### 3-3-3 Influence of the flood waves of the major rivers on the port water level

The Ganges river has a huge basin comprising India's northern plain and the south skirt of the Himalaya mountains. The Jamuna river has another huge basin including the Tibet highland and Assam, a heavy rainfall area, and the river Meghna has a basin covering the west half of Bangladesh. The annual average discharge and average dry season discharge (November to May) of these major rivers is shown in Table 4.3.6, which indicates that the discharges of the Jamuna, Ganges and Meghna account for 60%, 30% and 10% of the total discharge, respectively and each discharge volume corresponds to the size of each basin.

Table 4.3.6 Average Discharge of the Three Major Rivers per Year

($10^6$ t/year)

| Basin | Annual Average Discharge | Average Discharge in Flood Season |
|---|---|---|
| Ganges Basin | 367,360 | 60,600 |
| Brahmaputra Basin | 667,150 | 140,740 |
| Meghna | 190,450 | 25,580 |

Source: BWDB

The influence of the Meghna river's flood wave on the port water level is shown in Fig. 4.3.2. The flood wave is represented by the fluctuation at Bhairab Bazar 250 km upstream from the river mouth with a 3 m high MSL. (Refer to Fig. 4.3.4.) The water levels at Bhairab Bazar and at Dhaka fluctuate similarly with the same low level during the dry season from December to March. They begin to rise, keeping the same pattern, but at different rates from April, and so the water level in the Meghna becomes higher than at Dhaka port. The water levels begin to

descend quickly from the end of September and come back together in November.

As the two rivers basically keep the same fluctuation pattern over the course of the year, they probably belong to the same river system.

The influence of the Jamuna and Ganges flood waves on the port are shown in Fig. 4.3.2: the fluctuation at Shinojganj (330 km upstream from the river mouth and 11 m high) represents the wave in the Jamuna, and that at Handgine Bridge (330 km upstream from the river mouth and 12 m high) is influenced by the wave of the Ganges. The patterns of fluctuation in both rivers are the same only during the descending period and the dry season from September to February, but are different during the other months. The water level in the Jamuna river begins to rise at the beginning of March and rises step by step in mid-April and May and at the beginning of June and July. On the other hand, the water level in the Ganges keeps descending until the beginning of April, and then tends to rise slightly in the middle of April and at the beginning of June. It rises quickly at the beginning of July and reaches the same level as the Jamuna in August. The river Brahmaputra has a flat flood curve due to various climatic conditions in its river basin which includes Tibet, the north and south skirts of the Himalaya mountains and Assam. On the other hand, the river Ganges has a sharp curve due to the simple climate of its basin. The rising water level in the river in March to June is caused by the flood wave in the Jamuna. The back water effect is caused at the confluence by the blocking of the flood wave of the Jamuna, and brings about a slight rise in the Ganges. The water levels rise sharply in July, and this is caused by flood waves in the Ganges due to heavy rainfall in India.

The Jamuna river and the Ganges river form a kind a flood

control system through the confluence point. The other river channel serves as a kind of retarding basin due to the difference in flood time. This system is not limited only to the combination of the two major rivers, but covers all the rivers flowing in the delta.

The river formed by the confluence of the Jamuna and Ganges is named the Padma river. Mawa is a water gauge station standing on the Padma (170 km upstream from the river mouth and 3.6 m high). Observation records on HWL are shown in Table 4.3.6. The fluctuations at Mawa, Dhaka and Narayanganj are similar in spite of the big differences in discharge between the Padma and the Buriganga. The similarity is caused by the smoothing effect due to the connections between the river system.

The delta land is divided into two areas: one is higher (2 m to 4 m) than the other and serves as land for houses. The other is used for rice fields. When the river water level rises during the flood season, river water begins to flow over the fields.

This effect moderates the peak of floods in the delta area. The Jamuna, Ganges and Maghna rivers meet in the delta, and the flood waves in each river basin are smoothed through the back water system. Flooding in both Dhaka and Narayanganj ports is also reduced through this overflow system.

### 3-3-4 River cross sections in both ports

River cross sections sounded in Dhaka port and Narayanganj port are shown in Fig. 4.3.4 and Fig. 4.3.5. The soundings took place in 1982 and 1979, respectively, and the locations of the cross sections are shown in Fig. 4.3.6.

Table 4.3.7 is a list of the soundings carried out by BIWTA at Dhaka port and Narayanganj port.

Table 4.3.7 Sounding Locations and Dates

| | Sounding Range | Date |
|---|---|---|
| Dhaka | Sadaghat/Malancha: Fatulla | Sep & Nov 1964 |
| | B.G. Mouth/Dhaka Match Factory | July & Aug 1965 |
| | B.G. Mouth/B.G. & Dhaleswari Confluence | Oct to Feb 1967 |
| | Fatulla/Postagola; Postagola Shoal | Feb & Mar 1968 |
| | B.G. Mouth/Pogola Governors Jetty | Dec 1972 |
| | B.G. Mouth/Mirpur Bridge | Feb 1977 |
| | B.G Mouth/Raahmatganj | Dec 1979 |
| | Pagla/Jinjira | May 1982 |
| Narayanganj | Terminal | Apr 1969 |
| | Narayanganj Port Area/Sarulia | Sep 1970 |
| | Kalagachia/Kuripara | Apr 1975 |
| | Sonarchar/Kamarghop | 1979 |

Source: BWDB

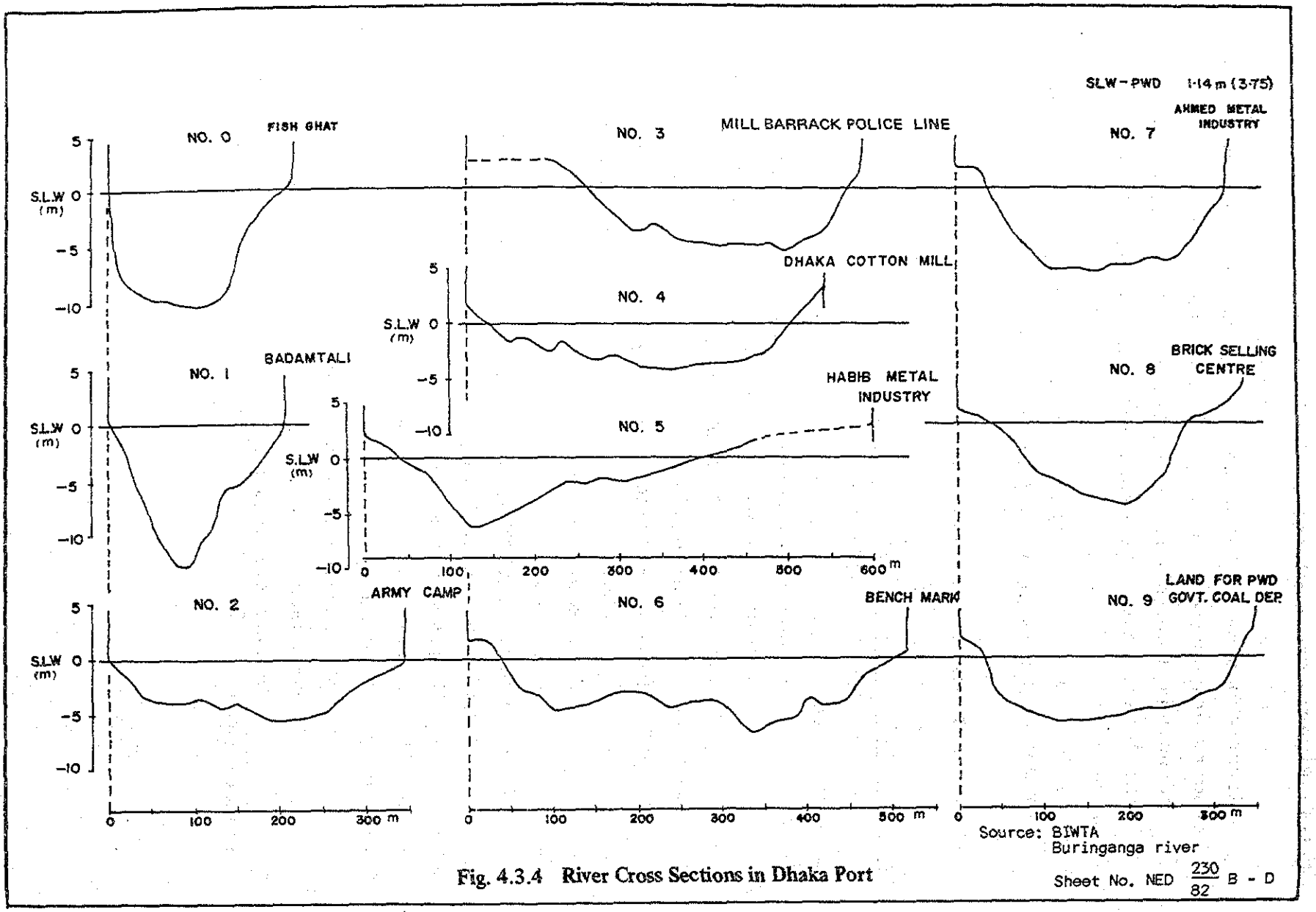



Fig. 4.3.4 River Cross Sections in Dhaka Port

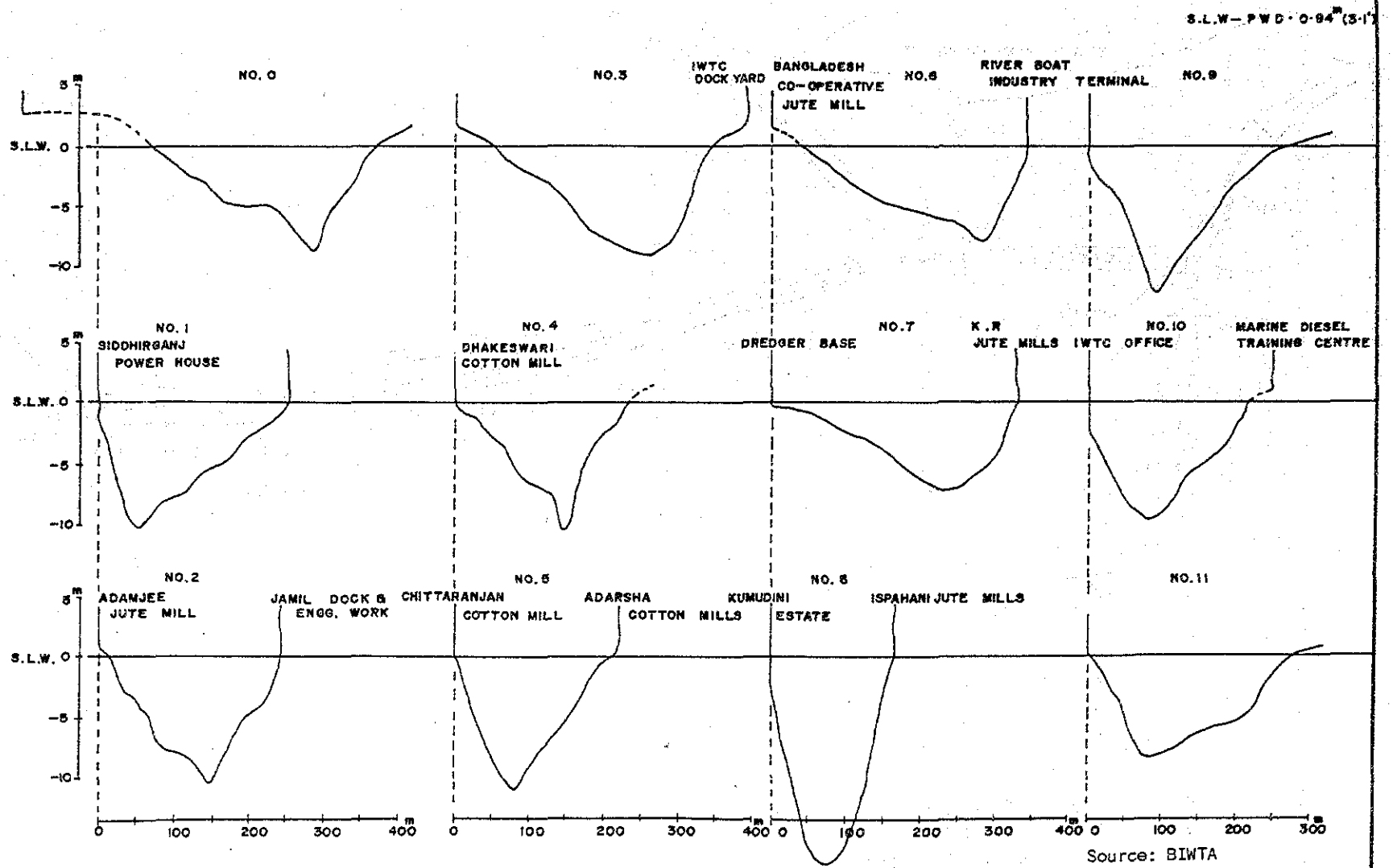



Fig. 4.3.5 River Cross Sections in Narayanganj Port

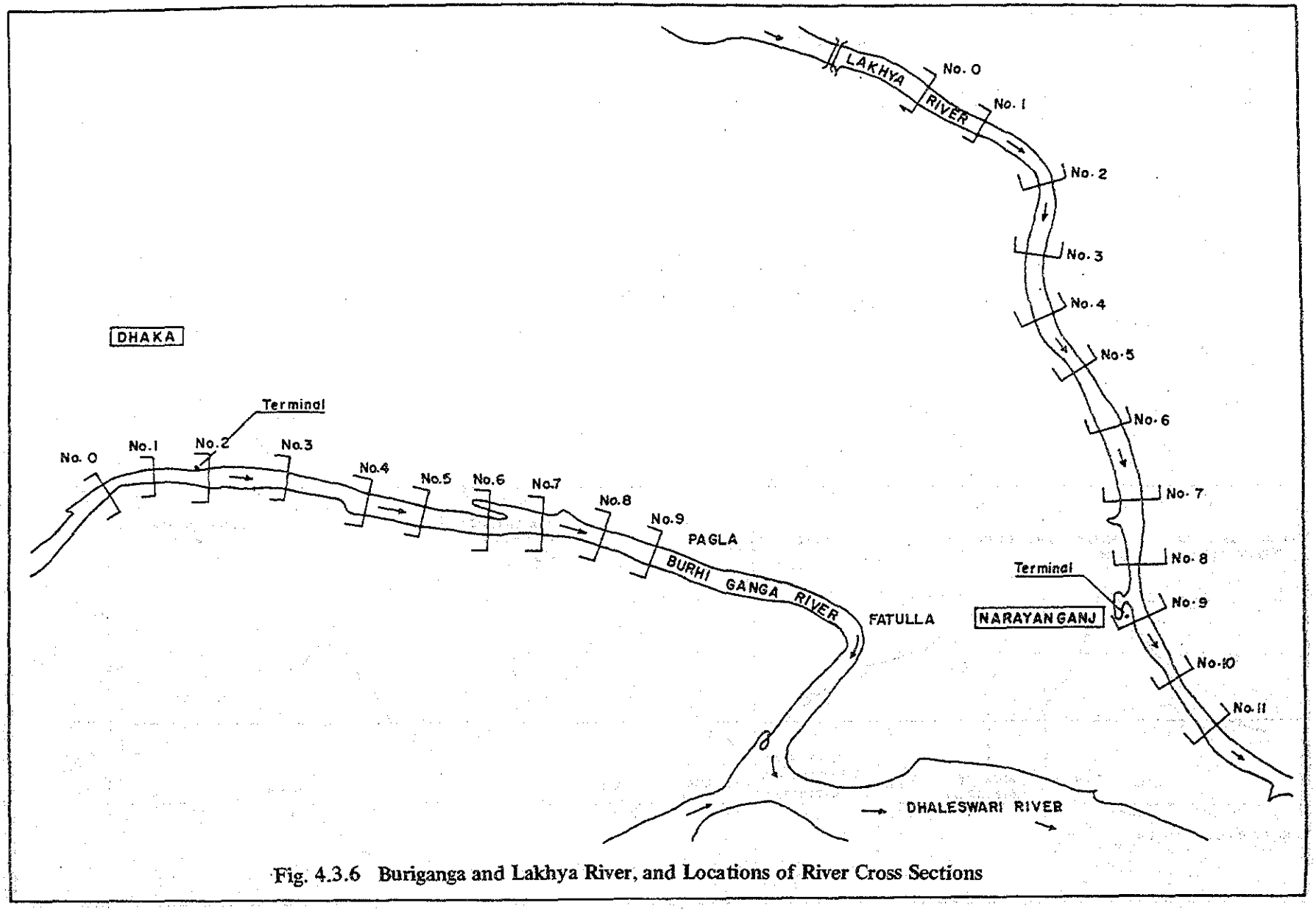



Fig. 4.3.6 Buriganga and Lakhya River, and Locations of River Cross Sections

### 3-3-5 Stability of river beds in both port area

Parts of the port areas in both Dhaka and Narayanganj have been sounded at 5 year intervals since 1964. It is quite difficult to exactly set a sounding line on one chart to another line on another chart because the sounding lines are set freely every time. Thus, the comparisons of river cross sections are not accurate and contain small errors. The locations of the river cross sections in the main port areas of Dhaka and Narayanganj are shown in the location map (Fig. 4.3.7). Simple comparisons of the cross sections in the Dhaka area are shown in Fig. 4.3.8 to Fig. 4.3.10 and comparisons of those in Narayanganj are shown in Fig. 4.3.11 to Fig. 4.3.14.

During 1964 to 1982, almost all of the public wharves were newly installed or improved, and the front berth basin was dredged along with the construction works. There is an old record indicating dredging of a large shoal lying on the left bank from Postogola to Syampur (4 km to 7 km from the fish ghat). It seems that this shoal is still dredged from time to time.

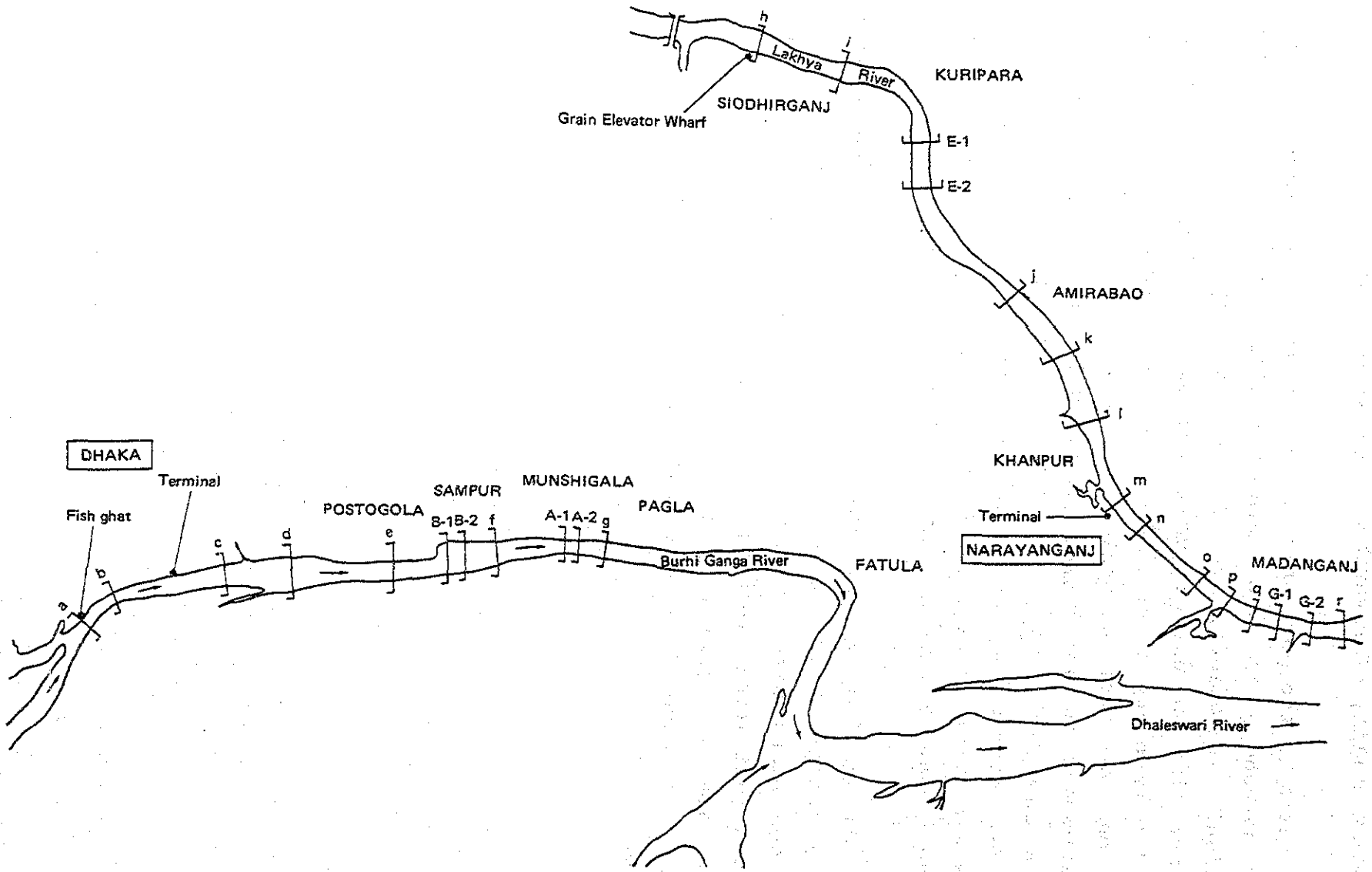



Fig. 4.3.7 Buriganga and Lakhya River, and Location of River Cross Sections

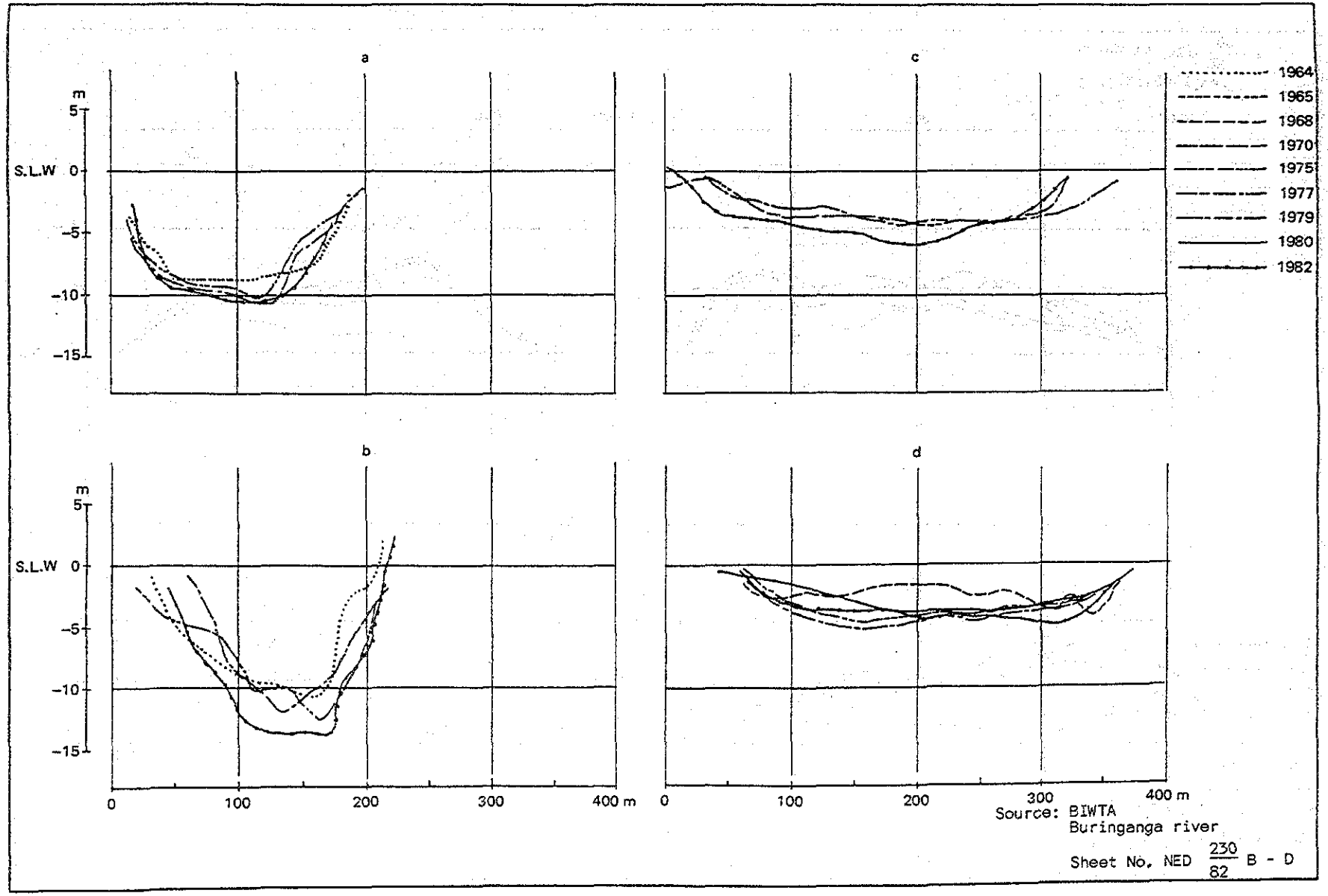



Fig. 4.3.8 Comparison of River Cross Sections Sounded in Dhaka Port at Different Times (1)

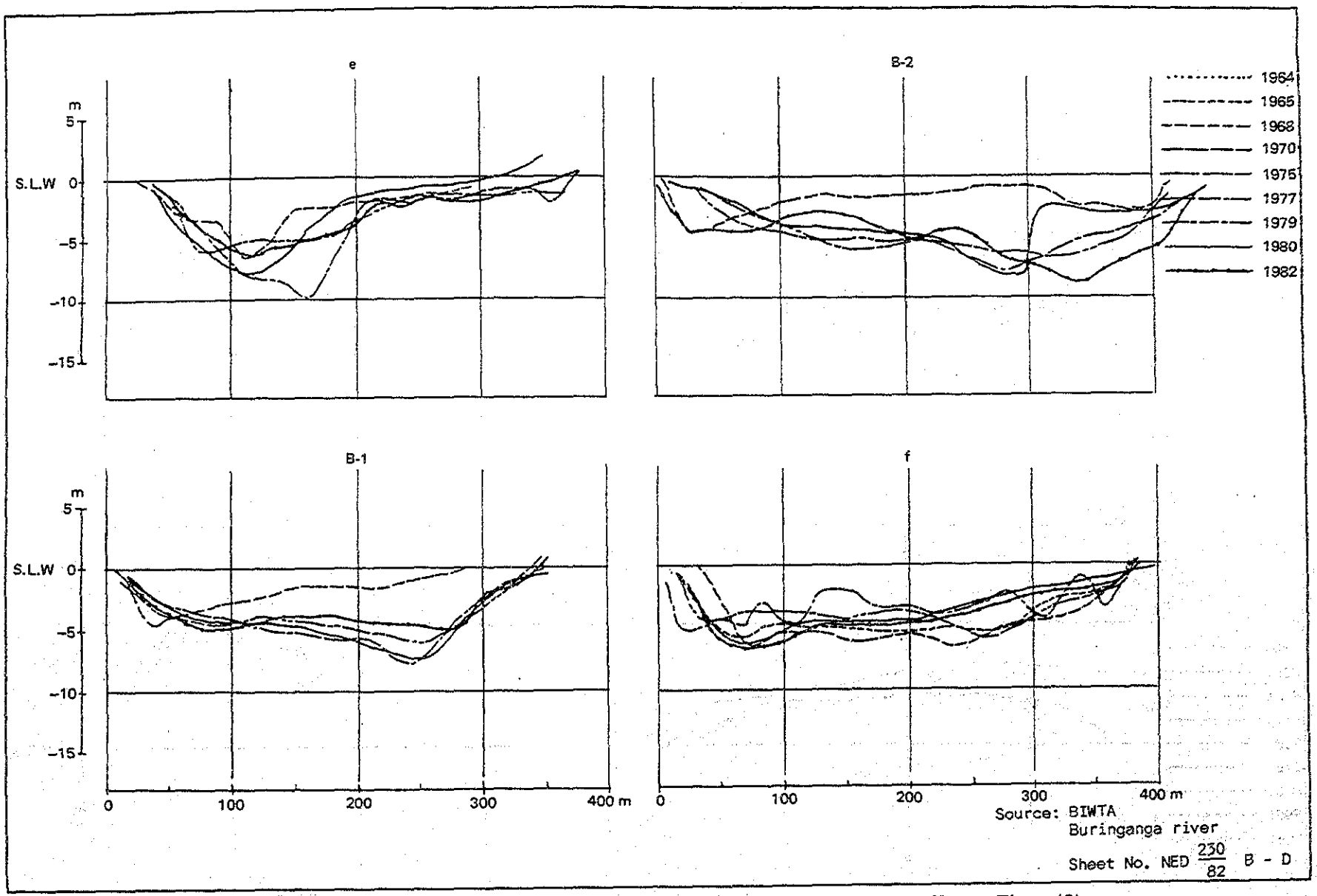



Fig. 4.3.9 Comparison of River Cross Sections Sounded in Dhaka Port at Different Times (2)

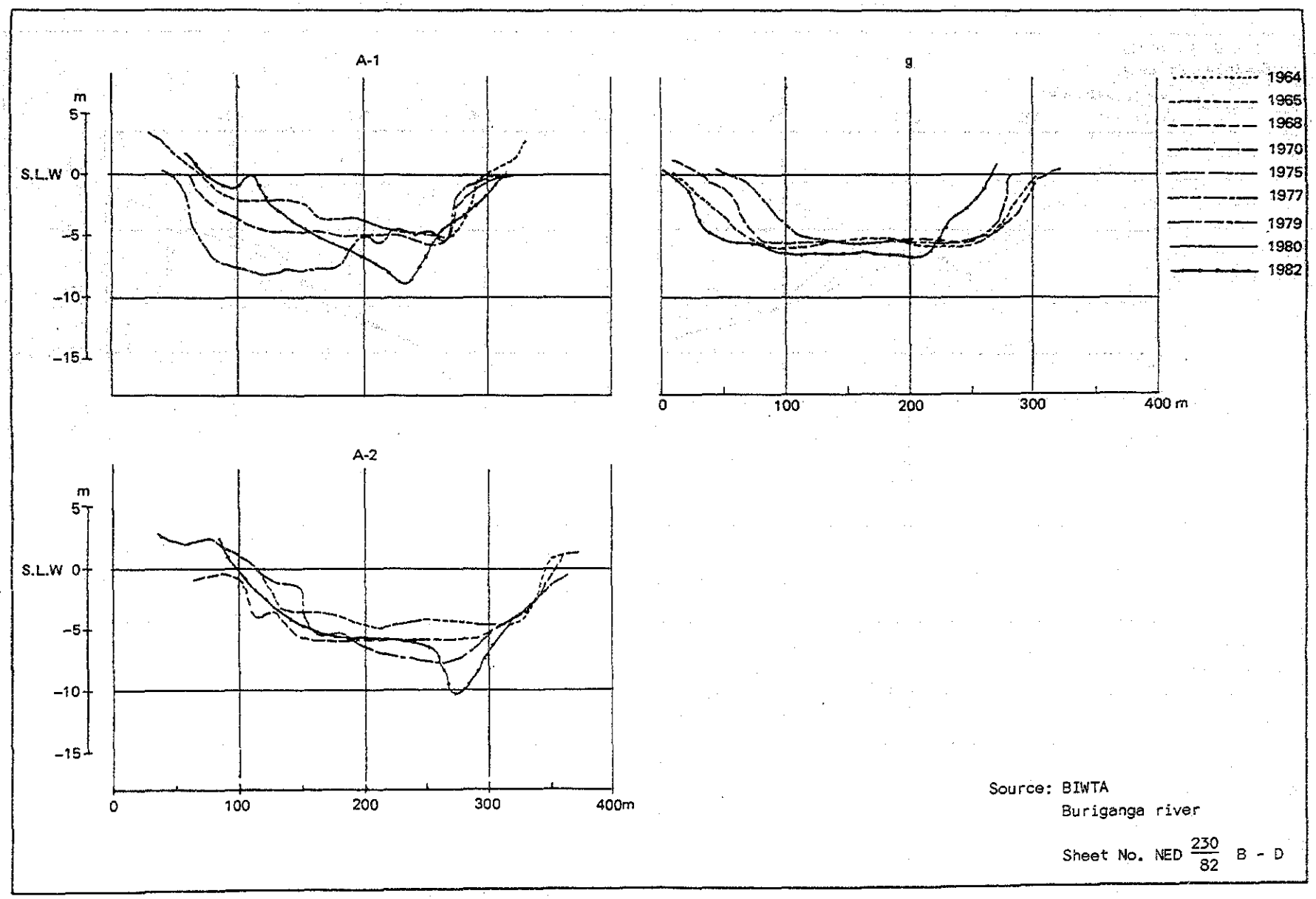



Fig. 4.3.10 Comparison of River Cross Sections Sounded in Dhaka Port at Different Times (3)

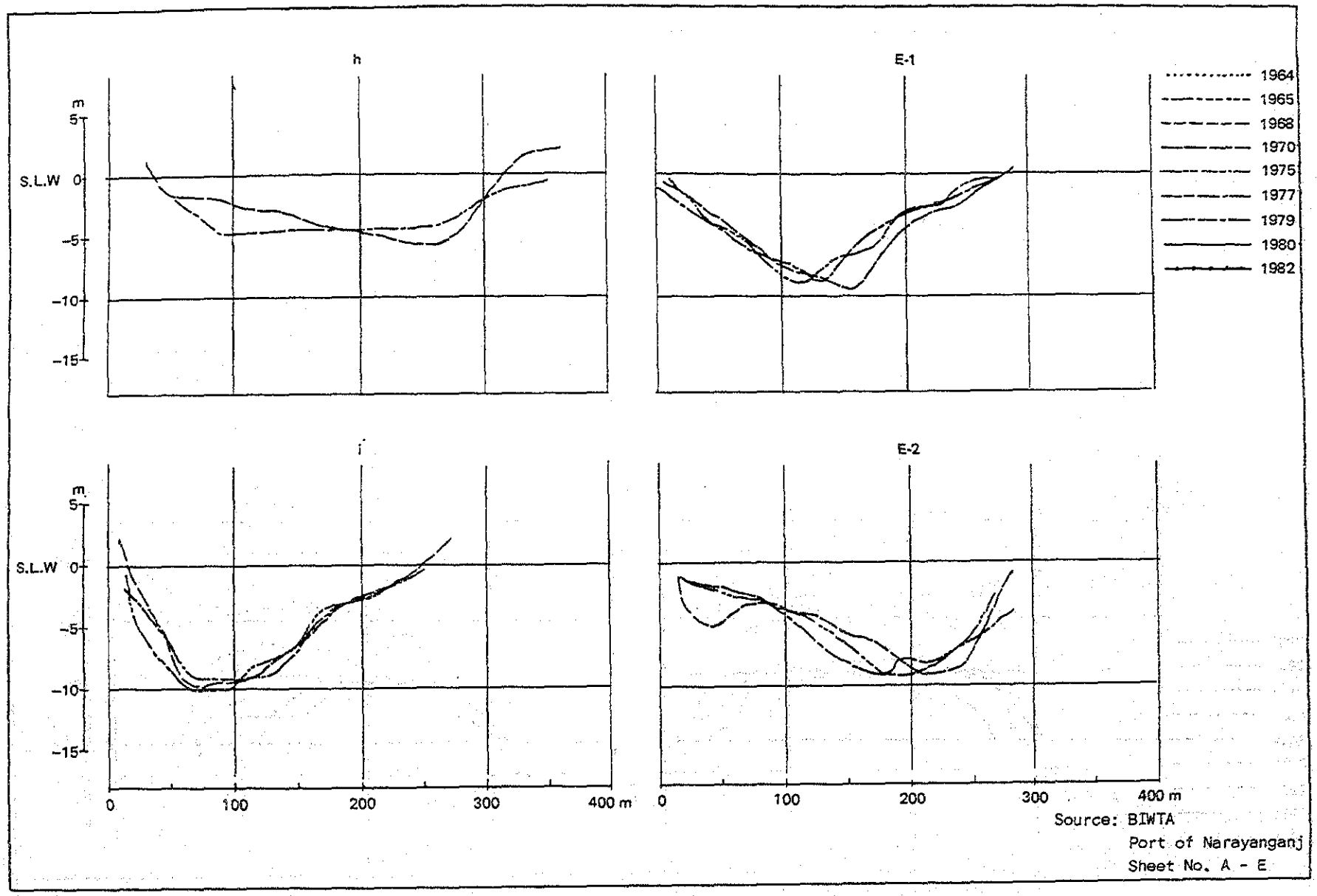



Fig. 4.3.11 Comparison of River Cross Sections Sounded in Narayanganj Port at Different Times (1)

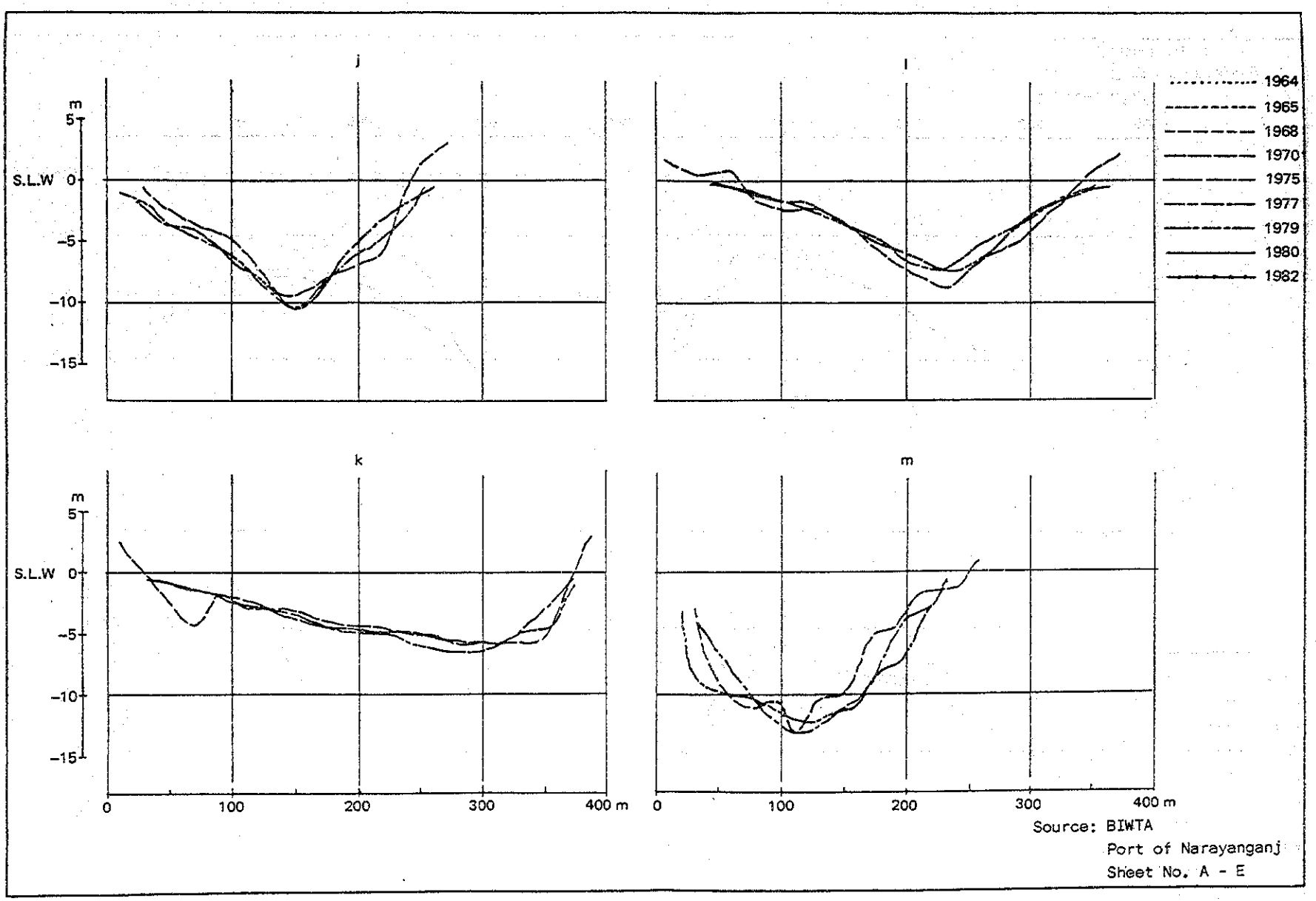



Fig. 4.3.12 Comparison of River Cross Sections Sounded in Narayanganj Port at Different Times (2)

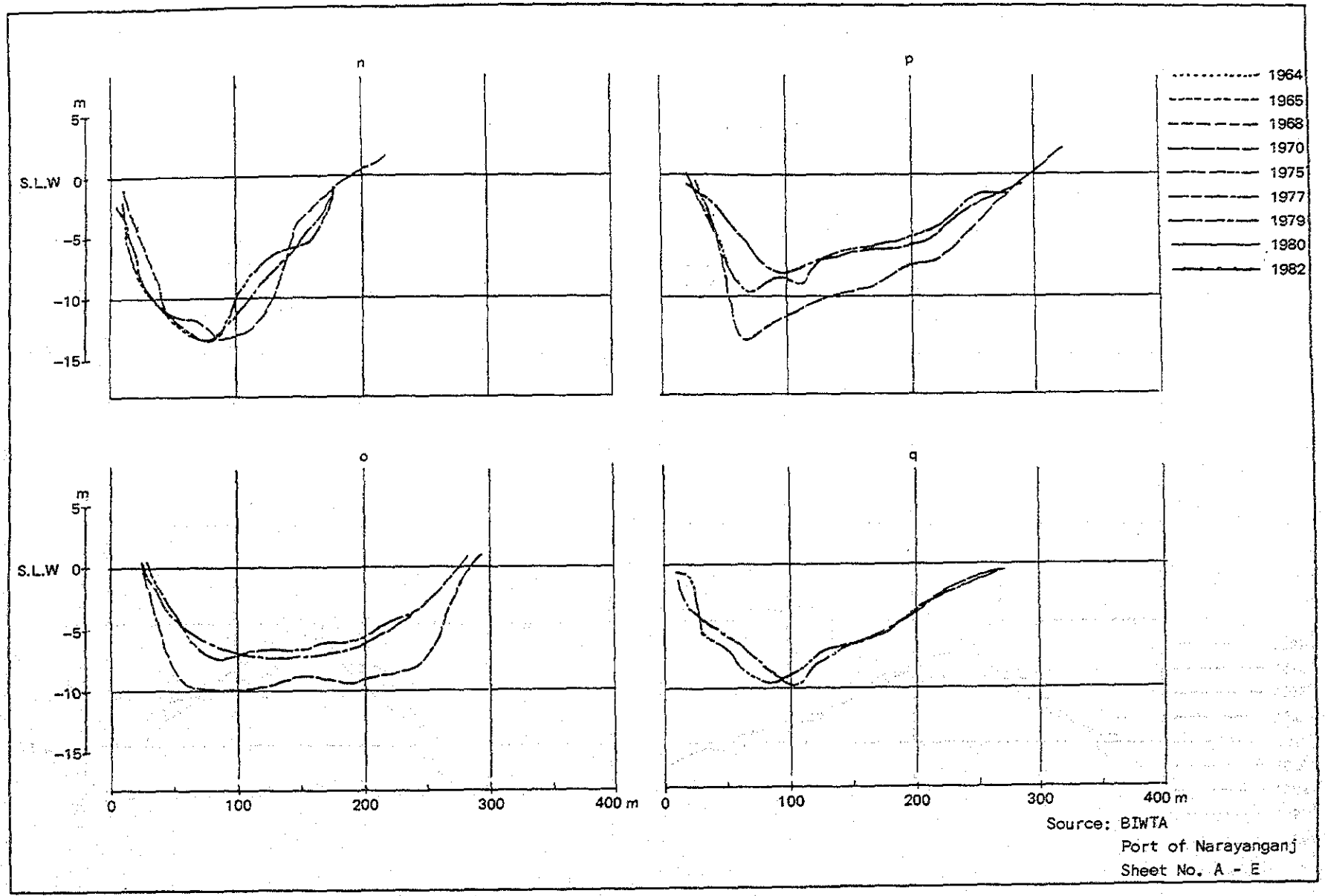



Fig. 4.3.13 Comparison of River Cross Sections Sounded in Narayanganj Port at Different Times (3)

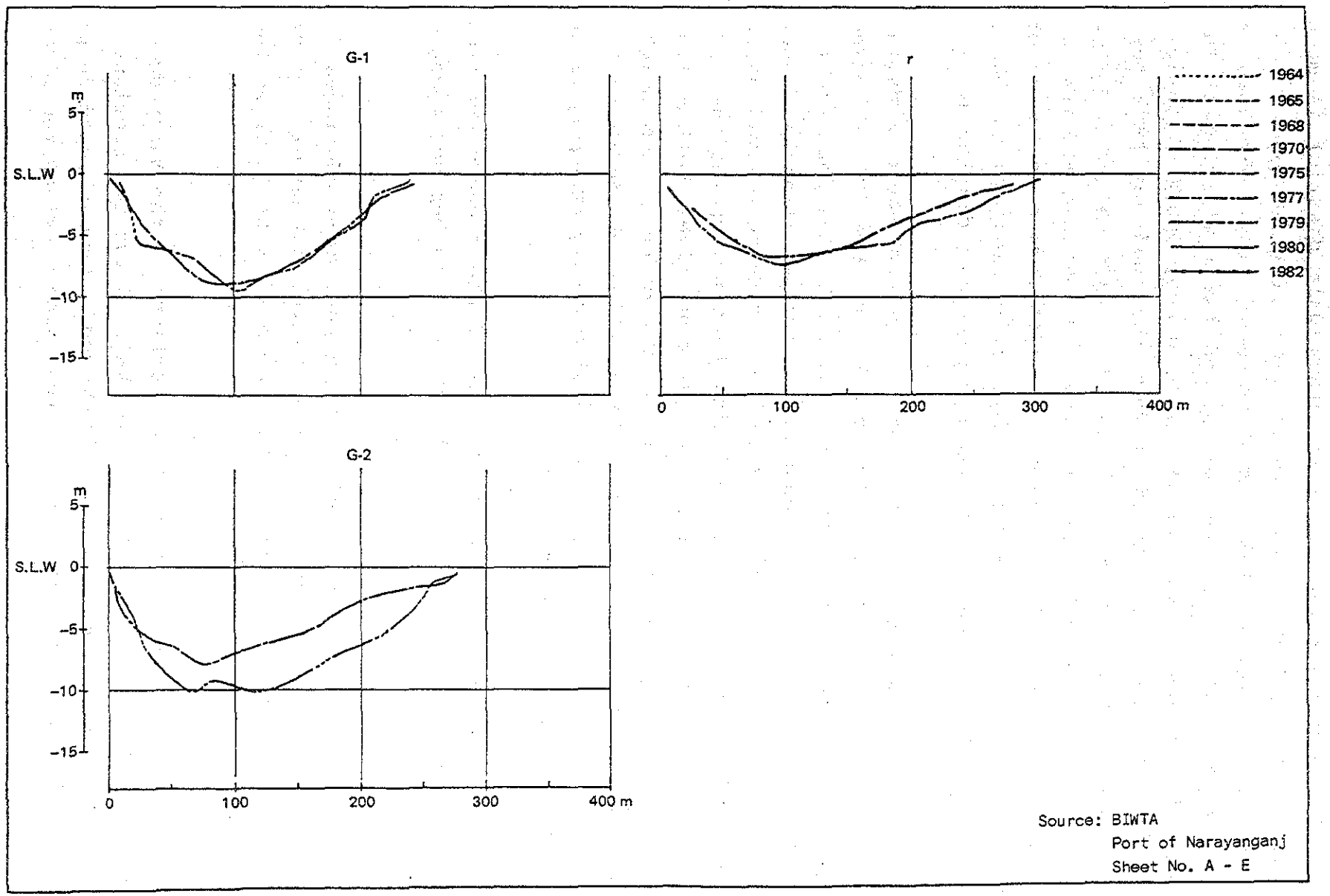



Fig. 4.3.14 Comparison of River Cross Sections Sounded in Narayanganj Port at Different Times (4)

The river flowing along the Munshigala district is much narrower than in adjoining river sections, and is close to the wide road connecting Dhaka and Narayanganj city. The road is on a part of the river embankment, and the land lying at the foot of the road embankment is low with many ponds of various sizes. The landscape indicates that the road may have been constructed crossing a part of the high water channel meandering on the left side more than 20 years ago, and that an artificial embankment and shore protection work made the river narrow and deep. As the centre line flows close to the bank, the river channel and flow centre may have been displaced.

Simply overlapping river cross sections sounded during 1965 to 1982 clearly shows the results of the IWTA dredging operations. The river bottom in front of the Terminal and the adjoining area downstream changes to become slightly deeper uniformly, as if caused by a series of dredging operations in front of the berth before beginning terminal operations. On the other hand, the change in the wide river bottom from Postagola to Syampur is limited to the effects from slight dredging to remove the shoal. The location and depth of the flow centre changes little in spite of markedly changing river cross sections in shallower areas.

In the Munshigala district, river depth changes occurred clearly during the 1960's, but the river depth has not changed clearly since 1970.

If the dredging of shoals in the port area continues in the future, a bellowing effect on the river bottom will occur near the dredging site, but little siltation will occur in the port area.

Simply overlapping river cross sections in the Narayanganj port area indicates that the bottom shape of the two sections, the upstream part and the downstream part, have changed shape over these 15 years. In the downstream area, part of the river

bottom was deeper in 1970 than in 1975 and later, but the river bottom has remained almost stable in other parts since 1970.

The complicated changes in the river bottom shape of the upstream area and the downstream area are caused by the dredging work for constructing the grain elevator wharf located at the right bank of the upstream area, and the maintenance dredging in the downstream area.

Continuation of maintenance dredging by IWTA as at present will protect the port area from siltation.

### 3-3-6 River current in Dhaka and Narayanganj Ports

Current velocity in the dry season observed at the Buriganga river bridge project site in March of 1984 is shown in Table 4.3.8. The observation of 9 points, forming a river cross section, were located at 3 vertical lines - right, centre and left - and at three depths 20%, 50% and 80% of the river depth. The time, river flow direction of ebbing on flooding, and river depth changes at the observation time are including in Table 4.3.8.

The results of river current observation in the flood season are shown in Table 4.3.9. The observations were carried out at the bridge project site in July to October of 1984. The table presents the mean velocity of the river cross section, the discharge, the river cross section, the width of river surface, and the average depth of river.

The current velocity distribution in the flood season is shown in Table 4.3.10 as observed on September 30th when the average velocity was the fastest, and on October 10th.

The current in the dry season was observed by the study team in the flow centres of the Buriganga river (project site A) and the Lakhya river (project site E) in February of 1986. Observation items are the vertical distribution of current velocity and suspended material. The current velocity distribution is shown in Table 4.3.11, including current direction and water level in PWD. The suspended material comprises only a little clay and organic material, and could not be weighed.

The current velocities observed by the study team are equal to the velocities observed at the bridge project site in the dry season.

## Table 4.3.8 River Current Velocity in Dry Season

DATE: 18 - 19.3.1984

| TIME | CURRENT DIRECTION | DEPTH (m) | | | VELOCITY (m/sec) | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | LEFT SIDE | | | | MIDDLE | | | | RIGHT SIDE | | | |
| | | LEFT SIDE | MIDDLE | RIGHT SIDE | 0.2 | 0.5 | 0.8 | AVE. | 0.2 | 0.5 | 0.8 | AVE. | 0.2 | 0.5 | 0.8 | AVE. |
| 9 | FLOODING | 6.035 | 7.559 | 6.248 | 0.331 | 0.300 | 0.525 | 0.288 | 0.388 | 0.316 | 0.285 | 0.340 | 0.392 | 0.392 | 0.376 | 0.387 |
| 10 | " | .096 | .589 | .400 | .185 | .176 | .165 | .175 | .325 | .263 | .199 | .262 | .252 | .271 | .238 | .254 |
| 11 | " | 5.944 | .559 | .400 | .000 | .000 | .065 | .022 | .142 | .121 | .112 | .125 | .060 | .064 | .094 | .072 |
| 12 | EBBING | .761 | .498 | .248 | .267 | .264 | .231 | .254 | .266 | .229 | .190 | .228 | .318 | .225 | .193 | .246 |
| 13 | " | .608 | .285 | 5.944 | .336 | .290 | .244 | .290 | .303 | .258 | .159 | .210 | .265 | .290 | .290 | .282 |
| 14 | " | .486 | .193 | .791 | .213 | .193 | .193 | .186 | .328 | .262 | .199 | .261 | .206 | .233 | .212 | .216 |
| 15 | " | .395 | .163 | .639 | .252 | .193 | .147 | .197 | .251 | .205 | .182 | .213 | .164 | .191 | .191 | .182 |
| 16 | " | .304 | 6.980 | .791 | .217 | .170 | .139 | .175 | .280 | .213 | .170 | .221 | .137 | .169 | .113 | .140 |
| 17 | " | .243 | .858 | .468 | .179 | .194 | .145 | .173 | .248 | .187 | .143 | .193 | .117 | .159 | .141 | .139 |
| 18 | " | .121 | .766 | .486 | .147 | .123 | .102 | .124 | .201 | .187 | .171 | .186 | .137 | .118 | .119 | .125 |
| 19 | FLOODING | .486 | 7.315 | .791 | .523 | .441 | .370 | .445 | .539 | .511 | .421 | .491 | .545 | .543 | .448 | .512 |
| 20 | " | 6.005 | .650 | 6.096 | .556 | .512 | .406 | .491 | .417 | .461 | .408 | .456 | .519 | .442 | .447 | .469 |
| 21 | " | .096 | .803 | .248 | .352 | .324 | .295 | .324 | .391 | .385 | .347 | .374 | .415 | .398 | .367 | .394 |
| 22 | " | .218 | .925 | .096 | .260 | .241 | .217 | .239 | .321 | .308 | .210 | .280 | .348 | .347 | .294 | .330 |
| 23 | " | .299 | .864 | .400 | .029 | .040 | .085 | .051 | .179 | .159 | .149 | .162 | .161 | .179 | .161 | .167 |
| 24 | EBBING | 5.913 | .803 | .339 | .165 | .142 | .131 | .146 | .108 | .108 | .096 | .105 | .171 | .167 | .157 | .165 |
| 1 | " | .944 | .498 | .096 | .300 | .276 | .232 | .269 | .261 | .250 | .216 | .242 | .265 | .256 | .238 | .253 |
| 2 | " | .730 | .346 | .096 | .280 | .265 | .236 | .260 | .267 | .226 | .205 | .233 | .248 | .222 | .196 | .222 |
| 3 | " | .678 | .163 | 5.913 | .234 | .221 | .185 | .213 | .260 | .241 | .204 | .235 | .202 | .190 | .177 | .190 |
| 4 | " | .486 | .041 | .791 | .185 | .170 | .188 | .181 | .240 | .213 | .167 | .207 | .171 | .149 | .131 | .151 |
| 5 | " | .334 | .010 | .791 | .199 | .176 | .136 | .170 | .211 | .191 | .142 | .181 | .171 | .157 | .121 | .150 |
| 6 | " | .212 | 6.888 | .640 | .158 | .153 | .129 | .147 | .214 | .182 | .147 | .181 | .157 | .155 | .121 | .144 |
| 7 | FLOODING | .699 | 7.254 | .852 | .460 | .406 | .375 | .414 | .439 | .391 | .327 | .386 | .438 | .384 | .308 | .375 |
| 8 | " | .791 | .528 | 6.096 | .465 | .460 | .441 | .455 | .565 | .520 | - | .503 | .521 | .560 | .497 | .526 |
| 9 | " | 6.157 | .711 | .400 | .404 | .376 | .294 | .358 | .421 | .398 | .323 | .381 | .412 | .421 | .386 | .406 |
| 10 | " | .340 | .894 | .553 | .295 | .278 | .278 | .283 | .346 | .317 | .290 | .318 | .381 | .358 | .321 | .353 |
| 11 | " | .370 | .772 | .492 | .178 | .181 | .113 | .157 | .228 | .201 | .185 | .205 | .204 | .208 | .188 | .200 |
| 12 | EBBING | .126 | .711 | .248 | .168 | .124 | .119 | - | .109 | .098 | .116 | .108 | .143 | .104 | .116 | .121 |

Source: BWDB

Table 4.3.9 Discharge and Average Current Velocity in Flood Season

| DATE | MEAN W.L (m) | DISCHARGE ($m^3$/sec) | AREA ($m^2$) | WIDTH (m) | MEAN VELOCITY |
|---|---|---|---|---|---|
| 7/10 | 4.426 | 1133 | 2401 | 382 | 0.472 |
| 19 | 5.391 | 1552 | 2661 | 410 | 0.583 |
| 26 | 5.381 | 1734 | 2657 | 409 | 0.653 |
| 8/9 | 5.747 | 2550 | 2879 | 412 | 0.836 |
| 18 | 5.197 | 1920 | 2645 | 407 | 0.726 |
| 20 | 4.920 | 2047 | 2628 | 398 | 0.779 |
| 22 | 4.685 | 1739 | 2606 | 391 | 0.667 |
| 24 | 4.580 | 1483 | 2490 | 386 | 0.596 |
| 28 | 4.715 | 1112 | 2608 | 397 | 0.427 |
| 30 | 4.755 | 1001 | 2628 | 397 | 0.221 |
| 9/1 | 4.740 | 1239 | 2576 | 397 | 0.451 |
| 3 | 4.800 | 1347 | 2614 | 398 | 0.526 |
| 5 | 4.890 | 1290 | 2629 | 400 | 0.491 |
| 9 | 5.000 | 1381 | 2666 | 400 | 0.518 |
| 11 | 5.055 | 1329 | 2696 | 405 | 0.493 |
| 13 | 5.105 | 1375 | 2393 | 406 | 0.511 |
| 17 | 5.360 | 1609 | 2699 | 410 | 0.596 |
| 19 | 5.495 | 1689 | 2809 | 410 | 0.601 |
| 21 | 5.640 | 1979 | 2876 | 412 | 0.688 |
| 23 | 5.780 | 2476 | 2497 | 413 | 0.826 |
| 25 | 5.975 | 2803 | 3057 | 413 | 0.917 |
| 28 | 5.920 | 2902 | 3040 | 413 | 0.954 |
| 30 | 5.725 | 2865 | 2996 | 412 | 0.956 |
| 10/2 | 5.430 | 2667 | 2862 | 410 | 0.932 |
| 4 | 5.115 | 2272 | 2811 | 406 | 0.808 |
| 6 | 4.905 | 1936 | 2690 | 399 | 0.720 |
| 8 | 4.695 | 1735 | 2646 | 389 | 0.655 |
| 10 | 4.520 | 1470 | 2591 | 380 | 0.567 |
| 12 | 4.320 | 1231 | 2448 | 372 | 0.503 |
| 14 | 4.360 | 741 | 2579 | 374 | 0.287 |
| 16 | 4.120 | 1075 | 2408 | 347 | 0.447 |
| 18 | 3.795 | 1127 | 2284 | 339 | 0.493 |
| 20 | 3.665 | 1036 | 2167 | 335 | 0.478 |
| 22 | 3.650 | 738 | 2156 | 334 | 0.342 |
| 24 | 3.605 | 503 | 2156 | 333 | 0.233 |
| 26 | 3.620 | 589 | 2152 | 333 | 0.214 |

Source: BWDB

Table 4.3.10 River Current Velocity - Flood Season

| | Sep.30 | | | | Oct. 10 | | | |
|---|---|---|---|---|---|---|---|---|
| | Distance (m) | Depth (m) | Velocity (m/sec) 0.2 | 0.8 | Distance (m) | Depth (m) | Velocity (m/sec) 0.2 | 0.8 |
| (left bank) | | | | | | | | |
| 0 | 415.5 | 0 | - | - | 410.8 | 0 | - | - |
| 1 | 390.3 | 5.88 | 0.869 | 0.947 | 380.6 | 4.90 | 0.370 | 0.257 |
| 2 | 372.7 | 6.91 | 1.031 | 0.883 | 365.1 | 6.03 | 0.586 | 0.464 |
| 3 | 361.4 | 7.68 | 1.072 | 0.829 | 350.0 | 8.53 | 0.626 | 0.478 |
| 4 | 347.3 | 10.21 | 1.180 | 0.977 | 331.0 | 10.18 | 0.613 | 0.478 |
| 5 | 330.2 | 11.58 | 1.180 | 1.045 | 321.7 | 10.18 | 0.667 | 0.532 |
| 6 | 319.8 | 11.70 | 1.342 | 0.990 | 312.4 | 9.93 | 0.680 | 0.545 |
| 7 | 310.6 | 11.30 | 1.153 | 0.815 | 303.9 | 9.90 | 0.680 | 0.586 |
| 8 | 304.3 | 11.06 | 1.233 | 0.909 | 292.8 | 9.81 | 0.721 | 0.640 |
| 9 | 295.5 | 10.91 | 1.206 | 0.930 | 282.0 | 9.72 | 0.737 | 0.599 |
| 10 | 289.7 | 11.15 | 1.193 | 0.808 | 274.0 | 9.93 | 0.775 | 0.653 |
| 11 | 280.4 | 10.97 | 1.301 | 0.991 | 259.7 | 10.08 | 0.640 | 0.559 |
| 12 | 266.9 | 11.15 | 1.193 | 0.883 | 252.9 | 10.02 | 0.721 | 0.613 |
| 13 | 255.5 | 11.52 | 1.193 | 1.112 | 242.6 | 9.90 | 0.640 | 0.599 |
| 14 | 243.8 | 11.21 | 1.260 | 0.977 | 231.2 | 9.87 | 0.640 | 0.599 |
| 15 | 223.8 | 10.88 | 1.180 | 0.963 | 220.6 | 9.76 | 0.761 | 0.586 |
| 16 | 210.0 | 11.33 | 1.234 | 0.936 | 208.9 | 9.60 | 0.856 | 0.572 |
| 17 | 188.3 | 11.05 | 1.220 | 0.991 | 199.3 | 9.60 | 0.748 | 0.599 |
| 18 | 177.9 | 9.20 | 1.229 | 1.004 | 191.6 | 9.23 | 0.788 | 0.626 |
| 19 | 157.6 | 8.96 | 1.186 | 0.963 | 108.4 | 8.74 | 0.815 | 0.626 |
| 20 | 141.1 | 8.83 | 1.167 | 0.923 | 142.9 | 7.68 | 0.626 | 0.545 |
| 21 | 119.1 | 5.12 | 0.126 | 0.369 | 119.1 | 3.96 | 0.316 | 0.275 |
| 22 | 89.4 | 2.74 | 0 | 0 | 93.4 | 3.65 | 0.113 | 0.073 |
| 23 | 85.4 | 0 | - | - | 30.6 | 0 | - | - |
| (Right bank) | | | | | | | | |

Source: BWDB

Table 4.3.11 Vertical Distribution of Current Velocity in the Dry Season

(Unit: m/sec)

| Date / Time / Depth | Buriganga river | | | | Lakhya river | | | |
|---|---|---|---|---|---|---|---|---|
| | 2/26 | | | | 2/28 | | | |
| | 10°00' | 12°31' | 13°30' | 14°30' | 11°50' | 13°30' | 15°00' | 15°30' |
| Surface | 0.33 | 0.38 | 0.48 | 0.38 | 0.27 | 0.15 | 0.40 | 0.32 |
| 0.5 m | 0.33 | | | | | | | |
| 1.0 | 0.31 | 0.34 | 0.45 | 0.37 | 0.30 | 0.10 | 0.33 | 0.35 |
| 2.0 | 0.27 | 0.30 | 0.40 | 0.30 | 0.32 | 0.02 | 0.30 | 0.31 |
| 3.0 | 0.22 | 0.28 | 0.37 | 0.30 | 0.31 | 0.16 | 0.28 | 0.32 |
| 4.0 | 0.30 | 0.28 | 0.36 | 0.33 | 0.35 | 0.04 | 0.35 | 0.35 |
| 5.0 | 0.33 | 0.27 | 0.36 | 0.28 | | 0.00 | 0.29 | 0.34 |
| 6.0 | 0.28 | 0.28 | 0.34 | 0.24 | 0.34 | 0.07 | 0.25 | 0.29 |
| 7.0 | 0.23 | 0.26 | 0.27 | 0.24 | 0.31 | 0.05 | 0.19 | 0.27 |
| 8.0 | | 0.20 | | | 0.28 | | | |
| Bottom | 0.19 | 0.13 | 0.22 | 0.20 | 0.23 | 0.08 | 0.24 | 0.18 |
| Tide | Flo | Ebb | Ebb | Ebb | Flo | Stack | Ebb | Ebb |
| Water level(m) | 2.44 | 2.42 | 2.27 | 2.12 | 1.91 | 1.79 | 1.64 | 1.60 |

Source: BWDB

### 3-3-7 Maintenance dredging in the entrance channel

Vessels approaching Dhaka port from the river mouth travel northwards and have to navigate the Meghna, Dhaleswari and Buriganga rivers (refer to Fig. 4.3.15).

BIWTA dredges 400,000 $m^3$ to 800,000 $m^3$ of river mud annually to maintain navigation channels in inland waterways. The volume of mud dredged annually in major spots over 9 years is shown in Fig. 4.3.16 and the annual volume of dredging is shown in Table 4.3.12. The most important dredging spots are Nilkamal in the River Meghna, Gopchar in the River Lakhya and Baktabali in the River Dhaleswari. The Nilkamal shoal is located at an entrance channel for Barisal port from the Meghna river, and has no relation to the entrance channel to Dhaka port. The other shoals are located just inside the entrance channel. Gopchar shoal is at the confluence of the Dhaleswari and the Lakhya, and Baktabali shoal is downstream of the confluence of the Dhaleswari and the Buriganga (refer to Fig. 3.16).

The clear difference of discharge between the Dhaleswari and the Lakhya pushes a tongue sand bar northwards gradually, and the extension of the Lakhya river course located in the northern part of the wide confluence water area becomes narrower and shallower than in the upstream section of the confluence. The 12 foot channel in this part is 50 m wide and 4.3 m deep. The southern channel connecting to Dhaka port is 150 m in width and 4.6 m in depth.

The Baktabali shoal is located 500 m to 1,000 m downstream from the confluence where the river becomes wide enough to reduce current velocity suddenly (refer to Fig. 4.3.17). BIWTA keeps the channel in good condition by means of dredging. Therefore, there is no problem at present.

However, it will be necessary to examine possible improvement works if large size vessels are introduced in this navigation channel.

The Dhaleswari river flows much wider (300 m) than the Buriganga and the Lakhya. Sounding records indicate that there is a stable channel 100 m wide and 6 m to 7.5 m deep in the flow centre along the right side bank. The river expands width at the confluence with the Meghna, Dhaleswari and Lakhya rivers, but reforms a navigable channel 150 m wide and 4.6 m deep along the south bank.

The navigation channel between Chittagong Port and the separation to Dhaleswari river consists of the Bengal Bay and the Meghna river. IWTA engineers say that any vessel of 12 feet draught can navigate by crossing any shoal or sand bar located in the estuary at high tide. Thus, there is little problem for navigation of smaller vessels.

It seems difficult to maintain a navigation channel in the lower Meghna river because the river is extremely wide with many scattered sand bars of various sizes.

However, sounding records indicate that a deep channel 0.5 km to 1 km wide and more than 10 m deep flows through groups of sand bars. The Meghna river's discharge of roughly 12 x 10 cubic tons/sec in the dry season indicates a sufficient ability to maintain this channel.

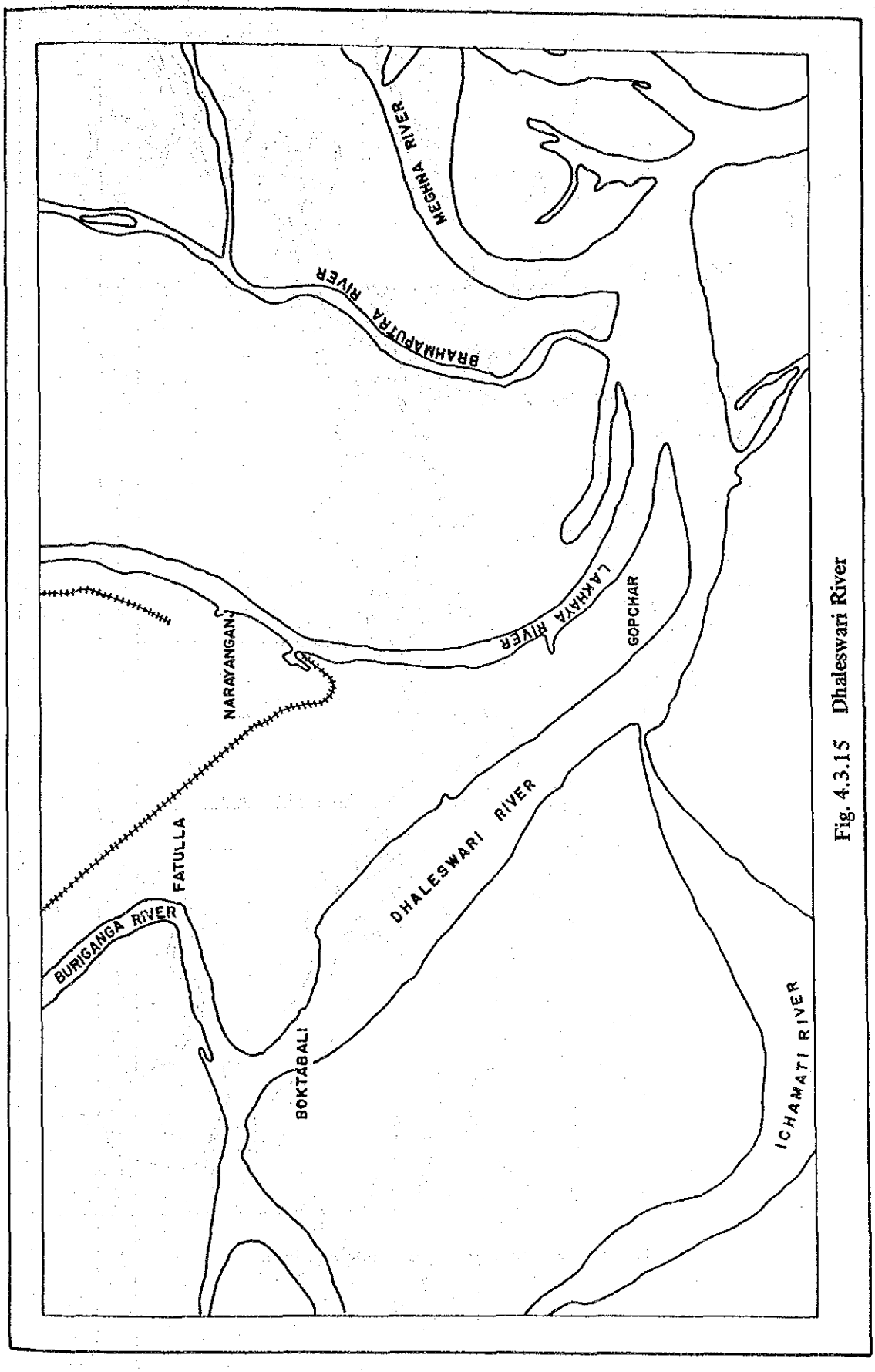



Fig. 4.3.15 Dhaleswari River

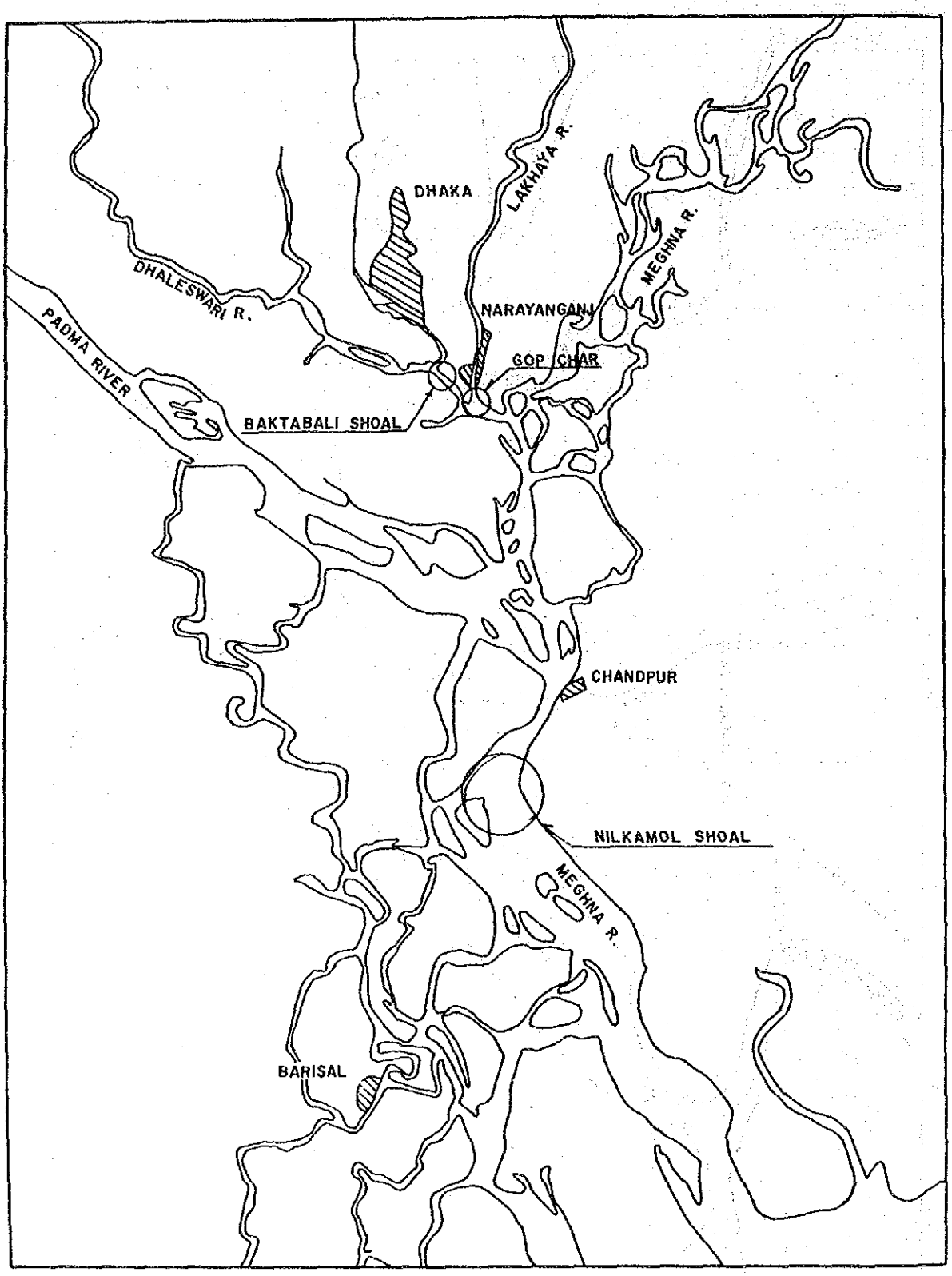


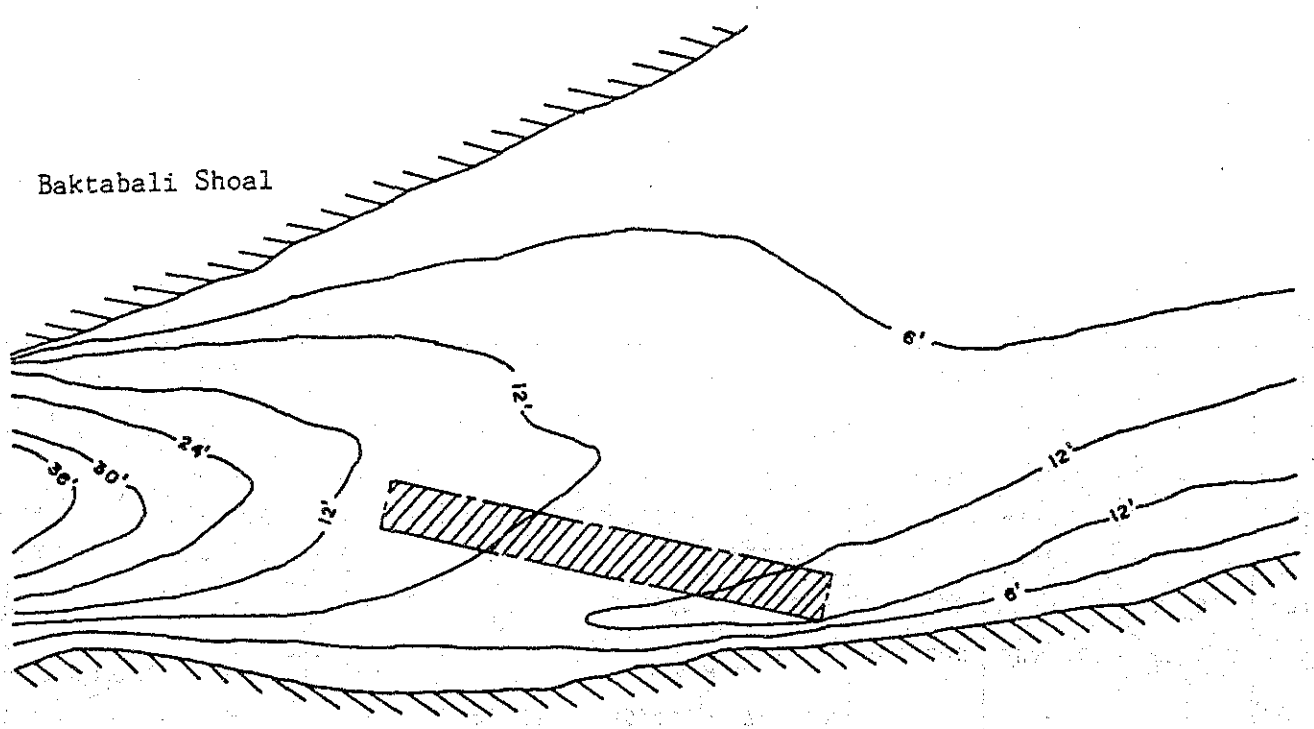

Fig. 4.3.16 Location of Major Dredging Spots

Table 4.3.12 Annual Dredging Volume

(Cu yds)

| Location | 1977/78 | 78/79 | 79/80 | 80/81 | 81/82 | 82/83 | 83/84 | 84/85 | 85/86 | Total |
|---|---|---|---|---|---|---|---|---|---|---|
| Dhaleswari (Katpatty Shoal) | 3,704 | - | 22,680 | - | - | 52,253 | - | - | - | 78,637 |
| Baktabili Shoal) | 30,000 | 109,876 | 73,733 | 89,350 | 158,760 | 100,549 | 71,614 | 100,331 | | 735,213 |
| Padma (Bohar) | - | - | 109,650 | 35,419 | 74,311 | - | - | - | - | 219,880 |
| Jumuna (Aricha Ferry Ghat) | - | - | - | - | - | 60,526 | 284,314 | 82,049 | - | 426,889 |
| Meghna (nil Kamol Shoal) | - | - | - | 133,863 | 123,535 | 393,798 | - | 621,547 | 474,182 | 1,746,925 |
| Lakhya (Basundia) | 105,000 | 31,472 | 105,677 | 84,051 | 111,068 | - | 44,140 | 24,138 | - | 505,546 |
| Lakhya (Gop Char) | 162,000 | 241,000 | 338,000 | 252,000 | 149,000 | 214,000 | 242,000 | - | 97,040 | 1,695,040 |
| Barisal Port | - | 82,849 | 9,482 | - | 61,645 | 81,994 | 87,454 | - | - | 323,424 |
| Talta'a Canal (Ichamati) | - | - | 122,399 | 57,890 | 122,588 | - | - | - | - | 610,269 |
| Gabkhan S. (Gabkhan) | 56,000 | - | 7,796 | - | - | 75,058 | - | - | - | 138,854 |

Source: BIWTA




Source: BIWTA

**Fig. 4.3.17 Details of Bakatabali Shoal Dredging**

## 3-4 Earthquakes

### 3-4-1 Earthquakes in Bangladesh

In pursuance of a Government directive, a Committee of experts reviewed the available data on earthquakes in Bangladesh, prepared a seismic zoning map, and suggested an outline of a code for earthquake resistant design of structures.

During the last one hundred years widespread damages were caused by only the Great Earthquake of 1897 which had its epicentral tract in the Shillong Plateau. Two othe major earthquakes, the Bengal Earthquake of 1885 and the Stimangal Earthquake of 1918 caused severe damages only in limited areas surrounding their epicentres. The present geological information does not indicate the existence of seismically active faults within the country. However north and east of Bangladesh, there are areas of high seismic activity in India and Burma and earthquakes originating in these areas affect adjacent regions of Bangladesh.

Bangladesh has been divided into three seismic zones. The northeastern part that includes the towns of Sylhet, Mymensingh and Rangpur are in Zone I, the most active seismic zone where an earthquake shock with a maximum intensity of the IX on the Modified Mercalli Scale is possible. Zone II includes the towns of Dinajpur, Bogra, Dacca and Chittagong. Here, shocks of itensity VIII are possible. The southwestern part, the least active region, where the maximum intensity is not likely to exceed VII, is in Zone III. The suggested Basic Horizontal Seismic Co-efficients are 0.08 for Zone I, 0.05 for Zone II, and 0.04 for Zone III. The outlines of the code for earthquake resistant design of structures presented in the report relate to normal buildings with a height of not

more than 200 feet. It has been suggested that for taller buildings, a dynamic analysis should be performed, with ground acceleration inputs appropriate for the probable maximum intensity of the particular zone.

Measures for minimization of earthquake damages can be effective only with full public co-operation. It has been suggested that mass awareness about earthquake damages and possible minimization measures should be generated through the information media, particularly in high earthquake zones.

Observational facilities for earthquakes are practically non-existant and lack of proper records has been a limiting factor in the seismicity evaluation of the country. Recommendations have been made for setting up three observatories in the country as early as possible including shifting the present Chittagong Observatory. The suggested locations for the other two are in the Sylhet and Dinajpur districts.

## 3-4-2 Outline of the code for earthquake resistant design

### (1) General

This Chapter presents in accordance with the second terms of reference of the Committee, an outline of the code for the Earthquake Resistant Design of Buildings. As already mentioned in Chapter I, a Committee appointed by the Ministry of Public Works and Urban Development is working on the formulation of a comprehensive National Building Code, which will contain detailed provisions for Earthquake Resistant Design of Structures.

Earthquake resistant design involves economic considerations and probabilities. It is entirely possible to design most structures to resist the greatest earthquake experienced so far with no damage. However, in view of the small probabilities of occurrence of major earthquakes at any specific location and the additional cost that may be involved, such investment would not be warranted.

The forces recommended hereinafter for consideration in the design of buildings are such that the buildings would not collapse in the event of the rarely occurring major earthquakes, although they might be subjected to damage. The main aim of this code is to ensure that structures are able to stand without structural damage through shocks of moderate intensities.

This code is meant only for normal buildings with a height of not more than 200 feet. In case of taller building, a dynamic analysis should be performed, with the ground acceleration inputs appropriate for the probable maximum intensity for the particular zone.

It should be emphasized that the performance of a building during earthquake is not necessarily related to the forces

which have been considered in its design. For example, a building, designed for a very high lateral force, but with little flexibility or energy absorbing mechanism, may have a performance inferior to a building designed for a smaller seismic force, but with a high flexibility. The aim of major earthquake resistant structural design, should therefore be to ensure the maximum possible elastic behaviour. This can be ensured by proper detailing of joints and connections.

(2) Base Shear

The shear force at the base of a building is given by the following formula;

$$V = ZIKCS$$

where Z is the basic seismic coefficient for the particular zone

I = importance factor shown in table 4.2
K = a factor to take into account structural type
C = a factor depending on the flexibility of the structure
S = soil foundation factor.

(3) Basic Beismic Coefficient (Z)

The basic seismic coefficient for the three different zones shown in the Seismic Zoning map are as follows:

| | |
|---|---|
| Zone I | Z = 0.08 |
| Zone II | Z = 0.05 |
| Zone III | Z = 0.04 |

The basic seismic coefficients for important cities and towns are shown in Table 4.4.1.

Table 4.4.1 Basic Seismic Coefficient Z

| | | | | | |
|---|---|---|---|---|---|
| Barisal | : 0.04 | Faridpur | : 0.04 | Patuakhali | : 0.04 |
| Bogra | : 0.05 | Jessore | : 0.04 | Rajshahi | : 0.04 |
| Chittagong | : 0.05 | Khulna | : 0.04 | Rangpur | : 0.08 |
| Comilla | : 0.05 | Kushtia | : 0.04 | Rangamati | : 0.05 |
| Cox's Bazar | : 0.05 | Mymensingh | : 0.08 | Sylhet | : 0.08 |
| Dacca | : 0.05 | Noakhali | : 0.04 | Tangail | : 0.05 |
| Dinajpur | : 0.05 | Pabna | : 0.04 | | |

(4) Importance Factor I

The I coefficient provides for higher force levels to be considered in the design of structures housing certain important facilities. Experience from past earthquakes has shown that some buildings, e.g. hospitals, telephone exchanges and fire stations, are called upon to play important roles in postdisaster activities. These have been assigned an importance factor of 1.5. There are certain other types of buildings, e.g. cinema halls, auditoriums, etc. where collapse may affect a large number of occupants under one roof. These buildings are also assigned an importance factor of 1.5.

Table 4.4.2

Importance Factor I — Design Life

| Type of Occupancy | value of Factor, I (See note) |
|---|---|
| Essential facilities (e.g. hospitals, telephone exchange and fire brigade) | 1.5 |
| Community Structures and Assembly halls (e.g. cinemas, auditorium, schools) | 1.5 |
| All others | 1.0 |

Note: The values of importance factor, I, given above are for guidance. A designer may choose suitable values depending on the importance based on economy, strategy and other considerations.

(5) Structural System Factor, K

This factor depends on the type of structural system and the nature of the structure itself. It is related to the elasticity or flexibility and the damping characteristics of the structure. Structural systems which are considered flexible and/or have a history of good performance in past earthquakes are assigned lower values of K and those which are considered brittle (i.e. with little or no flexibility) are assigned higher values of K as shown in the following table:

Table 4.4.3

| Structural System | Value of K |
|---|---|
| Buildings with a ductile moment resisting space frame, designed to resist the total required lateral force. | 0.67 |
| Buildings with a dual bracing system (shear wall plus ductile moment resisting space frame) | 0.80 |
| Buildings with a Box System | 1.33 |
| All other building framing System | 1.00 |

(6) Structure Flexibility factor, C

This factor defining the flexibility of the structure is a function of the fundamental time period of the building, T.

In the absence of reliable values of the theoretical or experimental values of T, the approximate expressions may be used for calculating T of regular structures:

i) For moment resisting space frames without bracing or shear walls

$$T = \frac{N}{10} \text{ Secs.}$$

ii) For all others

$$T = \frac{0'05H}{\sqrt{D}} \text{ Sec.}$$

where H = height of the building in ft.
D = maximum base dimension parallel to the applied face.
C = may be found from Table 4.4.4.

Table 4.4.4

| T. Sec. | C | T. Sec. | C |
|---|---|---|---|
| 0'35 | 1'0 | 1'6 | 0'33 |
| 0'4 | 0'90 | 1'8 | 0'33 |
| 0'6 | 0'75 | 2'0 | 0'30 |
| 0'8 | 0'62 | 2'2 | 0'27 |
| 1'0 | 0'54 | 2'4 | 0'25 |
| 1'2 | 0'48 | 2'6 | 0'23 |
| 1'4 | 0'42 | 2'8 | 0'21 |
| | | 3'0 | 0'20 |
| | | < 3'0 | 0'20 |

(7) Soil-foundation factor, S

This factor depends on the nature of soil and the type of foundation system used in the structure. The value of S lies between 1.0 and 1.5. Table 4.4.5 gives the values of S to be different cases.

Table 4.4.5

| Type of soil mainly constituting the foundation | Foundation type | | | | | |
|---|---|---|---|---|---|---|
| | Piles resting on Rock or Hard soils | Piles resting on Medium or soft soil | Raft foundations | Combined Isolated R.C.C. footing with tie beams | Isolated R.C.C footing without tie beams | Well Foundations |
| Rock or hard soils(includes sand clay mixture with N 30) | 1.0 | - | 1.0 | 1.0 | 1.0 | 1.0 |
| Medium soils N 15 | 1.0 | 1.0 | 1.0 | 1.0 | 1.2 | 1.2 |
| Soft soils N 15 | 1.0 | 1.2 | 1.0 | 1.2 | 1.5 | 1.5 |

# APPENDIX 4

## DEMAND FORECAST

(related to Chapter 6)

## 4-1 Macroeconomic Framework

## Table 6.1.1 Gross Regional Product in 1978/79 at Constant 1983/84 Prices

(Unit:million Taka)

| | District | Agricul | Indust. | Constr. | Power | Transp. | Others | G.R.P. |
|---|---|---|---|---|---|---|---|---|
| 1 | Chittagong | 9401 | 8308 | 1071 | 96 | 1742 | 6322 | 26940 |
| 2 | Chit.H.T. | 5678 | 663 | 127 | 15 | 127 | 1346 | 7957 |
| 3 | Comilla | 10880 | 1494 | 1343 | 179 | 1453 | 6141 | 21489 |
| 4 | Noakhali | 6907 | 542 | 792 | 26 | 451 | 3688 | 12406 |
| 5 | Sylhet | 10059 | 1275 | 1131 | 50 | 1053 | 5100 | 18668 |
| 6 | Dhaka | 12599 | 9191 | 1726 | 141 | 3248 | 9651 | 36556 |
| 7 | Faridpur | 8448 | 265 | 933 | 22 | 855 | 3692 | 14215 |
| 8 | Jamalpur | 4506 | 105 | 484 | 7 | 243 | 1981 | 7325 |
| 9 | Mymensingh | 12816 | 408 | 1294 | 17 | 850 | 5596 | 20981 |
| 10 | Tangail | 5213 | 253 | 449 | 12 | 423 | 2143 | 8494 |
| 11 | Barisal | 7833 | 170 | 964 | 26 | 809 | 4269 | 14071 |
| 12 | Jessore | 7785 | 509 | 713 | 29 | 664 | 3577 | 13277 |
| 13 | Khulna | 8250 | 1535 | 838 | 45 | 909 | 4196 | 15773 |
| 14 | Kushtia | 4024 | 423 | 401 | 31 | 267 | 1947 | 7093 |
| 15 | Patuakhali | 3368 | 60 | 373 | 14 | 201 | 1602 | 5620 |
| 16 | Bogra | 5427 | 160 | 532 | 21 | 372 | 2444 | 8955 |
| 17 | Dinajpur | 6590 | 432 | 633 | 17 | 373 | 2904 | 10950 |
| 18 | Pabna | 5747 | 552 | 613 | 26 | 489 | 2745 | 10172 |
| 19 | Rajshahi | 9344 | 386 | 964 | 22 | 1150 | 4427 | 16293 |
| 20 | Rangpur | 12358 | 532 | 1243 | 24 | 752 | 5308 | 20217 |
| | Bangladesh | 157232 | 27265 | 16623 | 821 | 16432 | 79078 | 297451 |

Source : Statistical Yearbook of Bangladesh (BBS, 1984/85)

## Table 6.1.2 Gross Regional Product in 1979/80 at Constant 1983/84 Prices

(Unit:million Taka)

| | District | Agricul | Indust. | Constr. | Power | Transp. | Others | G.R.P. |
|---|---|---|---|---|---|---|---|---|
| 1 | Chittagong | 9723 | 9033 | 912 | 94 | 1725 | 7085 | 28572 |
| 2 | Chit.H.T. | 5113 | 726 | 108 | 15 | 135 | 1559 | 7656 |
| 3 | Comilla | 10452 | 1664 | 1145 | 298 | 1463 | 6594 | 21615 |
| 4 | Noakhali | 6534 | 604 | 676 | 24 | 633 | 3826 | 12298 |
| 5 | Sylhet | 11037 | 1391 | 963 | 52 | 1139 | 5957 | 20539 |
| 6 | Dhaka | 11458 | 10021 | 1472 | 134 | 3405 | 10833 | 37323 |
| 7 | Faridpur | 7654 | 292 | 795 | 21 | 903 | 4059 | 13725 |
| 8 | Jamalpur | 4275 | 114 | 412 | 6 | 272 | 2164 | 7245 |
| 9 | Mymensingh | 12548 | 449 | 1104 | 15 | 895 | 6177 | 21187 |
| 10 | Tangail | 4693 | 283 | 384 | 12 | 438 | 2309 | 8119 |
| 11 | Barisal | 7621 | 192 | 822 | 26 | 845 | 4817 | 14323 |
| 12 | Jessore | 6374 | 554 | 607 | 33 | 694 | 3691 | 11954 |
| 13 | Khulna | 8641 | 1656 | 715 | 47 | 1198 | 4863 | 17120 |
| 14 | Kushtia | 3441 | 463 | 341 | 29 | 260 | 2097 | 6632 |
| 15 | Patuakhali | 3495 | 68 | 318 | 11 | 228 | 1837 | 5957 |
| 16 | Bogra | 4912 | 175 | 454 | 18 | 373 | 2619 | 8551 |
| 17 | Dinajpur | 6160 | 481 | 539 | 20 | 390 | 3070 | 10679 |
| 18 | Pabna | 5110 | 606 | 522 | 27 | 565 | 3046 | 9875 |
| 19 | Rajshahi | 8753 | 422 | 822 | 23 | 1187 | 4741 | 15948 |
| 20 | Rangpur | 13435 | 588 | 1059 | 24 | 788 | 6134 | 22029 |
| | Bangladesh | 151449 | 29782 | 14169 | 932 | 17536 | 87480 | 301347 |

Source : Statistical Yearbook of Bangladesh (BBS, 1984/85)

## Table 6.1.3 Gross Regional Product in 1980/81 at Constant 1983/84 Prices

(Unit:million Taka)

| | District | Agricul | Indust. | Constr. | Power | Transp. | Others | G.R.P. |
|---|---|---|---|---|---|---|---|---|
| 1 | Chittagong | 8935 | 9595 | 1160 | 96 | 2470 | 7759 | 30015 |
| 2 | Chit.H.T. | 5904 | 766 | 139 | 17 | 193 | 1528 | 8545 |
| 3 | Comilla | 9977 | 1730 | 1456 | 343 | 2090 | 7335 | 22930 |
| 4 | Noakhali | 6029 | 628 | 860 | 25 | 930 | 4050 | 12521 |
| 5 | Sylhet | 11196 | 1463 | 1226 | 55 | 1660 | 6481 | 22080 |
| 6 | Dhaka | 10742 | 10619 | 1873 | 156 | 5187 | 12106 | 40683 |
| 7 | Faridpur | 7040 | 306 | 1011 | 23 | 1288 | 4522 | 14190 |
| 8 | Jamalpur | 4379 | 121 | 525 | 7 | 412 | 2328 | 7771 |
| 9 | Mymensingh | 12061 | 466 | 1404 | 17 | 1225 | 6664 | 21835 |
| 10 | Tangail | 4387 | 295 | 488 | 11 | 617 | 2456 | 8253 |
| 11 | Barisal | 7510 | 200 | 1045 | 29 | 1219 | 5169 | 15172 |
| 12 | Jessore | 6226 | 587 | 773 | 34 | 1069 | 3993 | 12682 |
| 13 | Khulna | 8481 | 1771 | 909 | 51 | 1820 | 5132 | 18164 |
| 14 | Kushtia | 3625 | 490 | 434 | 30 | 376 | 2325 | 7281 |
| 15 | Patuakhali | 3525 | 70 | 405 | 11 | 331 | 2034 | 6376 |
| 16 | Bogra | 5406 | 186 | 576 | 19 | 555 | 2926 | 9668 |
| 17 | Dinajpur | 7157 | 503 | 686 | 19 | 541 | 3522 | 12428 |
| 18 | Pabna | 5369 | 639 | 665 | 30 | 848 | 3346 | 10898 |
| 19 | Rajshahi | 9023 | 444 | 1045 | 25 | 1288 | 5215 | 17040 |
| 20 | Rangpur | 13102 | 616 | 1348 | 26 | 1132 | 6541 | 22766 |
| | Bangladesh | 150073 | 31493 | 18028 | 1025 | 25249 | 95431 | 321299 |

Source : Statistical Yearbook of Bangladesh (BBS, 1984/85)

## Table 6.1.4 Gross Regional Product in 1981/82 at Constant 1983/84 Prices

(Unit:million Taka)

| | District | Agricul | Indust. | Constr. | Power | Transp. | Others | G.R.P. |
|---|---|---|---|---|---|---|---|---|
| 1 | Chittagong | 8694 | 9567 | 1250 | 113 | 2306 | 7709 | 29638 |
| 2 | Chit.H.T. | 5871 | 766 | 149 | 16 | 670 | 1481 | 8953 |
| 3 | Comilla | 10771 | 1743 | 1568 | 397 | 2377 | 7497 | 24353 |
| 4 | Noakhali | 5551 | 633 | 925 | 27 | 1089 | 4002 | 12228 |
| 5 | Sylhet | 10561 | 1465 | 1321 | 58 | 1802 | 6415 | 21621 |
| 6 | Dhaka | 10532 | 10600 | 2017 | 193 | 5884 | 12138 | 41365 |
| 7 | Faridpur | 7794 | 308 | 1088 | 26 | 1492 | 4622 | 15331 |
| 8 | Jamalpur | 4006 | 120 | 565 | 9 | 493 | 2278 | 7471 |
| 9 | Mymensingh | 12759 | 468 | 1512 | 21 | 1202 | 6744 | 22705 |
| 10 | Tangail | 4698 | 297 | 525 | 12 | 731 | 2499 | 8763 |
| 11 | Barisal | 7049 | 202 | 1126 | 32 | 1481 | 5142 | 15032 |
| 12 | Jessore | 6808 | 586 | 832 | 38 | 1143 | 4091 | 13498 |
| 13 | Khulna | 8196 | 1761 | 979 | 59 | 1901 | 5094 | 17990 |
| 14 | Kushtia | 3687 | 488 | 468 | 32 | 390 | 2343 | 7408 |
| 15 | Patuakhali | 3845 | 71 | 436 | 11 | 365 | 2071 | 6798 |
| 16 | Bogra | 5217 | 185 | 621 | 20 | 599 | 2897 | 9537 |
| 17 | Dinajpur | 6228 | 504 | 739 | 22 | 599 | 3364 | 11455 |
| 18 | Pabna | 5792 | 639 | 716 | 32 | 796 | 3414 | 11388 |
| 19 | Rajshahi | 9170 | 444 | 1126 | 28 | 1285 | 5228 | 17282 |
| 20 | Rangpur | 11902 | 618 | 1453 | 31 | 1375 | 6341 | 21720 |
| | Bangladesh | 149130 | 31466 | 19416 | 1174 | 27978 | 95370 | 324534 |

Source : Statistical Yearbook of Bangladesh (BBS, 1984/85)

## Table 6.1.5 Gross Regional Product in 1982/83 at Constant 1983/84 Prices

(Unit:million Taka)

| District | Agricul | Indust. | Constr. | Power | Transp. | Others | G.R.P. |
|---|---|---|---|---|---|---|---|
| 1 Chittagong | 9914 | 9883 | 1128 | 191 | 2439 | 7839 | 31304 |
| 2 Chit.H.T. | 7172 | 799 | 135 | 34 | 769 | 1663 | 10572 |
| 3 Comilla | 10936 | 1874 | 1417 | 240 | 2452 | 7526 | 24445 |
| 4 Noakhali | 6190 | 680 | 835 | 54 | 1117 | 4095 | 12971 |
| 5 Sylhet | 11315 | 1526 | 1193 | 166 | 1866 | 6498 | 22564 |
| 6 Dhaka | 10546 | 11001 | 1821 | 447 | 6111 | 12293 | 42219 |
| 7 Faridpur | 7751 | 327 | 984 | 50 | 1547 | 4571 | 15230 |
| 8 Jamalpur | 4778 | 124 | 510 | 16 | 504 | 2385 | 8317 |
| 9 Mymensingh | 13622 | 494 | 1365 | 41 | 1242 | 6835 | 23599 |
| 10 Tangail | 5422 | 320 | 474 | 26 | 756 | 2595 | 9593 |
| 11 Barisal | 7288 | 219 | 1018 | 64 | 1525 | 5188 | 15302 |
| 12 Jessore | 6750 | 608 | 751 | 76 | 1195 | 4098 | 13478 |
| 13 Khulna | 8606 | 1797 | 884 | 119 | 2138 | 5104 | 18648 |
| 14 Kushtia | 3474 | 505 | 422 | 65 | 403 | 2328 | 7197 |
| 15 Patuakhali | 3916 | 77 | 394 | 25 | 377 | 2057 | 6846 |
| 16 Bogra | 5530 | 191 | 561 | 41 | 617 | 2935 | 9875 |
| 17 Dinajpur | 6683 | 539 | 667 | 43 | 618 | 3407 | 11958 |
| 18 Pabna | 5714 | 670 | 646 | 64 | 821 | 3404 | 11320 |
| 19 Rajshahi | 9168 | 464 | 1016 | 57 | 1333 | 5219 | 17258 |
| 20 Rangpur | 13768 | 658 | 1312 | 62 | 1399 | 6566 | 23764 |
| Bangladesh | 158543 | 32757 | 17536 | 1881 | 29228 | 96606 | 336550 |

Source : Statistical Yearbook of Bangladesh (BBS, 1984/85)

## Table 6.1.6 Gross Regional Product in 1983/84

(Unit:million Taka)

| District | Agricul | Indust. | Constr. | Power | Transp. | Others | G.D.P. |
|---|---|---|---|---|---|---|---|
| 1 Chittagong | 11164 | 9352 | 1165 | 184 | 2180 | 8350 | 32395 |
| 2 Chit.H.T. | 8536 | 756 | 139 | 37 | 691 | 1912 | 12071 |
| 3 Comilla | 11871 | 1759 | 1462 | 241 | 2184 | 8105 | 25622 |
| 4 Noakhali | 6603 | 639 | 862 | 67 | 987 | 4404 | 13562 |
| 5 Sylhet | 12263 | 1441 | 1230 | 174 | 1662 | 6943 | 23713 |
| 6 Dhaka | 11516 | 10400 | 1880 | 451 | 5470 | 13047 | 42764 |
| 7 Faridpur | 8341 | 308 | 1015 | 53 | 1380 | 4944 | 16041 |
| 8 Jamalpur | 4827 | 117 | 527 | 17 | 447 | 2549 | 8484 |
| 9 Mymensingh | 13694 | 465 | 1409 | 40 | 1102 | 7263 | 23973 |
| 10 Tangail | 5607 | 301 | 489 | 28 | 674 | 2772 | 9871 |
| 11 Barisal | 7892 | 205 | 1050 | 66 | 1359 | 5598 | 16170 |
| 12 Jessore | 7054 | 575 | 775 | 81 | 1060 | 4393 | 13938 |
| 13 Khulna | 9487 | 1704 | 913 | 118 | 1910 | 5523 | 19655 |
| 14 Kushtia | 3814 | 479 | 436 | 70 | 354 | 2519 | 7672 |
| 15 Patuakhali | 4368 | 72 | 406 | 26 | 336 | 2239 | 7447 |
| 16 Bogra | 6126 | 180 | 578 | 50 | 544 | 3197 | 10675 |
| 17 Dinajpur | 6867 | 507 | 689 | 46 | 543 | 3632 | 12284 |
| 18 Pabna | 5835 | 632 | 667 | 72 | 725 | 3628 | 11559 |
| 19 Rajshahi | 9824 | 438 | 1049 | 57 | 1178 | 5636 | 18182 |
| 20 Rangpur | 13639 | 619 | 1354 | 61 | 1227 | 6944 | 23844 |
| Bangladesh | 169328 | 30949 | 18095 | 1939 | 26013 | 103598 | 349922 |

Source : Statistical Yearbook of Bangladesh (BBS, 1984/85)

## Table 6.1.7 Gross Regional Product Share in 1978/79

(Unit:percent)

| | District | Agricul | Indust. | Constr. | Power | Transp. | Others | G.R.P. |
|---|---|---|---|---|---|---|---|---|
| 1 | Chittagong | 6.0 | 30.5 | 6.4 | 11.7 | 10.6 | 8.0 | 9.1 |
| 2 | Chit.H.T. | 3.6 | 2.4 | 0.8 | 1.9 | 0.8 | 1.7 | 2.7 |
| 3 | Comilla | 6.9 | 5.5 | 8.1 | 21.8 | 8.8 | 7.8 | 7.2 |
| 4 | Noakhali | 4.4 | 2.0 | 4.8 | 3.1 | 2.7 | 4.7 | 4.2 |
| 5 | Sylhet | 6.4 | 4.7 | 6.8 | 6.1 | 6.4 | 6.4 | 6.3 |
| 6 | Dhaka | 8.0 | 33.7 | 10.4 | 17.2 | 19.8 | 12.2 | 12.3 |
| 7 | Faridpur | 5.4 | 1.0 | 5.6 | 2.7 | 5.2 | 4.7 | 4.8 |
| 8 | Jamalpur | 2.9 | 0.4 | 2.9 | 0.8 | 1.5 | 2.5 | 2.5 |
| 9 | Mymensingh | 8.2 | 1.5 | 7.8 | 2.1 | 5.2 | 7.1 | 7.1 |
| 10 | Tangail | 3.3 | 0.9 | 2.7 | 1.5 | 2.6 | 2.7 | 2.9 |
| 11 | Barisal | 5.0 | 0.6 | 5.8 | 3.1 | 4.9 | 5.4 | 4.7 |
| 12 | Jessore | 5.0 | 1.9 | 4.3 | 3.6 | 4.0 | 4.5 | 4.5 |
| 13 | Khulna | 5.2 | 5.6 | 5.0 | 5.5 | 5.5 | 5.3 | 5.3 |
| 14 | Kushtia | 2.6 | 1.6 | 2.4 | 3.8 | 1.6 | 2.5 | 2.4 |
| 15 | Patuakhali | 2.1 | 0.2 | 2.2 | 1.7 | 1.2 | 2.0 | 1.9 |
| 16 | Bogra | 3.5 | 0.6 | 3.2 | 2.5 | 2.3 | 3.1 | 3.0 |
| 17 | Dinajpur | 4.2 | 1.6 | 3.8 | 2.1 | 2.3 | 3.7 | 3.7 |
| 18 | Pabna | 3.7 | 2.0 | 3.7 | 3.1 | 3.0 | 3.5 | 3.4 |
| 19 | Rajshahi | 5.9 | 1.4 | 5.8 | 2.7 | 7.0 | 5.6 | 5.5 |
| 20 | Rangpur | 7.9 | 2.0 | 7.5 | 2.9 | 4.6 | 6.7 | 6.8 |
| | Bangladesh | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 |

Source : Statistical Yearbook of Bangladesh (BBS, 1984/85)

## Table 6.1.8 Gross Regional Product Share in 1979/80

(Unit:percent)

| | District | Agricul | Indust. | Constr. | Power | Transp. | Others | G.R.P. |
|---|---|---|---|---|---|---|---|---|
| 1 | Chittagong | 6.4 | 30.3 | 6.4 | 10.1 | 9.8 | 8.1 | 9.5 |
| 2 | Chit.H.T. | 3.4 | 2.4 | 0.8 | 1.6 | 0.8 | 1.8 | 2.5 |
| 3 | Comilla | 6.9 | 5.6 | 8.1 | 32.0 | 8.3 | 7.5 | 7.2 |
| 4 | Noakhali | 4.3 | 2.0 | 4.8 | 2.6 | 3.6 | 4.4 | 4.1 |
| 5 | Sylhet | 7.3 | 4.7 | 6.8 | 5.6 | 6.5 | 6.8 | 6.8 |
| 6 | Dhaka | 7.6 | 33.6 | 10.4 | 14.4 | 19.4 | 12.4 | 12.4 |
| 7 | Faridpur | 5.1 | 1.0 | 5.6 | 2.3 | 5.1 | 4.6 | 4.6 |
| 8 | Jamalpur | 2.8 | 0.4 | 2.9 | 0.7 | 1.6 | 2.5 | 2.4 |
| 9 | Mymensingh | 8.3 | 1.5 | 7.8 | 1.6 | 5.1 | 7.1 | 7.0 |
| 10 | Tangail | 3.1 | 1.0 | 2.7 | 1.3 | 2.5 | 2.6 | 2.7 |
| 11 | Barisal | 5.0 | 0.6 | 5.8 | 2.8 | 4.8 | 5.5 | 4.8 |
| 12 | Jessore | 4.2 | 1.9 | 4.3 | 3.6 | 4.0 | 4.2 | 4.0 |
| 13 | Khulna | 5.7 | 5.6 | 5.0 | 5.1 | 6.8 | 5.6 | 5.7 |
| 14 | Kushtia | 2.3 | 1.6 | 2.4 | 3.1 | 1.5 | 2.4 | 2.2 |
| 15 | Patuakhali | 2.3 | 0.2 | 2.2 | 1.1 | 1.3 | 2.1 | 2.0 |
| 16 | Bogra | 3.2 | 0.6 | 3.2 | 2.0 | 2.1 | 3.0 | 2.8 |
| 17 | Dinajpur | 4.1 | 1.6 | 3.8 | 2.1 | 2.2 | 3.5 | 3.5 |
| 18 | Pabna | 3.4 | 2.0 | 3.7 | 2.9 | 3.2 | 3.5 | 3.3 |
| 19 | Rajshahi | 5.8 | 1.4 | 5.8 | 2.5 | 6.8 | 5.4 | 5.3 |
| 20 | Rangpur | 8.9 | 2.0 | 7.5 | 2.6 | 4.5 | 7.0 | 7.3 |
| | Bangladesh | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 |

Source : Statistical Yearbook of Bangladesh (BBS, 1984/85)

## Table 6.1.9 Gross Regional Product Share in 1980/81

(Unit:percent)

| District | Agricul | Indust. | Constr. | Power | Transp. | Others | G.R.P. |
|---|---|---|---|---|---|---|---|
| 1 Chittagong | 6.0 | 30.5 | 6.4 | 9.4 | 9.8 | 8.1 | 9.3 |
| 2 Chit.H.T. | 3.9 | 2.4 | 0.8 | 1.6 | 0.8 | 1.6 | 2.7 |
| 3 Comilla | 6.6 | 5.5 | 8.1 | 33.5 | 8.3 | 7.7 | 7.1 |
| 4 Noakhali | 4.0 | 2.0 | 4.8 | 2.4 | 3.7 | 4.2 | 3.9 |
| 5 Sylhet | 7.5 | 4.6 | 6.8 | 5.4 | 6.6 | 6.8 | 6.9 |
| 6 Dhaka | 7.2 | 33.7 | 10.4 | 15.2 | 20.5 | 12.7 | 12.7 |
| 7 Faridpur | 4.7 | 1.0 | 5.6 | 2.3 | 5.1 | 4.7 | 4.4 |
| 8 Jamalpur | 2.9 | 0.4 | 2.9 | 0.7 | 1.6 | 2.4 | 2.4 |
| 9 Mymensingh | 8.0 | 1.5 | 7.8 | 1.6 | 4.8 | 7.0 | 6.8 |
| 10 Tangail | 2.9 | 0.9 | 2.7 | 1.1 | 2.4 | 2.6 | 2.6 |
| 11 Barisal | 5.0 | 0.6 | 5.8 | 2.8 | 4.8 | 5.4 | 4.7 |
| 12 Jessore | 4.1 | 1.9 | 4.3 | 3.4 | 4.2 | 4.2 | 3.9 |
| 13 Khulna | 5.7 | 5.6 | 5.0 | 5.0 | 7.2 | 5.4 | 5.7 |
| 14 Kushtia | 2.4 | 1.6 | 2.4 | 3.0 | 1.5 | 2.4 | 2.3 |
| 15 Patuakhali | 2.3 | 0.2 | 2.2 | 1.1 | 1.3 | 2.1 | 2.0 |
| 16 Bogra | 3.6 | 0.6 | 3.2 | 1.9 | 2.2 | 3.1 | 3.0 |
| 17 Dinajpur | 4.8 | 1.6 | 3.8 | 1.9 | 2.1 | 3.7 | 3.9 |
| 18 Pabna | 3.6 | 2.0 | 3.7 | 3.0 | 3.4 | 3.5 | 3.4 |
| 19 Rajshahi | 6.0 | 1.4 | 5.8 | 2.4 | 5.1 | 5.5 | 5.3 |
| 20 Rangpur | 8.7 | 2.0 | 7.5 | 2.6 | 4.5 | 6.9 | 7.1 |
| Bangladesh | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 |

Source : Statistical Yearbook of Bangladesh (BBS, 1984/85)

## Table 6.1.10 Gross Regional Product Share in 1981/82

(Unit:percent)

| District | Agricul | Indust. | Constr. | Power | Transp. | Others | G.R.P. |
|---|---|---|---|---|---|---|---|
| 1 Chittagong | 5.8 | 30.4 | 6.4 | 9.6 | 8.2 | 8.1 | 9.1 |
| 2 Chit.H.T. | 3.9 | 2.4 | 0.8 | 1.4 | 2.4 | 1.6 | 2.8 |
| 3 Comilla | 7.2 | 5.5 | 8.1 | 33.8 | 8.5 | 7.9 | 7.5 |
| 4 Noakhali | 3.7 | 2.0 | 4.8 | 2.3 | 3.9 | 4.2 | 3.8 |
| 5 Sylhet | 7.1 | 4.7 | 6.8 | 4.9 | 6.4 | 6.7 | 6.7 |
| 6 Dhaka | 7.1 | 33.7 | 10.4 | 16.5 | 21.0 | 12.7 | 12.7 |
| 7 Faridpur | 5.2 | 1.0 | 5.6 | 2.2 | 5.3 | 4.8 | 4.7 |
| 8 Jamalpur | 2.7 | 0.4 | 2.9 | 0.7 | 1.8 | 2.4 | 2.3 |
| 9 Mymensingh | 8.6 | 1.5 | 7.8 | 1.8 | 4.3 | 7.1 | 7.0 |
| 10 Tangail | 3.2 | 0.9 | 2.7 | 1.0 | 2.6 | 2.6 | 2.7 |
| 11 Barisal | 4.7 | 0.6 | 5.8 | 2.7 | 5.3 | 5.4 | 4.6 |
| 12 Jessore | 4.6 | 1.9 | 4.3 | 3.2 | 4.1 | 4.3 | 4.2 |
| 13 Khulna | 5.5 | 5.6 | 5.0 | 5.0 | 6.8 | 5.3 | 5.5 |
| 14 Kushtia | 2.5 | 1.6 | 2.4 | 2.7 | 1.4 | 2.5 | 2.3 |
| 15 Patuakhali | 2.6 | 0.2 | 2.2 | 0.9 | 1.3 | 2.2 | 2.1 |
| 16 Bogra | 3.5 | 0.6 | 3.2 | 1.7 | 2.1 | 3.0 | 2.9 |
| 17 Dinajpur | 4.2 | 1.6 | 3.8 | 1.9 | 2.1 | 3.5 | 3.5 |
| 18 Pabna | 3.9 | 2.0 | 3.7 | 2.7 | 2.8 | 3.6 | 3.5 |
| 19 Rajshahi | 6.1 | 1.4 | 5.8 | 2.4 | 4.6 | 5.5 | 5.3 |
| 20 Rangpur | 8.0 | 2.0 | 7.5 | 2.6 | 4.9 | 6.6 | 6.7 |
| Bangladesh | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 |

Source : Statistical Yearbook of Bangladesh (BBS, 1984/85)

## Table 6.1.11 Gross Regional Product Share in 1982/83

(Unit:percent)

| District | Agricul | Indust. | Constr. | Power | Transp. | Others | G.R.P. |
|---|---|---|---|---|---|---|---|
| 1 Chittagong | 6.3 | 30.2 | 6.4 | 10.2 | 8.3 | 8.1 | 9.3 |
| 2 Chit.H.T. | 4.5 | 2.4 | 0.8 | 1.8 | 2.6 | 1.7 | 3.1 |
| 3 Comilla | 6.9 | 5.7 | 8.1 | 12.8 | 8.4 | 7.8 | 7.3 |
| 4 Noakhali | 3.9 | 2.1 | 4.8 | 2.9 | 3.8 | 4.2 | 3.9 |
| 5 Sylhet | 7.1 | 4.7 | 6.8 | 8.8 | 6.4 | 6.7 | 6.7 |
| 6 Dhaka | 6.7 | 33.6 | 10.4 | 23.8 | 20.9 | 12.7 | 12.5 |
| 7 Faridpur | 4.9 | 1.0 | 5.6 | 2.7 | 5.3 | 4.7 | 4.5 |
| 8 Jamalpur | 3.0 | 0.4 | 2.9 | 0.9 | 1.7 | 2.5 | 2.5 |
| 9 Mymensingh | 8.6 | 1.5 | 7.8 | 2.2 | 4.2 | 7.1 | 7.0 |
| 10 Tangail | 3.4 | 1.0 | 2.7 | 1.4 | 2.6 | 2.7 | 2.9 |
| 11 Barisal | 4.6 | 0.7 | 5.8 | 3.4 | 5.2 | 5.4 | 4.5 |
| 12 Jessore | 4.3 | 1.9 | 4.3 | 4.0 | 4.1 | 4.2 | 4.0 |
| 13 Khulna | 5.4 | 5.5 | 5.0 | 6.3 | 7.3 | 5.3 | 5.5 |
| 14 Kushtia | 2.2 | 1.5 | 2.4 | 3.5 | 1.4 | 2.4 | 2.1 |
| 15 Patuakhali | 2.5 | 0.2 | 2.2 | 1.3 | 1.3 | 2.1 | 2.0 |
| 16 Bogra | 3.5 | 0.6 | 3.2 | 2.2 | 2.1 | 3.0 | 2.9 |
| 17 Dinajpur | 4.2 | 1.6 | 3.8 | 2.3 | 2.1 | 3.5 | 3.6 |
| 18 Pabna | 3.6 | 2.0 | 3.7 | 3.4 | 2.8 | 3.5 | 3.4 |
| 19 Rajshahi | 5.8 | 1.4 | 5.8 | 3.0 | 4.6 | 5.4 | 5.1 |
| 20 Rangpur | 8.7 | 2.0 | 7.5 | 3.3 | 4.8 | 6.8 | 7.1 |
| Bangladesh | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 |

Source : Statistical Yearbook of Bangladesh (BBS, 1984/85)

## Table 6.1.12 Gross Regional Product Share in 1983/84

(Unit:percent)

| District | Agricul | Indust. | Constr. | Power | Transp. | Others | G.R.P. |
|---|---|---|---|---|---|---|---|
| 1 Chittagong | 6.6 | 30.2 | 6.4 | 9.5 | 8.4 | 8.1 | 9.3 |
| 2 Chit.H.T. | 5.0 | 2.4 | 0.8 | 1.9 | 2.7 | 1.8 | 3.4 |
| 3 Comilla | 7.0 | 5.7 | 8.1 | 12.4 | 8.4 | 7.8 | 7.3 |
| 4 Noakhali | 3.9 | 2.1 | 4.8 | 3.5 | 3.8 | 4.3 | 3.9 |
| 5 Sylhet | 7.2 | 4.7 | 6.8 | 9.0 | 6.4 | 6.7 | 6.8 |
| 6 Dhaka | 6.8 | 33.6 | 10.4 | 23.3 | 21.0 | 12.6 | 12.2 |
| 7 Faridpur | 4.9 | 1.0 | 5.6 | 2.7 | 5.3 | 4.8 | 4.6 |
| 8 Jamalpur | 2.9 | 0.4 | 2.9 | 0.9 | 1.7 | 2.5 | 2.4 |
| 9 Mymensingh | 8.1 | 1.5 | 7.8 | 2.1 | 4.2 | 7.0 | 6.9 |
| 10 Tangail | 3.3 | 1.0 | 2.7 | 1.4 | 2.6 | 2.7 | 2.8 |
| 11 Barisal | 4.7 | 0.7 | 5.8 | 3.4 | 5.2 | 5.4 | 4.6 |
| 12 Jessore | 4.2 | 1.9 | 4.3 | 4.2 | 4.1 | 4.2 | 4.0 |
| 13 Khulna | 5.6 | 5.5 | 5.0 | 6.1 | 7.3 | 5.3 | 5.6 |
| 14 Kushtia | 2.3 | 1.5 | 2.4 | 3.6 | 1.4 | 2.4 | 2.2 |
| 15 Patuakhali | 2.6 | 0.2 | 2.2 | 1.3 | 1.3 | 2.2 | 2.1 |
| 16 Bogra | 3.6 | 0.6 | 3.2 | 2.6 | 2.1 | 3.1 | 3.1 |
| 17 Dinajpur | 4.1 | 1.6 | 3.8 | 2.4 | 2.1 | 3.5 | 3.5 |
| 18 Pabna | 3.4 | 2.0 | 3.7 | 3.7 | 2.8 | 3.5 | 3.3 |
| 19 Rajshahi | 5.8 | 1.4 | 5.8 | 2.9 | 4.5 | 5.4 | 5.2 |
| 20 Rangpur | 8.1 | 2.0 | 7.5 | 3.1 | 4.7 | 6.7 | 6.8 |
| Bangladesh | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 |

Source : Statistical Yearbook of Bangladesh (BBS, 1984/85)

## Table 6.1.13 Gross Regional Product in 1984/85 at Constant 1983/84 Prices

(Unit:million Taka)

| | District | Agricul | Indust. | Constr. | Power | Transp. | Others | G.R.P. |
|---|---|---|---|---|---|---|---|---|
| 1 | Chittagong | 10961 | 11203 | 1272 | 152 | 2541 | 9185 | 35314 |
| 2 | Chit.H.T. | 8381 | 906 | 152 | 31 | 806 | 2103 | 12377 |
| 3 | Comilla | 11655 | 2107 | 1597 | 200 | 2546 | 8915 | 27019 |
| 4 | Noakhali | 6483 | 765 | 941 | 55 | 1151 | 4844 | 14240 |
| 5 | Sylhet | 12040 | 1726 | 1343 | 144 | 1938 | 7637 | 24828 |
| 6 | Dhaka | 11306 | 12459 | 2053 | 373 | 6377 | 14351 | 46919 |
| 7 | Faridpur | 8189 | 369 | 1108 | 44 | 1609 | 5438 | 16757 |
| 8 | Jamalpur | 4739 | 140 | 576 | 14 | 521 | 2804 | 8794 |
| 9 | Mymensingh | 13445 | 557 | 1539 | 33 | 1285 | 7989 | 24847 |
| 10 | Tangail | 5505 | 361 | 534 | 23 | 786 | 3049 | 10258 |
| 11 | Barisal | 7748 | 246 | 1147 | 55 | 1584 | 6158 | 16937 |
| 12 | Jessore | 6926 | 689 | 846 | 67 | 1236 | 4832 | 14596 |
| 13 | Khulna | 9314 | 2041 | 997 | 98 | 2227 | 6075 | 20752 |
| 14 | Kushtia | 3745 | 574 | 476 | 58 | 413 | 2771 | 8036 |
| 15 | Patuakhali | 4289 | 86 | 443 | 22 | 392 | 2463 | 7694 |
| 16 | Bogra | 6015 | 216 | 631 | 41 | 634 | 3517 | 11054 |
| 17 | Dinajpur | 6742 | 607 | 752 | 38 | 633 | 3995 | 12768 |
| 18 | Pabna | 5729 | 757 | 728 | 60 | 845 | 3991 | 12110 |
| 19 | Rajshahi | 9645 | 525 | 1146 | 47 | 1373 | 6199 | 18935 |
| 20 | Rangpur | 13391 | 742 | 1479 | 51 | 1430 | 7638 | 24730 |
| | Bangladesh | 166246 | 37075 | 19761 | 1606 | 30326 | 113952 | 368965 |

## Table 6.1.14 Gross Regional Product in 1989/90 at Constant 1983/84 Prices

(Unit:million Taka)

| | District | Agricul | Indust. | Constr. | Power | Transp. | Others | G.R.P. |
|---|---|---|---|---|---|---|---|---|
| 1 | Chittagong | 12298 | 15693 | 1677 | 237 | 3067 | 13383 | 46354 |
| 2 | Chit.H.T. | 10406 | 1086 | 200 | 50 | 1072 | 2677 | 15490 |
| 3 | Comilla | 13244 | 3060 | 2104 | 330 | 3104 | 12438 | 34279 |
| 4 | Noakhali | 7568 | 987 | 1241 | 92 | 1404 | 6613 | 17904 |
| 5 | Sylhet | 13811 | 2073 | 1770 | 237 | 2365 | 10549 | 30805 |
| 6 | Dhaka | 12298 | 17273 | 2706 | 633 | 7759 | 20310 | 60978 |
| 7 | Faridpur | 8703 | 395 | 1461 | 71 | 1958 | 7400 | 19988 |
| 8 | Jamalpur | 5487 | 99 | 758 | 24 | 628 | 3779 | 10774 |
| 9 | Mymensingh | 15325 | 592 | 2028 | 55 | 1515 | 11021 | 30536 |
| 10 | Tangail | 6243 | 395 | 704 | 34 | 961 | 4093 | 12430 |
| 11 | Barisal | 8703 | 247 | 1511 | 90 | 1958 | 8502 | 21011 |
| 12 | Jessore | 7946 | 790 | 1115 | 111 | 1515 | 6455 | 17932 |
| 13 | Khulna | 10406 | 2961 | 1314 | 158 | 2697 | 8502 | 26038 |
| 14 | Kushtia | 4352 | 691 | 627 | 92 | 517 | 3621 | 9901 |
| 15 | Patuakhali | 4730 | 49 | 584 | 34 | 480 | 3306 | 9184 |
| 16 | Bogra | 6622 | 148 | 832 | 69 | 776 | 4881 | 13327 |
| 17 | Dinajpur | 7946 | 642 | 992 | 63 | 776 | 5353 | 15772 |
| 18 | Pabna | 6622 | 839 | 960 | 98 | 1035 | 5510 | 15063 |
| 19 | Rajshahi | 10973 | 494 | 1510 | 77 | 1626 | 8344 | 23023 |
| 20 | Rangpur | 15514 | 839 | 1949 | 82 | 1737 | 10706 | 30826 |
| | Bangladesh | 189196 | 49350 | 26041 | 2638 | 36949 | 157441 | 461615 |

## Table 6.1.15 Gross Regional Product in 1994/95 at Constant 1983/84 Prices

(Unit:million Taka)

| | District | Agricul | Indust. | Constr. | Power | Transp. | Others | G.R.P. |
|---|---|---|---|---|---|---|---|---|
| 1 | Chittagong | 14572 | 24170 | 2373 | 377 | 4041 | 19145 | 64678 |
| 2 | Chit.H.T. | 12330 | 1672 | 283 | 80 | 1412 | 3829 | 19606 |
| 3 | Comilla | 15693 | 4712 | 2978 | 524 | 4090 | 17794 | 45790 |
| 4 | Noakhali | 8967 | 1520 | 1756 | 147 | 1850 | 9460 | 23700 |
| 5 | Sylhet | 16365 | 3192 | 2505 | 377 | 3116 | 15091 | 40647 |
| 6 | Dhaka | 14572 | 26602 | 3829 | 1005 | 10225 | 29055 | 85288 |
| 7 | Faridpur | 10312 | 608 | 2067 | 113 | 2581 | 10586 | 26267 |
| 8 | Jamalpur | 6501 | 152 | 1073 | 38 | 828 | 5406 | 13998 |
| 9 | Mymensingh | 18159 | 912 | 2870 | 88 | 1996 | 15766 | 39791 |
| 10 | Tangail | 7398 | 608 | 996 | 54 | 1266 | 5856 | 16179 |
| 11 | Barisal | 10312 | 380 | 2138 | 142 | 2581 | 12163 | 27717 |
| 12 | Jessore | 9416 | 1216 | 1578 | 176 | 1996 | 9235 | 23617 |
| 13 | Khulna | 12330 | 4560 | 1859 | 251 | 3554 | 12163 | 34718 |
| 14 | Kushtia | 5156 | 1064 | 888 | 147 | 682 | 5180 | 13117 |
| 15 | Patuakhali | 5605 | 76 | 827 | 54 | 633 | 4730 | 11925 |
| 16 | Bogra | 7846 | 228 | 1177 | 109 | 1022 | 6982 | 17365 |
| 17 | Dinajpur | 9416 | 988 | 1403 | 101 | 1022 | 7658 | 20588 |
| 18 | Pabna | 7846 | 1292 | 1358 | 155 | 1363 | 7883 | 19899 |
| 19 | Rajshahi | 13003 | 760 | 2136 | 121 | 2142 | 11937 | 30100 |
| 20 | Rangpur | 18383 | 1292 | 2758 | 130 | 2288 | 15316 | 40167 |
| | Bangladesh | 224183 | 76006 | 36853 | 4189 | 48690 | 225235 | 615155 |

## Table 6.1.16 Gross Regional Product in 1999/00 at Constant 1983/84 Prices

(Unit:million Taka)

| | District | Agricul | Indust. | Constr. | Power | Transp. | Others | G.R.P. |
|---|---|---|---|---|---|---|---|---|
| 1 | Chittagong | 17361 | 40111 | 3823 | 571 | 5450 | 29850 | 97166 |
| 2 | Chit.H.T. | 16026 | 2409 | 456 | 131 | 2044 | 5490 | 26555 |
| 3 | Comilla | 18697 | 7227 | 4797 | 963 | 5791 | 27448 | 64923 |
| 4 | Noakhali | 10684 | 2048 | 2829 | 206 | 2589 | 14067 | 32423 |
| 5 | Sylhet | 20032 | 4216 | 4036 | 619 | 4360 | 22988 | 56251 |
| 6 | Dhaka | 16026 | 45531 | 6169 | 1685 | 14988 | 45633 | 130032 |
| 7 | Faridpur | 11485 | 602 | 3331 | 186 | 3611 | 16469 | 35683 |
| 8 | Jamalpur | 7746 | 120 | 1729 | 62 | 1158 | 8234 | 19050 |
| 9 | Mymensingh | 21635 | 1205 | 4623 | 138 | 2657 | 24017 | 54274 |
| 10 | Tangail | 8814 | 843 | 1605 | 89 | 1771 | 8578 | 21700 |
| 11 | Barisal | 12019 | 482 | 3445 | 227 | 3475 | 18528 | 38176 |
| 12 | Jessore | 12019 | 1566 | 2543 | 289 | 2725 | 13724 | 32866 |
| 13 | Khulna | 14690 | 7107 | 2996 | 413 | 5110 | 19214 | 49529 |
| 14 | Kushtia | 6143 | 1205 | 1431 | 241 | 886 | 7548 | 17453 |
| 15 | Patuakhali | 6677 | 120 | 1332 | 83 | 886 | 7205 | 16303 |
| 16 | Bogra | 9348 | 241 | 1897 | 172 | 1431 | 10293 | 23382 |
| 17 | Dinajpur | 10951 | 1205 | 2261 | 158 | 1431 | 10979 | 26985 |
| 18 | Pabna | 9348 | 1686 | 2189 | 241 | 1771 | 12009 | 27244 |
| 19 | Rajshahi | 15492 | 843 | 3442 | 199 | 2861 | 17841 | 40679 |
| 20 | Rangpur | 21902 | 1686 | 4443 | 206 | 3134 | 22988 | 54359 |
| | Bangladesh | 267096 | 120453 | 59376 | 6879 | 68128 | 343103 | 865034 |

Table 6.1.17 Gross Regional Product in 2004/05
at Constant 1983/84 Prices

(Unit:million Taka)

| | District | Agricul | Indust. | Constr. | Power | Transp. | Others | G.R.P. |
|---|---|---|---|---|---|---|---|---|
| 1 | Chittagong | 20464 | 64998 | 6162 | 941 | 8059 | 47110 | 147734 |
| 2 | Chit.H.T. | 18889 | 3904 | 735 | 215 | 3022 | 8664 | 35430 |
| 3 | Comilla | 22038 | 11711 | 7733 | 1587 | 8563 | 43320 | 94951 |
| 4 | Noakhali | 12593 | 3318 | 4559 | 340 | 3828 | 22201 | 46840 |
| 5 | Sylhet | 23612 | 6832 | 6506 | 1020 | 6448 | 36280 | 80697 |
| 6 | Dhaka | 18869 | 73782 | 9943 | 2777 | 22164 | 72019 | 199574 |
| 7 | Faridpur | 13537 | 976 | 5368 | 306 | 5339 | 25992 | 51519 |
| 8 | Jamalpur | 9130 | 195 | 2787 | 102 | 1713 | 12996 | 26923 |
| 9 | Mymensingh | 25501 | 1952 | 7452 | 227 | 3929 | 37905 | 76965 |
| 10 | Tangail | 10389 | 1366 | 2586 | 147 | 2619 | 13537 | 30646 |
| 11 | Barisal | 14167 | 781 | 5554 | 374 | 5138 | 29241 | 55254 |
| 12 | Jessore | 14167 | 2537 | 4099 | 476 | 4030 | 21660 | 46969 |
| 13 | Khulna | 17315 | 11516 | 4829 | 680 | 7556 | 30324 | 72220 |
| 14 | Kushtia | 7241 | 1952 | 2306 | 397 | 1310 | 11913 | 25118 |
| 15 | Patuakhali | 7871 | 195 | 2147 | 136 | 1310 | 11371 | 23030 |
| 16 | Bogra | 11019 | 390 | 3057 | 283 | 2116 | 16245 | 33110 |
| 17 | Dinajpur | 12908 | 1952 | 3644 | 261 | 2116 | 17328 | 38208 |
| 18 | Pabna | 11019 | 2733 | 3528 | 397 | 2619 | 18952 | 39248 |
| 19 | Rajshahi | 18260 | 1366 | 5548 | 329 | 4231 | 28158 | 57892 |
| 20 | Rangpur | 25816 | 2733 | 7161 | 340 | 4634 | 36280 | 76964 |
| | Bangladesh | 314824 | 195190 | 95706 | 11334 | 100743 | 541496 | 1259290 |

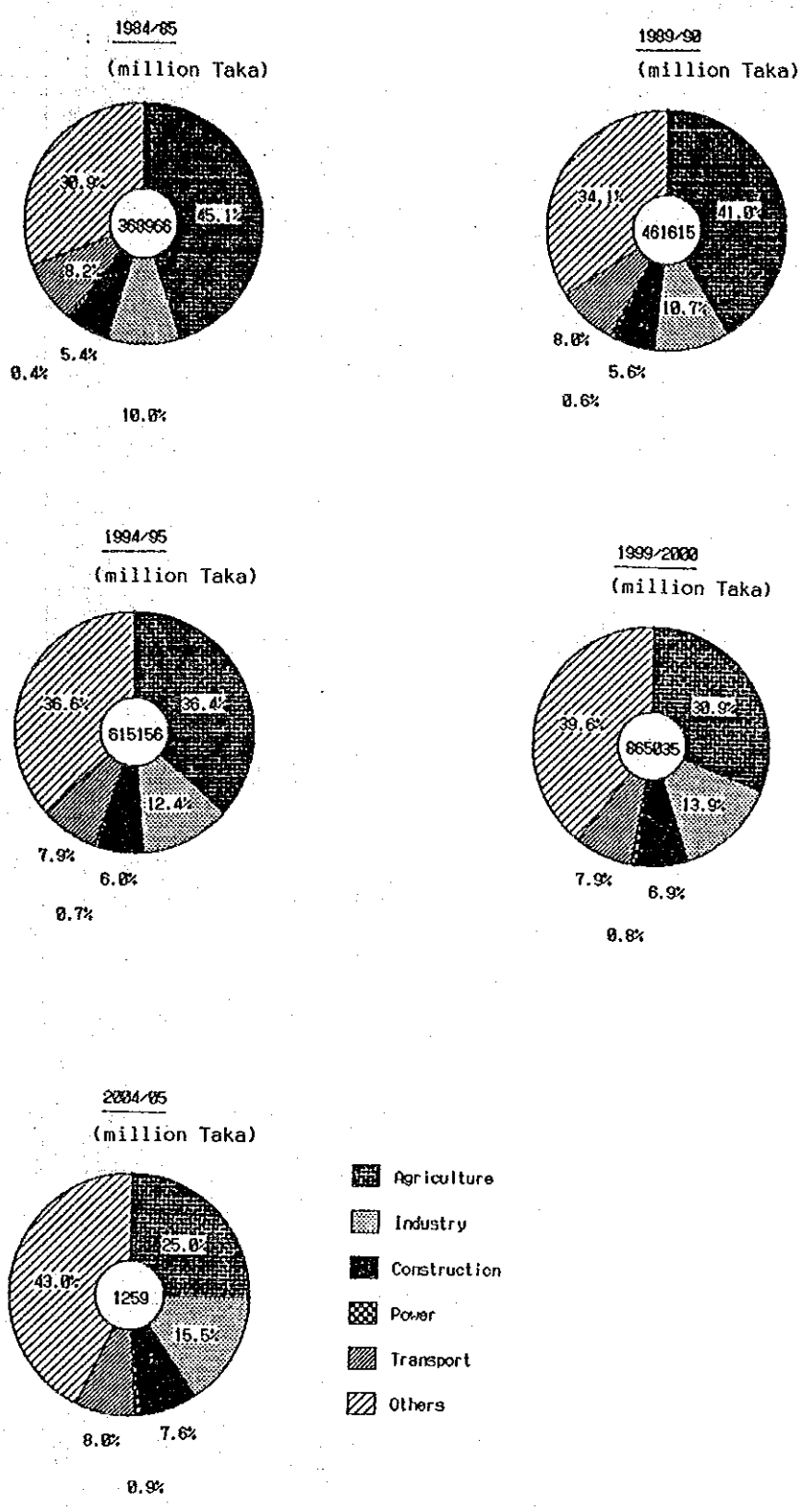



Fig. 6.1.1 Future Sectoral Shares of GDP

## 4-2 Traffic Forecast

# Table 6.2.1 Cargo Flow (All Commodities)

Unit: tons

## Incoming

| Origin & Destination \ Via Port | Origin to Jetty | | | Jetty to Destination | | |
|---|---|---|---|---|---|---|
| | Dhaka | N'ganj | Total | Dhaka | N'ganj | Total |
| Chittagong | 32,421 | 37,888 | 70,309 | 140 | 302 | 442 |
| Chit, H.T. | - | - | - | 20 | - | 20 |
| Comilla | 665 | 21,590 | 22,255 | 2,978 | 2,484 | 5,462 |
| Noakhali | - | 113 | 113 | 40 | 170 | 210 |
| Sylhet | 400 | 1,405 | 1,805 | 1,688 | - | 1,688 |
| Dhaka | 4,678 | 31,748 | 36,426 | 61,259 | 97,712 | 158,971 |
| Faridpur | 384 | 4,673 | 5,057 | 290 | 471 | 761 |
| Jamalpur | - | 2,740 | 2,740 | 295 | 3,594 | 3,889 |
| Mymensingh | - | 1,774 | 1,774 | 2,491 | 7,485 | 9,967 |
| Tangail | - | 261 | 261 | 671 | 6,743 | 7,414 |
| Barisal | 482 | 928 | 1,410 | 115 | 245 | 360 |
| Jessore | 1,382 | 209 | 1,563 | 80 | - | 80 |
| Khulna | 30,593 | 7,640 | 38,233 | - | 2 | 2 |
| Kushtia | - | - | - | - | - | - |
| Patuakhali | 87 | 11 | 98 | 1 | - | 1 |
| Bogra | - | 69 | 69 | 10 | 171 | 181 |
| Dinajpur | - | 423 | 423 | - | 78 | 78 |
| Pabna | 302 | 1,851 | 2,153 | 75 | - | 75 |
| Rajshahi | - | 495 | 495 | 15 | 200 | 215 |
| Rangpur | - | 6,037 | 6,937 | - | 200 | 200 |
| Total | 71,366 | 119,855 | 191,221 | 70,168 | 119,857 | 190,025 |

Source: OD Survey by the study team (18.2.1986 19.3.1986)

## Outgoing

| Origin & Destination \ via Port | Origin to Jetty | | | Jetty to Destination | | |
|---|---|---|---|---|---|---|
| | Dhaka | N'ganj | Total | Dhaka | N'ganj | Total |
| Chittagong | - | 51 | 51 | 30 | 653 | 683 |
| Chit, H.T. | - | - | - | - | - | - |
| Comilla | - | 159 | 159 | 57 | 2,036 | 2,093 |
| Noakhali | - | - | - | - | 13 | 13 |
| Sylhet | - | - | - | - | 30 | 30 |
| Dhaka | 1,778 | 43,568 | 45,346 | 605 | 25,326 | 25,931 |
| Faridpur | - | 360 | 360 | 139 | 78 | 217 |
| Jamalpur | - | 1,266 | 1,266 | - | 10 | 10 |
| Mymensingh | - | 4,506 | 4,506 | 167 | 1,087 | 1,254 |
| Tangail | - | 1,528 | 1,528 | - | 18 | 18 |
| Barisal | - | - | - | 407 | 104 | 511 |
| Jessore | - | - | - | 2 | 350 | 352 |
| Khulna | - | - | - | 191 | 24,961 | 25,152 |
| Kushtia | - | 6 | 6 | - | - | - |
| Patuakhali | 1 | - | 1 | 179 | - | 179 |
| Bogra | - | 136 | 136 | - | 11 | 11 |
| Dinajpur | - | 63 | 63 | - | - | - |
| Pabna | - | 41 | 41 | - | 229 | 229 |
| Rajshahi | - | 7 | 7 | - | 19 | 19 |
| Rangpur | - | 3,266 | 3,266 | - | 30 | 30 |
| Total | 1,799 | 54,957 | 56,736 | 1,777 | 54,955 | 46,732 |

Table 6.2.2 Cargo Flow (Commodity: Food grains)

Incoming

(Unit: tons)

| Origin & Destination \ Via Port | Origin to Jetty | | | Jetty to Destination | | |
|---|---|---|---|---|---|---|
| | Dhaka | N'ganj | Total | Dhaka | N'ganj | Total |
| Chittagong | 2,475 | 29,390 | 31,865 | - | - | - |
| Chit, H.T. | - | - | - | - | - | - |
| Comilla | 2 | 238 | 240 | - | - | - |
| Noakhali | - | - | - | - | - | - |
| Sylhet | - | 12 | 12 | - | - | - |
| Dhaka | 28 | 5,336 | 5,364 | 2,802 | 35,941 | 38,743 |
| Faridpur | 28 | 30 | 58 | - | - | - |
| Jamalpur | - | 19 | 19 | - | 13 | 13 |
| Mymensingh | - | 84 | 84 | - | 3 | 3 |
| Tangail | - | 6 | 6 | - | - | - |
| Barisal | 217 | 67 | 284 | - | - | - |
| Jessore | - | - | - | - | - | - |
| Khulna | 101 | 32 | 133 | - | - | - |
| Kushtia | - | - | - | - | - | - |
| Patuakhali | 30 | - | 30 | - | - | - |
| Bogra | - | 26 | 26 | - | - | - |
| Dinajpur | - | 103 | 103 | - | - | - |
| Pabna | 300 | 519 | 819 | - | - | - |
| Rajshahi | - | - | - | - | - | - |
| Rangpur | - | 63 | 63 | - | - | - |
| Total | 3,181 | 35,925 | 39,106 | 2,802 | 35,957 | 38,759 |

# Table 6.2.3 Cargo Flow (Commodity: Fertilizer)

Unit: tons

## Incoming

| Origin & Destination \ Via Port | Origin to Jetty | | | Jetty to Destination | | |
|---|---|---|---|---|---|---|
| | Dhaka | N'ganj | Total | Dhaka | N'ganj | Total |
| Chittagong | 1,200 | 7,180 | 8,380 | 100 | - | 100 |
| Chit, H.T. | - | - | - | - | - | - |
| Comilla | 600 | 14,391 | 14,991 | 1,370 | 2,461 | 3,831 |
| Noakhali | - | - | - | 40 | 170 | 210 |
| Sylhet | 400 | - | 400 | 75 | - | 75 |
| Dhaka | 400 | 13,393 | 17,814 | 5,086 | 20,937 | 26,023 |
| Faridpur | - | - | - | 80 | 470 | 550 |
| Jamalpur | - | - | - | - | 3,518 | 3,518 |
| Mymensingh | - | - | - | 42 | 7,324 | 7,366 |
| Tangail | - | - | - | 78 | 6,681 | 6,759 |
| Barisal | - | - | - | 100 | 245 | 345 |
| Jessore | - | - | - | - | - | - |
| Khulna | 350 | 7,536 | 7,886 | - | - | - |
| Kushtia | - | - | - | - | - | - |
| Patuakhali | - | - | - | - | - | - |
| Bogra | - | - | - | - | 171 | 171 |
| Dinajpur | - | - | - | - | 60 | 60 |
| Pabna | - | - | - | - | - | - |
| Rajshahi | - | - | - | - | 200 | 200 |
| Rangpur | - | - | - | - | 200 | 200 |
| Total | 6,971 | 42,500 | 49,471 | 6,971 | 42,437 | 49,408 |

Source: OD Survey by the study team (18.2.1986 19.3.1986)

## Outgoing

| Origin & Destination \ Via Port | Origin to Jetty | | | Jetty to Destination | | |
|---|---|---|---|---|---|---|
| | Dhaka | N'ganj | Total | Dhaka | N'ganj | Total |
| Chittagong | - | - | - | - | - | - |
| Chit, H.T. | - | - | - | - | - | - |
| Comilla | - | 19 | 19 | - | 349 | 349 |
| Noakhali | - | - | - | - | - | - |
| Sylhet | - | - | - | - | - | - |
| Dhaka | - | 765 | 765 | - | 338 | 338 |
| Faridpur | - | - | - | - | - | - |
| Jamalpur | - | - | - | - | - | - |
| Mymensingh | - | - | - | - | 97 | 97 |
| Tangail | - | - | - | - | - | - |
| Barisal | - | - | - | - | - | - |
| Jessore | - | - | - | - | - | - |
| Khulna | - | - | - | - | - | - |
| Kushtia | - | - | - | - | - | - |
| Patuakhali | - | - | - | - | - | - |
| Bogra | - | - | - | - | - | - |
| Dinajpur | - | - | - | - | - | - |
| Pabna | - | - | - | - | - | - |
| Rajshahi | - | - | - | - | - | - |
| Rangpur | - | - | - | - | - | - |
| Total | - | 784 | 784 | - | 784 | 784 |

Table 6.2.4 Cargo Flow (Commodity: Cement and Iron & Steel)

Unit: tons

Cement

Incoming

| Origin & Destination \ Via Port | Origin to Jetty | | | Jetty to Destination | | |
|---|---|---|---|---|---|---|
| | Dhaka | N'ganj | Total | Dhaka | N'ganj | Total |
| Chittagong | 20,833 | - | 20,833 | - | - | - |
| Chit, H.T. | - | - | - | 20 | - | 20 |
| Comilla | - | - | - | 1,608 | - | 1,608 |
| Noakhali | - | - | - | - | - | - |
| Sylhet | - | - | - | 1,090 | - | 1,090 |
| Dhaka | - | - | - | 43,251 | - | 43,251 |
| Faridpur | - | - | - | 210 | - | 210 |
| Jamalpur | - | - | - | 130 | - | 130 |
| Mymensingh | - | - | - | 1,898 | - | 1,898 |
| Tangail | - | - | - | 456 | - | 456 |
| Barisal | - | - | - | 15 | - | 15 |
| Jessore | 1,275 | - | 1,275 | 80 | - | 80 |
| Khulna | 26,749 | - | 26,749 | - | - | - |
| Kushtia | - | - | - | - | - | - |
| Patuakhali | - | - | - | - | - | - |
| Bogra | - | - | - | 10 | - | 10 |
| Dinajpur | - | - | - | - | - | - |
| Pabna | - | - | - | 75 | - | 75 |
| Rajshahi | - | - | - | 15 | - | 15 |
| Rangpur | - | - | - | - | - | - |
| Total | 48,857 | - | 48,857 | 48,858 | - | 48,858 |

Source: OD Survey by the study team (18.2.1986 19.3.1986)

Iron & Steel

Incoming

| Origin & Destination \ Via Port | Origin to Jetty | | | Jetty to Destination | | |
|---|---|---|---|---|---|---|
| | Dhaka | N'ganj | Total | Dhaka | N'ganj | Total |
| Chittagong | 901 | - | 901 | - | 5 | 5 |
| Chit, H.T. | - | - | - | - | - | - |
| Comilla | - | - | - | - | - | - |
| Noakhali | - | - | - | - | - | - |
| Sylhet | - | - | - | - | - | - |
| Dhaka | - | 28 | 28 | 921 | 23 | 944 |
| Faridpur | - | - | - | - | - | - |
| Jamalpur | - | - | - | - | - | - |
| Mymensingh | - | - | - | - | - | - |
| Tangail | - | - | - | - | - | - |
| Barisal | 7 | - | 7 | - | - | - |
| Jessore | - | - | - | - | - | - |
| Khulna | 28 | - | 28 | - | - | - |
| Kushtia | - | - | - | - | - | - |
| Patuakhali | - | - | - | - | - | - |
| Bogra | - | - | - | - | - | - |
| Dinajpur | - | - | - | - | - | - |
| Pabna | - | - | - | - | - | - |
| Rajshahi | - | - | - | - | - | - |
| Rangpur | - | - | - | - | - | - |
| Total | 936 | 28 | 964 | 921 | 28 | 949 |

# Table 6.2.5 Cargo Flow (Commodity: Jute)

Unit: tons

## Incoming

| Origin & Destination \ Via Port | Origin to Jetty | | | Jetty to Destination | | |
|---|---|---|---|---|---|---|
| | Dhaka | N'ganj | Total | Dhaka | N'ganj | Total |
| Chittagong | - | 19 | 19 | - | 228 | 228 |
| Chit, H.T. | - | - | - | - | - | - |
| Comilla | - | 6,456 | 6,456 | - | 22 | 22 |
| Noakhali | - | - | - | - | - | - |
| Sylhet | - | 1,363 | 1,363 | - | - | - |
| Dhaka | - | 12,031 | 12,031 | - | 37,545 | 37,545 |
| Faridpur | - | 4,571 | 4,571 | - | - | - |
| Jamalpur | - | 2,722 | 2,722 | - | - | - |
| Mymensingh | - | 1,650 | 1,650 | - | 37 | 37 |
| Tangail | - | 254 | 254 | - | - | - |
| Barisal | - | 457 | 457 | - | - | - |
| Jessore | - | 209 | 209 | - | - | - |
| Khulna | - | - | - | - | - | - |
| Kushtia | - | - | - | - | - | - |
| Patuakhali | - | - | - | - | - | - |
| Bogra | - | 43 | 43 | - | - | - |
| Dinajpur | - | 305 | 305 | - | - | - |
| Pabna | - | 1,281 | 1,281 | - | - | - |
| Rajshahi | - | 496 | 496 | - | - | - |
| Rangpur | - | 5,975 | 5,975 | - | - | - |
| Total | - | 37,832 | 37,832 | - | 37,832 | 37,832 |

Source: OD Survey by the study team (18.2.1986 19.3.1986)

## Outgoing

| Origin & Destination \ Via Port | Origin to Jetty | | | Jetty to Destination | | |
|---|---|---|---|---|---|---|
| | Dhaka | N'ganj | Total | Dhaka | N'ganj | Total |
| Chittagong | - | - | - | - | 540 | 540 |
| Chit, H.T. | - | - | - | - | - | - |
| Comilla | - | 137 | 137 | - | - | - |
| Noakhali | - | - | - | - | - | - |
| Sylhet | - | - | - | - | - | - |
| Dhaka | - | 6,191 | 6,191 | - | 11,093 | 11,093 |
| Faridpur | - | 305 | 305 | - | - | - |
| Jamalpur | - | 1,229 | 1,229 | - | - | - |
| Mymensingh | - | 4,347 | 4,347 | - | - | - |
| Tangail | - | 1,505 | 1,505 | - | - | - |
| Barisal | - | - | - | - | - | - |
| Jessore | - | - | - | - | - | - |
| Khulna | - | - | - | - | 5,296 | 5,296 |
| Kushtia | - | 6 | 6 | - | - | - |
| Patuakhali | - | - | - | 100 | - | 100 |
| Bogra | - | 21 | 21 | - | - | - |
| Dinajpur | - | 11 | 11 | - | - | - |
| Pabna | - | 41 | 41 | - | - | - |
| Rajshahi | - | 7 | 7 | - | - | - |
| Rangpur | - | 3,233 | 3,233 | - | 30 | 30 |
| Total | | 17,033 | 17,033 | 100 | 16,959 | 17,059 |

## Table 6.2.6 Cargo Flow (Commodity: Jute goods)

Unit: tons

Incoming

| Origin & Destination \ Via Port | Origin to Jetty | | | Jetty to Destination | | |
|---|---|---|---|---|---|---|
| | Dhaka | N'ganj | Total | Dhaka | N'ganj | Total |
| Chittagong | - | - | - | - | 36 | 36 |
| Chit, H.T. | - | - | - | - | - | - |
| Comilla | 7 | 79 | 86 | - | - | - |
| Noakhali | - | - | - | - | - | - |
| Sylhet | - | - | - | - | - | - |
| Dhaka | 117 | 79 | 196 | 120 | 173 | 293 |
| Faridpur | - | - | - | - | - | - |
| Jamalpur | - | - | - | - | - | - |
| Mymensingh | - | - | - | - | 37 | 37 |
| Tangail | - | - | - | - | - | - |
| Barisal | - | 26 | 26 | - | - | - |
| Jessore | - | - | - | - | - | - |
| Khulna | 19 | 25 | 44 | - | - | - |
| Kushtia | - | - | - | - | - | - |
| Patuakhali | - | - | - | - | - | - |
| Bogra | - | - | - | - | - | - |
| Dinajpur | - | - | - | - | - | - |
| Pabna | - | - | - | - | - | - |
| Rajshahi | - | - | - | - | - | - |
| Rangpur | - | - | - | - | - | - |
| Total | 143 | 209 | 352 | 120 | 209 | 329 |

Source: OD Survey by the study team (18.2.1986 19.3.1986)

Outgoing

| Origin & Destination \ Via Port | Origin to Jetty | | | Jetty to Destination | | |
|---|---|---|---|---|---|---|
| | Dhaka | N'ganj | Total | Dhaka | N'ganj | Total |
| Chittagong | - | - | - | - | 95 | 95 |
| Chit, H.T. | - | - | - | - | - | - |
| Comilla | - | - | - | - | 1 | 1 |
| Noakhali | - | - | - | - | - | - |
| Sylhet | - | - | - | - | - | - |
| Dhaka | - | 20,553 | 20,553 | - | 275 | 275 |
| Faridpur | - | 10 | 10 | - | - | - |
| Jamalpur | - | - | - | - | - | - |
| Mymensingh | - | 2 | 2 | - | 90 | 90 |
| Tangail | - | - | - | - | - | - |
| Barisal | - | - | - | - | - | - |
| Jessore | - | - | - | - | 350 | 350 |
| Khulna | - | - | - | - | 19,592 | 19,592 |
| Kushtia | - | - | - | - | - | - |
| Patuakhali | - | - | - | - | - | - |
| Bogra | - | - | - | - | - | - |
| Dinajpur | - | - | - | - | - | - |
| Pabna | - | - | - | - | 130 | 130 |
| Rajshahi | - | - | - | - | - | - |
| Rangpur | - | - | - | - | - | - |
| Total | - | 20,545 | 20,545 | - | 20,533 | 20,533 |

# Table 6.2.7 IWT Freight Flow 1982-1983

Commodity : All Commodities

| | Chittagong | Chitt.HT | Comilla | Noakhali | Sylhet | Dhaka | Faridpur | Jamalpur | Mymensingh | Tangail | Barisal |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Chittagong | 0 | 58510 | 54322 | 2336 | 0 | 1289750 | 0 | 0 | 1450 | 0 | 51794 |
| Chitt.HT | 12573 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Comilla | 346 | 0 | 0 | 481 | 2534 | 8025 | 2497 | 0 | 1408 | 0 | 7586 |
| Noakhali | 590 | 0 | 913 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 613 |
| Sylhet | 0 | 0 | 35453 | 0 | 0 | 101406 | 304 | 0 | 0 | 0 | 7523 |
| Dhaka | 37259 | 0 | 22062 | 0 | 3821 | 0 | 6283 | 0 | 6164 | 0 | 8378 |
| Faridpur | 0 | 0 | 0 | 0 | 0 | 729 | 0 | 0 | 0 | 0 | 227 |
| Jamalpur | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Mymensingh | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 182 |
| Tangail | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Barisal | 608 | 0 | 4286 | 496 | 90 | 10597 | 927 | 0 | 0 | 0 | 0 |
| Jessore | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Khulna | 5904 | 0 | 2780 | 257 | 1158 | 65525 | 26661 | 0 | 100 | 0 | 66695 |
| Kushtia | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Patuakhali | 0 | 0 | 970 | 58 | 420 | 3504 | 395 | 0 | 0 | 0 | 1094 |
| Bogra | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Dinajpur | 165 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Pabna | 0 | 0 | 913 | 0 | 0 | 3006 | 0 | 0 | 0 | 0 | 0 |
| Rajshai | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Rangpur | 0 | 0 | 0 | 0 | 0 | 903 | 0 | 0 | 0 | 0 | 0 |
| Total | 57445 | 58510 | 121699 | 3628 | 8023 | 1483440 | 37067 | 0 | 9122 | 0 | 144092 |

| | Jessore | Khulna | Kushtia | Patuakhali | Bogra | Dinajpur | Pabna | Rajshai | Rangpur | Total | (Intra) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Chittagong | 537 | 410110 | 0 | 4456 | 0 | 123 | 0 | 0 | 0 | 1873390 | 34933 |
| Chitt.HT | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 12573 | 0 |
| Comilla | 0 | 16678 | 0 | 2044 | 0 | 0 | 9624 | 0 | 0 | 51223 | 7989 |
| Noakhali | 0 | 0 | 0 | 57 | 0 | 0 | 0 | 0 | 0 | 2173 | 0 |
| Sylhet | 481 | 16075 | 0 | 597 | 0 | 0 | 14612 | 0 | 0 | 176451 | 11037 |
| Dhaka | 0 | 255612 | 0 | 6389 | 0 | 0 | 89652 | 0 | 0 | 435620 | 71103 |
| Faridpur | 0 | 891 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1847 | 0 |
| Jamalpur | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Mymensingh | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 182 | 0 |
| Tangail | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Barisal | 0 | 4688 | 0 | 5982 | 0 | 0 | 0 | 0 | 0 | 27674 | 11689 |
| Jessore | 0 | 43128 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 43128 | 0 |
| Khulna | 2207 | 0 | 568 | 31418 | 0 | 0 | 400 | 0 | 0 | 203673 | 809490 |
| Kushtia | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Patuakhali | 0 | 1321 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 7762 | 639 |
| Bogra | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Dinajpur | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 165 | 0 |
| Pabna | 0 | 350 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 4269 | 200 |
| Rajshai | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Rangpur | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 903 | 0 |
| Total | 3225 | 748853 | 568 | 50943 | 0 | 123 | 114288 | 0 | 0 | 2841030 | 947080 |

Source : Annual Ports & Traffic Report , BIWTA
Unit : tons

## 4-3 Land Demand for Urban Activities

### 1. Future Crude Activity Rate in DNMA

When the growth rates of the crude activity rates of DNMA and the rest of Dhaka Region are equal, the following equation can be obtained.

$$\gamma_t = \frac{(1-So)\gamma oRt}{(1-St)Ro + (St-So)\gamma o}$$

Where

- $\gamma t$ : crude activity rate of DNMA in period t
- $\gamma o$ : crude activity rate of DNMA in the initial period
- Rt : crude activity rate of Dhaka Region in period t
- Ro : crude activity rate of Dhaka Region in the initial period
- St : DNMA's share of population in period t
- So : DNMA's share of population in the initial period

By substituting known figures in place of the initial factors, we derive

$$\gamma_t = \frac{0.198Rt}{0.164 + 0.034St}$$

We can obtain $\gamma t$ in each quinquennial period, substituting the figures shown in the following table in place of Rt and St.

| | 1984/85 | 1989/90 | 1994/95 | 1999/00 | 2004/05 |
|---|---|---|---|---|---|
| Rt | 0.306 | 0.312 | 0.317 | 0.327 | 0.342 |
| St | 0.418 | 0.436 | 0.454 | 0.470 | 0.487 |

# APPENDIX 5

# ENGINEERING ASPECTS OF PORT FACILITIES

(related to Chapter 7)

## 5-1 Engineering Aspects

### 5-1-1 Current Speed

Fig. 7.1.1 shows the measuring points for measuring current speed at the Postogola Bridge Site in Dhaka harbor. The current speed for the cutaway during the period of measurement at this site (July 10th to October 26th) is greatly affected by the wave conditions (Fig. 7.1.2).

Fig. 7.1.3 shows the current speed distribution on the day showing the highest current speed during the observation period. At a position equal to 20% of the water depth measured from the surface, the current speed ranges between 1.2 m/sec. and 1.3 m/sec.. At a position equal to 80% of the water depth measured from the surface, the current speed is 1.09 m/sec.. Thus, 1.3 m/sec. is considered to be the current speed in Dhaka harbor as a design condition, and the same figure is used for Narayanganj harbor.

### 5-1-2 Wave Conditions

When examining wave conditions at each of the proposed construction sites, wave heights were computed making use of the Bretschneider method. Results appear in Table 7.1.1 which shows that the proposed construction sites all displayed about the same wave heights: somewhere between 0.30 and 0.39 meters. Thus, the wave height is considered to be 0.40 meters as a design condition.

### 5-1-3 Measurements for Truck-Cranes and Forklifts

Tables 7.1.2 and 7.1.3 show various measurements used for the truck-cranes (maximum suspension load 150t) and forklifts (maximum capacity 25t) used as live weight.

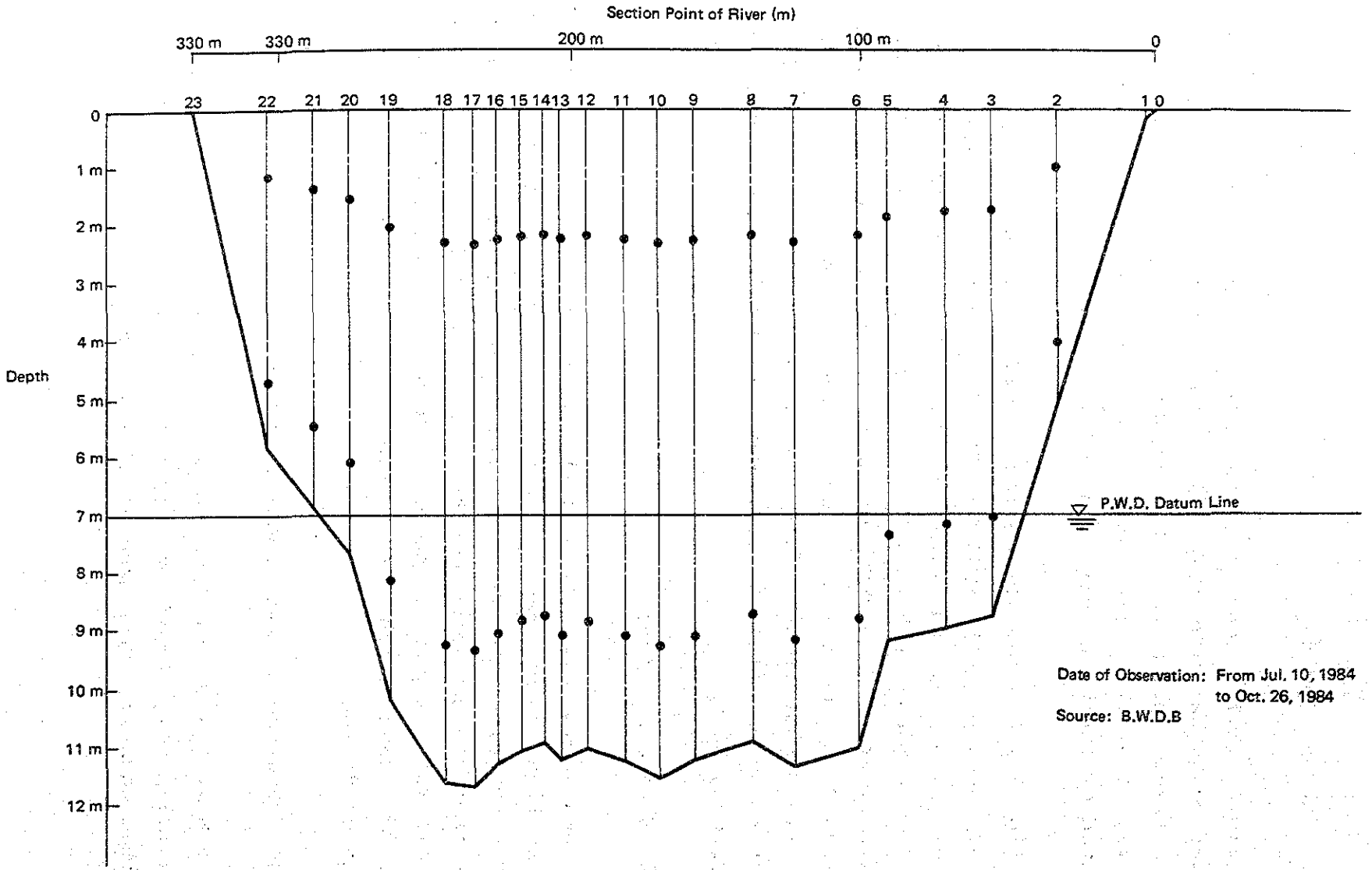
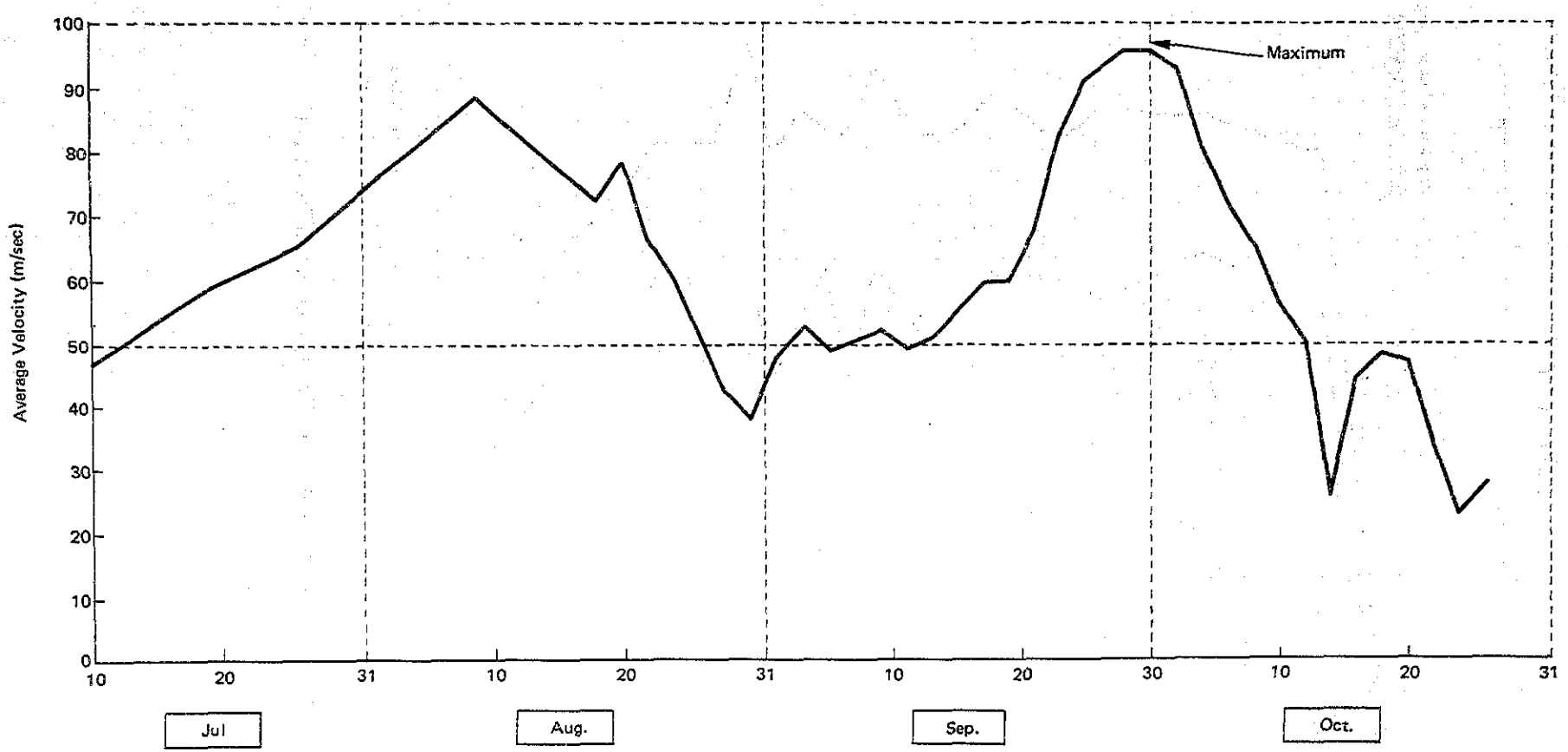



Fig. 7.1.1 River Section and the Points of Water Velocity Measurement at the Postogola Bridge Site (Dhaka Port)




Source: B.W.D.B

Fig. 7.1.2 Average Velocity of the Section at the Postogola Bridge Site

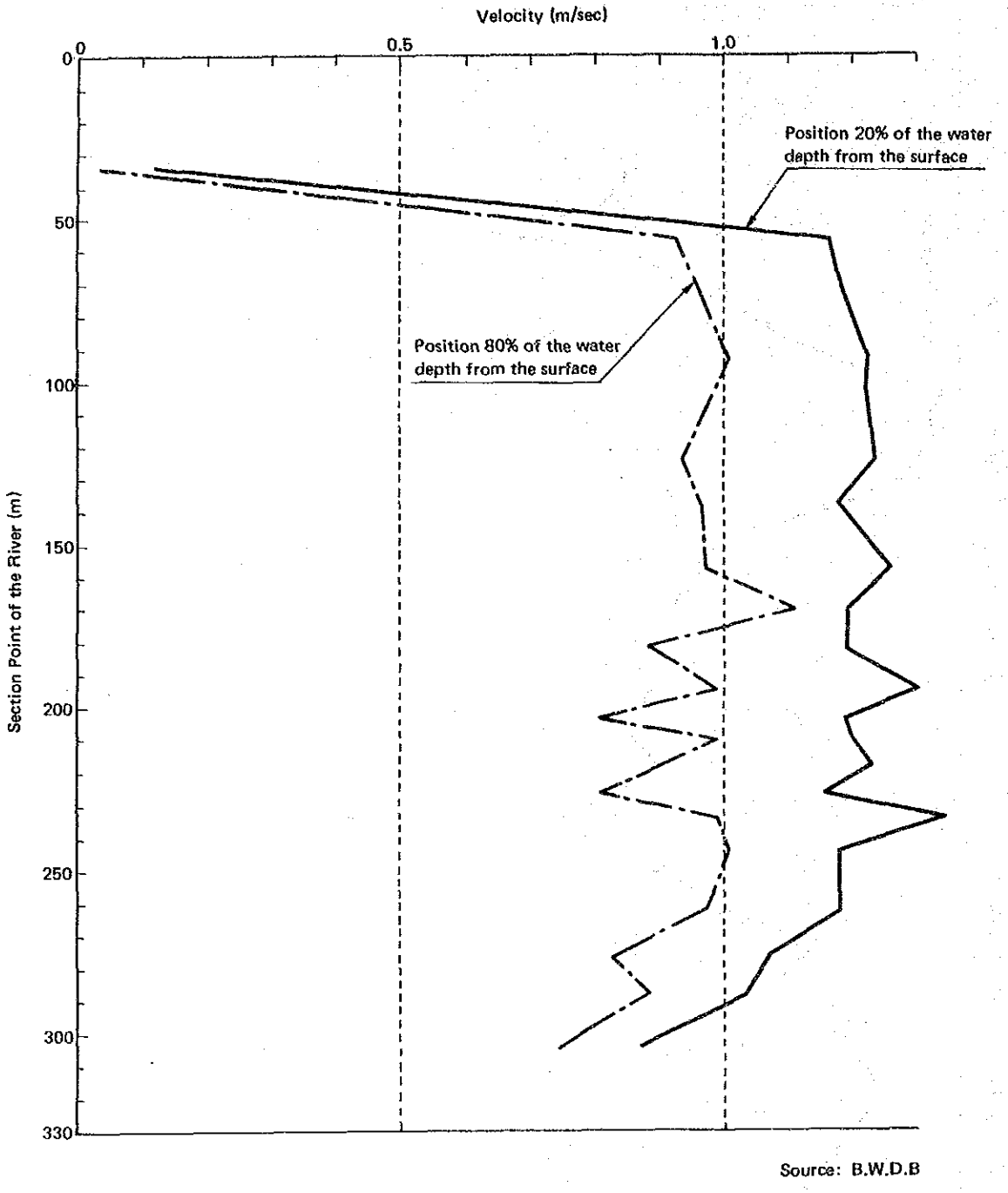



Fig. 7.1.3 State of Current Velocity: (At Maximum Current Velocity)

Table 7.1.1 Wave Hindcasting by Bretschneider Method

| Proposed Site | Wind Direction | Wind velocity at 10 m above sea surface U (m/sec) | Fetch length F (m) | Significant wave height H 1/3 (m) | Significant wave period T 1/3 (sec) |
|---|---|---|---|---|---|
| A | S | 20.0 | 473 | 0.30 | 1.32 |
| | SW | 20.0 | 309 | 0.25 | 1.17 |
| | W | 20.0 | 468 | 0.30 | 1.31 |
| | NW | 20.0 | 456 | 0.29 | 1.31 |
| A1 | N | 20.0 | 452 | 0.29 | 1.30 |
| | NE | 20.0 | 304 | 0.24 | 1.17 |
| | E | 20.0 | 475 | 0.30 | 1.32 |
| | SE | 20.0 | 447 | 0.29 | 1.30 |
| B | NW | 20.0 | 782 | 0.37 | 1.51 |
| | N | 20.0 | 863 | 0.39 | 1.55 |
| | NE | 20.0 | 489 | 0.30 | 1.33 |
| | E | 20.0 | 761 | 0.37 | 1.50 |
| | SE | 20.0 | 611 | 0.33 | 1.41 |
| E | E | 20.0 | 437 | 0.29 | 1.29 |
| | SE | 20.0 | 316 | 0.25 | 1.18 |
| | S | 20.0 | 571 | 0.32 | 1.39 |
| | SW | 20.0 | 495 | 0.30 | 1.34 |
| G | N | 20.0 | 704 | 0.35 | 1.47 |
| | NE | 20.0 | 353 | 0.26 | 1.22 |
| | E | 20.0 | 517 | 0.31 | 1.35 |
| | SE | 20.0 | 710 | 0.36 | 1.47 |

Table 7.1.2 Specifications of Truck Cranes

| Capacity (t) | Vehicle Weight (t) | General Dimensions (m) | | | | Outrigger | | |
|---|---|---|---|---|---|---|---|---|
| | | Length | Width | Height | Wheel Base | Width | Dimension of Float (m x m) | Maximum Reaction (t) |
| 150 | 91.9 | 11.98 | 3.40 | 4.09 | 5.80 | 6.70 | 0.70 x 0.71 | 121.6 |
| 95 | 66.0 | 14.58 | 3.39 | 4.10 | 5.80 | 6.70 | 0.70 x 0.71 | 75.6 |
| 80 | 52.5 | 14.57 | 3.40 | 4.10 | 5.80 | 6.40 | 0.70 x 0.71 | 58.6 |
| 50 | 42.3 | 11.75 | 3.20 | 3.80 | 5.00 | 5.80 | 0.55 x 0.71 | - |
| 40 | 39.9 | 14.33 | 3.23 | 3.80 | 5.00 | 5.70 | 0.50 x 0.50 | - |
| 35 | 36.5 | 14.35 | 2.80 | 3.69 | 4.80 | 5.44 | 0.47 x 0.53 | 44.1 |
| 20 | 20.1 | 11.91 | 2.50 | 3.48 | 4.00 | 4.50 | 0.40 x 0.40 | 22.9 |
| 15 | 19.8 | 11.90 | 2.48 | 3.45 | 5.30 | 4.33 | 0.40ø | 23.7 |
| 12.8 | 20.6 | 11.10 | 2.49 | 3.45 | 4.95 | 4.55 | 0.43 x 0.43 | 21.8 |

Table 7.1.3 Specifications of Forklifts

| Capacity (t) | Vehicle Weight (t) | General Dimensions (m) | | | Maximum wheel load (t) | Remarks |
|---|---|---|---|---|---|---|
| | | Length (with Fork) | Width | Height (Fork is down) | | |
| 25 | 38.10 | 9.33 | 3.83 | 3.96 | 14.16 | |
| 20 | 34.00 | 8.33 | 3.83 | 3.96 | 11.33 | |
| 15 | 23.50 | 7.02 | 2.87 | 3.30 | 8.69 | 4 Wheels in Front |
| 10 | 14.00 | 5.53 | 2.22 | 3.00 | 5.63 | |
| 6 | 8.50 | 5.01 | 1.94 | 2.83 | 3.37 | |
| 5 | 7.75 | 4.90 | 1.94 | 2.69 | 2.90 | |
| 3 | 4.18 | 3.86 | 1.21 | 2.09 | 3.43 | 2 Wheels in Front |
| 2 | 3.29 | 3.42 | 1.15 | 2.15 | 2.40 | |
| 1 | 2.10 | 2.75 | 1.00 | 1.97 | 1.31 | |

# APPENDIX 6

## MASTER PLAN

(related to CHAPTER 8)

## 6-1 Land Use Concept Around the Port Area

### 6-1-1 Rough Estimation of Road Traffic Demand in the Port-related Zone

Applying the growth rate of population to the demand for passenger cars and the growth rate of employment to the demand for cargo vehicles, the future demand of road traffic is estimated roughly as follows:

(P.C.E. per day)

| | | 1983 | 1994/95 | 2004/05 |
|---|---|---|---|---|
| Dhaka-Narayanganj Road (Pagla) | Passenger Cars | 5,776 | 11,000 | 19,000 |
| | Cargo Vehicles | 4,605 | 5,000 | 13,000 |
| | Total | 10,381 | 19,000 | 32,000 |
| Narayanganj-Demra Road (Adanjee) | Passenger Cars | 2,960 | 5,500 | 10,000 |
| | Cargo Vehicles | 2,031 | 3,500 | 6,000 |
| | Total | 4,991 | 9,000 | 16,000 |
| Dhaka-Chittagong Road (Kajla) | Passenger Cars | 6,739 | 12,000 | 20,000 |
| | Cargo Vehicles | 4,752 | 9,000 | 15,000 |
| | Total | 11,491 | 21,000 | 35,000 |

Passenger Cars: Buses, Cars, Auto Rickshaws, Motorcycles, Bicycles and Rickshaws

Cargo Vehicles: Trucks, Pick-ups, Vans and Pushcarts

# APPENDIX 7

## ECONOMIC ANALYSIS

(related to Chapter 11)

## 7-1 Coaster Transportation Cost

### 7-1-1 Vessel Operating Performance

The vessel performance of Bangladeshi coasters has been examined in several reports. The results of the "Intermodal Transport Study" are adopted for this study.

The vessel performance figures should represent both private and public sector vessels. However, the figures presented below are calculated based on BIWTC coaster performance records because of the difficulty in obtains vessel performance records from the private sector.

| | | | |
|---|---|---|---|
| Average sailing distance | | 294 | km |
| Average speed Delay factor (=0.8) | | 7 | knots |
| Delay factor (=0.8) | | 5.6 | knots |
| | | = 10.4 | km/hr |
| Average DWT | | 896 | tons |
| Trips per year | | 28.8 | times |
| Number of working vessels in 1983/84 | | 19 | |
| Total volume handled in 1983/84 | | 446,000 | tons |
| Average load per vessel | | 815 | tons |
| Average steaming days per year | | | |
| 2 x (294/10.4) x 28.8/24 | = | 68 | days |
| Non-steaming days per year | 300 - 68 = | 232 | days |
| Non-steaming days per round trip | | | |
| 232/28.2 | = | 8.1 | days |

The available days per year are assumed to be 300 days.

7-1-2 Transport Cost

(a) Fixed Costs per year (unit: 1000 Tk)

| | Financial | | Economic |
|---|---|---|---|
| Wages *1) | 346 | 0.853 | 295 |
| Maintenance *2) | 388 | 0.692 | 268 |
| Insurance *3) | 582 | 0.884 | 514 |
| Toll & Fees *4) | 250 | 0.0 | 0 |
| Overhead (5%) | 78 | - | 54 |
| Amortization *5) | 5,993 | | 3,877 |
| Total | 7,637 | | 5,008 |

(b) Variable Costs per year (unit: 1000 Tk)

| | Financial | | Economic |
|---|---|---|---|
| Fuel *6) | 1,974 | 0.910 | 1,796 |
| Lubricant *6) | 132 | 0.910 | 120 |
| Maintenance *7) | 129 | 0.692 | 116 |
| Direct costs (5%) | 112 | - | 102 |
| Total | 2,347 | | 2,134 |

(c) Transport Cost

| | Financial | Economic |
|---|---|---|
| Fixed Cost (Tk/day) | 25,457 | 16,693 |
| Variable Cost (Tk/km) | 139 | 126 |

$$\text{Route trip days} = 8.1 + \frac{2L}{10.4 \times 24}$$

$$= 8.1 + 0.008L$$

where, L = Distance (km)

The transport cost in terms of ton-km is summarized in Table 11.1.1.

Table 11.1.1 Economic cost of Coaster Transportation

| Distance (km) | Round trip time (days) | Fixed Costs (Tk) | Variable Costs (Tk) | Total (Tk) | Transport Cost (Tk/ton-km) |
|---|---|---|---|---|---|
| 25 | 8.3 | 138,552 | 6,300 | 144,852 | 4.60 |
| 50 | 8.5 | 141,891 | 12,600 | 154,491 | 2.45 |
| 75 | 8.7 | 145,229 | 18,900 | 164,129 | 1.74 |
| 100 | 8.9 | 148,568 | 25,200 | 173,768 | 1.38 |
| 150 | 9.3 | 155,245 | 37,800 | 193,045 | 1.02 |
| 200 | 9.7 | 161,922 | 50,400 | 212,322 | 0.84 |
| 250 | 10.1 | 168,599 | 63,000 | 231,599 | 0.74 |
| 300 | 10.5 | 175,277 | 75,600 | 250,877 | 0.66 |
| 350 | 10.9 | 181,954 | 88,200 | 270,154 | 0.61 |
| 400 | 11.3 | 188,631 | 100,800 | 289,431 | 0.57 |

* The average load factor is assumed to be 0.70 based on the forecast cargo movement.

*1) Wage Cost

The wage cost per vessel is assumed as follows:

| | (Tk/month) |
|---|---|
| Captain/Master | 2250 x (2) x 1.5 |
| Serang/Greaser | 1400 x (3) x 1.5 |
| Lascar | 1200 x (6) x 1.5 |
| Bhandari/Sweeper | 1100 x (3) x 1.5 |
| Total | 28,800 |

where, the figures in parenthesis show the number of persons. Each crew wage is increased by 50% to determine the total wage cost based on the payment performance of BIWTC.

*2) Maintenance Cost

The maintenence cost is assumed to be 1% of the capital cost per year.

*3) Insurance Cost

The insurance cost is assumed to be 1.5% of the capital cost per year.

*4) Tolls & Fees Cost

The tolls and fees cost is assumed to be 0.5% of the capital cost per year.

*5) Amortization Cost

The amortization cost is computed for newly built vessels in Bangladesh using an annual interest rate of 15% over the vessel life time of 25 years. The salvage vale of the vessel is assumed to be 5% of the new cost.

New vessel cost 38.8 million (Tk)

| | Financial | | Economic |
|---|---|---|---|
| Imported goods (Taxes 80%) | 27.2 | 0.556 | 15.1 |
| Domestic goods | 1.9 | 0.884 | 1.7 |
| laborers | 9.7 | 0.853 | 8.3 |
| Total | 38.8 | | 25.1 |
| Annuity factor | | 0.15446 | |
| Amortization | 5.993 | | 3.877 |

*6) Fuel and Lubricant Cost

The fuel and lubricant cost is computed based on the assumed unit fuel consumption rate of 0.182 /hr.Hp and the average operation time. The power of the diesel engine is assumed to be 900 Hp.

$$\text{Fuel cost} = \frac{7.4 \times 900 \times 294 \times 2 \times 28.8 \times 0.182}{10.4}$$

$$= 1,974,000 \text{ (Tk/year)}$$

where, the unit price of fuel is 7.4 Tk/l

The cost of lubricant is assumed to be one-fifteenth of the fuel consumption cost.

*7) Maintenance Cost

The running maintenance cost is assumed as one-third of the standing maintenance cost.

## 7-2 Truck Transportation Cost

### 7-2-1 Truck Operating Performance

Truck performance figures are also presented in the "Intermodal Transport Study" comparing the public sector BRTC and the private sector in terms of the unit cost of operation. The truck performance figures presented in the I.T.S. are adopted for this study.

| | | |
|---|---|---|
| Average trip distance | 170 | km |
| Overall average load | 4.7 | tons |
| Average travel speed | 28 | km/hr |
| Number of working day per year | 300 | days |
| Working hours per day | 12 | hrs |
| Annual utilization | 44,800 | km |
| Average no. of trips per year | 263 | times |
| Non-running hours per trip | | |
| (12 x 300 - 44800 / 28) / 263 = | 7.6 | hrs |

### 7-2-2 Transport Cost

(a) Fixed Costs per year (unit : Taka)

| | Financial | | Economic |
|---|---|---|---|
| Wages | 69,300 | 0.853 | 59,113 |
| Overhead | 30,690 | 0.884 | 27,130 |
| Insurance | 3,850 | 0.884 | 3,403 |
| Fees & Taxes | 7,000 | 0.0 | 0 |
| Amortization | 102,465 | 0.692 | 70,906 |
| Total | 213,305 | | 160,552 |

(b) Variable Costs per km (unit : Taka)

| | Financial | | Economic |
|---|---|---|---|
| Fuel & Lubricant | 2.66 | 0.910 | 2.42 |
| Types & Tubes | 1.23 | 0.692 | 0.85 |
| Maintenance | 2.53 | 0.692 | 1.75 |
| Tolls & Fees | 0.41 | 0.0 | 0 |
| Total | 6.83 | | 5.02 |

(c) Transport Cost

| | Financial | Economic |
|---|---|---|
| Fixed Costs (Tk/hr) | 59.3 | 44.6 |
| Variable Costs (Tk/hr) | 6.83 | 5.02 |

The transport cost in terms of ton-km is summarized in Table 11.2.1. Each of the fixed and variable cost items are derived from the "Intermodal Transport Study". Tolls, fees and taxes are assumed as equal to those presented in the ITS as they have not change significantly in the short period since the ITS was completed. However, other cost items are assumed to have increased by 10%.

Table 11.2.1 Economic Cost of Truck Transportation

| Distance (km) | Running hours (hrs) | Trip hours (hrs) | Fixed Cost (Tk) | Variable Cost (Tk) | Total (Tk) | Transport Cost (Tk/ton.km) |
|---|---|---|---|---|---|---|
| 25 | 1.79 | 9.39 | 419 | 251 | 670 | 2.86 |
| 50 | 3.57 | 11.27 | 503 | 502 | 1,005 | 2.14 |
| 75 | 5.36 | 12.96 | 578 | 753 | 1,331 | 1.89 |
| 100 | 7.14 | 14.74 | 657 | 1,004 | 1,661 | 1.77 |
| 150 | 10.71 | 18.31 | 817 | 1,506 | 2,323 | 1.65 |
| 200 | 14.29 | 21.89 | 976 | 2,008 | 2,984 | 1.59 |
| 250 | 17.86 | 25.46 | 1,136 | 2,510 | 3,646 | 1.56 |
| 300 | 21.43 | 29.03 | 1,296 | 3,012 | 4,307 | 1.53 |
| 350 | 25.00 | 32.60 | 1,454 | 3,514 | 4,968 | 1.51 |
| 400 | 28.57 | 36.17 | 1,613 | 4,016 | 5,629 | 1.50 |

* Average load factor is assumed as 0.67 based on the "I.T.S.".

## 7-3 Train Transportation Cost

### 7-3-1 Transport Cost

An attempt has been made to estimate the unit cost of the train tranport in the "Intermodal Transport Study" based on the "Railway Development Planning Project (RDPP)" report. In the report, the unit cost is estimated based on the market prices comprising the operating and the capital costs, and the operating cost is further broken down into working expenses, depreciation and interest.

In order to apply the unit cost of transport to this study at economic prices, the cost data are updated and the standard conversion factor and a tax rate 10% are adopted.

Further, the relative shares of working expenses, depreciation and interest in the operating cost are taken into consideration for estimating the economic cost.

The estimated transport cost of train is shown in Table 11.3.1

Table 11.3.1 Economic Cost of Rail Transportation

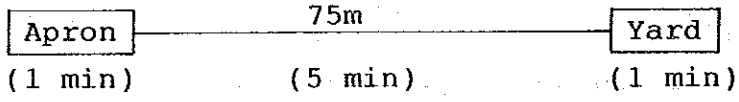
| Distance (km) | Operating C. (Tk/t.km) | Capital C. (Tk/t.km) | Transport Cost (Tk/t.km) |
|---|---|---|---|
| 25 | 3.72 | 4.01 | 7.73 |
| 50 | 2.12 | 2.12 | 4.24 |
| 75 | 1.61 | 1.49 | 3.10 |
| 100 | 1.31 | 1.18 | 2.49 |
| 150 | 1.05 | 0.86 | 1.91 |
| 200 | 0.91 | 0.71 | 1.62 |
| 250 | 0.83 | 0.61 | 1.41 |
| 300 | 0.77 | 0.55 | 1.32 |
| 350 | 0.74 | 0.50 | 1.24 |
| 400 | 0.72 | 0.47 | 1.19 |

## 7-4 Cargo Handling Cost

### 7-4-1 Conventional Cargo Handling

(a) Performance of Head Loaders

| | |
|---|---|
| Cargo handling volume | 300 t/day |
| Cargo transfer distance | 75 m |
| Velocity (Study team observation) | 30 m/min |
| Working hours per day | 8 hr |
| Loading ability | 1 mound |
| | (37.2 kg) |
| Cycle time | 7 min |




Cargo handling ability of head loaders

8 x 60 / 7 x 0.0372 = 2.55 t/day

Assuming a loss time of 10% 2.55 / 1.1 = 2.3 t/day

(b) Unit Cargo Handling Cost

Unit wage of head loaders 50 TK/day

Number of head loaders 300 / 2.3 = 131 persons

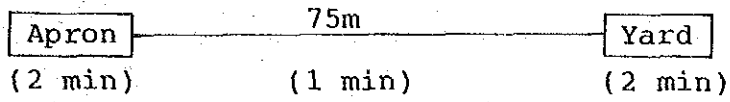
| | Financial | | Economic |
|---|---|---|---|
| Wage (Tk) | 6550 | 0.729 | 4775 |
| Unit cost (Tk/t) | 21.8 | | 15.9 |

### 7-4-2 Improved Cargo Handling

(a) Performance of Forklifts

| | |
|---|---|
| Cargo handling volume | 300 t/day |
| Cargo transfer distance | 75 m |
| Velocity (loaded) | 8 m/hr |
| (empty) | 20 m/hr |
| Average velocity | |
| (75/8 + 75/20) x (60/1000)= 0.8 ⟶ | 1.0 min |

| | |
|---|---|
| Working hours per day | 8 hr |
| Loading capacity | 2 ton |
| Cycle time | 5 min |




Cargo handling ability of forklifts

8 x 60 / 5 x 2 = 192 t/day

Assuming a loss time of 10% 192 / 1.1 = 175 t/day

(b) Unit Cargo Handling Cost

| | |
|---|---|
| Unit wage of helpers | 50 TK/day |
| Number of helpers | 15 persons |
| Number of folklift units | 300 / 175 = 1.7 unit |

| | Financial | | Economic |
|---|---|---|---|
| Wage of operators | 80 | 1.0 | 80 |
| Maintenance *1) | 223 | 0.694 | 154 |
| Insurance *2) | 111 | 0.884 | 98 |
| Fuel & Lubricants *3) | 118 | 0.910 | 107 |
| Overhead (5%) | 47 | - | 34 |
| Amortization *4) | 480 | - | 320 |
| Wage of helpers | 750 | 0.729 | 547 |
| Total (TK) | 1809 | | 1340 |
| Unit cost (Tk/t) | 10.3 | | 7.6 |

*1) Maintenance cost

The maintenance cost is assumed as 10 % of the capital cost per year.

*2) Insurance cost

The insurance cost is assumed as 5 % of the capital cost per year.

*3) Fuel & Lubricant cost

The fuel and lubricant cost is computed based on

the assumed unit fuel consumption of 0.04 l/hr.Hp, and the power of the engine is 45 Hp.

Fuel cost = 7.4 x 0.04 x 45 x 8
= 107 Tk/day

The lubricant cost is assumed as 10% of the fuel cost.

*4) Amortization cost

The amortization cost is calculated for new imported forklifts using an interest rate of 15% per year over the life time of 8 years. The salvage value of the forklifts is assumed to be 10% of the purchase cost.

New forklift cost 667,500 Tk

| | Financial | Economic |
|---|---|---|
| Forklift | 667,500 | 445,000 |
| (Taxes 50%) | | |
| Annuity factor | 0.2156 | |
| Amortization | 113,913 | 95,942 |
| Amortization per day | 480 | 320 |

## 7-5 Value of Handling Cargo

The value of public cargo handling at Dhaka and Narayanganj ports in 1995 is assumed as follows:

| Commodity | Volume (1000 tons) | Unit Price (Tk/ton) |
|---|---|---|
| Bulk | | |
| Grain | 116 ( 8.9) | 9,000 |
| Cement | 270 (20.8) | 2,600 |
| Fertilizer | 465 (35.7) | 3,200 |
| Iron & Steel | 81 ( 6.2) | 20,000 |
| Others | 220 (16.9) | 6,000 |
| Non-Bulk | | |
| Others | 149 (11.5) | 10,000 |
| Sub total | 1,301 (100%) | |
| Container | 403 | |
| Total | 1,704 | |

The weighted average unit price of the commodities is 5888 Tk/t, and the economic price calculated by multiplying by the standard conversion factor 0.884 becomes 5205 Tk/t.

## 7-6 Costs of Land

The land costs are the foregone products which is measured based on the value added of the cereal production. According to the statistics in agricultural sector, total production of rice and the cultivated area in Dhaka are 801,000 tons and 1,347,000 acres in 1983/84. The average producer price of rice is about 4,200 Tk/ton and the average value added of rice is 93 % of the production value deducting the value of the inputs such as fertilizer, labor, etc.

Thus, the value added of cereal production is assumed as follows:

$$\text{Value added} = 801{,}000 \times 4{,}200 \times 0.93 / 1{,}347{,}000$$
$$= 2{,}323 \text{ Tk/acre}$$
$$= 5{,}730 \text{ Tk/ha}$$

# APPENDIX 8

## A comparison of feeder transportation costs

## 8-1 Tranportation Cost

There are many areas congested with traffic within about a 2 mile radius of the terminal. Trucks transporting cargo from the Badamtali area to outside the city proceed at a speed of only about 3 miles per hour through these congested areas. Traffic moves more quickly in the areas outside the 2 mile radius, and the average speed increases to about 20 miles per hour. The more passenger and cargo loads increase in future, the worse road congestion around the terminal will become and there is no doubt that road traffic volume will surpass the road traffic capacity.

The new port area proposed in the Short-term Development Plan is located on the right bank of the Buriganga river. Cargo transport by truck from this area to the northern part of Dhaka city takes an additional 4 miles compared with the distance from Badamtali, but takes 22 minutes less in time.

$$Tb = 2 / 3 \times 60 = 40 \text{ (min)}$$
$$Tn = (2 + 4) / 20 \times 60 = 18 \text{ (min)}$$

With regard to specific destinations to Tongi (distance 15 miles), for example, truck transport time from Badamtali and the new site is 79 and 57 minutes, respectively.

$$Tb = (2 / 3 + 13 / 20) \times 60 = 79 \text{ (min)}$$
$$Tn = (6 + 13) / 20 \times 60 = 57 \text{ (min)}$$

Therefore transport time is cut by more than 25%. This savings in transport time improves the efficiency of truck transport and also means a savings in the consumption of scarce resources.

The following is an attempt to evaluate the savings of transportation time in monetary term.

Based on the study team's interviews with truck drivers, average truck operation per day on short distance routes is as follows;

| | |
|---|---|
| Working hours per day | 10 hrs |
| Round trips per day | 2.5 trips |
| Average lead | 41 miles |

The following is also considered.

i) From Badamtali

| | |
|---|---|
| Average speed | 15/79x60=11.4 miles/hr |
| Working days per year | 300 days |
| Running distance per year | 41x300=12300 miles |
| Running hours per year | 12300/11.4=1079 hrs |
| Non-running hours per year | 10x300-1079=1921 hrs |
| No. of trips per year | 2.5x300=750 trips |
| No. of non-running hours per trip | 1921/750=2.56 hr/trip |

ii) From the new site

Running hours per year are considered the same as above.

| | |
|---|---|
| Average speed | 19/57x60= 20 miles/hr |
| Working days per year | 300 days |
| Running hours per year | 1079 hrs |
| Running distance per year | 1079x20=21580 miles |
| Running distance per day | 21580/300=72 miles |
| No. of trips per day | 72/(41/2.5)=4.4 trips |
| No. of trips per year | 4.4x300=1320 trips |
| No. of non-running hours per trip | 1921/1320=1.46 hr/trip |

iii) Economic transportation cost (Appendix 7)

| | |
|---|---|
| Fixed cost (Tk/hr) | 160552/300/10=53.5 |
| Variable cost (Tk/mile) | 1.6x5.02=8.03 |

Round trip transport costs between the port area and the Tongi area area as follows:

| | Badamtali | New site |
|---|---|---|
| Running hours | 2.63 | 1.90 |
| Trip hours | 5.19 | 3.36 |
| Trip distance (mile) | 30 | 38 |
| Fixed cost (Tk) | 277.7 | 179.8 |
| Variable cost (Tk) | 240.9 | 305.1 |
| Total cost (Tk) | 518.6 | 484.9 |

These figures show that the transport costs from the new site are more advantageous due to the improvement of the efficiency of truck operation even when variable costs increase.

Furthermore, the transport from the new site greatly contributes to decreases in congestion at the terminal area because alternative routes are taken.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