-shore.
* The west shore of the jetty is projected more then 100m off-shore from the east shore.
* The land in the vicinity of site is flat.

133. Land Use Conditions

* There is an open space along the beach on the east of the jetty.
* Along the beach on the west of the jetty, there are many fishermen's houses on the water.
* The area behind the shore is occupied by many houses, markets, schools etc.

(2) Terminal Site Evaluation/Selection

134. In East Kabaena, two sites were surveyed, Dongkala and Toli Toli, and the results are summarized as follows:

a) The site at Dongkala is protected against waves by two islands in front of the site and seems very calm, except waves entering sometimes from the south. The site at Toli Toli is protected against waves by a coral reef on the east side of the site and also seems very calm.
b) The distances from shore to the mooring sites are about 250 m (Donkala) and 400 m(Toli Toli) respectively.
c) The lands for terminal site should be obtained by reclamation in both sites.

Taking the above item b) into account and considering that Dongkala is the center of social and economic activity in the Kecamatan of East Kabaena, Dongkala is recommended as the terminal site on East Kabaena site.

135. The tip of the existing jetty in Mawasangka is located 0.5m above the low water level, and it is necessary to expand the jetty by 700m offshore to secure a necessary water depth.

2-6 Kendari-Wowonii Route

2-6-1 Ferry Network Alternatives

136. In this study on a route connecting Wowonii Island with the main island of Southeast Sulawesi, Kendari City is presupposed to be the terminal site on the main island side considering the existing sea communication. The existence of the main coastal road and houses and other facilities behind the road make it necessary to prepare the terminal area by reclamation. The mouth of Kendari Bay is composed of the cliff, then inconvenient for land access. Accordingly the candidate terminal site is limited the area between Kendari sea port for general cargo and a small fishery port. There is a jetty that has been used for the transportation of cargoes and passengers to and from Wowonii Island and village on the other side of the Bay. The neighboring shoal seems to be convenient for reclamation. As mentioned in 3-6, accessibility to the center of the city is very good. The candidate terminal site has been decided based on the conditions mentioned above and on the suggestion of Kanwil of Southeast Sulawesi that the southeastward extension of the existing jetty will be appropriate for the building of new facilities, with a farther short extension of its length.

137. Wowonii Island is divided into two Kecamatans, Wowonii and Waworete, and the respective populations in 1990 were 10,174 and 10,877. Langgara (Langara Laut and Langara Iwawo) has a population of 3796 . The looped island road with a length of 142km is under construction, of which 42km from Langara to Ladianta along the northeast coast of the island will be completed in 1992/93 .

138. Langgara coast is protected against waves by reefs and very calm. A wooden pier with a 30m long exists and has been used for transportation between Wowonii and Kendari, and fishing boats as well. The north side of the jetty is relatively deep, and the other side is shallow. The south side has a water depth sufficient for mooring facilities and the north side is convenient for reclamation, if necessary.

2-6-2 Terminal Site Study

(1) The Natural Conditions of the Terminal Site Alternatives

1) Kendari (Sulawesi) Site

139. Oceanographic Conditions

* This site is located in the bay approx. 4km from the bay mouth, and waves are negligiblly small.
* The tidal range is 2.60m and the tide is mixed semi-diurnal.
* The max. drift is 1.0 knot.

140. Topographic Conditions

* There is a 150 m long jetty. East shore of the jetty is a relamed land and west side is a natural sedimentary shore covered by mangroves.
* The water depth around the shore is very shallow, and 5m below LWS is obtained about 60m off the tip of jetty.
* The land behind the shore is flat.
* There are two small rivers about 40m and 140m to the west of the jetty.

141. Land Use Conditions

* The existing jetty is managed by DGSC and is utilized extensively by the small wooden boats from islands and river ports in the vicinity.
* There is a central market behind the site.

142. Others

* It was confirmed that the extension of the jetty and its utilization for the ferry service will be no problem.

2) Langgara (Wowonii) Site

143. Oceanographic Conditions

* High waves occur in Banda Sea, on the opposite side of the island, but do not occur on this side.
* During December to February, NE waves of 2m high occur some times but the site is protected by coral reefs.
* Tide is the same as Kendari site.

144. Topographic Conditions

* Southern area of the site is a sandy beach and coral reefs, and the seabed slope is gentle.
* No sandy beach exists in the northern area of the site and the slope of the seabed is very steep.
* There is a river about 500m to the south of the site.
* On the eastern side behind the existing wooden jetty, there is a small and shallow bay.
* The land around the site is flat.

145. Land Use Conditions

* In the small bay, there is a ship building yard for wooden boats and there are many houses on the water.
* On the land 100m stretch of land behind the site, there are houses and a school along the road.

146. Others

* The land acquisition for the ferry terminal will not be difficult near the existing jetty.

(2) Terminal Site Evaluation/Selection

147. Around the jetty at Kendari, required water depth is found about 60m to the southeast of the tip of the jetty. The shoal on the west is +2.5 to 3.0m

above ground level and it will provide a low cost reclamation area to construct the ferry terminal. Around the jetty at Langara, the iso-water-depth contour is parallel to the jetty and minimum distance to the point of a water depth of 5m is about 50m from the tip of the jetty, and the ground level of the south side of the jetty is 0-1.0m. On both sides, Kendari and Langara, the distance between the jetty and the mooring facilities will be short. The land for terminal facilities can be obtained relatively cheaply by reclamation.

2-7 Morotai - Halmahera Route

2-7-1 Ferry Network Alternatives

148. A ferry route should be introduced between the two islands to connect Daruba and some place around Tobelo, as shown in Fig. 2-7-1A.
These two towns are the centers of the traffic demand in each island or area.

The route connecting Daruba and the northern end of Halmahera Island has a little shorter distance by sea than the one mentioned above, but the total distance on the sea and land to Tobelo is much longer. Besides, the road from Galela to the northern area has not yet been improved. So, this route is not be recommended.

2-7-2 Terminal Site Study

(1) The Natural Conditions of the Terminal Site Alternatives

1) Tobelo (Halmahera) Site

149. Oceanographic Conditions

* There are many islands in front of the site. Thus, the wave is very calm at the site.
* The tidal range is 2.10m, and the tide is mixed semi-diurnal.
* The tidal current is negligible.

150. Topographic Conditions

* The shore is black sandy beach with very gentle slope.
* There are coral reefs in front of the site.
* The land behind the shore is flat.

151. Land Use Conditions

* The land and beach are occupied by fishermen's houses.
* The water front is used by small wooden boats for anchoring.
* This area is in the territory of the sea port.

2) Gura (Halmahera) Site

152. Oceanographic Conditions

* The site is located in a wide bay and there are many islands surrounding it. Therefore, the site is fairly well protected against waves. However, East direction is susceptible to the invasion of waves.
* The tide and current condition is the same as Tobelo site.

153. Topographic Conditions

* The shore is black sandy beach and sea bed is coral reefs.
* The water depth of 5m below LWS is obtained 60m off the shore.
* The land behind the coast is flat.

154. Land Use Conditions

* The land of about 300m wide between the shore to the main road is used for a coconut field and there are few houses.
* The coast side land of 150m wide on the shore side is owned by local people and the road side land is owned by the Government.

155. Others

* There is a wooden jetty of palm oil factory in the north of the bay.
* The team was told that this site will be bought by a can factory based in Manado.

3) Gorua (Halmahera) Site

156. Oceanographic Condition

* This site is protected against waves by the many islands such as Tonuoe. Thus, the wave conditions are very good.
* Tide and current condition is the same as Tobelo site.

157. Topographic Conditions

* Topography of the site is similar to Gura site.

158. Land Use Conditions

* An unpaved road of 300m long runs from the main road to the shore, and along the unpaved road, private houses are standing on both sides.
* North side behind the private houses consists of fields and farms stretching for 500m along the shore.
* The land around the site is owned by the local peoples.

4) Galela (Halmahera) Site

159. Oceanographic Conditions

* This site is opened to N to NE sea and high waves easily reach here.
* Tide and current condition is nearly the same as Tobelo site.

160. Topographic Conditions

* The shore is black sandy beach and the slope of sea bed is normal.
* The land behind the coast is flat.

161. Land Use Conditions

* There are many houses on the land behind the beach.
* This land is owned by the local people.

162. Others

* There is a private wooden jetty near the site.

5) Daruba (Morotai) Site

163. Oceanographic Condition

* This site is protected against SE waves by the peninsula in the south, against N, NE and W waves by coral reefs. Therefore, waves are not high at the site.
* The tidal range is 2.20m and the tide is mixed semi-diurnal.
* There was no local information indicating that the current might have an influence on navigation or on mooring ships at the jetty.

164. Topographic Conditions

* There remain five broken rubble mound jetties and corroded steel piles of pier.
* The shore is rocky beach and the slope of sea bed is not gentle.
* The land immediately behind the shore has a slope and its elevation increase to about 10m above HWS around 50m ashore. The land farther behind is flat.
* To the south of the jetties, there is a sandy beach.

165. Land Use Conditions

* The shore in this area is not utilized.
* The land of approx. 50m wide between the shoreline and the village road is covered by the grass and coconut trees.
* The land on the south side of southern end jetty belongs to the air force.

(2) Terminal Sites Evaluation/Selection

1) Daruba, Morotai Island

166. There is one terminal site proposed, the location of which is shown in Fig. 2-7-2A. The main characteristics are as follows, and it can be said that the site has relatively good conditions for the terminal.

A-1. Daruba: "A"

a. Accessibility: "A"

* Very near the center of Daruba, about 1,500m.
* A good paved road near the site, only in need of the entrance access road

b. Land Conditions: "A"

* The regional Government owns the land just behind the shoreline, and the Air Force owns the hinterland.
* Not currently utilized
* No problem in obtaining the land

c. Sea Conditions: "B"

* No protection against the waves from the west
* -5m LWS is about 160m off the shore high water level

2) Halmahela Island

167. There are four site alternatives proposed, which are as follows and are shown in Fig. 2-7-3A.

Alternative-1: Tobelo
A-2: Gura
A-3: Gorua
A-4: Galela

168. The evaluation of the alternatives are as follows;

A-1. Tobelo: "C"

a. Accessibility: "A"

* About 0.5km from the center of Tobelo

b. Land Conditions: "C"

* The people are living just behind the shoreline.
* Under the Administration of DGSC

c. Sea Conditions: "B"

* Wave protection by islands in front
* Gentle sea bed slope, need of reclamation to

get land and port facilities

* Some traffic of small boats in front

A-2. Gura "B"

a. Accessibility: "A"

* About 1km to the north of the center of Tobelo

b. Land Conditions: "A"

* Privately owned(Private Co. owned by Gov.), Currently not utilized

c. Sea Conditions: "B"

* Possibility of NE-N high wave through strait between islands in front

A-3. Gorua: "A"

a. Accessibility: "A"

* About 3-4km from the center of Tobelo

b. Land Conditions: "A"

* Privately owned
* The people are living behind the beach, but some space remains not utilized.

c. Sea Condition: "A"

* Good wave protection by islands in front

A-4. Galela: "C"

a. Accessibility: "C"

* 27Km from Tobelo

b. Land Condition: "B"

* The people are living behind the beach

c. Sea Condition: "C"

* No protection against the wave from NNE and E

2-8 South Sulawesi-Southeast Sulawesi Route

2-8-1 Evaluation of the Existing Ferry Route

169. Bajoe-Kolaka route connects South Sulawesi Province and Southeast Sulawesi Province with a distance of 80 miles crossing Bone Bay.
The characteristics of this route are:

(1) The load factor of cargo is higher than that of passenger.
(2) The distribution of origin and destination of passengers is very wide, although those are concentrated almost to two provinces.
(3) The future demand is assumed very high, judging from the fact that in proportion to the increase in the number of trips during 1989 (360 trips) to 1990 (572 trips), the volume of cargoes and the number of vehicles increases rapidly.
(4) Because the trip distance is 80 miles and the trip time is 10 hours now, the operation is conducted at night.

170. In light of the above, the following items are required:
(1) the building of a new terminal (including parking lot) on Kolaka side (the land will be obtained by reclamation)
(2) the expansion of the parking lot on Bajoe side,
(3) dredging of sea bed around the mooring facilities on Bajoe side,
(4) the installment of a movable bridge for rolling on/off of vehicles,
(5) the improvement of navigation aids at Bajoe site,
(6) others,

171. It is firstly necessary to forecast the future demand of cargo and passengers transported by ferry and then draft a ferry port plan (increase in the number of berths, determine most suitable ship size,etc.).

2-8-2 Terminal Site Study

(1) Natural Condition of the Terminal Site

1) Kolaka (Sulawesi) Site

172. Oceanographic Condition

* During December to March, strong westerly winds raise the max. wave height to 3.0 m. Thus, it happened that once or twice a year a ferry was unable to berth.
* The tidal is 2.53m.
* The tidal current is negligible.

173. Topographic Conditions

* The area on the south of the existing jetty is covered by the mangroves and on the north a sandy beach.
* Kolaka river flows into the sea about 0.5km to the south of the jetty.
* The seabed slope is very gentle and a ferry berth is located 700m off the shore, where water depth is 7.0m below LWS.
* The sea bottom material is sand in surface layer of 0.5m thick with coral rocks underneath.
* The land area is flat.

174. Land Use Conditions

* There are many houses and offices around the port area.
* The existing port area is approx. 3.0ha and mostly occupied by the offices,thus the parking space is not sufficient.
* On the sea around the existing port area, 4.0ha of space is scheduled to be reclaimed.

175. Others

* One breasting dolphin at the end of berth was broken.
* The existing berthing facilities were rebuilt in a different direction after

demolishing the original one. Therefore, there are many debris scattered on the sea bottom around the berth.

2) Bajoe (Sulawesi) Site

176. Oceanographic Conditions

* From November to December, the max. wave of 1.0m high attacks the site from SE direction.
* The tidal range is 2.32m.
* The sediments at the rate of 4 to 6cm/year is reported in the vicinity of the berth.

177. Topographic Conditions

* The shore is a muddy sandy beach and the slope of seabed is very gentle. The water depth of 5m below LWS is obtained around 3.5km off the shore.
* Pattiro river flows into the sea about 3.0km to the south of the exiting jetty. This is the source of sediments on the south of the jetty.
* The existing jetty is extended by 2,700m offshore, and a large shoal exists beside the jetty around 2,500m off the shore.
* This port area was obtained by the reclamation.

178. Land Use Conditions

* There are many houses and offices around the port area.
* The beach is used by the fishing boats for mooring.
* A part of the jetty is used by local ships for landing and mooring.

2-9 South Sumatra-Bangka-Belitung

2-9-1 Evaluation of the Existing Ferry Route and Alternatives for South Sumatra-Bangka Route

(1) Terminal Sites Selection

179. Palembang-Kayu Arang ferry route connects Sumatra Island and Bangka Island. As mentioned in 2-9 of Part 1, the defects of this route are unreliable schedule and frequent changes in the destination port. Since ferry service restarted in 1986 with new mooring facilities in Kayu Arang, dredging around the mouth of the Jering River has not been implemented yet. The present state of sedimentation is not clear in that the rate in which the water depth decreases each year is unknown. One alternative is to dredge the mouth of the river to continue to use the existing ferry port. To compare with the other alternatives, it is necessary to clarify the mechanism of sedimentation around the mouth of the Jering River; practical approach for this is interviewing ferry navigators on this route or persons familiar with the history of this type of change in the river mouth. The present mooring facilities were built only six years ago and still function well.

180. Muntok Port is also suffering from the same problem of sedimentation. In 1977, the inner and outer parts of the port were dredged, and in 1988, only the outer part was dredged. Dredging is scheduled for the inner and outer parts in 1993/94. It seems that the cause of the sedimentation here is not the supply of sand from the neighboring river, but west waves transporting sea material eastward. The team, then, tried to find a terminal site which is not affected by sedimentation and has a shorter distance from Palembang than the distance from Palembang to Kayu Arang.

181. In this field survey, the team tried to find the alternative terminal site near Muntok port, since it represents the shortest distance from Palembang to Bangka Island. Based on the chart and interviews at the Muntok Port office, the team surveyed the shore on the east side of Tanjung Kelian, 3.5 km west-south-west from Muntok(Fig 2-9-1A). Judging from the map, the shore on the east side of Tanjung Kelian is somehow protected against westerly waves by the effect of the cape. And if the direction of littoral drift around this area is eastward, this

site will not suffer from the decrease of water depth by the littoral drift, because the west side of the site is protected by the cape.

182. The access road from Muntok to the site was completed in 1992/1993. The distance from the site to Pangkal Pinang is 135km, an increases of 55km compared with the route from Kayu Arang to Pangkal Pinang. (The distance from Kayu Arang to Pangkal Pinang is 80km). The sea distance from Palembang to Tanjung Kelian is about 74 miles, 29 miles shorter than the distance from Palembang to Kayu Arang.

(2) Natural Conditions of the Terminal Site Alternatives

1) Palembang (Sumatra) site

183. Oceanographic and Hydrographic Conditions

* The site is located on Musi River approx. 80 km from the river mouth. Therefore, waves are negligible at the site.
* The max. tidal current is 2.3 knot and the river flow is 0.6 knot.
* The tidal range is 3.70m and the tide is diurnal.

184. Topographic Conditions

* The existing terminal site is located on the right bank of 400m-wide river and the water depth of 5m below LWS is obtained 35m from the river bank.
* The river bed is muddy.
* The land behind the bank is low and flat.

185. Land Use Condition

* This terminal site is surrounded by many private houses.
* The land of approx. 4ha is now utilized for ferry service and approx 20ha is reserved for future development.

186. Others

* There are many floating obstacles that makes navigation very dangerous especially in rainy season.
* A severe dry season occurs once every three or four years in which dense fog forces navigation on the Musi river to be controlled for one way traffic.

2) Kayu Arang (Bangka) Site

187. Oceanographic Conditions

* This site is located on Jering River approx. 17km from the river mouth, Therefore, waves at site are negligible.
* The tidal range is 4.12m and the tide is diurnal.

188. Topographic Conditions

* In the river, a minimum water depth of 4.0 m is maintained even during low tide. However, the water depth in the vicinity of the river mouth is very shallow. The present water depth there is only 1.0m below LWS.
* The land behind the bank slopes gently and the port area is divided into a few sections that have different elevation.

189. Land USe Conditions

* There are few houses in the vicinity of the port.
* Total port area is approx. 1,500m^2.

3) Muntok (Bangka) Site

190. Oceanographic Conditions

* This site faces the Bangka strait, and protected by cape of Kelian against the strong northwesterly monsoon.
* But, since this site opens to SE, the max. wave of 1.5m high is likely

to invade during the southeasterly monsoon season.

* The littoral drift is predominant to the east and the site has the tendency of erosion. However, there is a sandy beach of 25 m wide and no trace of erosion is seen on the beach.
* The tidal range is 3.80m and the tide is diurnal.

191. Topographic Conditions

* This shore is sandy beach and the slope of seabed is relatively steep. The water depth of 5m below LWS is obtainable 80m off the shore.
* The sea bottom material is sand in the surface layer.
* The land behind the coast is flat and covered by white sand.

192. Land Use Conditions

* There are several houses along the beach where is used by a few fishing boats for landing.
* The area of 100ha between this site and muntok port is planned to be used for a dock yard and the northern area of 280km is planned for a tourist resort zone.
* This land is owned by local people.

193. Others

* The jetty of tin factory is located about 1.5km to the east, which has no breakwater but is available all year around due to the good oceanographic conditions.

(3) Evaluation

194. Comparing the alternative terminal site mentioned above with the existing Kayu Arang terminal, advantages and disadvantages are as follows:

a) Concerning the total time of trip (sea and land) from Palembang to Pangkal Pinang, the alternative is a little shorter than the route from Palembang to Kayu Arang.
b) The alternative route will be more punctual because the water depth is

sufficient in the access channel and at the mooring facilities; it is not necessary for the ferry boat to wait for the tide of high water level.

c) Although further detailed surveys will be necessary, the alternative site will not suffer from littoral drift/sedimentation.

d) The terminal site at Kayu Arang is located in the river and calm, while the alternative terminal site is open to the south and is susceptible to southerly waves although it is somewhat protected from westerly waves.

2-9-2 Evaluation of the Existing Ferry Route and Alternatives for Bangka - Belitung Route

(1) Selection of Terminal Site

195. The existing ferry route connecting Pankal Balam Port of Bangka Is. to Tanjung Pandan Port of Belitung Is. has a distance of 110 miles which takes 16hr sailing by ferry boat. Pankal Balam, a river port, lies about 6km upstream from the mouth of the Mentawang River, and Tanjung Pandan, a sea port, lies at the mouth of the Cerucup River. The present common conditions of both ports, in fact, are insufficient for forthcoming ferry boat; the two ports do not have enough space for maneuvering and exclusive mooring facilities of Ro-Ro system. The study team conducted field surveys to find appropriate candidate places for a ferry terminal around the east coast of Bangka Is. and the west coast of Belitung Is..

Bangka Island side

196. In Bangka Is., the study team conducted a field survey at three candidate sites of Ketapang, Sadai and Batuberiga(Tanjung Belikat).

Ketapang is located 6km upstream from the mouth of the Metawang River and 1km downstream from Pangkal Balam sea port.

The sailing distance from Batuberiga(Tanjung.Belikat) to Belitung Is. is expected to be shorted and the sea is fairly calm. The road from Pangkal Pinang to here which was constructed by the local government is being kept in fairly good condition.

197. DGLT is planning to develop a new 50 mile ferry route between Sadai(Bangka Is.) and Tk.Gambira(Belitung Is.) in conjunction with its plan to develop the southern district of Bangka Is. The existing roads here from/to the main cities of Bangka Is.have been considerably damaged, which causes difficulty for vehicles, especially in the rainy season.

Belitung Island side

198. In Tanjung Pandan Port, the renewal work on the passenger terminal is scheduled in 1992/93. In this plan, the renewal of mooring facilities is also included but it will not be exclusively used for ferry boat.

199. The water basin of Tanjung Pandan Port is rather small for the usage of various kinds of vessels. Recognizing this situation, the construction of a new terminal exclusively used for ferry boat in an appropriate place was strongly requested by the local authority concerned.

200. Based on the obtained information, the team conducted field surveys in Belitung Is. at four candidate sites of Tanjung Barong, Tanjung Binga, a northward proximity of Tanjung Pandan port and Teluk Gambira on their natural conditions etc.

201. Tanjung Barong is located in the middle of the west coast in Belitung Is., about 45km south of Tanjung Pandan city. The road here from/to the city is good, although it is under repair in some places.

202. Tanjung.Binga is located 20km north of the city, and there are some wooden piers for fishing boats.

203. The north shore of the tin factory next to Tanjung Pandan Port, and the south shore of Tk.Gambira, 60km south of Tanjung.Pandan, have also been explored.

(2) The Natural Conditions of Terminal Site Alternatives

4) Ketapang (Bangka) Site

204. Oceanographic and Hydrographic Conditions

* The site is located at the right bank of Mentawang river approx. 6km from the river mouth, thus, no waves around the site.
* The down stream is 1.5 knot at the ebb tide and the up stream occurs at the flood tide.
* The tidal range is 3.0m and the tide is diurnal.
* In the estuary, the sedimantation in the dredged approach channel is reported as 0.5m per year.

205. Topographic Conditions

* The water depth of more than 5m below LWS is maintained in the river, howeyer the shore around estuary is very shallow.
* In the approach channel of 5km long is maintained at 4m depth by dredging of every two years.
* The land elevation is about 5.0m above MWL.

206. Land Use Conditions

* The land is vacant except two old warehouses standing along the river bank.
* This site is owned by the sea port authority.

207. Others

* The wharves of sea port are located 1.0km up stream from the site.

5) Sadai (Bangka) Site

208. Oceanographic Conditions

* One big Lepar island lies in front of the site and there are three

small islands to the north. The site opens to the sea in the SE direction but there are many scattering reefs off-shore. Therefore the wave condition is calm.

* The tidal range is 3.0m and the tide is diurnal.
* The tidal current is rather weak and does not affect adversely vessel's maneuvering.

209. Topographic Conditions

* The coast is sandy beach and the slope of seabed is steep. The water depth of 5m below LWS is obtained around 50m off the shore.
* Many coral reefs and submerged rocks are scattering in the southern off-shore.
* The land behind the shore is flat.

210. Land Use Conditions

* A existing small wood pier is used by fishing boats and small traffic crafts from the islands in the vicinity.
* Several shops for local people are standing along the shore.
* The land behind the shops is vacant.
* The land around shore is owned by the local people.

211. Others

* There is a small wooden pier at the beach.

6) Batuberiga (Bangka) Site

212. Oceanographic Conditions

* The site is protected by a cape against the strong NE monsoon.
* The tidal conditions is almost same as Sadai.

213. Topographic Conditions

* The shore is sandy beach and the slope of seabed is very gentle. The

water depth is only 2m below LWS around 200m off the shore.

* The land behind the shore is flat and sandy.

214. Land Use Conditions

* The shore is used by a lot of fishing boats for landing and mooring.
* Many houses are standing along and behind the shore.
* This land is owned by the local peoples.

7) Tanjung Binga (Belitung) Site

215. Oceanographic Conditions

* Several islands lie within 1km off-shore, thus the shore is fairly protected from the waves. From December to February, however, waves of 2.0m high attacks this shore from the west.
* The tidal range is 3.0m and the tide is diurnal.

216. Topographic Conditions

* The shore and sea bottom consist of sand and rock. The slope of seabed is very gentle and the water depth of 400m off the shore is only 2.0m below LWS.
* The shore of 20 to 50m wide is flat and a mountain lies behind it.

217. Land Use Conditions

* A jetty of 200m long was constructed by local Government in 1985.
* Many houses are standing along the waterfront.
* The front sea and beach of the site are mainly used for fishermen's activities such as housing, keeping boats and fishing.
* The land in this area is owned by the local peoples.

8) Tanjung Pandan (Belitung) Site

218. Oceanographic and Hydrographic Conditions

* The site is located on the right bank of Cerucuk river approx. 2km upstream from the estuary and approx. 300m downstream of anjung Pandan Port,no waves occur in this area accordingly.
* The tidal conditions is the same as Tanjung Binga.
* There is a sedimentation due to the bed load of Cerucuk river. Although the sedimentation rate haven't been confirmed yet, the maintenance dredging of 500,000 m^3 in 1989 is reported and 125,000 m^3 is scheduled in 1992 in the approach channel of the sea port.

219. Topographic Conditions

* In front of the site,there is an approach channel to the sea port which water depth is planned to be 5m below LWS.
* The shore is sandy beach and the slope of the river bed is very gentle.
* The land around the site is flat and sandy.

220. Land Use Conditions

* The water in front of the site is a fairway for various vessels bound for the sea port, fishing port and tin factory.
* The beach and land in the vicinity of the site are vacant.
* This land is owned by the tin company.

221. Others

* At present, the ferry terminal is inmost basin of the sea port and used by PASDP. The facilities is scheduled to be improved by DGSC in near future.
  The existing basin is small and shallow, and the land space of terminal is also insufficient.

9) Tanjung Barong (Belitung) Site

222. Oceanographic Conditions

* Ringgit island is in front of the site and many small islands and coral reefs surround the site. Accordingly, the sea is fairly calm in this area.

* The tidal range is 3.0m and the tide is diurnal.
* No current which unfavorably affect the vessel's maneuvering is reported.

223. Topographic Conditions

* The shore is sandy beach and the slope of seabed is relatively steep. The water depth of 5m below LWS is about 100m off-shore.
* The land around here is flat and sandy.

224. Land Use Conditions

* There are two small wooden jetties at the site which are used by fishing boats and traffic boats from/to the islands in the vicinity.
* In the east side, there is a small basin utilized by fishing boats for mooring and setting of fishing trap.
* There are several houses and a coconut field behind the site.
* This land is owned by the local people.

10) Teluk Gembira (Belitung) Site

225. Oceanographic Conditions

* The site is located at south shore of Tk.Gembira. The bay opens widely to NW to SW, accordingly 2 to 3 m high waves would attack the site during December to February.
* The tidal conditions is the same as Tanjung Barong.

226. Topographic Conditions

* The shore consists of sand and rock. Many rocks are scattering in the sea within 500m off-shore.
* The slope of seabed is very gentle and the water depth is only 1.0 m bellow LWS about 500m from the shore.
* The land around the site is flat.

227. Land Use Conditions

* The shore have not been utilized for any purpose.
* There is an house near the shore and the neighboring land is a coconut field.

228. Others

* In the opposite side of this cape, there is a small wooden jetty for the traffic boats between Seliu island.

(3) Evaluation

Bangka Island side

Ketapang, being located 6km upstream of the mouth of the Mentawang River, is free from the influence of waves. The water depth is maintained at 4m for the activity of sea transportation from/to Pankal Balam Port. Land for on-land facilities of candidate terminal site, which is now owned by sea port authority, is slightly insufficient for future development of a ferry terminal; the construction of new access road is also required.

229. The shore slope of the south side of Tanjung Belikat(its location is shown in Fig. 2-9-2A) is generally gentle and water depth is very shallow, which indicates that the shore of this area is protected from waves. The shore of Batu Beriga is slightly steeper than that of neighboring Tanjung Belikat but water depth is insufficient for sailing of larger ferry boats.

In the case of Sadai, trip time from Pangkal Pinang to Tanjung Pandan through Sadai and Tanjung Barong(Belitung Is.) is estimated at about (4+6+1) hours = 11hr (here, the speed of ferry is assumed to be 8 knots). If a ferry sails at the same speed(8 knots) between Pangkal Balam and Tanjung Pandan directly, the trip time can be estimated at 14 hours although in reality it takes more time. Natural conditions(water depth, wave calmness) and land use condition are favorable for the construction of a ferry terminal, the improvement of the road is required.

Belitung island side

230. As mentioned in (2), Tanjung Barong has good protection from waves by islands. An approx. 100m length jetty will be required for the new ferry terminal.

As mentioned in (2), water depth at Tanjung Binga candidate terminal site is a little shallow for the size of the ferry to be introduced in future. The north side land of Tanjung Pandan is occupied by a private tin company.

As mentioned in (2), the distance from the present coast line to Tanjung Pandan port channel is about 100 m. Even if it is possible to utilize the channel, the problem of land acquisition and adjustment with DGSC remain.

In Teluk Gambira, the Belitung Is. terminal site of the southern route,the distance from shore to the berthing point is about 1km.

231. Among the four alternative terminal sites to connect with Bangka Is. side, Tanjung Barong is most appropriate.

2-10 Evaluation for ferry terminal site selection

232. Based on the field reconnaissance survey, all terminal sites including alternative candidate sites are evaluated from the view points of accessibility, land condition and sea condition as shown in Table 2-10-1.

The main points considered for the evaluation are as follows;

1) Accessibility
   * Distance from main town
   * Road condition

2) Land Conditions
   * Easiness of land acquisition
   * Necessity of land reclamation
   * Topographic and geographic conditions

3) Sea Conditions
   * Wave calmness
   * Water depth
   * Sedimentation

233. Sites evaluated as "A" rank are recommended for the terminal site. In the north Yapen of Route 2 and Muna of Route 5, however, "B" ranked sites are recommended since there will be no better sites in these areas.

Table 2-10-1 Evaluation for Ferry Terminal Site Selection

Route No	Location	Nama of Site	Accessi-bility	Land Condition	Sea Condition	Evaluation
1	AMBON	Hunumua	B	A	A	A
	SERAM	Waipirit	A	A	B	A
2	BIAK	Mokmer	A	B	B	A
		Parai	B	C	B	B
		Mandon	C	C	B	C
	NORTH YAPEN	Yobi	C	B	C	C
		Saubeba	B	A	B	B
	SOUTH YAPEN	Turu	A	C	B	B
		Kabuaena	B	B	A	A
		Pasar Ikan	A	C	B	C
	IRIAN JAYA	Nabire	A	B	C	C
		Kimi	B	B	A	A
3	FLORES	Larantuka	A	B	A	A
	ADONARA	Wailebe	C	B	A	C
		Terong	B	A	A	A
		Waiwerang	A	C	B	C
		Riangderi	C	B	A	C
	LOMBLEN	Lewoleba	A	A	A	A
		Balauring	B	B	A	B
		Wairiang	C	C	B	C
	PANTAR	Baranusa	A	B	A	A
	ALOR	Karabahi	A	A	A	A
4	SOUTHEAST SULAWESI	Banbaea	A	B	C	C
		Pulemo	B	A	B	A
	WEST KABAENA	Sikeli	A	B	A	A
5	EAST KABAENA	Toli Toli	B	C	A	B
		Dongkala	A	B	A	A
	MUNA	Mawasangka	A	B	C	B
6	SOUTHEAST SULAWESI	Kendari	A	B	A	A
	WAWONII	Langgara	A	B	B	A
7	HALMAHERA	Tobelo	A	C	B	C
		Gura	A	A	B	B
		Gorua	A	A	A	A
		Galela	C	B	C	C
	MOTOTAI	Daruba	A	A	B	A
8	SOUTHEAST SULAWESI	Kolaka	A	B	B	A
	SOUTH SULAWESI	Bajoe	A	A	C	A
9-1	SOUTH SUMATRA	Palembang	A	A	A	A
	WEST BANGKA	Kayu Arang	B	B	C	B
		Muntok	B	A	B	A
9-2	EAST BANGKA	Ketapan	A	C	A	B
		Batu Beriga	B	B	C	C
		Sadai	A	B	A	A
	BELITUNG	Tg. Binga	A	C	C	C
		Tg. Pandan	A	C	B	B
		Tg. Barong	B	B	A	A
		Teluk Gambira	C	A	C	C

A: Good B: Fair C: Poor

Chapter 3 Forecast of Ferry Transportation Demand

3-1 Future Socioeconomic Framework

1. To prepare the Master Plan up to the year of 2010 of the Nationwide Ferry Service Routes in Indonesia, a demand forecast is carried out to project the traffic volume of passengers, cargoes and vehicles in the respective target year. In this section, population and Gross Regional Domestic Product(GRDP), which are key factors in carrying out the demand forecast, will be covered.

3-1-1 Population

2. A population projection can be carried out based on mortality and fertility rates and external migration. These components, however, are governed by many factors, for instance, human behavior patterns, social, cultural and environmental factors, government policies and so on. It is, therefore, difficult to predict trends by these components of population growth. The time-series method is simple but it can only be used under the assumption that the above-mentioned factors remain unchanged in future. The estimation by "REPELITA V 1989/1990 - 1993/1994"(future 5 years plan) is performed reflecting them rationally although the migration factor is uncertain. In this study, therefore, annual growth rate by REPELITA V is used for forecasting population. Annual growth rate in each province by REPELITA V is as follows: 2.45% in Maluku, 2.97% in Irian Jaya, 2.10% in East Nusa Tenggara, 3.08% in South-East Sulawesi, 2.70% in South Sumatra. These rates for the eastern part of the nation are not necessarily high compared to the rate of the past 10 years, and the rates of the past 10 years in these provinces are higher than the average rate of Indonesia. The growth rate of population in Indonesia has shown a tendency to decrease, 2.23% in 1971-1980 and 1.97% in 1980-1990. According to the projections by the Demographic Institute, the growth rate of national population is forecasted as follows;

1990-1995 1.64% 1996-2000 1.43%
2001-2005 1.19% 2006-2010 1.04%

3. Concerning the area in which proposed routes are located, except Irian Jaya and Southeast Sulawesi, the same tendency prevails. We therefore decrease the growth rate in these areas to the same rate as the national population. Concerning Irian Jaya and Southeast Sulawesi Province, by settling population

unbalance among regions, the same tendency will be expected here in future. We use the growth rate of REPELITA V until 2000 and decrease the growth rate from 2001.

4. The adopted population growth rate of each province is as follows;

Province	1990-1995	1996-2000	2001-2005	2006-2010
Maluku	2.45%	2.13%	1.77%	1.54%
East Nusa Tenggara	2.10%	1.83%	1.52%	1.32%
South Sumatra	2.70%	2.35%	1.95%	1.70%
Irian Jaya	2.97%	2.97%	2.58%	2.14%
Southeast Sulawesi	3.08%	3.08%	2.68%	2.33%

5. The future population in 2010 can be calculated based on the adopted growth rates. In 2010 the maximum growth is expected at 1.73 times compared with 1990 in South-East Sulawesi and between 1.69 and 1.40 times in the other provinces.

Province	1990	2010	2010 /1990	Growth Rate 1980-1990
Maluku	1,858	2,746	1.48	2.78%
East Nusa Tenggara	3,269	4,573	1.40	1.79%
South Sumatra	6,277	9,651	1.54	3.09%
Irian Jaya	1,641	2,777	1.69	3.41%
Southeast Sulawesi	1,350	2,342	1.73	3.66%

3-1-2 Gross Regional Domestic Product(GRDP)

6. The future annual growth rate of GRDP is predicted in REPELITA V. Concerning GRDP, the growth rate also depends on the similar factors cited to forecast population growth. In this study, for the same reason mentioned in the population projection, annual growth rate by REPELITA V is used for forecasting GRDP. Annual growth rate by REPELITA V of each province is as follows: 6.40% in Maluku, 6.50% in Irian Jaya, 6.50% in East Nusa Tenggara, 6.60% in South-East Sulawesi, and 5.00% in South Sumatra.

7. In REPELITA V, the projected annual average growth rate of GRDP for the provinces in eastern Indonesia anticipate high growth rates in some specific sectors such as industry, service and so on. In South-East Sulawesi, for example, annual growth rate is projected at 14% for industry sector, 10% for service sector, etc. It will require large efforts to achieve those high growth rates, therefore, using the growth rate by REPELITA V might result in an overestimation of the traffic volume.

8. The future GRDP in 2010 can be calculated based on the growth rates of GRDP in REPELITA V.

Province	1988	2010	2010 /1988	REPELITA V
Maluku	734	2,874	3.91	6.40%
East Nusa Tenggara	632	2,526	4.00	6.50%
South Sumatra	4,330	12,666	2.93	5.00%
Irian Jaya	923	3,689	4.00	6.50%
Southeast Sulawesi	421	1,718	4.08	6.60%

3-2 Methodology of Demand Forecast

3-2-1 Elasticity

9. Generally the growth of passenger and cargo demand isn't in proportion to that of GRDP. We calculate elasticity, which is the growth rate of passenger and cargo per that of GRDP, based on existing data. Elasticity varies according to aspects of human behavior and conditions such as standards of living, industrial organizations and so on. Therefore, we calculate elasticity for the various transportation systems.(See Table 3-2-1A)

(1) Passenger

10. The elasticity based on passengers of all ferry routes in Indonesia (1984-1990) is 2.0. During the period in which this data was obtained, some changes have occured in ferry operation such as the opening of new routes and introduction of new ships to the existing routes. The elasticity above includes the influence that the reinforcement of ferry transportation arouses demand potential. Therefore it shows a high value. Other aspects and result of the calculation are as follows;

All Ferry Routes(1984-1990)	2.0
All Transportation Means(1986-1990)	1.2
(Ferry, Conventional ships, Railway and Air)	
Bajoe-Kolaka route(1979-1990)	1.2
Railway(Jawa)(1986-1990)	0.8

11. Concerning Bajoe-Kolaka route, passenger demand falls temporarily, we therefore adjust the data to perform the calculation.
Generally, in an economic growth period elasticity is high, however the tendency doesn't continue very long. Passenger demand of Bajoe-Kolaka route and railway in Jawa are already stable and the value of elasticity is small. In this study, 1.1 will be utilized as the elasticity, that is, lower than the average of all ferry routes.

(2) Cargo

12. The elasticity based on cargoes of all ferry routes in Indonesia (1984-1990) is 3.0. It shows a high value just the same as that of passenger. When cargoes of all transportation means are included, namely conventional ships, railway and air, the elasticity is 0.6. Other aspects and results of the calculation are as follows;

All Ferry Routes(1984-1990)	3.0
All Transportation Means(1986-1990)	0.6
(Ferry, Conventional ships, Railway and Air)	
Bajoe-Kolaka route(1979-1990)	0.7
Railway(Jawa)(1986-1990)	1.5

In this study, 1.5 will be utilized as the elasticity.

3-2-2 Passenger

(1) Existing Routes

13. Concerning the existing routes, the future passenger demand can be calculated using the past data. The past data accurately reflects the general characteristics and the trend of social/economic activities in the related hinterlands. Concerning the existing routes, therefore, the past data is used to predict future passenger traffic with some adjustment by the growth rates of population and elasticity.

(2) New Routes

14. Small islands and towns generally depend on nearby big cities for their daily necessities. Traffic demand from small islands and towns to big cities is proportional to the scale of social/economic activities in small islands and towns. In the same manner, traffic demand in the opposite direction won't depend on social/economic activities in originated area but on those in small islands and towns because traffic demand in this direction will be naturally generated within the scale of social/economic activities. Passenger demand, therefore, principally depends on the population of small islands and towns, not on that of big cities.

And there are conspicuous differences in the characteristics between day trip routes and the other routes. Day trip routes are mainly used for performing inhabitant's daily routines such as shopping, attending school, going to the office, visiting friends and relatives and so on. The other routes, on the other hand, will be used for business trips and visiting relatives and so on, on a weekly or monthly basis and scarcely play a role in meeting daily needs. Considering the supposed differences in the characteristics between day trip routes and the other routes, we therefore divide the existing routes into two groups depending on the length of the routes. One is with the day trip distance of less than 50 miles, the other more than 50 miles. In this study, we predict future passenger traffic on the new routes by adopting the following formula separately to each group.

$$T_{ij} = k * P_i^a * P_j^b * E$$

T_{ij} : Passengers between i-zone and j-zone
P_i : Population of i-zone(small)
P_j : Population of j-zone(large)
E,k,a,b : Parameter

$$E = (1 + G * E_l)$$

G : Growth rate of GRDP per capita
E_l : Elasticity

15. The parameters are decided by recurrent analysis of the routes in each group. By using the data shown in Table 3-2-2A, the parameter k, a and b are calculated at 0.02294, 1.00983 and 0.14147 for the first group(routes longer than 50 miles) and 0.02077, 1.32333 and 0.00367 for the second group(routes shorter than 50 miles), respectively. The correlation coefficient is fairly good. (See Table 3-2-3A)

16. The data used to decide the parameters in Table 3-2-2A is for the ferry routes with competitive service offered by conventional ships. These data, therefore, already include sharing effect of ferry and conventional ships. To forecast future passenger demand by using the parameters calculated from these data, therefore, implies the same degree of sharing with conventional ships.

17. The applied process for forecasting the passenger traffic demand is shown in Fig. 3-2-1A.

3-2-3 Cargo

18. Based on data on the existing routes, we calculate the basic unit value to indicate the average cargo demand level in the related region by dividing the cargo volume transported by ferry boats by the population in the hinterland. In this case we divide existing routes into two groups just the same as in forecasting passenger. The result of the calculation shows that the basic unit value for the routes longer than 50 miles is about 0.01 and about 0.03 for the routes shorter than 50 miles. It means that 0.01ton or 0.03ton of cargo per one inhabitant is to be transported by ferry in one year. Kupang-Ende route only started operation from May in 1991 and thus data in 1991 has been obtained only for eight months. We modify the data into annual data. (See Table 3-2-4A)

19. Concerning Bajoe-Kolaka route (Route No.8), cargo volume is fairly high compared to the other routes. The basic unit value on this route based on the past data is about 0.6. Therefore, we specifically apply this basic unit value on this route.

20. Palembang-Bangka route (Route No.9-1, 74 miles) is categorized as a route longer than 50 miles, then 0.01 must be applied as the basic unit value on this route. However, as mentioned in **Chapter 1**, this route is classified as a "Regional Trunk Route" and has very big potential with Palembang as its hinterland. Therefore, we apply the basic unit value of routes shorter than 50 miles(0.03) on this route.

21. The applied process for forecasting the cargo demand is shown in Fig. 3-2-2A.

3-2-4 Vehicle

22. The Study Team assumes that cargoes are transported by 2-ton or 4-ton trucks and load factor is 70%, which results in an average load per truck of 2.1 tons.

On Bajoe-Kolaka route, the ratio of large-size truck is exceptionally high. The

large-size trucks are becoming a main trend for mass-transportation on specific routes. Based on the past data, the average load per truck is assumed 75% for an 8-ton truck, that is 6.0 tons, on this route.

23. All vehicles except trucks are forecasted based on past data. We calculate the basic unit value by dividing the number of passenger cars by that of passengers. It indicates that 25 passenger cars per 1,000 passenger are transported in a year. Taking growth rate of passenger cars per capita into consideration, we forecast vehicle volume.
(See Table 3-2-5A)

24. The applied process for forecasting the traffic of vehicles is shown in Fig. 3-2-3A.

25. Concerning two-wheeled-vehicles, we conduct a forecast based on passenger volume. Based on data of the existing routes, we calculate the basic unit value to show the number of 2-wheeled-vehicles per 1,000 passengers by dividing the number of 2-wheeled-vehicles by the number of passengers. In this case we divide existing routes into two groups just the same as in forecasting passenger. The result of the calculation shows that the basic unit value for the routes longer than 50 miles is about 40 and about 15 two-wheeled-vehicles per 1,000 passengers for the routes shorter than 50 miles. (See Table 3-2-4A)

3-3 Forecast of Ferry Transportation Demand

3-3-1 Population in the Hinterland of Each Route

26. Population in the hinterland of each route to be used for forecasting future demand is shown in Table 3-3-1A. Population in target years is calculated by the rate mentioned in section **3-1.** In deciding hinterlands, the Study Team selects those areas which will be served by the related ferry route on the island or kecamatan level. Small islands and towns generally depend on nearby big cities for their daily necessities. The parameters of the formula imply this situation. Namely parameter "a" is close to 1.0 and parameter "b" is close to zero.

3-3-2 Demand Forecast

27. Demand forecast calculated by the method above mentioned is as follows:

Table 3-3-1 Result of Demand Forecast

No.	Passenger		Cargo	Truck	Sedan	Total	V-2	Distance
	1990	2010	2010	2010	2010	2010	2010	
1	300,141	1,110,000	33,000	16,000	41,000	57,000	64,000	11
2-1		154,000	7,000	3,300	5,200	8,500	8,300	36
2-2		17,000	1,800	800	600	1,400	350	93
2-3		18,000	1,800	800	600	1,400	400	
3-1		135,000	9,000	4,300	5,400	9,700	6,500	17
3-2		135,000	8,000	3,800	5,400	9,200	6,500	31
3-3		46,000	1,600	800	1,900	2,700	1,100	128
3-4		85,000	5,000	2,400	3,400	5,800	5,400	37
4		24,000	1,700	800	800	1,600	1,300	34
5		29,000	2,000	1,000	1,000	1,900	1,500	14
6		50,000	3,000	1,400	1,600	3,000	2,600	26
7		120,000	6,000	2,900	4,400	7,300	7,000	25
8	304,738	1,110,000	206,000	34,000	37,000	71,000	22,000	80
9-1	81,119	319,000	40,000	19,000	11,000	30,000	18,000	74
9-2	28,068	70,000	5,600	2,700	2,500	5,200	1,500	70

Note : Sedan : All 4-wheeled vehicle except truck(Sedan, Mini-bus, Jeep etc.)
V-2 : 2-wheeled vehicle

Chapter 4 Weather/Sea conditions in Ferry Operation Sea Area and Planning of Ferry Operation

As an introduction to planning of ferry operation, the report shall begin by first identifying the weather/sea conditions in the entire Indonesian sea area. The following collective study is mainly based upon the authority of THE INDONESIA PILOT published by THE HYDROGRAPHER OF THE NAVY, UNITED KINGDOM.

4-1 Weather/Sea Conditions

4-1-1 The Eastern Sea Area Relevant to The Route 1,2 and 7

Currents

1. The area dealt with in this chapter, lying between the continents of Asia and Australia, has a monsoon system of winds and as a result there are marked seasonal variation, often reversals of current; but over the adjacent Pacific, the currents are governed more by the broad pattern of winds over that ocean and seasonal changes are less marked. The major currents of the Pacific have some influence on the flow through the bordering straits and seas.

Although the area covers only 16 degrees of latitude the winds throughout this range vary appreciably in direction during each season, wind directions in the S being well backed from those in the N. Thus in the northern winter (broadly termed the N monsoon in this area) winds over Banda Sea are from WNW or NW. During the S monsoon winds over Banda Sea are from SE and over Molukka Sea from S. More detailed information about the monsoons and their seasons is given under "Climate and Weather". The pattern of currents shown for February in Fig. 4-1-1(1)A is broadly representative of N monsoon season, that for August in Fig. 4-1-1(2)A of the S monsoon; patterns for April(Fig. 4-1-1(3)A) and October(Fig 4-1-1(4)A) are representative of the intermediate periods between monsoons.

Although the monsoon system accounts for reversals of current during the course of the year the local wind on specific occasions may not give good indication of the current there, since the flow of water is much deflected around islands and in these restricted waters a drift produced by the wind causes variations in sea level which in turn modify the flow.

There are rather few observations of currents in the area and consequently it has been necessary to deduce the pattern of currents to some extent from knowledge of winds and geographical variation in sea level. It should be appreciated that only non-tidal movements water are described current here; through the straits and more restricted passages tidalstreams may attain considerable rates as described in the relevant paragraph of the chapter.

Molucca Sea

There is little observational data and currents in this sea appear to be rather variable. On the whole sets to N or NE predominate with waters flowing out of Molucca Sea to join the E-going Equatorial Counter Current. The flow to N or NE is at its strongest during the S monsoon when reinforced by winds. During the N monsoon (December to March) weak current probably the most common with some flow from Molucca Sea to Ceram Sea, passing between Sula Islands and Obi. However near the coast of Sulawesi sets to N are reported to predominate even during the N monsoon.

Eastward of Halmahera

During the S-monsoon(May to October) the strongest and most constant currents flow off the N part of Halmahera. The W-going South Equatorial Current flowing strongly off the coast of New Guinea turns N on approaching Halmahera and then E to join the Equatorial Counter Current. Rates in the N-going flow off the island may reach three knots during June to August. To the E of the S part of the island, however, currents are probably weak and variable during the S monsoon; but few observations are available.

During the N monsoon some of the waters of the Equatorial Counter Current that pass N of Halmahera turn SE to join the general ESE-going flow off the N coast of New Guinea. This flow is also enhanced by water from Ceram Sea which is E-going S of Halmahera.

Northward of Irian Jaya

Currents flow parallel to the coast, WNW-going during March to October and ESE-going during November to February. The strongest currents are likely during July and August when rates may exceed three knots at times in the WNW-going current.

Ceram Sea

The strongest and most consistent flows in Ceram Sea are in the N and W; they either contribute(December-February, NE-going) to the ESE-going current off the N coast of New Guinea or are derived from the WNW-going current(April-October, SW-going). Current setting SW are strongest during July and August when they may exceed two knots at times.

In the SE part of Ceram Sea currents are weak and variable. The most probable set throughout the year is to NW.

Banda Sea

The general flow is in broad accordance with the monsoon winds;E-going during the N monsoon(when winds locally blow from NW or NNW) and W-going during the S monsoon(with local winds from SE). In both seasons most of the flow is in the N part of Banda Sea; in the S rates are weak and the direction of set is very variable.

Tides and Tidal Streams

2. Within the area covered by this paragraph there is considerable diurnal inequality. This is least in the NW, on the coast of Halmahera(00°-40'N,128°-00'E) and Sulawesi(02°-00'N,121°-00'E) and the islands in Celebes Sea to the N, where, despite the inequality, the tides are classified as semi-diurnal, and greatest in SE where, on the E coast of Pulau Pulau Aru(06°-00'N,134°-30'E) and a stretch of the SW coast of Irian Jaya, the tide is usually diurnal.

The greatest tidal ranges are to be found in Selat Marianne, where it is five point four meters, and at the head of Teluk Bintumi where it is four point four meters. In the islands fringing Celebes Sea, the range is between one point five and two meters; elsewhere it is for the most part between one and one point five meters.

Sea and Swell

3. The information below is based on scarce data and should be treated with caution.

Seas from between E and S prevail over the area from about the end of May until late August or early September when the area is dominated by the SE monsoon. In the area N of about 5°S the seas are from SE to S, mostly slight

to moderate but occasionally becoming rough. In the area S of five degree S the E to SE seas are often only slight to moderate but may be rough or very rough on up to ten per cent of occasions.

As the SE monsoon weakens and recedes S to be followed by the NW monsoon, seas from between NW and NE in response to this change of regime gradually extend S to most part, reaching the S of the area by December. Wave heights are mainly moderate or slight but rough or very rough seas are not uncommon. These NW to NE seas continue through March and then the SE monsoon spreads N again, sometimes preceded by a few weeks of less well defined seas.

On the rare occasions when a tropical storm affects the area the seas become high and confused and steady swell from these storms affects the area.

The N shores exposed to the Pacific also experience considerable swell from December to February, during the NW monsoon. Heavy swell accompanied by high seas is a hazard during these months but conditions vary markedly according to the strength of the monsoon.

The extreme conditions can occur in straits and constricted channels, when favorable winds are funnelled and thereby increased in strength.

Climate and Weather

General Meteorological and Climatic Conditions

4. All coasts N of 5°S experience a typical equatorial maritime climate with comparatively uniform high temperature and abundant rainfall. The heat and high humidity give oppressive weather when there is little wind but at most times there are alleviating breezes. In these regions winds rather than temperature mark the change of seasons--the prevailing winds changing from the NW monsoon(November to March) to the SE monsoon(May to September). Rainfall varies greatly at different times of the year and in different years; the amounts of rain being dependent upon the extent of exposure to the prevailing monsoon. Since the interiors of the islands are hilly or mountainous it is not uncommon to find that the wettest period in one area coincides with a very dry period across the island not many miles away. In such areas the rainfall and rainy periods, though highly significant locally, have no general application over extended areas.

5. Throughout the region winds are mainly light or moderate. They are

stronger and more constant in the SE monsoon than in the NW monsoon but gales(Beaufort force seven or over) are rare. A large part of the area covered by this chapter enjoys almost complete immunity from tropical cyclones. Occasionally typhoons affect parts N of about 3°N or S of about 5°S, though it is only when these typhoons move further away from the equator toward the N and S limits of the area that they reach full maturity and then only occasionally.

6. **Pressure.** Fig. 4-1-2(1)A and 4-1-2(2)A show that the area covered by this chapter is one of weak pressure gradients. Though mean pressure changes are small the pressure patterns do change slowly during the year, being quite different in January from those in July, with the strongest gradient in the S during the SE monsoon in July. The adjacent months December, February and March resemble January and the months of June, August and September resemble July. Apart from the rare occasions when a tropical storm affects the extreme N or extreme S of the area, mean pressure changes little from one day to the next. However the diurnal variation, appearing as a double oscillation each 24 hours with maxima at 1000 and 2200 and minima at 1600 and 0400 local time, has a range of three mb.

7. **Winds and Gales.** The winds have a monsoon, or seasonal character. The main wind systems over the area covered by this chapter and neighbouring seas are the NE trades of the N hemisphere, the SE trades of the S hemisphere and the tropical wind belt separating the two trades. In the tropical belt the winds are from N or W from about November to March when they are referred to as the NW monsoon, but the winds become backed towards S from about May to September.

To the N of the equator the winds have the following sequence. Mostly fresh, occasionally strong, NW winds extend from the equator to about 3°N in January with moderate to fresh NE trades further N. As the year advances the NE trades retreat to beyond 6°N by July to be replaced by more variable and lighter winds mostly between NW and SW. The winds usually become fresh, occasionally strong, from between SW and SE in the third quarter of the year before the NE trades push S again to reestablish the January pattern by the end of the year.

To the S of the equator the sequence starts in January with fresh or strong winds between W and N and with the SE trades well S of 10°S. These

SE trades, often fresh and sometimes strong, extend N as the NW winds weaken, reaching 5°S by about April and the equator by July. In the following months the reverse movement takes place with the SE trades giving way before the strengthening NWly winds which cover these southern latitude by November/December. Fig. 4-1-3(1)A to 4-1-3(4)A show the frequency distribution for the four months January, April, July and October.

To the S of about 5°S the SE monsoon blows from about April to November, averaging Beaufort force four from May to August with occasional increases to five to six. They are somewhat lighter and more variable in direction in the W than in the E especially near the beginning and end of the season. According to the rather limited data available gales(force seven or over) have only been reported in April and May and then only with a frequency of less than one per cent. December to March is the period of the NW monsoon, the WNW winds averaging three or four but being strongest in January and February when force five or six is fairly frequent; winds of force seven are reported in these latter months and are most frequent(about two per cent) in the E in January.

Between 5°S and the equator the SE monsoon is a shorter season -- May to September. In the E these monsoon winds are still predominantly SE but in the W they are often SSE. The monsoon here is strongest in July and August, average force four with force five or six quite frequent. The change to the NW monsoon, which lasts from December through April, is a gradual one with variable winds over October and November, but the end of this monsoon is often fairly abrupt, with a very short transitional period before the SE monsoon starts. The winds during the NW monsoon vary between SW and N, and are mainly about force three with only a small portion reaching force five or six. Force seven has been reported in October, less than one per cent however; ship observations are unfortunately rather few.

8. To the N of equator the winds are often light and variable though the monsoon effect can still be detected. From June to October SE to SW winds predominate; in July and August when these S winds are strongest the average force is three to four and force five to six is reported quite frequently. November is the month of transition with variable or light W winds. The winter monsoon, corresponding with the NW monsoon further S lasts from December to March with NW to NE winds, NE winds being more frequent in February and March than in other months. From December to March there are sometimes

strong winds associated with depressions or typhoons in the neighborhood of the Philippines. Gale(force seven or more) have been reported in a few months but with a frequency less than one per cent.

9. All the above remarks refer to winds away from coasts. On approaching the coasts wind undergo progressive modification in various ways. These include dynamic effects such as diversion on winds through narrow channels and also thermal due to uneven heating of land and sea surfaces. Land and sea breezes are among the most important of the latter effect. In this region where many of the islands are mountainous and temperature are high, local effects are important and produce significant differences in the winds even at places near each other. At many coastal stations these local effects completely obscure monsoon effects or modify them very remarkably.

10. **Front,** as normally understood in temperate latitude do not occur in this region, though somewhat similar phenomena are the convergence zones. These are marked by a discontinuity in the wind field and are accompanied at least intermittently by belts of thick cloud and rain, but the zones are more diffuse than the frontal zones in temperate latitudes. The most important of these convergence zones is that commonly known as the Intertropical Convergence Zone(ITCZ). This in its simplest form represents the zone separating the two trade wind systems of the two hemispheres; the position of the ITCZ oscillates about the equator being further S in January and February and further N in July and August. At times the ITCZ is quite wide in the area covered by this chapter, with a belt of equatorial W to NW winds in the zone separating the two trade wind systems. Over much of the area except the N part the change during the year is from the SE trades to these WNW winds usually referred to as the "NW monsoon". The ITCZ is shown where appropriate on Fig.-4.7a to 4.7d which give the wind distribution.

11. **Depressions and Tropical Storms.** Most of the area covered by this paragraph not seriously affected by depressions or tropical storms but S of about 5°S and N of about 3°N, tropical storms occur on infrequent occasions.

To the S of 5°S tropical storms may be encountered during the period March to May and although these storms are rare and in an early stage of development winds of up to force 10 have been reported and can cause considerable destruction. These storms move usually on a SW track, developing

as they do so, and can reach typhoon intensity at the extreme S of the area.

To the N of about 3°N only rare tropical storms are liable to be met in October through January. Most of the typhoons of the N Pacific pass over or N of the Philippine, though strong winds around the periphery of these typhoons sometimes affect the area. On rare occasions a typhoon has passed to S of Mindanano and the islands of the Sangihe and Talaud groups lying to the N of 3°N are sometimes affected. The months when the risk is greatest is are from October to January, but N of 5°N the months most at risk are from September to April. No figures are available for the frequency generally, although over a period of 60 years only 22 typhoons affected Mindanao and the frequency falls rapidly towards the equator.

Fig. 4-1-4A shows the tracks of some of these storms.

12. **Visibility and Fog.** Fog, defined as visibility less than 1,000m, is very rare in these seas and November appears to be the only month that fog has been reported from ships; even then the frequency does not exceed two per cent and the area is limited to a belt extending from Irian Jaya to Arnhem Land in the Northern Territory of Australia. Mist or haze(visibility below five miles) is noticeably more frequently observed, in particular in the month of August through November when a frequency of 10 to 20 per cent occurs in S and SW parts of the area and more than 20 per cent in an area SW of Pulau Pulau Tanimbar(7°-30'N,131°-30'E) in November.

Poor visibility at sea takes the form of a whitish haze, the haze being thicker when there are strong SE monsoon winds. Dust and forest fires, mainly Australia origin, are thought to be the explanation of this denser haze but some haze of local origin is due to the burning of crops at the end of the drier season. It is also thought that the haze is worse in years of drought in Australia. On occasions the haze is sufficiently dense to reduce visibility to below 1,000m and this type of fog sometimes occurs over a wide belt extending from New Guinea to Arnhem Land.

Volcanic dust may also, on rare occasions, cause very bad visibility; in 1966, SS Hanettia, Captain B.S.Horloyd, reported visibility reduced to barely the length of the ship by dust emitted from a volcano in the Sangihe group.

Although fog is rare at sea it is somewhat more frequent on the coasts and island, forming around dawn in river valleys, over marshy ground or at the foot of hills. It is however local and short-lived usually dispersing within an hour or so of sunrise.

The other source of fog is the heavy tropical downpour which is usually of short duration -- of about 10 minutes -- but such poor visibil
ity may accompany the more wide spread and prolonged rain associated with a tropical cyclone.

13. Local Weather and Climate

Tobelo(1°-45'N, 128°-02'E). November to March, daytime winds are mainly from NE; in May to September these winds are mainly from SE.

Halmahera and Morotai(2°-15'N,127°-10'S). On the E coasts of these islands a steady swell breaks strongly on steep beaches, especially in NE winds.

Buru and Ceram(3°-15'S,129°-15'E)--**South coasts.** Off these coasts the SE monsoon(May to September) is reinforced by the afternoon sea breeze and sometimes reaching force seven.

Ambon(3°-40'S,128°-10'E). Winds are:

May to November	Mainly E or SE
December and April	Variable
January to March	Between W and NE

Sudden squalls are said to occur in Teluk Ambon. The SW corner of Latimor is known for strong winds and rough seas.

Biak In the vicinity of Biak, November and April are transition months. The change from NW to the SE monsoon and the beginning of this last season is characterized by a period of prolonged calm called **Wampasis(Quiet wind)** by the Papuans. In both monsoons the sky is overcast and especially near the equator, much rain was experienced. During the SE monsoon there was often a thick mist over the sea for months on end.

Land and sea breezes usually occur over Biak three hours after sun- rise and sunset. They are only of any importance during the period that the monsoon is less strong. During the SE monsoon the wind is not generally very strong, but during this period **Wambraus**(next paragraph) come from the SW; they may last from four to eight days, and vessels can seek shelter off the N and E coasts of Biak. The Papuans assert that the Wambraus only occur about new moon. During the survey in June,1942, trouble was experienced from Wambraus during all phases of the moon.

During the survey in June to September, 1931, no Wambrau was experienced, but heavy squalls from E occurred in May. During the survey of Sorido Lagoon in June 1952, strong SW to WNW winds, frequently accompanied by heavy showers of rain, were experienced almost throughout the month. The wind developed three times to force seven to nine. these periods were alternated by a few days of good weather with a SW wind, force three to four. Heavy squalls from SE also occurred occasionally. During the NW monsoon the wind is usually very strong; repeated heavy W'ly squalls called **Wamanda** by the Papuans, come almost unexpectedly from W and WSW on the S coast of the main islands, and from a more N'ly direction on the N coast.

During the SE monsoon, the influence of a typhoon E of the Philippine islands, on July 30th,1931, caused a strong NE wind and heavy squalls with rain on August 2nd and 3rd, whilst elsewhere the weather was very fine and the sea was calm.

Irian Jaya -- north coast. In the NW monsoon winds on this exposed coast are between NW and NE with most frequent squalls in January.

Along this coast between Manokwari(0°-52'S, 134°-05'E) and Jayapura, about 400 miles ESE, during the SE season, a strong, hot and dry SW wind known as the **"Wambrau"**, sometimes blows down from the hills. It usually persists from four to eight days and, in places, blows strongly enough to disrupt local shipping. The area of Teluk Irian is particularly affected.

14. Local Current and Tidal Streams

Tidal streams in Teluk Piru(3°-20'S,128°-10'E).

The stream sets in the same direction on both sides of Kasa(3°-19'S, 128°-09'E); however this is probably not a tidal stream but a current which enters Teluk Piru on one side and sets out on the other, its direction being dependent on the wind. During the month of February a continual stream, with a rate of nearly one knot, was observed to set out of the bay; the wind was constant NW increasing suddenly to force six at times.

Selat Haruku

Tidal streams in Selat Haruku(separating Ambon from Haruku) set N and S at a maximum rate of one and a half knots. They are strongest off Batu Kapal, where tide rips occur, and on both side of Pompo.

Selat Ceram

There is usually a moderate W-going current in the strait.

Halmahera Sea

Current in Halmahera Sea are not strong and depend on the force and direction of the wind. See also par.1 Current -- Eastward Halmahera.

Sorido Lagoon

Tidal streams in Sorido Lagoon are weak and do not exceed half knot, the flood stream setting W and the ebb stream E.

SE of Biak

Tidal streams. During the survey, in 1930, in the channels between Pakriki(1°-14'S, 136°-31'E) and the islands on each side, the tidal streams set strongly S with the falling tide and weakly N with the rising tide. In the vicinity of Pakriki,to the S of a line joining the N end of Padaidori and Pai, there were constant heavy tide rips; at the same time there was a constant layer of water setting S from the W side of Pakiri, and a whirlpool E of this line.

Between Pulau Pulau Padaido and the E end of Biak, during October and November, there was a constant SSW set with a maximum rate of two knots, with a SW wind which raised a heavy sea, especially between Tg. Warai, the E end of Biak, and Padaidori(1°-09'S, 136°-37'E).

Selat Kurudu

There is a strong tidal stream in the strait which, during springs, sets constantly SW at a maximum rate of three and a half knots.

Around Biak

During the SE trade the current sets NW dividing at Tanjung Warari(1°-04'S,136°23'E) and setting along both sides of Biak.

During the NW monsoon the current divides into two branches W of Tanjung Mandundi, one setting N of Biak and the other SE between Supiori and Numfoor,lying 32 miles SW; thence E through ST.Sorenarwa(St.Yapen) and thence NE and out through its E end. From the latter branch another sets NNE and NE along the SE coast of Biak and unites with the N branch off Tanjung Warari. During the SE trade the reverse occurs.

The greatest variations of the main direction of drift stream occur near Numfoor on each side of which it is S in the NW monsoon and N in the SE trade. During the latter an ENE-going stream has sometimes been observed along the S coast of Numfoor instead of a W-going stream.

Sorenarwa(Yapen)

Tidal streams close off the N coast of Sorenarwa and off the S coast, except near the E and W extremities, set E and W but do not exceed a rate of one knot. Further N they come under the influence of the currents.

4-1-2 The Central Sea Area Relevant to The Route 3,4,5,6 and 8

Currents

15. **Currents** in the area covered by this paragraph are controlled to a very large extent by the monsoon, which affects most of the area. As a result over the greater part of the area the current directions are reversed twice each year in phase of with the monsoon. Since almost all of this area lies S of the equator, the monsoon will be referred to as the north-west monsoon(November to March) and the south-east monsoon(May to September), with April and October as the transition months.

The exception to the biannual reversal of current direction occur in channels to the W and E of Sulawesi, and in the oceanic region in the SW of the whole area where the current directions are more constant throughout the year.

Jawa and Nusa Tenggara form a natural boundary across the area. Surface water derived from the Pacific Ocean enters the area to the N of this island chain by way of either the South China Sea or the Banda Sea according to the season, while, to the S the water is derived from the Indian Ocean for the most part, though some water from the Pacific Ocean enters the area from the Arafura Sea in some months.

Since the currents are controlled by varying oceanographic and meteorological conditions both within and outside the area, it follows that the currents show a high degree of variability both in the direction and rate in most area, so that the current actually experienced on any specific occasion may set in any direction. Despite this variability a definite current pattern emerges which is displayed, by seasons, in Fig. 4-1-5(1)-(4)A.

Currents in the Java Sea and Flores Sea

16. In the NW monsoon the current sets in a predominantly ESE direction through the Java Sea, and E through the Flores Sea. The constancy of these directions is moderate except in the S part of this area where it is high. The mean rates are stronger in the S in this season than elsewhere. The ESE to E currents sets along the N coasts of Java and Nusa Tenggara at a rate of about one to one and a half knots, whereas the mean rates elsewhere are about three quarter knot. Currents in excess of three knots setting towards the E have been experienced in the former region on rare occasions.

During the SE monsoon the current pattern over the greater part of the

area is reversed. The predominant directions of the currents are WNW-going through the Java Sea, and W-going through the Flores Sea, except along the N coasts of Nusa Tenggara E of about the meridian of 117°E, where a counter current runs towards the E. The constancy of these directions moderate to high in the N part of these seas, but only moderate in the S in this season. The mean rates are about three quarter knot in the S and one knot in the N. The maximum rate lies in the range of two to three knots.

In the transition months the currents are more variable though a pattern of predominantly W sets in the N and E sets in the S can be distinguished in both months. The constancy of these direction is low. The mean rate of the E set in the S is about one knot. Elsewhere the mean rates are about three quarter knot. On rare occasions currents of up to three knots setting either E or W may be expected.

Currents in the Banda Sea

17. A strong current, which alternates in direction with the seasons, runs diagonally across the W Banda Sea. During the NW monsoon this current is directed towards the NE. It is then a continuation of the E flow through the Java Sea and Flores Sea. In the SE monsoon the current runs towards the SW. It then feeds the W sets of these seas. The constancy of both the NE and SW-going currents is high, and their mean rates are about one knot. At rare intervals currents in excess of three knots setting NE or SW according to the season have been experienced.

In the NW part of the Banda Sea a weak current is said to set NE towards the Molucca Sea in both seasons.

In the extreme S of the Banda Sea the current set E throughout the year along the N coasts of Nusa Tenggara with a high constancy. The mean rate of this current is about one knot during NW monsoon, but it decreases to about a half knot during the SE monsoon. The rates in excess of three knots have occasionally been experienced in the NW monsoon. This E set founds the extremity of Timor and sets SW into the Timor Sea.

Tides and Tidal Streams

18. **Tidal streams** throughout the area covered by this paragraph have a strong diurnal inequality. This is especially marked on the coasts of Kalimantan and Java bording the Java Sea, where the tides are predominantly diurnal. The

range of the tide is mostly between one and two metre though at some places on the E coast of Kalimantan and on Flores it reaches two and a half metres.

Climate and Weather

19. **General Remarks.** The climate is hot and humid, with high rainfall. In the N part of the area a tropical climate prevails with high temperature throughout the year, and considerable rainfall even in the drier months. In Nusa Tenggara and in Timor, a typical monsoon climate prevails with well marked wet and dry seasons corresponding with the monsoon. The SW part of the area towards Christmas Island enjoys a trade wind climate with SE winds predominating during most of the year.

Tropical cyclones occur in the seas S of Java and near Nusa Tenggara, but are not frequent.

The mountains dominating the interior of the islands and the irregular coastlines cause significant modifications to the coastal climate.
Places on the lee side are protected from the unpleasant features of the prevailing monsoon.

Except for local squalls, strong winds are rare. Some of the squalls are violent and may develop quite suddenly causing a temporary hazard to small vessels. Severe thunderstorms frequently occur during the squalls.

Fog is rare, though visibility may fall to fog level in heavy rain. Apart from rain, visibility is usually excellent during the NW monsoon.

Tropical Revolving Storms

20. These regions are liable to be affected, although infrequently, by tropical revolving storms, which do not, however, affect the majority of the area. These storms are liable to occur in the Indian Ocean S of Java and Nusa Tenggara. They occur E of the meridian of 120°E in lower latitudes than farther W, and an occasional one has been reported in the Flores and Banda Sea, ie, to the N as well as the S of Timor. Most of these storms affecting the S part of the area move towards the WSW or SW, and those that later recurve towards the SE mostly do so S of the parallel of 13°S. A vessel's report of a tropical revolving storm, which was first reported in the Timor Sea near Kupung recorded a pressure of 992mb in 11°S, 121°E. The average frequency of tropical revolving storms in the sea around Timor is less than one per annum which occur in the period January to April. Fig. 4-1-6A shows tropical revolving storms, which have

occurred S of Indonesia on rare occasions.

Although the normal variation in pressure from day to day is small, there is a regular diurnal rise and fall of pressure of three mb. Maximum occur at 1000 and 2200, and minimum at 0400 and 1600.

Fronts

21. Well marked frontal boundaries between warm and cold air, with the accompanying wind and weather changes which are familiar in temperate latitudes, are not experienced in the area covered by this chapter. Nevertheless, belts or zones do occur, which are similar in some respect to the fronts of higher latitudes. The most important of these is **Inter-tropical Convergence Zone(ITCZ)**, sometimes called the **Inter-tropical Front.** This represents the boundary between the wind circulations of the two hemispheres, ie, between the NW and the SE monsoons. These opposing wind stream do not produce a well defined boundary. Rather there is a belt of varying width between the S boundary at which the SE winds changes to light and variable winds, and a N boundary at which these latter change to NW winds. The ITCZ is orientated roughly E and W, and has a seasonal movement N and S conforming to the position of the low pressure trough, which is over N Australia in January and N of Borneo in July. One or other of the boundaries of the ITCZ may be marked by heavy cumlo-nimbus and rain squalls or thunderstorms. The weather varies along the zone so that, in places, the zone is active, and in others inactive. The mean position of the ITCZ is shown in Fig. 4-1-7(1), (2), (3) and (4)A.

Apart from the ITCZ, convergence lines(tropical fronts) also develop within the SE and NW monsoons. They are marked by a line of squally showers and thunderstorms.

Winds

22. Winds over 20 miles from the coast are governed by the seasonal pressure changes and the position of the ITCZ. The wind stays relatively constant for several months and then changes gradually to the opposite direction after the passage of the ITCZ.

On the S side E to SE winds are dominant, and W to NW winds prevail to the N of the convergence zone. These two air streams are known as the SE and NW monsoons.

A significant gradual change occurs with latitude during both monsoons. The winds during the NW monsoon blow mainly from between NW and N over

the N part of the area described in this chapter, with occasional swing towards NE. Over the S zone the prevailing direction is between NW and W with temporary backing towards SW. Similarly the SE monsoon blow from SE and S in the vicinity of the equator, and from between SE and E over Jawa and Timor and all the sea area to the S.

The strength of the monsoon also varies with latitude. The NW monsoon averages force two to four over most of the sea area, but increases to force three to five S of the parallel of 7°S.

The winds are mainly light and variable during the two transition periods as the ITCZ moves N in the first months of the year, and returns S over the area described in this chapter between September to December.

The approximate position of the ITCZ in each month may be estimated from the mean positions indicated in the wind rose diagrams.

Winds near the coast are affected by local variations of the wind direction and speed caused by topography, orientation of the coastline, and the daily effects of radiation near the coast.

The land breeze effect is usually less than the sea breeze component, but the nightly flow of air from land to sea is frequently accentuated by "down-slope" winds from hills close to the coast. A similar sudden increase, "fohn", on the lee coasts may occur at any time of the day or night.

The effect of land and sea breezes may extend up to 10 miles, and occasionally 20 miles, from the coast.

For wind roses and mean position of ITCZ see Fig. 4-1-7(1), (2), (3) and (4)A.

Gales

23. Reports of gale force winds over the sea are rare. Fig. 4-1-8(1) and (2)A and b show gale frequency distribution of January and July. High winds are likely to be encountered to the S and SW of Java. The E and SE air stream from the Timor Sea to the South Indian Ocean may reach force seven and, very occasionally, force eight either during the very rare tropical storm or when such storms move SW between the S boundary of the area described in this chapter and the Australian coast.

Most gale reports elsewhere in the area are very localized and occur:

1) In isolated gusts when sudden squalls descend from high ground near the coast.
2) Thundery squalls in any part of the area

3) Occasional sudden gusts at the onset of a "fohn".
4) In confined straits when the onshore monsoon is reinforced by funneling
5) When the "Barat", near Menado, increases as a typhoon moves W across the S part of the South China Sea.

Fog and Visibility

24. Fog is rare and visibility generally good. Shallow fog patches develop during the night in river valleys, and clear soon after sunrise.
It occurs on ten days per month from July to October in parts of Borneo.
The limited extent and duration of these fogs reduces any serious hazard to shipping in the estuaries.

Visibility frequently drops below two miles in showers and below fog limits in heavy downpours.

For the most part, during the NW monsoon, visibility is excellent unless it is raining. The SE monsoon tends to be hazy, the haze being more marked in the SE part of the area and in the latter part of the season. It is especially thick in years of drought in Australia.

The haze gives the sky a grey tint. It reduces visibility to ten miles and more rarely to four miles. On rare occasions the visibility falls below fog limits at the change to the NW monsoon. Fog is very rare in the sea area between Java and Christmas Island.

Sea and Swell

25. Sea disturbance and swell is slight or moderate in all sectors for most of the year. The main exceptions are occasional heavy sea and swell in exposed anchorages on the N coast of Sulawesi during the "Barat", strong W winds during the NW monsoon. The W coast of Pulau-Pulau Sangi are also affected.

In the Celebes Sea a N swell occurs from December to April, and is most marked in January. A slight S swell prevails in this area during July to September.

The SE trade wind maintain a SE swell and moderate sea over the area S of Java and Timor for most of the year. Periodic freshening of the SE wind may cause a higher swell and rougher seas for a few days at a time.

Sea and swell increases gradually over the W sector between Christmas Island and Selat Sunda. The swell movement is from SW and less marked during December to February over this sector.

Due consideration should be given to the degree of hindrance and the

hazards which develop when a well established monsoon blows directly into the entrance to ports and harbours along the irregular coastline. The conditions are often aggravated by increased wind due to "funnelling", and the sea which develops when the tidal and current effect is contrary. Diverse groups of rocks also increase the navigational problems under these conditions.

26. Local Weather, Currents and Tidal Streams

Tidal streams in Selat Larantuka. The N-going tidal streams, known locally as "Wurrah", starts in Selat Larantuka with the rising of the moon, and the S-going stream, known locally as "Olah", six hours later, the changes recurring regularly. During the survey this theory was found to be fairly correct, with an average departure of one hour in the times given by local inhabitants. It may be generally accepted that the N-going stream being one hour after the rising and setting of the moon, and the S-going six hours later. Slack water,especially during the spring tides, is of very short duration.

The maximum rate of the stream occurs from two to three days after full and new moon, when it may attain a rate of nine knots. The lowest rate occurs two to three days after the quarters, when it does not exceed three and a half knots.

In port Larantuka there is usually a N-going tidal stream, the average rate being one knot and the maximum two knots. Whenever there is a S-going stream in the strait an eddy may be excepted in the roadstead, its strength and also the distance it is felt from the shore being influenced by the rate in Selat Larantuka.

Tidal Streams in Selat Solor. During the short period occupied in the survey of Selat Solor it was observed that the tidal streams set W and E, **never attaining a rate of more than one and a half knots,** and usually not more than one knot. The direction of the stream is governed by the tidal streams setting at that time in Selat Flores, Selat Lamakera and Selat Boling, also by the vertical movement of the water in the straits.

Tidal Streams in Selat Lamakera and Selat Boling set NE and SW. The horizontal movement of the water in both straits is of a semi-diurnal character, the NE-going running for two to three hours before to two to three hours after the moon's passage in Selat Boling, and usually earlier in Selat Lamakera. The

SW-going stream runs from three to four hours after to nine to ten hours after the moon's passage. In Selat Boling the NE-going stream sets towards Tg.Wurgobin and the reef on which Pulau Ipet and Pulau Kenawehlie, whilst the SW-going stream sets more in the direction of the channel.

In Selat Lamakera the NE-going stream sets strongly towards the coast of Adonara, especially between Tg.Watu Woko and Tg.Ana-burakawutun, three and three quarters miles W, but decreases in strength to Tg.Anaburakawutun. With the SW-going stream there is **a strong eddy under this part of the coast,** and heavy tide-rips may be seen both here and N of Tg.Watu Woko.

The strongest tidal streams are found in the narrows close under Tg.Watu Woko. During the survey a **rate of five knots** was observed two days after spring tides, so it may be assumed that **the maximum rate there may be seven knots.**

Tidal streams in Selat Boling are also **very strong.** Spring tides occur about three days after full and new moon, and neap tides the same period after the quarters. **Eddies** are caused by the strong tidal stream in the various bights and bays in the straits. The NE-going stream into Leba Leba Bay causes **a strong eddy in the bight on the coast of Pulau Adonara** opposite N of Tg.Deriwutun. The survey vessel, when lying at anchor here, was nearly swung with her head N.

With strong tidal streams there are often **whirling eddies near the coast of Plau Lomblen off Tg.Mitanwutun,** caused by the irregular nature of the bottom. The N-going stream may be expected two to three hours before to two to three hours after the moon's passage, and S-going stream three to four hours after to nine to ten hours after the moon's passage.

The stream sets W with the NE-going stream S of Tg.Tuak, thus causing the set towards Tg.Wurgobin. Farther inside Leba Leba Bay the tidal streams are not so noticeable.

Tidal streams in Selat Alor. The horizontal movement of the water in Selat Alor is of a semidiurnal character, and may attain a considerable rate. Owing to the lack of anchorage in the strait it was impossible to carry out any thorough observations during survey. The following general information, obtained from the local inhabitants and checked by observations, give a fairly good idea of the prevailing tidal streams.

The tidal streams mainly follow the direction of the strait, throughout.

During the SE monsoon the SW-going stream lasts longer and is stronger than the NE-going stream. It has been observed that the SW-going stream flowed from about two hours after to about nine hours after the moon's passage, and the NE-going stream for the remaining hours. During the NW monsoon the NE-going stream is presumably of longer duration and stronger than the SW-going stream.

Spring tidal streams appear to occur two to three days after the full moon and new moon, and neaps from two to three days after the quarters. The rate at springs average five to six knots. The maximum rate can probably be expected when spring tides occur during the period of the moon's greatest declination either S or N, and particularly the years that the moon's declination greater than the sun's declination.

Off projecting points and around the islands the direction and rate of the tidal streams are naturally irregular. In the N part of the strait the rate of the tidal streams is considerably less than in the S part, except close off Tg.Leur, where a rate of five knots was observed.

Tidal eddies have been reported midway between Pulau Lapang and Tg.Leur.

Tidal streams in Donggala roadstead are sometimes strong. It may occur that during a strong SE-going stream outside the charted 100fm(183m) line there may be a strong NNW-going stream in the roadstead.

Tidal streams in Selat Muna set N with the flood tide and S during ebb through the strait, but seldom exceed two knots.

Winds in Selat Tiworo during the NW monsoon, winds between SW and NW blow fairly regularly in the afternoon, abating again in the evening. During squalls the wind sometimes reaches Force eight.

Tidal streams in Selat Wowoni set N and S and may attain a rate of three knots. There is practically no period of slack water, except at neap tides, and even then it is only of short duration. Tidal streams in the approach channels to Teluk Kendari and in the bay are strong at times.

Tidal streams in Teluk Bone. Little is known of the horizontal movement of the water in Teluk Bone, but in the outside ebb and flood tidal streams of the larger river entrances, it appears to consist merely of weak and irregular

drifts of a more or less local nature. The direction of the current S of the Teluk Bone is in accordance with the monsoon, being W-going from June to October, and E-going from December to May.

Tidal streams set irregularly between the reefs in Teluk Mekongga. They set generally E and W in N of the islands. A S-going stream has been observed E of the islands and between Pulau Maniang and the coast.

4-1-3 The Western Sea Area Relevant to the Route 9

Current

27. The currents in the area covered by this chapter alternate in direction twice yearly in phase with the monsoon, and the flow of water through the region is almost entirely derived from the Pacific Ocean. During the NE monsoon, from November to March, Pacific water enters the region via South China Sea, and during the SE monsoon, from May to September, via the Flores Sea. Since the currents are controlled by oceanographic and meteorological conditions both within and outside the area, which vary from day to day as well as from season to season, the current in any particular location varies both in direction and rate.
Nevertheless a definite current pattern emerges which is shown in Fig. 4-1-9(1)A and (2)A.

Current Directions. In the open sea the direction of the predominant current conforms with the prevailing monsoon. From November to March the current set SSE in the region N of Karimata Strait and ESE in the Java Sea. From May to September the current directions are reversed so that they set WNW in the Java Sea, and NNW in the region N of Karimata Strait. In April and October, the months of transition, the currents are variable over the whole open sea region.

The constancy of the predominant directions at the height of the monsoon is high, but it is low in the transition months and only moderate in the months immediately preceding and following the height of the monsoons.

Current Rates. In general, the current run more strongly during the NW monsoon than during the SE monsoon. In the former season the mean rates lie between three quarter and one knot compared with three quarter knot in the latter season. Maximum rates are usually **less than two knots** but on rare occasions in either monsoon, current of up to **three knots may occur.**

Tides and Tidal Streams

28. Tidal streams in the area covered by this paragraph have a marked diurnal inequality which generally increases E. One stream of the day in each direction

is markedly stronger than the other and, in many cases, there is only one stream of any strength in each direction per day. Also the strength of the tidal streams, in general, decreases from W to E of the area; whereas rates exceeding three knots occur in many channels in Kepulauan Lingga and Kepulauan Riau, rates rare attain one knot off Pulau Belitung and W coast of Borneo.

In the open sea, the tidal streams are generally weak and, in general, negligible compared with the seasonal currents described in 26.

Even in these straits where the tidal streams are strong, the seasonal currents are not negligible compared with and their contribution to the flow of water should not be neglected. Details of the tidal streams and coastal currents are given in their appropriate places in the paragraph of **local currents and tidal streams.**

29. Tides in Sunda Strait and round the islands on the S side of Singapore are semi-diurnal, the mean spring range in the former being not more than 1.0 m, and in the latter about 1.5 m at the E end, increasing to 3.0 m at the W end.

Throughout the remainder of the area covered by this chapter, the tides are predominantly diurnal. On the N coast of Jawa the range seldom exceed 0.5 m. On the E coast of Sumatera and the coasts of Pulau Bangka and Pulau Belitung, **the range is mostly between 1.0 and 1.5 m** but it increases to **over 2 m at the outer bar of Air Musi** and on the coast N of Kuala Niur.

Climate and Weather

30. **General.** The region covered by this chapter has a tropical monsoon climate. Temperature and humidity are high with seasonal variation. Rainfall varies from abundant to excessive, with little difference from month to month near the equator. Farther S the wettest period, from November to March, has about three times as much rain as the driest period, from June to September. Winds are light to moderate and gales are rare. Fog is seldom reported over the sea. Patches of radiation fog form towards dawn over flat land near the coast but clears quickly after sunrise.

31. **Pressure and Depressions.** The mean pressure over the area varies only about one or two mb throughout the year, but there is a significant change in the pattern of the isobar due to larger changes over Asia and Australia. See Fig. 4-1-10(1)A and (2)A.